ADDICTION AND ATTACHMENT

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PUBLISHED IN: Frontiers in Psychiatry and Frontiers in Psychology

frontiers Research Topics

ISSN 1664-8714
ISBN 978-2-88966-386-6
DOI 10.3389/978-2-88966-386-6

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ADDICTION AND ATTACHMENT

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Citation: Lewis, A. J., Unterrainer, H. F., Galbally, M., Schindler, A., eds. (2021). Addiction and Attachment. Lausanne: Frontiers Media SA.
doi: 10.3389/978-2-88966-386-6

Table of Contents

frontiers in Psychiatry

EDITORIAL
published: 27 November 2020
doi: 10.3389/fpsyt.2020.612044

Editorial: Addiction and Attachment

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Keywords: attachment, addiction, substance use disorder, trauma, evolution

Editorial on the Research Topic

Addiction and Attachment

In the postscript to "Attachment Across the Life Cycle," John Bowlby wrote: "Once we postulate the presence within the organism of an attachment behavioral system regarded as the product of evolution and as having protection as its biological function, many of the puzzles that have perplexed students of human relationships are found to be soluble" (1). This statement displays Bowlby's theoretical integration of evolutionary, functional, and behavioral levels of analysis, thereby giving attachment theory the ability to investigate a wide range of social and emotional relationships at both psychological and biological levels.

There is a complex interaction between a person's attachment history, the quality of early experiences, and their propensity to addictive behaviors. Clinicians and therapists working in the addiction field address this reality on a daily basis, but the research that brings precision, systematization, and the capacity to test these assumptions is only beginning to gather pace. Connecting research in the two areas of attachment and addiction can be beneficial to each; the neurobiology of basic motivational systems of social affiliation might help us understand behavioral patterns and motivations of addiction, while the biology of addiction might help us identify the evolved systems underlying attachment.

In May 2018, in the grounds of the *Schloß Schönbrunn* in Vienna nearly 400 delegates gathered to discuss the many facets of the relationship between attachment and addiction. Following the success of the "*Sucht und Bindung*" *[Addiction and Attachment]* conference—graciously hosted by the *Grüner Kreis* Society—we put out a call for papers for a Frontiers Research Topic. We were delighted to receive 22 high quality papers providing both original studies, reviews of the latest findings, theoretically oriented discussions, and applications to clinical treatments.

SECTION 1: TREATMENT APPROACHES AND MODELS OF ADDICTION AND ATTACHMENT

As an integrative psychological and biological theory of social affiliation, attachment research includes neurobiological, neuroimaging, and endocrine studies of the biological correlates of social affiliation and bonding across many mammalian species. Schindler notes a substantial growth in the literature on addiction and attachment over the last decade. His review of 34 cross-sectional studies, three longitudinal studies, and a recent meta-analysis suggests that there is consistent evidence of an association between insecure attachment and substance abuse both cross-sectionally and in longitudinal studies. There is also evidence in studies of a bidirectional relationship which accounts for how substance use also predicts a deterioration in attachment relationships. The specific patterns of the attachment involved remains less clear, but several studies suggest

OPEN ACCESS

Edited and reviewed by:
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Specialty section:
This article was submitted to Addictive Disorders, a section of the journal Frontiers in Psychiatry

Received: *30 September 2020*
Accepted: *03 November 2020*
Published: *27 November 2020*

Citation:
Lewis AJ, Unterrainer HF, Galbally M and Schindler A (2020) Editorial: Addiction and Attachment. Front. Psychiatry 11:612044. doi: 10.3389/fpsyt.2020.612044

that fearful–avoidant attachment may be more frequent in heroin addicts, while alcohol abuse tends to display more heterogeneous patterns. Hiebler-Ragger and Unterrainer also contribute a review of the theories on the development and treatment of Substance Use Disorders (SUD). Their review covers the interaction between addiction and attachment also from a neuroscientific perspective, suggesting that changes in brain white matter integrity may be involved in the emotional dysregulation associated with substance use.

Attachment ideas can be extended beyond dyadic relations to enhance our understanding of the inter-subjective dynamics of family functioning and community-based interventions. In this regard Lewis presents a theoretical overview and description of the treatment approach for an attachment based intervention used to treat adolescent substance use and mental health. The intervention focuses on attachment dynamics across whole families and has been successfully evaluated over several trials. On a similar theme, Heerde et al. leads a paper using comparative data from Australia and the USA on family environmental factors as predictors of substance use in young adults. Finally, De Leon and Unterrainer present an overview of many decades of work pioneering the therapeutic community approach to the treatment of addictions, drawing in links between a therapeutic community and the attachment needs of its members.

SECTION 2: EVOLUTIONARY HYPOTHESES AND NEUROBIOLOGICAL MODELS

Another major theme to emerge from the contributions shows the value in attachment theory as a psychobiological model grounded in developmental and evolutionary hypotheses as a function of attachment behavior. This produces one of the major hypotheses of attachment research—that such functions must be derived from evolved mechanisms that are inherent in neurobiological systems and emerge at critical periods of ontogeny. Strathearn et al. leads a review that addresses the developmental pathway through which compromised early experience—which includes insecure and disorganized attachment but also early abuse, neglect, or trauma—influences later susceptibility to addictions later in life. This paper provided a detailed account of the neurobiological pathways associated with this developmental pathway. Currently, studies focus on the oxytocin system of social affiliation, the role of dopamine, and opioid reward systems and alterations in the corticoid stress response system. Mosri presents a novel model of addiction drawing on neuro-psychoanalysis and Pankseep's model of separation distress as a compromise of opioid regulation. This paper integrates neurobiological and subjective data which conceptualizes addiction as a latent type of depression.

We then have three empirical studies of the neurobiology of attachment and addiction. First a study lead by Unterrainer et al. reporting brain structure modifications in Poly-Drug Users (PUD), specifically cortical thickness and White Matter Impairments, second Fuchshuber, Tatzer et al. lead a study reporting differences in oxytocin reactivity in an experimental study of SUD patients compared to controls in which the Adult Attachment Projective was used as an attachment stimulus, and third Torres examines a neuro-evolutionary model of social bonding finding that methadone use predicts reduced Attachment Anxiety, Comfort With Closeness, and Proximity Maintenance.

SECTION 3: TRAUMA AND ATTACHMENT

Four papers addressed the relationship between attachment, trauma, and addiction. Lahousen et al. present a comprehensive overview of the evolutionary foundations of attachment theory and consider how this is compromised by attachment trauma. This paper draws in links between trauma and dissociation to account for the vulnerability in emotional dysregulation which leads to addiction. Meulewaeter et al. leads a paper presenting the findings of a qualitative study of substance using mothers to examine the impact of trauma and its role as a precipitant of substance use. Lotzin et al. present important data from a large sample of treatment-seeking women with SUD and comorbid posttraumatic stress disorders. Using the Childhood Trauma Questionnaire, they distinguish four different childhood trauma profiles showing that those with more severe levels of childhood trauma show an earlier age at initiation and escalation of substance use. To highlight the growth in the literature that examines trauma and addiction, Rinker provides a book review of a collection edited by Richard Gill: "Addictions From an Attachment Perspective: Do Broken Bonds and Early Trauma Lead to Addictive Behavior?"

SECTION 4: ATTACHMENT, EMOTION REGULATION, AND PERSONALITY FUNCTIONING

This section features a total of six contributions, which address the relationship between addiction, deficient emotional and personality dysfunction, seen through the lens of attachment theory. In the first, an empirical study based on a population sample, conducted by Fuchshuber et al. (b), showed that attachment styles, personality organization, and emotional functioning after traumatic experiences in childhood are interconnected. Based on their results the authors conclude that SUD treatment might be improved by focusing on facilitating the development of more secure attachment patterns and improved personality functioning. In line with these findings, a study lead by Ramirez-Castillo et al., found a significantly lower amount of Frustration Tolerance as being related to disorganized attachment in SUD-patients. This suggests that Frustration Tolerance might also be seen as an important factor to consider in addiction treatment programs. Along similar lines, Yang et al. present findings from a cross-sectional assessment of 298 SUD patients which suggests that an increase in self-control, resilience, and self-esteem contributes to improved self-efficacy in SUD-patients.

Furthermore, in another study conducted by Fuchshuber et al. (a) data from a community sample is used to examine

the predictive value of primary emotions for psychopathological symptoms by means of a Multi-group Path Analysis. In line with the hypothesis, primary emotions were observed to be a substantial predictor or even promotor for the development of psychopathology. Based on these findings it is concluded that primary emotion functioning could also be a valuable target in mental health care. Furthermore, in a study done by Vismara et al. the quality of attachment in SUD patients is investigated in order to identify the role of attachment security in choosing a suitable treatment facility. In this paper substantial differences in attachment styles between SUD out- and inpatients are reported. Consequently, the authors conclude that considering the variability of attachment patterns in SUD patients, could also contribute to improved interventions. Lastly, Jauk and Dieterich review the literature on the relationship between the Dark Triad of personality (Narcissism, Machiavellianism, and Psychopathy) and addictive behaviors, both substance-related and non-substance-related. In a similar way to the other papers in this section, they conclude that considering such parameters of personality functioning is of real importance for a better understanding and treatment of addictive disorders.

SECTION 5: NEW MODES OF ADDICTION TO SOCIAL MEDIA

Finally the Research Topic presents two papers describing new forms of addiction related to the excessive use of smartphones and the internet lead by Eichenberg et al. and Jung et al., respectively. In the first study, attachment patterns predicted problematic smartphone usage and specifically lower attachment security. In the second study, participants with larger social networks and higher scores in the received social support showed the lowest rates of Internet Use Disorder (IUD).

In addressing the topic of *Addiction and Attachment*, this Research Topic has identified five broad research areas. The reviews presented show strong progress in the field, with a growing application of attachment models and measures to the challenge of addiction. While much of the empirical research presented is exploratory this Research Topic provides clear direction for future research endeavors and confirms the importance and relevance of attachment theory in understanding addiction.

AUTHOR CONTRIBUTIONS

AL and HU wrote the first draft of the manuscript. MG and AS provided critical revision of the manuscript and important intellectual contributions. All authors read and approved the submitted version.

ACKNOWLEDGMENTS

The 3-day international conference Sucht & Bindung [Addiction and Attachment] was held for the 35th anniversary of the Grüner Kreis society, Austria's largest institution for long-term addiction treatment, based on the concepts of Therapeutic Communities. The conference was organized in cooperation between the Grüner Kreis Society and the Medical University of Graz (MUG), Austria. We would like to express a very special thank you to Dir. Alfred Rohrhofer (executive director of the Grüner Kreis society) and Prof. Hans-Peter Kapfhammer (head and chair of the Department for Psychiatry and Psychotherapeutic Medicine; MUG). Furthermore, our deepest gratitude goes to all the contributing authors who made this Research Topic possible.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychiatry

ORIGINAL RESEARCH
published: 12 June 2019
doi: 10.3389/fpsyt.2019.00388

The Relationship Between Self-Control and Self-Efficacy Among Patients With Substance Use Disorders: Resilience and Self-Esteem as Mediators

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Background: While substance use disorder is one of the overarching health and social issues that might seriously disrupt individuals' self-control and self-efficacy, most previous studies have been conducted among university students or other groups, and little is known about how the underlying mechanisms between self-control and self-efficacy might impact patients with substance use disorders.

Objectives: The purpose of this study is to investigate how resilience and self-esteem mediate the relationships between self-control and self-efficacy among patients with substance use disorders.

Methods: We conducted a cross-sectional study of 298 patients with substance use disorder from Shifosi rehab in China. Diagnostic and Statistical Manual of Mental Disorders (5th Edition)-based diagnostic questionnaires were used to collect demographic information and assess addiction severity. The Dual-Modes of Self-Control Scale (DMSC-S) was implemented to measure self-control, while self-esteem was measured using the Self-esteem Scale (SES). The Connor-Davidson Resilience Scale (CD-RISC) was used to measure resilience, and self-efficacy was measured by the regulatory emotional self-efficacy scale (RESE).

Results: The correlations between all the dimensions and total scores on the self-control, resilience, self-esteem, and self-efficacy were significantly positive ($p < 0.01$), indicating that they could predict patients' self-efficacy. Bootstrap testing indicated that resilience and self-esteem fully mediated the relationship between self-control and self-efficacy, relationships between self-control and self-esteem were partially mediated by resilience, and resilience partially mediated the relationship between self-esteem and self-efficacy. Finally, the multiple-group analysis indicated that the relationships among self-control, resilience, self-esteem, and self-efficiency did not differ with respect to gender.

Conclusions: The path from self-control through resilience and self-esteem and on to self-efficacy is significant among patients with substance use disorders, suggesting that increasing self-control, resilience, and self-esteem can improve self-efficacy among patients with substance use disorders.

Keywords: self-control, resilience, self-esteem, self-efficacy, patients with substance use disorders

OPEN ACCESS

Edited by:
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Specialty section:
This article was submitted to Addictive Disorders, a section of the journal Frontiers in Psychiatry

Received: *01 November 2018*
Accepted: *16 May 2019*
Published: *12 June 2019*

Citation:
Yang C, Zhou Y, Cao Q, Xia M and An J (2019) The Relationship Between Self-Control and Self-Efficacy Among Patients With Substance Use Disorders: Resilience and Self-Esteem as Mediators. Front. Psychiatry 10:388. doi: 10.3389/fpsyt.2019.00388

INTRODUCTION

Substance use disorder is among the overarching health and social issues that could alter both psychological states and neural mechanisms (1–3), and a wide range of studies has suggested that illicit drug use might disrupt individuals' self-control and self-efficacy capabilities (4–7). Although extensive studies have examined the relationships between self-control and self-efficacy (8–11), it is still complicated to draw general and incontestable conclusions about the complex relationships between self-control and self-efficacy, and one primary reason for this is that self-control and self-efficacy are both susceptible to situational factors (12, 13). In addition, since most correlational studies of such relationships have been conducted among university students or other groups (8, 10, 14), and few have dealt with patients with substance use disorder, it seems worthwhile to evaluate potential relationships between self-control and self-efficacy among patients suffering from such disorders.

Self-Control and Self-Efficacy

Self-control is now widely conceptualized as a self-initiated ability that enables individuals to resist inappropriate or self-destructive temptations to achieve long-term goals. Historically, the definition of self-control has been developed from the concept of "effortful control" to the concept of "pursuing enduringly valued goals" (15). People with higher levels of self-control are more inclined to delay personal gratification based on instant impulses and allocate more well-resource energy to their future goals. At the same time, self-control is susceptible to various situational factors, including substance use disorders (13), family cohesion (16), and peer norms (17), and self-control has also been found to be closely correlated with a wide range of behaviors like psychological well-being (18, 19), academic performance (20, 21), and pathology (22, 23).

Self-efficacy plays a crucial role in forming self-judgment about whether one could realize intended goals. Self-efficacy can be separated into two types: general self-efficacy and task-specific self-efficacy. According to Bandura (12), general efficacy refers to an individual's ability to perform across various situations, while task-specific self-efficacy is related to an individual's ability to perform in a specific situation (that study assessed general self-efficacy). Many studies have suggested that people with high self-efficacy are more likely to be confident in coping with and handling resource-demanding tasks (24–26). According to Bandura (12), self-efficacy develops through individuals' interactions with their surroundings because they are increasingly familiar with their ability to overcome tough tasks. The more demanding a task is, the less self-efficacy individuals may have, and they may then be less likely to engage in the task (27). Some studies also suggest that self-efficacy is closely associated with physical and mental health (25, 28), academic performance (29), and employment skills (30).

A large proportion of studies insist that self-control is positively correlated with self-efficacy (9, 10), and Bandura (31) suggested that self-control also plays a significant role in promoting self-efficacy. One interpretation of this underlying mechanism is that, on one hand, people with high self-control tend to pay more attention to their intended goals, while on the other hand, individuals with higher self-control are more likely to possess stable self-efficacy with respect to future tasks because they have successfully overcome similar hurdles in the past. Conversely, some studies have revealed that under specific circumstances self-control is negatively associated with self-efficacy (8, 32). Ein-Gar and Steinhart (8) revealed that people with low self-control might show higher self-efficacy when confronted with distant-future tasks. They may procrastinate not because of a failure in self-control, but because they have experienced sufficiently high self-efficacy before the task deadline. However, there is no general and incontestable finding as to the relationship between self-control and self-efficacy because both traits are susceptible to situational factors (12, 13).

Substance dependence can be a remarkable situational factor not only because it might alter individuals' psychological states, but also it may modify their neural mechanisms. Numerous studies have suggested that consuming illicit drugs would most likely disrupt individuals' self-control and self-efficacy capabilities (4–7), and many studies have verified that illicit drugs often lead to structural changes within specific brain regions, such as the prefrontal cortex (2) that modulates capabilities of balancing self-interests and aligning actions with internal goals (33), and those capabilities are the major components of self-control (15). Given the occurrence of psychological and physical alterations, while there might be heterogeneity between patients with substance use disorder and other groups with respect to analyzing relationships between these two traits, less attention has been given to examining the potential association between self-control and self-efficacy among patients with substance use disorder. To fill in this gap, this study integrated resilience and self-esteem as mediators to further analyze underlying mechanisms between self-control and self-efficacy among patients with substance use disorders.

Resilience and Self-Esteem as Mediators

One specific mediator is resilience, defined as the ability to adapt to stress and negative emotions (34). Although few researchers have focused on the role of resilience in mediating between self-control and self-efficacy, there are numerous studies committed to exploring associations between self-control and resilience (35, 36), and association between resilience and self-efficacy (37–39). The findings of those studies showed that patients with higher levels of self-control are more likely to exhibit greater resilience than those with lower self-control (35, 40). Self-control acts as a protective factor to reduce the possibilities of feeling ashamed by providing resistance to temptation by inappropriate impulsion. It has been proven that shameful feelings are negatively correlated with resilience (41, 42), and there are many studies suggesting that resilience may predict self-efficacy. According to Schwarzer and Warner (43), adolescents with higher resilience are more likely to feel confident and be more effective and efficient in completing tasks, especially in high-effort situations.

Self-esteem serves as another mediator between self-control and self-efficacy by reflecting the evaluation made by individuals regarding their own worth (44). Extant research indicates that people with higher self-control tend to exhibit higher levels of self-esteem than those with lower levels of self-control (22, 45). Self-control might also contribute to various types of positive outcomes that act as indicators of self-esteem, such as better academic grades (46), better psychological adjustment (22), and better interpersonal relationships (47). Many other studies have also shown that self-esteem demonstrates the potential for fostering self-efficacy (48, 49) by providing self-confidence, regarded as a crucial component of self-efficacy (50).

Still, other studies have also identified close correlation between resilience and self-esteem. For example, Benetti and Kambouropoulos (51) published a study suggesting that resilience exerts a positive impact on self-esteem *via* a positive affect. Based on the fact that there are numerous studies evaluating the correlational roles of resilience and self-esteem, it seemed favorable for this study to select resilience and self-esteem as mediators between self-control and self-efficacy.

The Present Study

There are numerous studies suggested that self-esteem and resilience have close links with self-control and self-efficacy (10, 22, 43, 45). Moreover, based on previous studies, a multiple-mediator model is more comprehensive than a single-mediator model with respect to conceptualizing the intermediary mechanisms (52, 53). In this study, we hypothesized resilience and self-esteem as mediators in the relationships between self-control and self-efficacy among patients with substance use disorder. Specifically, substance dependents with high self-control might ultimately experience higher levels of resilience and self-esteem to promote the functioning of self-efficacy. The detailed hypothesized model is presented in **Figure 1**.

METHOD

Participants and Procedure

The study was conducted at Shifosi Rehabilitation Center, a compulsory detoxification center, and involved 298 Chinese participants who had experienced substance use disorders. The Ethics Committee of Nanjing Medical University approved the study to ensure that it fully considered human rights, ethics, and safety throughout the procedures, and all participants signed informed-consent documents prior to the initiation of the assessment. To ensure confidentiality of the whole study, participants were separately placed in a separate conference room while completing the questionnaires in about 30 min.

The study dealt with seven socio-demographic characteristics of the participants: age, gender, education level, work status, years of use, substance classification, and DSM-5 addiction severity criteria. Inclusion criteria included the following: were of age of 18 years or more, exhibited normal and stable cognitive states, had been diagnosed with substance use disorders within the last 12 months, had normal vision and color perception, were right-handed, and had voluntarily agreed to participant in the study. Exclusion criteria included the following: a history of serious heart, liver, or kidney illnesses, cognitive disabilities, or psychiatric impairment caused by functional factors (e.g., physical illness, dysfunctions of neuroactive substance). The collective socio-demographic characteristics of the 298 participants are shown in **Table 1**.

The substance classes examined in the present study were matched with the drug classification of DSM-5 (54). Since some of the participants were polysubstance users (using more than one illicit substance), the sum of the prevalence with respect to drug classes exceeded 100%. As shown in **Table 1**, there were six drug classes: heroin (27.5%), methamphetamine (84.9%), ketamine (17.8%), methyenedioxymethamphetamine (MDMA)/ecstasy (9.7%), marihuana (11.1%), and others (2.7%).

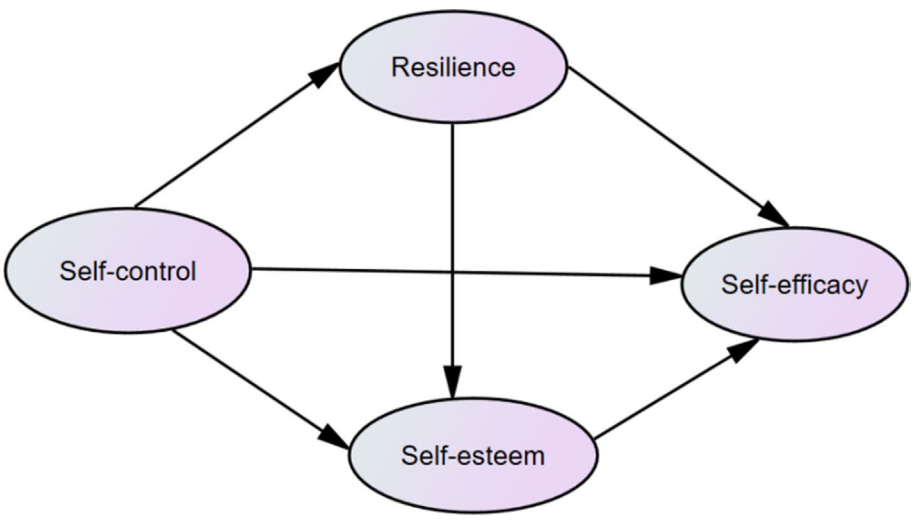

FIGURE 1 | The hypothesized model concerning the relationship between self-control and self-efficiency: resilience and self-esteem as mediators.

TABLE 1 | Sample characteristics.

Sample characteristics		Total (N = 298)		Male		Female	
		M	SD	n	%	n	%
Age	Male (18–64)	37.5	9.5	–	–	–	–
	Female (19–55)	35.2	8.2	–	–	–	–
		n	%				
Gender	1. Male	210	70.5	–	–	–	–
	2. Female	88	29.5	–	–	–	–
Education level: (n = 293)	1. Elementary school and below	49	16.4	35	16.7	14	15.9
	2. Middle school	125	41.9	87	41.4	38	43.2
	3. High school	88	29.5	61	29.0	26	29.5
	4. College	29	9.7	20	9.5	9	10.2
	5. Above college	2	0.7	2	1.0	0	0.0
Work status: (n = 289)	1. Unemployment	136	45.6	88	41.9	48	54.5
	2. Employment	134	45.0	108	51.4	25	28.4
	3. Others	19	6.4	11	5.2	8	9.1
Years of substance use:	<5 years	85	28.5	66	31.4	19	21.6
(n = 271)	6–10 years	94	31.5	62	29.5	32	36.4
	>10 years	91	30.5	57	27.1	34	38.6
Substance Classification	1. Heroin	82	27.5	60	28.6	22	25.0
	2. Methamphetamine	253	84.9	172	81.9	81	92.0
	3. Ketamine	53	17.8	30	14.3	23	26.1
	4. MDMA (ecstasy)	29	9.7	18	8.6	11	12.5
	5. Marihuana	33	11.1	19	9.0	14	15.9
	6. Others	8	2.7	6	2.9	2	2.3
Addiction severity	Mild	2	0.67	2	1.0	0	0.0
	Moderate	5	1.68	4	1.9	1	1.1
	Severe	291	97.65	204	97.1	87	98.9

The DSM-5 lists the following 11 symptoms of substance use disorders for assessing addiction severity: hazardous use, craving, withdrawal, tolerance, prolonged use of substantial amounts, collapse of relational and social relationships, withdrawal from social and occupational activities, use-related physical/psychological issues, substantial time spent using, repeated attempts to quit/control use, and social/interpersonal issues related to use (54). In DSM-5, addiction severity is measured by a criteria count: mild (from 2 to 3 criteria), moderate (from 4 to 5 criteria), and severe (from 6 to 11 criteria). The assessments were conducted using a diagnostic questionnaire that merged 11 DSM-5 criteria, and 291 of the participants (97.65%) were designated with the severest level of substance use disorders, while only 5 participants (1.68%) and 2 (0.67%), respectively, of the participants, were designated with moderate level and mild level disorders. The vast majority of patients were diagnosed with severe level of addiction because they were being treated in a mandatory drug treatment center that mainly tends to hospitalize patients with chronic substance use disorders.

Measures

The study used a diagnostic questionnaire to acquire demographic information and assess the participants' addiction severity levels. In the questionnaire, the participants self-reported demographic information such as gender, age, education level, and work status. The diagnostic questionnaire included three parts related to assessing addiction severity: substance use history, substance use behavior, and consequences and intervention history related to substance use. The diagnosis was based on 11 DSM-5 criteria. Finally, addiction severity was measured by counting the number of criteria matched in the questionnaires, resulting in a Cronbach's α coefficient of 0.70.

The Dual-Modes of Self-Control Scale (DMSC-S) was administered to assess participants' levels of self-control. The scale consists of 21 items with responses on a five-point Likert scale from 1 = "not at all true" to 5 = "very true" (55). The DMSC-S is assessed using the impulse system and control system subscales. The impulse system subscale includes three factors: impulsive, easy distraction, and delay gratification, and the control system subscale includes two factors: problem-solving and future time view. The higher the score on the impulse system subscale, the stronger the factors of impulsiveness, distraction, and delay gratification, and the weaker the self-control ability. The higher the score in the control system subscale, the more likely the problem is solved satisfactorily, the stronger the future time view, and the stronger the self-control. The Cronbach's α coefficient in our study was 0.901.

The Connor-Davidson Resilience Scale (CD-RISC25) (56) was administered to assess participant resilience. The CD-RISC consists of 25 items with responses given using a five-point Likert scale from 0 = "not true at all" to 4 = "true nearly all of the time" (57). The total scores ranged from 0 to 100. The scale consists of three factors, viz., toughness, strength, and optimism, and the higher the score, the higher the resilience and the easier for an individual to recover when a stressful time is experienced. The Cronbach's α coefficient in our study was 0.939.

To assess participant self-esteem, we administered the Rosenberg Self-Esteem Scale (RSES) (58), designed to assess an individual's overall perception of self-worth and self-acceptance.

The RSES consists of 10 items, scored at four levels, with a total score of 10–40 points (59). The higher the score, the higher the degree of self-esteem. The scale includes items such as, "I feel that I am a valuable person, at least on the same level as others" and "I feel that I have many good qualities." The Cronbach's α coefficient in our study was 0.711.

The Chinese version of the Regulatory Emotional Self-Efficacy Scale (RESS) was used to assess each participant's evaluation of their ability to manage their emotions (60). This scale has two dimensions: perceived self-efficacy in expressing positive emotion and perceived self-efficacy in managing negative emotion (61). RESE consists of 17 items (e.g., "When the happy things happen, I will express my pleasure"), with responses using a five-point score ranging from 1 (completely disagree) to 5 (completely agree). The Cronbach's α coefficient in our study was 0.895.

Data Analysis

We used initial correlational analysis to examine the relationships between self-control, resilience, self-esteem, and self-efficacy. Descriptive statistics and means and standard deviations (SD) were tested *via* IBM SPSS Statistics version 22.

In accordance with Anderson and Gerbing (62), we performed a two-step procedure to analyze mediation effects. We first used a measurement model that contained four potential variables: self-control, resilience, self-esteem, and self-efficacy, to test whether each latent variable could be well-represented by its indicators. We next determined whether the results from the measurement model were satisfactory; the structural model could be tested using maximum likelihood (ML) estimation in the AMOS 24.0 program. To control inflation of measurement errors generated by multiple items for the latent variable, we created several parcels using a random assignment method (63), and specially created three-item parcels for resilience and self-esteem, two-item parcels for self-control, and five-item parcels for self-efficacy.

To assess the adequacy of model fit, we used the following eight goodness-of-fit indices (64, 65): 1) chi-square statistics between 1 and 3; 2) a standardized root mean square residual (SRMR) of 0.06 or less; 3) a root-mean-square error of approximation (RMSEA) of 0.08 or less; 4) a goodness-of-fit index (GFI) of 0.90 or higher; 5) a Tucker–Lewis Index (TLI) of 0.90 or higher; 6) a comparative fit index (CFI) of 0.90 or higher; 7) Akaike information criterion (AIC); and 8) an expected cross-validation index (ECVI). We also used AIC and ECVI to compare two or more models, with a smaller value of AIC representing the better fit to the hypothesized model (66) and a smaller value of ECVI indicating a more significant potential for replication (67).

RESULTS

Preliminary Analyses

The descriptive statistics including mean, SD, alpha, reliability estimates (Cronbach's alpha coefficients), and correlations for all the study variables and clinical variables are shown in **Table 2**. They showed that, with respect to the clinical variables, there were significant negative correlations of age with gender, education level, and self-esteem, with gender on work status, and with work status on addiction severity, while there were significant positive correlations of age with years of addiction, with gender on addiction severity, self-control, and self-esteem, with education level on work status and self-efficiency, and with years of addiction on addiction severity. Moreover, all correlations among self-control, resilience, self-esteem, and self-efficiency were proven to be statistically significant ($p < 0.01$).

Measurement Model

The measurement model included 4 latent factors: self-control, resilience, self-esteem, and self-efficacy, and 13 observed variables. Although the initial estimate was unsatisfactory, a revised model reflected satisfactory data: ($\chi^2 = 156.67$, df = 54, $\chi^2/df = 2.901$, $p < 0.001$; SRMR = 0.0495; RMSEA = 0.080; GFI = 0.927; TLI = 0.922; CFI = 0.946, and ACI = 256.667 ECVI = 0.864, CFA). All latent variable factor loadings were reliable ($p < 0.01$), and fitting results show that all latent variables could be well represented by the respective indicators.

TABLE 2 | Means, standard deviations (SD), Alpha, reliabilities, and intercorrelations among study variables.

Measure	Mean	SD	α	1	2	3	4	5	6	7	8	9	10
Age	36.8	9.17	–	1									
Gender[a]	–	–	–	–0.116*	1								
Education level	–	–	–	–0.135*	–0.005	1							
Work status	–	–	–	–0.026	–0.153**	0.122**	1						
Years of addict	10.3	7.71	–	0.594**	0.087	–0.085	–0.110	1					
Addiction severity	9.71	1.61	0.70	–0.048	0.220**	0.056	–0.209**	0.282**	1				
Self-control	65.87	8.04	0.901	0.022	0.149**	0.061	0.109	–0.021	0.042	1			
Resilience	82.27	17.62	0.939	0.020	0.059	0.034	0.047	–0.037	0.079	0.160**	1		
Self-esteem	25.79	2.74	0.711	–0.130*	0.156**	0.032	0.068	0.037	–0.104	0.292**	0.184**	1	
Self-efficacy	56.58	11.75	0.895	0.018	0.058	0.129*	0.035	0.038	0.054	0.171**	0.481**	0.231**	1

α = Cronbach's alpha.

**Correlation is significant at the 0.05 level (two-tailed).*

***Correlation is significant at the 0.01 level (two-tailed).*

[a]Gender is coded 1 = male, 2 = female.

Structural Model

Without mediators, the direct path from self-control (the predictor) to self-efficacy (the criterion, $r = 0.171$, $p < 0.01$) was significant. We first built a fully mediated model (Model 1) containing two mediator variables (resilience and self-esteem) without a direct path from self-control to self-efficacy. While the initial results were unsatisfactory, a revised model produced satisfactory results [NC ($\chi 2/df$) = 2.751, RMSEA = 0.077, SRMR = 0.0561, GFI = 0.924, TLI = 0.912, CFI = 0.931, and AIC = 250.070], and all standardized path coefficients were significant (**Table 2**). Next, based on results from Model 1, a partially mediated model (Model 2) was tested by adding a direct path from self-control to self-efficacy, producing satisfactory test results: NC ($\chi 2/df$) = 2.780, RMSEA = 0.077, SRMR = 0.0563, GFI = 0.925, TLI = 0.911, CFI = 0.937, and Akaike information criterion (AIC) = 250.882, although the standardized path coefficient from self-control to self-efficacy in Model 2 was not significant. With respect to goodness-of-fit indices, while there was no noticeable difference between Model 1 and Model 2, there was one standardized path coefficient that was not significant in Model 2, so Model 1 was found to be better than Model 2. Next, in order to test the distal mediation effect, based on Model 1, a path from resilience to self-esteem (Model 3) was added to the model, with test results showing that, with respect to goodness-of-fit indices, while there was little difference between Model 1 and Model 3, the AIC and ECVI indices in Model 3 were smaller than for Model 1, indicating that Model 3 was better than Model 1.

To further explain the mediating model, we built Model 4 that reversed the paths among self-efficacy, self-esteem, and resilience by controlling self-control (i.e., from self-efficacy to self-control and resilience followed by self-esteem to resilience), to test an alternative causal hypothesis. Although nearly all indices in Model 4 were inconsistent with the data, the GFI and CFI values were greater than 0.900 [($NC\chi^2/df$) = 3.565, RMSEA = 0.093, SRMR = 0.1067, GFI = 0.908, TLI = 0.872, CFI = 0.909, and AIC = 268.054], and the standardized path coefficients between self-esteem and resilience were not significant in Model 4. In addition, the indices of AIC and ECVI in Model 3 were smaller than those from Model 4, so Model 3 was chosen as the most suitable model for evaluating the mediating effects (**Table 3**). The final structure model is shown in **Figure 2**.

We used the bootstrapping procedures method of AMOS24.0 to test the significance of the mediated models. Based on recommendations of MacKinnon et al. (68), we generated 10,000 samples by random sampling of the original dataset (N = 426). If the 95% confidence interval for the outcome of the mediation effect did not contain zero, the mediation effect would be significant at the 0.05 level, and **Table 4** shows the indirect effects and their associated 95% confidence intervals, revealing that self-esteem and resilience exerted significant indirect effects on self-control and self-efficacy.

Gender Differences

There was no statistically significant gender difference in terms of self-efficacy, resilience, and self-esteem, although females scored higher than males with respect to self-control.

To further examine gender differences in the intermediary model, we conducted a multigroup analysis to explore whether the path coefficients differed significantly for males and females. According to Byrne (69), we compared gender difference using the following two models: 1) an unconstrained model, allowing all the paths to vary across both male and female groups; and 2) a constrained model, constraining all the parameters, including factor loading, error variances, and structure covariance, to be equal across male and female groups. After confirming the moderating effect of gender, we examined mediating models for males and

TABLE 3 | Fit indices among competing models.

Regression weights	Model1	Model2	Model3	Model4	Target value
Self-control→Self-efficacy		0.142			
Self-control→Self-esteem	0.558***	0.546***	**0.315***	0.352***	
Self-esteem→Self-efficacy	0.304**	0.250*	**0.303****		
Self-control→Resilience	0.719***	0.715***	**0.679*****	0.525***	
Resilience→Self-efficacy	0.434***	0.352**	**0.421*****		
Self-esteem→Resilience				0.103	
Resilience→Self-esteem			**0.190***		
Self-efficacy→Resilience				0.366***	
Self-efficacy→Self-esteem				0.384***	
χ^2	154.070	152.882	**149.968**	196.054	
df	56	55	**55**	55	
χ^2/df	2.751	2.780	**2.727**	3.565	
SRMR	0.0561	0.0563	**0.0539**	0.1067	<0.06
RMSEA	0.077	0.077	**0.076**	0.093	<0.08
GFI	0.924	0.925	**0.926**	0.908	>0.90
TLI	0.912	0.911	**0.914**	0.872	>0.90
CFI	0.937	0.937	**0.939**	0.909	>0.90
AIC	250.070	250.882	**221.968**	268.054	
ECVI	0.842	0.845	**0.747**	0.903	

**Correlation is significant at the 0.05 level (two-tailed).*

***Correlation is significant at the 0.01 level (two-tailed).*

****Correlation is significant at the 0.001 level (two-tailed).*

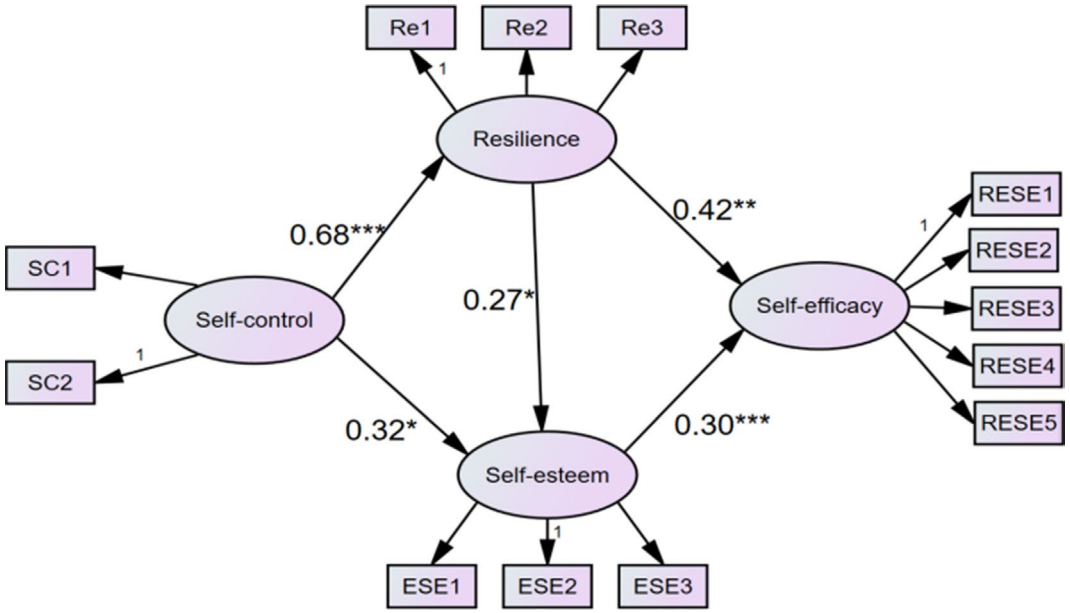

FIGURE 2 | The finalized structural model (N = 298) in the present study. Note. Factor loading is standardized. SC1-SC2 = Two parcels of self-control; Re1-Re3 = Three parcels of Resilience; ESE1-ESE3 = Three parcels of Self-esteem. RESE1-RESE5 = Five parcels of regulatory emotional self-efficacy.

TABLE 4 | Bootstrapping indirect effects and 95% confidence intervals (CI) for the final mediational model.

Number	Model pathways	Point estimates β	95%CI	
			Lower	Upper
1	Self-control→Resilience→Self-efficacy	0.1046	0.0346	0.1902
2	Self-control→Self-esteem→Self-efficacy	0.0516	0.0146	0.1050
3	Self-control→Resilience→Self-esteem→Self-efficacy	0.0043	0.0009	0.0132
4	Self-control→Resilience→ Self-esteem	0.0920	0.0546	0.1294
5	Resilience→ self-esteem→Self-efficacy	0.0181	0.0061	0.0389

females separately, with results indicating that differences between these two models were not significant [$\Delta\chi 2$ (18) = 26.480, p = 0.089]. Furthermore, in accordance with Arbuckle (70), we used the critical ratios of differences (CRDs) to judge the difference between two parameter estimates, measured by dividing the difference between two estimates by an estimate of the standard error of the difference. If a CRD value is greater than 1.96 (or 2.58), the two parameters were estimated to be significantly different at levels of $p < 0.05$ (or $p < 0.01$). Since the CRD analysis in this study indicated no structure path identified as significantly different, the finding indicated that the relationship among self-control, resilience, self-esteem, and self-efficiency did not differ with respect to gender.

DISCUSSION

Following the methodology of previous literature, in this study, we analyzed the relationship between self-control and self-efficacy among patients with substance use disorder by investigating the mediating role of resilience and self-esteem with respect to the impact of self-control on self-efficacy. The results indicated that self-control is positively related to resilience, self-esteem, and self-efficacy, indicating that our hypothesis is correct.

The mediating impacts of resilience and self-esteem with respect to the relationship between self-control and self-efficacy were identified as significant, with results indicating that participants exhibiting a more positive performance on the self-control scale performed better in terms of resilience and self-efficacy compared with participants exhibiting poorer self-control performance. These results are consistent with those of previous studies that also found resilience to be positively associated with self-control (36, 71) and self-efficacy (43, 72). Furthermore, participants who performed better in self-control were also identified as achieving more positive performance with respect to self-esteem and self-efficacy, in accordance with previous studies that found self-esteem to be closely correlated with self-control (22, 45) and self-efficacy (48, 49).

The combined theoretical underpinnings of this study might inform some practical implementations regarding patients' substance use disorders. The theoretical underpinnings of intermediary mechanisms between self-control and self-efficacy

reflect the idea that success in resisting inappropriate temptations (self-control) might contribute to developing propensity toward enduring pressure or negative emotions (resilience) and achieving greater self-confidence (self-esteem) in ways that enhance chances for individual success in overcoming challenging and resource-demanding tasks (self-efficacy). This suggests that there might be types of practical interventions for enhancing self-efficacy in patients with substance use disorders. For example, interventions might pay closer attention to designing specialized and supervised trait-enhancement programs in ways that provide evidence-based events focusing on fostering traits of self-control, resilience, and self-esteem. Overall, the present findings provide evidence of a psychological process whereby self-control exerts benefits on drug dependents to promote their self-efficacy *via* improved resilience and self-esteem.

Using the final model of this study, we found that the path "self-control →resilience →self-esteem → self-efficacy" was significant and showed that individuals with higher self-control are prone to experience higher levels of resilience, possibly enhancing their self-esteem and, in turn, producing a greater sense of self-efficacy. For one thing, this path suggests that resilience is a mediator between self-control and self-esteem, agreeing with earlier studies that resilience is significantly associated with self-control (40) and self-esteem (73). This path also demonstrates that self-esteem might act as a mediator between resilience and self-efficacy, an idea consistent with findings that resilience can play a crucial role in promoting self-esteem (74), and self-esteem is closely correlated with self-efficacy (49). Based on these findings, it is reasonable to speculate that resilience might play a mediating role in the relationship between self-control and self-esteem, while self-esteem might act as a mediator between resilience and self-efficacy.

The results of this study also indicated that females experience higher levels of self-control than males. The results related to self-control were in agreement with previous studies suggesting that females tend to regulate themselves better than males (75), probably because the female's prefrontal cortex that dominates the functions of self-control is more active than that of the male (75). However, the final model did not suggest gender differences, rather indicating that both males and females have the same mediating mechanisms between self-control and self-esteem.

In short, the study broadens our horizon with respect to the complicated interplay between self-control, resilience, self-esteem, and self-efficacy among patients with substance use disorder in China. Considering the significant path from self-control through resilience and self-esteem to self-efficacy sheds light on potential mechanisms linking self-control and self-efficacy. This study may also offer valuable evidence on how to organize psychological interventions that aim to promote self-efficacy of patients with substance use disorders. Encouraging self-control, resilience, and self-esteem in the future would work as proactive tools, helping them enhance self-efficacy.

LIMITATIONS

This study, like most studies, has some limitations, the main one being the lack of a control group. Also, all the information was collected by questionnaires and scales that can be influenced by subjectivity. Second, to moderate such adverse impacts, it is also recommended that multiple assessment methods such as structured interviews be introduced (SCD-1) to support more in-depth and accurate diagnoses. Third, the diagnostic questionnaire did not cover assessment of histories of comorbid disorders and psychotropic mediation that have been identified as significant variables by many studies of substance use disorders (76, 77). Furthermore, the results were based only on two-dimensional measures of resilience and self-esteem, and in future studies, it might be useful to examine other facets of self-control and explore effects of other possible mediating factors such as social support, affect, and loneliness, on the relationship between self-control and self-efficacy. Finally, the study's sample population's age range was from 18 to 64, so it remains to be seen whether the results could be duplicated with younger or older participants.

ETHICS STATEMENT

This study was approved by the ethics committee of Nanjing Medical University. All participants volunteered to participate in the study and signed informed consent documents.

AUTHOR CONTRIBUTIONS

CY, YZ, QC, MX and JA conceived this work. CY conducted the development of the manuscript and contributed to the modeling and data analysis. YZ contributed literature review, discussion, revision and polish. QC, MX and JA revised and finalized the manuscript. All authors read and approved the final manuscript.

FUNDING

This paper was supported by the Research Fund for Philosophy and Social Science of Universities in Jiangsu Province (2017SJB1800), China Postdoctoral Science Foundation (2018M632285), and Jiangsu Province Social Science Fund Project (18SHC006).

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychiatry

ORIGINAL RESEARCH
published: 14 June 2019
doi: 10.3389/fpsyt.2019.00421

Frustration Tolerance and Personality Traits in Patients With Substance Use Disorders

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Previous research has suggested the prevalence of certain personality traits, some of which are related to a disorganized attachment, in substance abuse disorders. Further, frustration tolerance (FT) has been proposed as an important factor in addiction, both at the inception—following the "self-medication" hypothesis—and regarding treatment compliance. In turn, an inadequate response to frustrating events has been also associated with a disrupted attachment. Our goal is to explore the mediational role of FT in the relationship between personality traits and two different treatments for substance addiction: therapeutic community (TC) and ambulatory treatment (AT). Eighty-four subjects with substance abuse disorder were recruited in total (22 female), including 46 volunteers (13 female) in TC and 38 (9 female) in AT. They were assessed with Rosenzweig's test for FT and the Millon Clinical Multiaxial Inventory-III (MCMI-III) test to evaluate personality factors. By comparing with a control sample (335 volunteers, 268 female), we found that FT was lower in patients. Between therapeutic groups, FT was significantly lower in TC. Depressive, antisocial, sadistic, negativistic, schizotypal, borderline, paranoid, anxiety, dysthymia, alcohol use, drug use, posttraumatic stress disorder (PTSD), thought disorder, and delusional disorder traits were suggestive of pathology in the clinical samples and were significantly different between control, AT, and TC groups. Further, anxiety and PTSD traits were higher in TC than in AT. A mediational analysis revealed that the effect of anxiety and PTSD scales on therapeutic group was partially mediated by FT. In conclusion, FT and its interplay with personality traits commonly related to disorganized attachment (anxiety and PTSD) might be important factors to consider within therapeutic programs for persons with substance addiction.

Keywords: substance addiction, frustration tolerance, ambulatory treatment, MCMI-III, therapeutic community

OPEN ACCESS

Edited by:
Human Friedrich Unterrainer, University of Vienna, Austria

Reviewed by:
Martin Zack, Centre for Addiction and Mental Health (CAMH), Canada
Michaela Hiebler-Ragger, Medical University of Graz, Austria

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Specialty section:
This article was submitted to Addictive Disorders, a section of the journal Frontiers in Psychiatry

Received: *11 February 2019*
Accepted: *28 May 2019*
Published: *14 June 2019*

Citation:
Ramirez-Castillo D, Garcia-Roda C, Guell F, Fernandez-Montalvo J, Bernacer J and Morón I (2019) Frustration Tolerance and Personality Traits in Patients With Substance Use Disorders. Front. Psychiatry 10:421. doi: 10.3389/fpsyt.2019.00421

INTRODUCTION

Drug addiction withdrawal implies a set of physiological and psychological challenges that should be faced by the patient and taken into account by the therapist (1–3). Physiological alterations appear a few hours after the cessation of drug administration, do not extend longer than 3 weeks (1), and can be alleviated by pharmacological treatment (4). However, psychological challenges are

more persistent (5), and pharmacological intervention is not always effective to treat them (6, 7). Frustration is one of the common negative emotions involved in withdrawal (8–18), and its experience during detoxification significantly contributes to relapse and treatment discontinuation (7). Moreover, following the self-medication hypothesis, it has been proposed that illicit-drug consumption—and subsequent addiction—could be used as a means of alleviating negative emotions such as frustration (19).

Taking this into account, the ability of the patient to tolerate frustrating events might be an important factor in substance addiction, both in the development of the disorder and during treatment. Frustration is defined as a negative emotional response triggered after the omission and/or devaluation of an expected reward (20). Animal research has extensively demonstrated the influence of this negative emotion on substance abuse [see, for example, Ref. (21)]. Concerning humans, frustration tolerance (FT) is negatively associated with the number of relapses (22) and positively predicts recovery from alcoholism (23, 24). It is also an essential component of the complex construct of distress tolerance (25), which is, in turn, an important factor of withdrawal (26–28).

Previous studies have suggested the attachment hypothesis of addiction as an alternative to self-medication. Attachment is defined in developmental psychology as the emotional tie that connects the child with his or her main caregiver (29, 30). In her first works, Mary Ainsworth described three main types of attachment, namely, secure, anxious insecure, and avoidant insecure. Nowadays, the most common classification includes organized (secure, insecure–avoidant, or insecure–resistant) and insecure–disorganized attachment types (31). Within organized attachment, insecure children are hesitant to rely on their main caregiver in distress situations, due to a prior unreliable response from the adult. They are considered organized because children can develop strategies to handle stressful situations. In contrast, children with a disorganized attachment show a fearful, conflicted, or apprehensive behavior when reunited with their caregivers after distress (32). It is important to note that a disorganized attachment may co-exist with any of the organized subtypes, mostly insecure (33). In adults, insecure attachment is mostly manifested in enhanced avoidant and anxious behaviors. Like children, adults expect unresponsive peers in stressful situations, leading them to avoid close relationships or to desire proximity but lacking trust in their partners (32). Current research has proposed that an insecure (disorganized) attachment may be a risk factor for developing substance addiction (34–36). Moreover, a disorganized mother–child attachment can be associated with poorer FT in children (37, 38), and adults with insecure attachment are prone to show problems coping with emotion regulation (39, 40). Therefore, since FT is a relevant factor for both the self-medication hypothesis of addiction and disorganized attachment (which in turn may be a risk factor for developing substance addiction), the assessment of FT in patients with substance use disorders may help bring together both fields of research.

Interestingly, other authors have highlighted the influence of personality traits on addiction and attachment. Magor-Blatch and collaborators (41) explored pathological symptoms and clinical syndromes, assessed by the Millon Clinical Multiaxial Inventory-III (MCMI-III) (42), in a large sample of amphetamine-type substance users. They found scores in the pathological range in anxiety, bipolar, borderline, dependent, narcissistic, negativistic, and sadistic scales, although these values did not predict completion of the therapeutic program. Fernandez-Montalvo et al. (43) found that over 76% of patients in therapeutic community (TC) had a pathological personality, antisocial being the most prevalent trait (43%). Other studies report a significant presence of antisocial, anxiety, depressive, borderline, bipolar, and posttraumatic stress disorder (PTSD) traits in patients with substance dependency (44–47). Psychopathology is understood under the scope of attachment theory as an adaptive resource to compensate for an insecure attachment (48). Previous research has demonstrated a relationship between certain elements of a dysfunctional attachment (unresolved loss and unresolved trauma) and personality (49). Using the Adult Attachment Interview, these authors found that borderline and anxiety traits were higher in trauma inpatients with unresolved attachment. Furthermore, within the scope of the self-medication hypothesis of addiction, antisocial personality was described as a mediator of the relationship between alcohol consumption and parental bonds in male college students (50). Besides, other authors found a relationship between anxiety and insecure attachment styles in alcohol-addicted inpatients: anxiety traits were significantly higher in participants with insecure, compared with secure, attachment (51). Beyond the scope of addictive disorders, a disorganized attachment has been associated with higher values of paranoid, borderline, and histrionic traits in adults (52).

The present study intends to contribute to this field of research by evaluating personality traits and FT in subjects included in two different therapeutic approaches: TC and ambulatory treatment (AT). To the best of our knowledge, our research is the first to explore FT and personality traits in both types of treatment, since previous works have focused on TCs (11, 14, 22, 41, 53–55). Although we do not measure attachment directly, we aim to evaluate the association between the type of withdrawal program (TC and AT) (which is an indirect indicator of addiction severity and risk of social exclusion) (56), the presence of pathological personality traits that have been previously related to a disorganized attachment (i.e., antisocial, anxiety, PTSD, borderline) [see, for example, Ref. (57)], and the role of FT as a mediating factor between them.

Considering this, the objectives of our research are: 1) to evaluate FT in TC and AT groups; 2) to explore the personality traits of the whole clinical sample under study; 3) to compare personality traits between therapeutic groups, focusing on those previously related to disorganized attachment; and 4) to explore whether the influence of personality on treatment group is mediated by FT. A deeper knowledge of negative psychological emotions involved in withdrawal, such as frustration, and its mediation in the relationship between personality and treatment, may help improve these therapeutic programs and their probability of success.

METHODS

Participants

Participants under treatment for substance abuse were recruited through an advertisement made by the therapists of Asociación

Proyecto Hombre in the centers of Navarra and Granada. All volunteers signed an informed consent, and the protocol was approved by the Committee for Ethics in Research of the University of Navarra. Data were collected between 2015 and 2016. Proyecto Hombre verified, by means of urine tests, that participants were not consuming any drug—other than tobacco—during the 2 weeks prior to their psychological assessment. The total number of participants was 84 patients (22 female) from both centers. Age ranged from 20 to 63 years (40.06 ± 1.10, mean ± standard error of the mean), and it was not significantly different between male (39.31 ± 1.17) and female (42.18 ± 2.58) participants: Student's $t(82) = -1.156$, $p = 0.251$. Concerning the therapeutic program, 46 participants (13 female) were in TC, whereas 38 received AT (9 female). The mean age of these groups was also similar: age(TC) = 38.70 ± 1.54, age(AT) = 41.71 ± 1.53; $t(82) = -1.377$, $p = 0.172$. A chi-square test of independence showed that gender composition was not different between therapeutic groups ($\chi^2(1) = 0.225$, $p = 0.635$). At the time of assessment, the duration of treatment was similar in both groups: TC, 4.12 ± 0.38 months; AT, 4.80 ± 0.34 months, $t(82) = 1.317$, $p = 0.192$. We did not collect information about psychopharmacological medication prescribed to volunteers (**Table 1**).

Inclusion criteria for the participants were: i) fulfilling the diagnostic criteria of the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition, Text Revision (DSM-IV-TR) for substance dependence, substance abuse, and substance withdrawal; ii) participation in TC or AT for at least 2 weeks before data collection; and iii) presenting physical or psychological harm and/or dependence due to substance consumption in the past.

In order to assess FT in substance abuse with respect to the general population, we recruited a control sample ($N = 335$, 268 female), which included community controls (next of kin of the patients) and university students. Exclusion criteria were: 1) alcohol or substance abuse or dependence, as assessed by the Alcohol Use Disorders Identification Test (AUDIT) and Alcohol, Smoking and Substance Involvement Screening Test (ASSIST) tests; 2) self-reported previous treatment for substance abuse dependence; and 3) self-reported history of neurological or mental disorders. All control participants signed the informed consent to take part in the study. This sample was not matched in terms of sex and age with the clinical group. Thus, in the Results section, we present three different strategies to compare FT between both samples. In addition, a subsample of 76 participants from the initial control sample was assessed with the MCMI-III questionnaire (see below and **Table 1** for details).

Procedure and Therapeutic Strategies

Asociación Proyecto Hombre is a Spanish institution for treating and preventing addiction, involving 27 centers and 16,600 persons under treatment annually. They work in three fundamental areas: prevention, rehabilitation, and reintegration of former users (www.proyectohombre.es). The tests were conducted in the centers of Proyecto Hombre in the Spanish provinces of Granada and Navarra. Among others, they offer TC and AT therapeutic strategies. The former is inpatient, and the latter is outpatient, involving 1.5–2 h of treatment 5 days a week (Monday to Friday). Patients are assigned to either program depending on their preferences, as well as on the therapists' recommendation based on their social situation. It is important to note that the assignment to TC points to a more compromised social and/or pathological situation, since inclusion in TC is related to the fact that patients do not or cannot have employment, or they do not have enough social support to tackle withdrawal treatment by themselves (56). The most common profile of AT patients, however, is a jobholder supported by family and acquaintances. In spite of this, therapeutic strategy is the same in both programs: group therapy for psychological and emotional aspects such as problem solving, anxiety control, emotional regulation, or relapse prevention, for instance. The only difference, apart from the number of hours spent daily in the program, is the emphasis on achieving personal and social autonomy in TC. Although the total time spent in the program depends on each person, TC treatment usually lasts 6–10 months, and AT is maintained for at least 1 year. Participants were allowed to smoke tobacco before assessment, so nicotine withdrawal is not expected to influence the study.

All data were anonymized and coded for each participant. First, the MCMI-III test was administered for approximately 45 min. Then, subjects were evaluated with the Rosenzweig test for about 25 min. After a short break in the same room, participants were screened for substance use, abuse, dependency, and damage. This procedure was also followed by the control sample, although the MCMI-III test was administered only to a subsample of 76 participants, including university students and community controls.

TABLE 1 | Characteristics of the clinical and control samples included in the study.

	Clinical			Control		Matched	
	TC	**AT**	**Whole**	**Whole**	**MCMI**	**Clinical**	**Control**
N	46	38	84	335	76	29	26
Age	38.7 ± 1.54 (20–60)	41.7 ± 1.53 (24–63)	40.1 ± 1.1 (20–63)	21.1 ± 0.32 (18–58)	23.2 ± 1.21 (18–58)	35.6 ± 2.16 (20–56)	36.3 ± 2.37 (20–58)
Gender							
Female	13	9	22	268	59	21	20
Male	33	29	62	67	17	8	6
Treatment duration (months)	4.1 ± 0.38	4.8 ± 0.34	4.4 ± 0.04				

Descriptive statistics are means ± standard errors of the mean. In parentheses, age range. "Matched" refers to samples randomly matched by MedCalc software (see Methods for details).

AT, ambulatory treatment; MCMI, subsample of control participants evaluated with the MCMI-III (see Methods for details); TC, therapeutic community.

Questionnaires

Millon Clinical Multiaxial Inventory-III (MCMI-III). This test (42) is used for testing clinical personality patterns (11 scales), severe personality pathology (3 scales), clinical syndromes (7 scales), and severe clinical syndromes (3 scales). It consists of 175 true/false items, and it also contains 3 control scales. This inventory identifies personality features underlying symptoms, and it is commonly used to assist clinicians in diagnosis and for therapy selection. According to the standards (58), scores between 60 and 74 are suggestive of symptoms at a subclinical level, values of 75–85 indicate presence and prevalence of the pathology or syndrome, and scores over 85 point to prominence of the pathology or syndrome.

Rosenzweig Picture Frustration Test, PFT. This is a semi-structured projective test to assess tolerance or intolerance to a frustrating situation (59). It consists of 24 vignettes where pairs of characters are interacting. The subject assumes the role of one of the characters and provides his or her expected behavior in that situation. The test provides an FT index that is calculated through a simple procedure: the response for each vignette is scored by two different raters (from 0 to 2) considering the degree of aggression, avoidance, blocking, or coping (2 = aggressive response, 0 = non-emotional response). In our study, inter-rater reliability of this assessment was very high (average intraclass correlation coefficient = 0.943). In spite of the high reliability, the final score of each vignette was agreed upon in case of a mismatch between the raters. Higher scores indicate lower FT (higher level of aggressive response).

Substance use, abuse, and dependence. All participants were screened with a 13-item test to identify the substances they used (in the case of patients, before joining the therapeutic program) (alcohol, ecstasy, heroin, speed, cocaine, caffeine, tobacco, cannabis, hallucinogens, tranquilizers, and marijuana). The two last items indicated substance dependency and physical or psychological harm due to substance consumption. This test is based on the ASSIST 3.0, published by the World Health Organization (WHO) (60).

Subjects were also screened with the AUDIT (WHO) in its Spanish version (61).

STATISTICAL ANALYSIS

All statistical analyses were performed in Stata 12.1. We present three different strategies to compare FT between both samples: 1) unpaired *t* test including all subjects (clinical vs. control sample); 2) multiple regression to predict FT (dependent variable) from group (case = 1, control = 0), controlling by age and sex (male = 1, female = 0); and 3) randomly choosing age- and sex-matched subsamples of both groups with MedCalc (Ostend, Belgium) and then comparing FT with an unpaired *t* test. In order to achieve matching, the software randomly selected the maximum number of cases within group that produced non-significant differences between groups for age and sex. Therefore, matches were not necessarily exact. A Shapiro–Wilk test was conducted to assess normality. For normally distributed samples, means and standard errors of the mean are reported; for non-normal distributions, we report medians and interquartile ranges (IQRs). Comparisons between therapeutic groups were carried out with parametric *t* tests, due to sample sizes larger than 30. A multivariate analysis of variance (MANOVA) was used to test the omnibus differences in personality traits between therapeutic groups. The effect of covariates (i.e., duration of treatment) was assessed with analysis of covariance (ANCOVA) and a MANOVA, respectively.

In order to assess the mediational role of FT on the influence between personality traits and therapeutic group, we performed mediational analyses as described by MacKinnon and Dwyer (62), and as explained by Kenny (63). We used the command binary_mediation available in Stata's repositories. In our case, we wanted to test whether the relationship between certain personality traits (for example, anxiety) and the assignment to a particular therapeutic group (TC or AT) was influenced by FT. In short, the analysis explores first the total effect of the independent variable (i.e., anxiety personality trait) on the dependent variable (i.e., inclusion in either AT or TC), in this case with a logistic regression (AT = 0, TC = 1). Then, the total effect is divided into the direct effect (the influence of the independent variable, i.e., anxiety) on the dependent variable (AT or TC) controlling for the mediator (FT) and the indirect effect (the influence of the independent variable, i.e., anxiety) on the mediator (FT), and the effect of the mediator (FT) on the dependent variable (AT or TC); if the direct effect is negligible and the other tests are significant, the mediational role of the variable may be assumed. Practically, to fully assess the mediational role of a variable, four steps must be fulfilled: 1) the independent variable (i.e., anxiety) must have an effect on the dependent variable (treatment: TC = 1 or AT = 0); 2) the independent variable must have a significant effect on the mediational variable (FT as assessed by the PFT); 3) the mediational variable must have a significant effect on the dependent variable when controlling for the independent variable; and 4) the direct effect of the independent variable on the dependent variable, when controlling for the mediational variable, must be null (total mediation), or at least lower than when the mediational variable is considered (partial mediation).

Step 1 is assessed by a logistic regression and gives the total effect of the independent variable on the dependent variable (coefficient *c*). Step 2 is evaluated by a linear regression, taking FT as the dependent variable and the personality trait as predictor, and it provides coefficient *a*. Steps 3 and 4 are assessed with a logistic regression, including treatment as the dependent variable and the personality trait and FT as predictors. The influence of FT on treatment (controlling by personality trait) is coefficient *b* in the mediational model, and the effect of the personality trait on treatment (controlling for FT) is coefficient *c'*.

RESULTS

Frustration Tolerance

Overall, the whole clinical sample (AT and TC) showed a score of 16 ± 6.5 (median ± IQR; Shapiro–Wilk $p = 0.0235$) in the Rosenzweig test (**Figure 1**). This is considered a medium FT according to the standards, as defined by Rosenzweig and based on the Dollard et al. theory of frustration–aggression (64),

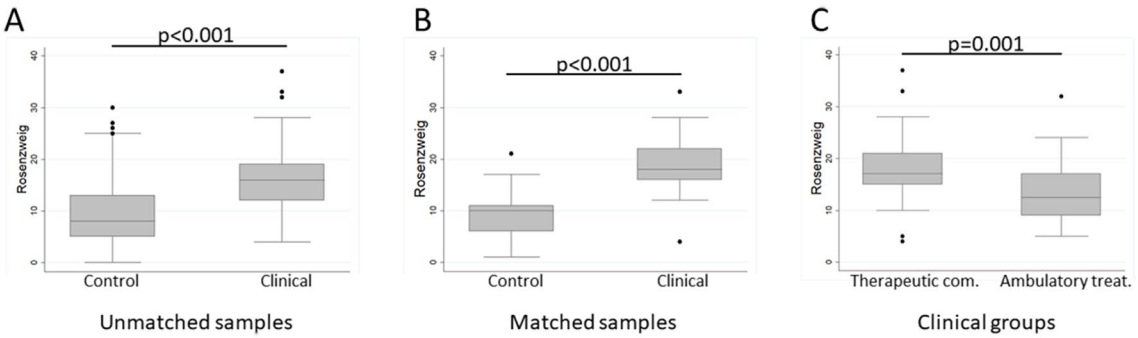

FIGURE 1 | Box plots showing differences in frustration tolerance (FT) between clinical and control samples, as well as between therapeutic programs. **(A)** Rosenzweig Picture Frustration Test (PFT) scores in the unmatched clinical and control samples. **(B)**, median scores for the MedCalc-matched samples. **(C)** Rosenzweig PFT scores in therapeutic community and ambulatory treatment. Note that high values indicate poor FT.

and points to an avoidant or blocking behavior when facing frustrating situations, masking a desire for aggression that the subject intentionally conceals (65). Note that higher scores on this test indicate a lower FT.

The control sample showed lower values on average (8 ± 8, Shapiro–Wilk $p < 0.0001$) (**Figure 1**), which reflect a strategic resolution of the frustrating vignettes based on social skills, empathy, and assertiveness. The comparison between these samples, unmatched for sex and age, yielded statistically significant results: $t(417) = -9.99$, $p < 0.001$, Cohen's $d = 1.22$, pointing to a better FT in controls than in the clinical sample. In order to test whether this result was due to the difference in age (control, 21.09 ± 0.32 yr; clinical sample, 40.06 ± 1.1 yr) or sex composition (control, 80% female; clinical sample, 26.2%), we performed a linear regression to predict FT values from group, sex, and age. A significant regression equation was found [$F(3,415) = 33.178$, $p < 0.001$, $\eta p^2 = 0.19$], with a corrected $R^2 = 0.188$. The only significant regressor was group (p(group) < 0.001, p(sex) = 0.695, p(age) = 0.964), controlling by sex and age. Participants' predicted FT was 9.18 + 7.10(group), where group was coded as 0 = control, 1 = clinical sample. These results were confirmed by randomly selecting subsamples for each group with MedCalc ($N_{control} = 26$, 20 female; $N_{clinical} = 29$, 21 female; age(control) = 36.31 ± 2.37; age(clinical) = 35.55 ± 2.16). In this case, we used non-parametric statistics since $N < 30$: Mann–Whitney $U = 63.5$, $z = -5.295$, $p < 0.001$, Cohen's $d = 1.815$. In these subsamples, PFT was 10 ± 5 for controls and 18 ± 6 for the clinical sample (**Figure 1**).

In conclusion, as hypothesized, FT was lower in the clinical group than in the control sample, as measured by Rosenzweig's PFT.

With respect to therapeutic groups, PFT values were higher in TC (18.22 ± 0.95, mean ± SEM; Shapiro–Wilk $p = 0.0912$) than in AT (13.34 ± 0.98; Shapiro–Wilk $p = 0.0645$) (**Figure 1**). As explained in the Methods section, these samples were matched for sex and age. A parametric t test confirmed statistical differences: $t(82) = -3.54$, $p = 0.001$, Cohen's $d = 0.78$. Therefore, in accordance with our hypothesis, FT was lower in TC than in AT. Even though treatment duration was similar between groups, we performed an ANCOVA to confirm the difference between TC and AT in FT controlling for treatment duration (in months). As expected, between-group differences held when controlling by treatment duration at the time of assessment [$F(1,25) = 1.83$, $p = 0.0302$, $\eta p^2 = 0.07$].

Personality Factors and Treatment Groups

We explored personality traits in TC and AT. Scores from the MCMI-III were processed as described by Millon et al. (58). All patients were assessed with this tool, whereas it was restricted to a subsample of 76 controls. Considering all the scales, Cronbach's α was 0.90, showing a high internal consistency. With respect to individual subscales, values ranged from 0.9509 (borderline) to 0.9556 (narcissist).

In order to analyze the clinical relevance of each personality trait, we focused on those that were significantly different between groups (control, AT, and TC) and with a median equal to or above 60 for at least one of the clinical groups. Thus, we performed an ANOVA for each scale, using Bonferroni correction for multiple comparisons ($p = 0.05/24 = 0.0021$). Depressive, antisocial, sadistic, negativistic, schizotypal, borderline, paranoid, anxiety, dysthymia, alcohol use, drug use, PTSD, thought disorder, and delusional disorder traits fulfilled these criteria (**Table 2**). Due to the possible clinical relevance of these 14 scales, we focused on them for subsequent analysis.

In order to assess whether these personality traits were different between therapeutic groups, we performed a MANOVA with the MCMI scales as dependent variables and treatment group as an independent variable. There was a statistically significant difference between treatment groups in MCMI scales, $F(14, 69) = 2.06$, $p = 0.025$, Wilks' lambda = 0.705. As *post hoc* analyses, we performed two-tailed independent t tests for each variable, assuming a critical p value of 0.0036 (i.e., 0.05/14). Anxiety [$t(82) = -3.42$, $p = 0.001$; Hedges $g = 0.743$) and PTSD ($t(82) = -3.23$, $p = 0.0018$; Hedges $g = 0.703$) survived this threshold (**Table 3**).

Influence of Personality Traits and Frustration Tolerance on Treatment Group

We hypothesized that FT may act as a mediational variable in the relationship between pathological personality traits and treatment group, which is an indicator of addiction severity. In order to test mediation, we followed the recommendations

TABLE 2 | MCMI-III personality traits in the control, therapeutic community, and ambulatory treatment samples.

	Control (*N* = 76)	TC (*N* = 46)	AT (*N* = 38)	ANOVA *F*(2,157)	*p*
Clinical personality patterns					
Schizoid	26 ± 34	53.5 ± 16	51.5 ± 33	19.23	<0.0001*
Avoidant	32 ± 41	60 ± 30	51 ± 45	6.10	0.0028
Depressive	25 ± 27.5	61 ± 23	53 ± 41	21.84	<0.0001*
Dependent	42 ± 36	59.5 ± 24	53 ± 35	2.84	0.0616
Histrionic	68 ± 24.5	35 ± 36	47 ± 35	36.94	<0.0001*
Narcissist	63 ± 7.5	59.5 ± 21	64.5 ± 9	4.40	0.0138
Antisocial	60 ± 29	70 ± 13	69.5 ± 13	30.55	<0.0001*
Sadistic	45 ± 34.5	61.5 ± 16	64.5 ± 18	19.37	<0.0001*
Compulsive	63 ± 28.5	34 ± 32	44 ± 27	28.81	<0.0001*
Negativistic	44 ± 33	59.5 ± 14	61.5 ± 18	10.49	0.0001*
Masochistic	20 ± 32.5	54.5 ± 11	52.5 ± 30	24.77	<0.0001*
Severe personality pathology					
Schizotypal	24 ± 53	60 ± 8	48 ± 38	11.98	<0.0001*
Borderline	40 ± 43.5	65 ± 7	60 ± 31	21.53	<0.0001*
Paranoid	48 ± 47	63.5 ± 13	63.5 ± 19	11.63	<0.0001*
Clinical syndromes					
Anxiety	41.5 ± 58.5	82 ± 17	59 ± 49	13.42	<0.0001*
Somatoform	10 ± 27.5	46 ± 44	27.5 ± 42	7.71	0.0006*
Bipolar	60 ± 38.5	70.5 ± 19	63.5 ± 29	5.61	0.0044
Dysthymia	8 ± 29	64 ± 20	50 ± 46	38.83	<0.0001*
Alcohol use	60 ± 45.5	77.5 ± 16	74.5 ± 20	44.98	<0.0001*
Drug use	60 ± 33	89.5 ± 22	81 ± 25	74.58	<0.0001*
PTSD	30 ± 50	60 ± 10	38 ± 52	11.38	<0.0001*
Severe clinical syndromes					
Thought disorder	33 ± 43.5	69.5 ± 24	43 ± 44	24.15	<0.0001*
Major depression	12 ± 27	53.5 ± 36	33 ± 47	17.35	<0.0001*
Delusional dis.	60 ± 61	63.5 ± 10	64 ± 8	13.25	<0.0001*

Median ± interquartile range is reported for all variables, since most of the traits (82%) followed a non-normal distribution. In gray, personality traits with a median ≥60 for any of the clinical samples and significant differences between groups (control, AT, and TC).

**Significant differences between all three groups. Bonferroni correction is applied to determine critical p (0.05/24 = 0.0021).*

AT, ambulatory treatment; TC, therapeutic community.

TABLE 3 | Between-group (clinical samples) differences in the MCMI-III personality traits suggestive of symptoms at a subclinical or clinical level.

	TC (*N* = 46)	AT (*N* = 38)	*t*	*p*
Clinical personality patterns				
Depressive	61 ± 23	53 ± 41	1.85	0.068
Antisocial	70 ± 13	69.5 ± 13	2.02	0.047
Sadistic	61.5 ± 16	64.5 ± 18	1.30	0.196
Negativistic	59.5 ± 14	61.5 ± 18	0.29	0.77
Severe personality pathology				
Schizotypal	60 ± 8	48 ± 38	2.33	0.022
Borderline	65 ± 7	60 ± 31	2.57	0.012
Paranoid	63.5 ± 13	63.5 ± 19	0.77	0.44
Clinical syndromes				
Anxiety	82 ± 17	59 ± 49	3.42	0.001*
Dysthymia	64 ± 20	50 ± 46	1.78	0.078
Alcohol use	77.5 ± 16	74.5 ± 20	2.31	0.023
Drug use	89.5 ± 22	81 ± 25	2.58	0.011
PTSD	60 ± 10	38 ± 52	3.23	0.0018*
Severe clinical syndromes				
Thought disorder	69.5 ± 24	43 ± 44	2.85	0.0055
Delusional dis.	63.5 ± 10	64 ± 8	0.49	0.622

Median ± interquartile range is reported.

**Significant differences between groups. Bonferroni correction is applied to determine critical p (0.05/14=0.0036).*

AT, ambulatory treatment; TC, therapeutic community.

by Kenny (63), which assume the fulfillment of the four steps described in the Methods section of the present manuscript. We independently evaluated the effect of each scale suggestive of pathology (the 14 traits mentioned in the previous section) on treatment (TC = 1, AT = 0). Hence, we followed an approach suitable for dichotomous outcomes (66). Since we performed several different analyses, the critical *p* value was Bonferroni-corrected ($p = 0.05/14 = 0.0036$).

As expected from the results of the previous section, only anxiety and PTSD survived Bonferroni correction when evaluating the influence of the independent variables (personality traits) on the dependent variable (treatment group) (Step 1): anxiety, $\chi^2(1) = 10.91$, $p = 0.001$; PTSD, $\chi^2(1) = 9.80$, $p = 0.0017$. These traits also influenced FT (Step 2), as assessed by a linear regression: anxiety, $F(1,82) = 9.689$, $p = 0.003$, $\eta p^2 = 0.106$; PTSD, $F(1,82) = 11.84$, $p = 0.0009$, $\eta p^2 = 0.126$. Both fulfilled Step 3, that is, PFT values significantly influenced treatment group when controlling for the corresponding personality trait (see standardized coefficients in **Table 4**): anxiety, $B_{PTF} = 0.107 \pm 0.044$, $p = 0.015$; PTSD, $B_{PTF} = 0.110 \pm 0.044$, $p = 0.013$. Finally, the influence of each personality trait on treatment group was reduced when controlling for FT, although they remained significant (Step 4; see **Table 4** for details): $B_{anxiety} = 0.020 \pm 0.009$,

TABLE 4 | Mediational analyses between personality traits, frustration tolerance, and treatment group.

		Total effects (c)	Direct effects (c')	Indirect effect (a)	Indirect effect (b)	Total indirect effects (a*b)	% Total effect mediated
Anxiety	β	0.399	0.289	0.325	0.340	0.111	27.7%
	BC CI 95%	0.155, 0.625	0.041, 0.542			0.033, 0.229	
PTSD	β	0.387	0.263	0.355	0.350	0.124	32.1%
	BC CI 95%	0.148, 0.602	0.040, 0.505			0.034, 0.259	

a (indirect effect), effect of the personality scale on frustration tolerance; b (indirect effect), effect of frustration tolerance on treatment group (1 = therapeutic community, 0 = ambulatory treatment), controlling for the corresponding personality trait; β, standardized coefficient; BC CI 95%, bias-corrected 95% confidence interval after bootstrapping standardized coefficients; c, total effect of personality scale on treatment group; c', direct effect of personality trait on treatment type controlling for frustration tolerance.

$p = 0.024$; $B_{PTSD} = 0.023 \pm 0.011$, $p = 0.037$. The significance of direct and indirect effects in each case was tested using bootstrapping procedures on standardized coefficients (5,000 samples), and the bias-corrected 95% confidence intervals are reported in **Table 3** (see also **Figure 2**).

In other words, an increase of one standard deviation in anxiety and PTSD personality traits increases the odds of receiving TC treatment to 1.49 and 1.47, respectively. Part of this effect (27.7% in the case of anxiety and 32.1% for PTSD) was mediated by FT, suggesting the presence of hidden mediators.

DISCUSSION

The present results show an association between personality traits, FT, and two different therapeutic strategies to overcome substance abuse: TC and AT. Concerning MCMI-III, there were scores suggestive of pathology and significant differences between the control and clinical samples in depressive, antisocial, sadistic, negativistic, schizotypal, borderline, paranoid, anxiety, dysthymia, alcohol use, drug use, PTSD, thought disorder, and delusional disorder scales. Regarding personality and addiction, a previous report (41) analyzed personality factors in TCs of substance users. They also found scores in the pathological range in drug and alcohol use, antisocial, sadistic, and anxiety traits, among others. Overall, MCMI-III scores were higher in their study, but the general organization of clinical personality and syndrome scales resembles our results. The globally lower scores of our participants may be due to the different nature of the samples included in both studies: whereas the present report included subjects addicted to alcohol, marijuana, cocaine, or benzodiazepines, that of Magor-Blatch et al. (41) was restricted

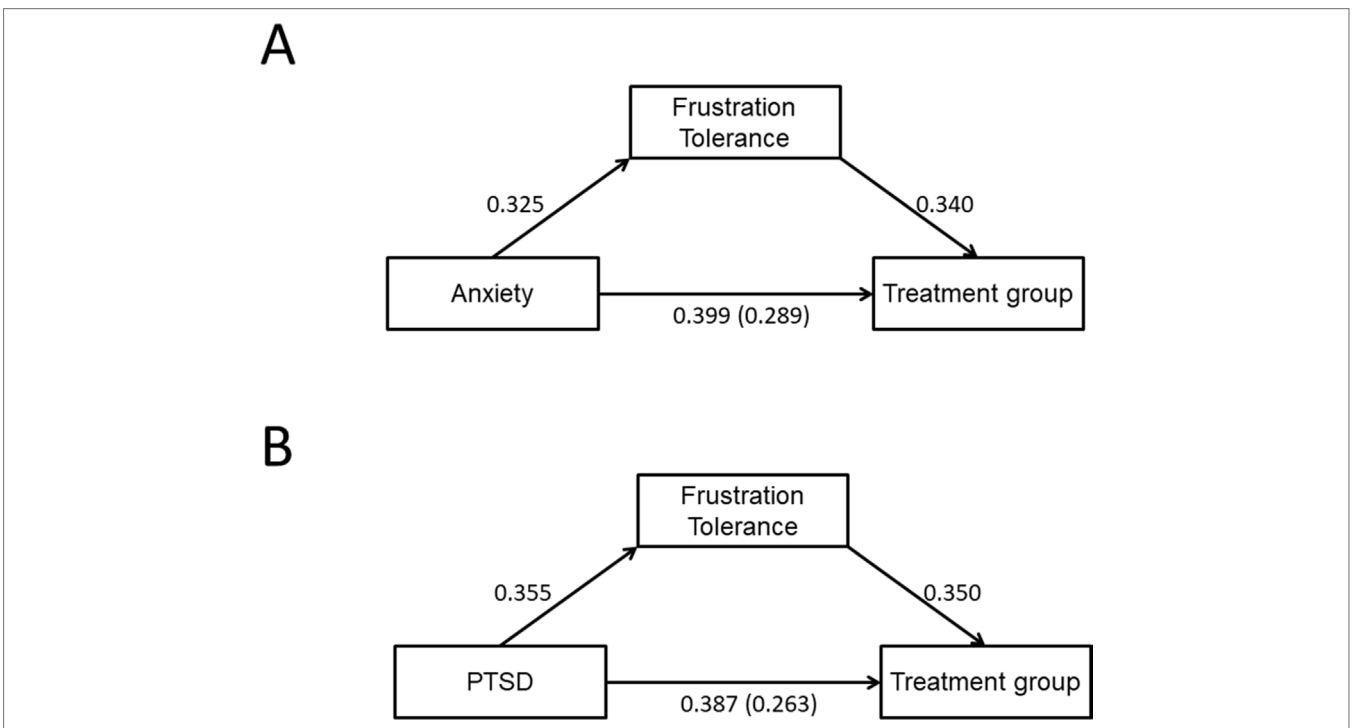

FIGURE 2 | Mediation analyses between personality traits, FT, and treatment program (therapeutic community or ambulatory treatment). Personality traits are anxiety **(A)** and PTSD **(B)**. Numbers are standardized regression coefficients. Paths from each personality trait to FT correspond to coefficient *a*; paths from FT to treatment correspond to coefficient *b*; and paths between personality traits and treatment are total effects (*c*) (in parentheses, direct effect (*c'*) when controlling for FT).

to amphetamine-type prior users. Besides, we administered the MCMI-III test two weeks after the initiation of the program, whereas they assessed participants at the commencement of the therapy. Interestingly, the control sample assessed with the MCMI-III in our research showed relatively high values (≥60) in several subscales (histrionic, narcissist, antisocial, compulsive, bipolar, alcohol and drug use, and delusional disorder). Whereas antisocial, alcohol and drug use, and delusional disorder scores were significantly lower than in the clinical samples, the median value for histrionic and compulsive traits was significantly higher in control participants than in patients. The latter result is not surprising, since elevated scores in histrionic, narcissistic, and compulsive scales have been extensively reported for nonclinical groups, pointing to normal traits; moreover, they are associated with less severity of the disorder when present in clinical samples (67). With respect to the relatively high values in alcohol and substance use, the absence of dependence and harm indicators based on the AUDIT and ASSIST justifies the consideration of this sample as "control," compared with the clinical samples.

One of the main goals of our research was to seek differences in personality factors between TC and AT groups. To our knowledge, our study is the first to compare personality patterns of substance users between both programs. Previous reports have focused on TCs (11, 14, 22, 41, 53–55, 68), while studies on outpatients addressed low-intensity drug abuse such as tobacco (69, 70), alcohol, or cannabis (17). In our study, focusing on those scales with a putative pathological meaning (with scores ≥60) that showed significant differences between the three groups, patients in TC showed higher scores than those in AT in all of the traits that were statistically different between both clinical samples (see **Table 3**). Patients in TC are more vulnerable due to the higher severity of their condition and/or a risk of social exclusion; in the case of Proyecto Hombre, the institution that hosted the volunteers included in our study, the main reason to be included in TC is insufficient family or social support. This, together with a severe substance addiction disorder, may pose difficulties for the patient to find or retain a job, stable housing, and consequently solid ground to recover from his or her condition. Due to this, patients in TC are at a higher risk for social exclusion. Our results confirm significant differences in a number of scales, pointing to an overall pathological condition that should be considered during treatment. The subscales that showed significant differences were anxiety and PTSD, with medium-large effect sizes (Hedges *g* values above 0.80 are considered large effects) (71). Previous research suggests usual co-morbidity of cocaine addiction with psychiatric disorders such as major depression, bipolar disorder, schizophrenia, PTSD, attention-deficit hyperactivity disorder (ADHD), anxiety, or borderline disorder (72). In fact, the European Monitoring Center for Drugs and Drug Addiction in 2015 stated that dual pathology and co-morbidity between drug addiction and mental disorders had risen up to 60%. According to our results, although we have not assessed co-morbidity per se, the higher scores in TC than in AT for most of the personality traits point to an enhanced vulnerability of patients in the former to develop mental disorders. This highlights the potential importance of a thorough personality profile before assigning a patient to either therapeutic program, as other authors suggest (6, 7).

With respect to negative emotional symptoms, our results show a lower FT in the clinical sample than in controls, and in TC compared with AT. The effect sizes of these results are quite large, indicating that about 96% of the matched control sample have better FT (lower scores) than the clinical sample, and about 79% of the TC sample have lower FT than the AT sample. Hence, this construct may be an important distinctive factor in substance abuse. Different stages of addiction, and relapse in particular, have been understood as a behavioral response to overcome the negative emotions (dysphoria, anxiety, irritability, etc.) that occur after the cessation of drug administration (73). Our result on the difference in FT between patients and controls may point to a crucial role in the development of addiction itself: in the presence of frustrating situations, when negative emotions are linked to a response of the pituitary–hypothalamus–adrenal axis (74), a poorer management of frustration may lead to its alleviation through the euphoric effects of recreational drugs. As has been recently suggested in children, negative emotions such as frustration may be regulated by the lateral prefrontal cortex (75). Moreover, a poor FT may trigger treatment discontinuation or relapse during withdrawal (22). We show here that patients in TC, where more frustrating situations are expected to occur due to the radical change in daily conditions, have a lower FT even when excluding the effect of treatment duration. Therefore, we suggest that a specific treatment for frustration intolerance may be useful in TCs. These results fit well with the "strength model" of self-regulation, which uses the metaphor of muscular exercise (and fatigue) to explain a decrease in self-control under stressful situations, leading to an "ego depletion" (extreme fatigue of self-control) (76, 77). In our study, FT would be a manifestation of self-control, which would be "depleted" in a greater extent in TC patients, due to the more severe conditions of the treatment and their lack of social support. As we propose below, future longitudinal studies could help clarify this potential inclusion of FT within the strength model of self-regulation.

Furthermore, we propose that clinical personality traits, mediated by a poor FT, may influence addiction severity, which is manifested in the type of treatment in which the patient is enrolled. Thus, a particular set of clinical personality features could be associated with a worse prognosis; however, this total effect might be better understood by the mediating role of FT. According to our results, this is the case for anxiety and PTSD personality traits. For example, a one-standard-deviation (23.8) increase in the MCMI-III anxiety scale would increase the odds to receive TC treatment by 49%. If the mediating role of FT were excluded, the association between both variables would decrease, and the odds would only increase 33.5%. In other words, a poor FT worsens the addiction prognosis of patients with higher levels of anxiety or PTSD personality traits. To our knowledge, this is the first time that the interaction between personality and FT has been explored in the context of addiction, and our results may suggest new strategies to improve withdrawal treatments. On the other hand, our conclusions are in line with classical psychotherapeutic approaches, such as rational emotive behavior therapy (78). According to this, even though a negative emotion is important to understand a behavioral outcome, implicit beliefs have a more important role in such emotion and its causes. The final goal of therapists, according to this account, is to help patients

minimize anxiety, guilt, and depression by accepting themselves (79); alleviate their aggression by accepting others (80); and reduce their low FT by accepting negative events (81). Hence, frustration is considered a healthy negative emotion, but a low FT is an "irrational belief" (78). Similarly, our results suggest that an improvement in FT, as a mediational variable, may alleviate the influence of more stable personality traits on addiction severity.

Our study has a number of limitations. One aspect that should be considered is the gender composition of the samples. Females were underrepresented, and therefore, the conclusions of the study could be driven by male participants. This is a usual caveat in studies about addictions. We tackled this limitation by randomly selecting age- and sex-matched subsamples with MedCalc software. Furthermore, the size of the patient sample was relatively small. Access to a clinical sample cognitively intact and willing to participate in a research project was limited; besides that, it was challenging to complete evaluation in all cases because of treatment discontinuation. With respect to the control sample and its personality assessment, median scores are relatively high (=60) for alcohol and substance use subscales; however, in our opinion, it qualifies as a control sample for two main reasons: 1) large differences in these traits with respect to the clinical samples and 2) absence of alcohol and substance dependence and/or harm after evaluation with the AUDIT and ASSIST tools, which are more specific to detecting alcohol and substance problematic use. It should be taken into account that some of the participants in the control sample were the next of kin of those in the clinical sample. Therefore, a certain degree of similarity in the psychological variables that we assessed, such as personality traits, might occur due to an akin genetic or educational background. Considering this, the differences that were found become even more relevant. Concerning the assessment of FT, we used a semi-projective test where participants were asked to explain how they would react in a frustrating situation. It could be criticized that we did not use a task that actually induced frustration in participants. However, construct validity of Rosenzweig's PFT has been adequately confirmed (82), it is considered a useful tool in clinical practice (83), and it has been shown to predict actual problem solving and stress coping in experimental settings (84, 85). In any case, future research should confirm our results with tasks eliciting actual frustration. Also, we did not collect information about the psychopharmacological medication that volunteers in the clinical samples were taking. Finally, it should be considered that the interplay between personality, FT, and treatment should be adequately assessed in longitudinal studies, including rates of relapse and dropouts. The conclusions of our study justify further research to elucidate this relationship.

Our study also suggests future directions to investigate the relationship between addiction, personality, and attachment. One crucial limitation is that we did not assess attachment styles in any of our samples, although our results can be interpreted to draw some preliminary conclusions and inspire future research. First of all, previous results show the relationship between a disorganized attachment and a higher probability of suffering anxiety (86), depression (87), addiction (88), or PTSD (89), and expressing personality disorders such as borderline, avoidant, or antisocial, among others (90). In turn, recent research has shown an association between insecure attachment, alcohol/substance addiction, and an increased amount of borderline personality organization (57). Even though the borderline trait did not survive Bonferroni correction in our study, it was suggestive of symptoms at a subclinical level in the clinical samples included in our study. Moreover, the relationship between attachment styles and substance addiction has been proven to have a biological correlate, in particular, white matter integrity: in a sample of poly-drug users, Unterrainer et al. (91) showed a decreased fractional anisotropy compared with recreational users or non-users. Furthermore, impairment of the superior longitudinal fasciculus and corona radiata was associated with an insecure attachment and negative affectivity. Interestingly, this research group previously found a relationship between white matter integrity, attachment styles, and personality factors in the aforementioned tracts (92): in this case, structural connectivity impairment positively correlated with anxious attachment and personality dysfunctioning, whereas white matter integrity positively correlated with openness and agreeableness.

Early attachment relationships, which are based on the mental models that children build about themselves, their interrelationships with their caregivers, and their environment, are essential for them to acquire the abilities of emotional management, attentional control, mentalizing, and autonomy (93). In turn, attachment theory is becoming strongly influential in research and intervention on personality disorders (94–96). According to Adshead and Sarkar (96), these disorders include an intrapersonal component (related to a dysregulation of arousal, impulse, and affect systems in response to stress), an interpersonal component (dysfunctional attachment patterns), and a social component (dysfunction in social behaviors). To some extent, our research covers an interpersonal (FT) and social component (substance addiction inpatient or outpatient treatment), which can be related with the interpersonal component. According to our results, anxiety and PTSD are those personality traits more affected in the TC group, and under the influence of FT, they predict the inclusion in TC or AT treatment. The link between attachment styles and anxiety has been extensively demonstrated [see, for example, the review by Ref. (97)]. According to these authors, anxiety is more frequent in adolescents who experienced resistant attachment during childhood compared to those with secure or avoidant styles. This association remained when considering attachment-related negative experiences during childhood (such as parental divorce or loss) or attachment states of mind (i.e., preoccupied), instead of self-reported assessment of attachment. Similarly, PTSD has been related to disorganized attachment. For instance, unresolved attachment-related state of mind is associated with a higher risk (7.5) of expressing PTSD (98). Furthermore, posttraumatic symptoms through midlife and old age are associated with adult attachment insecurity (99). In conclusion, our results point to a plausible interplay between disorganized attachment, FT, and certain personality traits (mainly anxiety and PTSD) in substance abuse disorders. Future research on these topics from a unitary perspective may increase our understanding of substance addiction, improving prevention

policies, and hopefully designing improved individualized treatments for patients suffering this devastating disorder.

ETHICS STATEMENT

This study was approved by the Committee of Ethics in Research of the University of Navarra. All subjects gave written informed consent in accordance with the Declaration of Helsinki.

AUTHOR CONTRIBUTIONS

FG, JB, and IM conceived the study; DR-C, CG-R, FG, and IM collected data and organized the database; DR-C, IM, and JB performed the statistical analyses; JF-M wrote sections of the manuscript and supervised data analyses. All authors contributed to manuscript revision, read and approved the submitted version.

ACKNOWLEDGMENTS

The authors are grateful to Drs. Gonzalo Arrondo, Maite Aznarez, and Jose Ignacio Murillo for their technical and theoretical advice on this research. We also acknowledge the collaboration of the users and personnel of Fundación Proyecto Hombre Navarra and Asociación Proyecto Hombre Granada for making possible this research. This project was funded by Fundación Caja de Ahorros de Navarra (grant number 70721) and the Spanish Ministerio de Sanidad, Servicios Sociales e Igualdad (2016/057).

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychiatry

REVIEW
published: 27 August 2019
doi: 10.3389/fpsyt.2019.00579

The Role of Attachment in Poly-Drug Use Disorder: An Overview of the Literature, Recent Findings and Clinical Implications

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Background: Substance use disorders (SUDs) represent a worldwide epidemic with extensive costs to the individual and to society. Occasionally described as an attachment disorder, they have been linked to various impairments in self-regulation and social functioning. However, while there have been significant advances in the development and validation of treatment strategies for SUD in recent years, the components of these treatment approaches have yet to be fully explored. The characteristics of polydrug use disorder (PUD) especially need to be addressed in more detail, as this diagnosis is highly common in individuals seeking treatment, while simultaneously being associated with poor treatment success.

Aim and Scope: This review aims at further exploring the relevance of attachment in PUD and its treatment. To this end, this review provides a concise summary of relevant theories on the development and treatment of SUD in general, including related parameters of attachment, emotion regulation, and neuroscience. Furthermore, several studies focused specifically on PUD are described in more detail. These studies explored the connections between attachment, personality structure, primary and higher emotions (including spirituality), as well as structural and functional neural parameters in inpatients with PUD as well as in healthy controls. Most notably, the described studies highlight that insecure attachment and impairments in personality structure are present in inpatients with PUD. In addition, these characteristics are paralleled by extensive impairments in white matter integrity, especially in tracts connected to facets of emotion regulation.

Conclusions: Based on our findings, we emphasize conceptualization of PUD as an Attachment Disorder, on a behavioral as well as on a neural level. Furthermore, we point out the importance of an integrated bio-psycho-social approach in this research area. Consequently, future studies might more closely focus on the influence of attachment-based interventions on emotion regulation abilities as well as a potentially related neuroplasticity. Neuroplastic changes, which are still rather unexplored, might represent important parameters for the assessment of treatment outcomes especially in long-term SUD treatment.

Keywords: substance use disorder, attachment, emotion regulation, treatment, polydrug use disorder

OPEN ACCESS

Edited by:
Carlos Roncero, University of Salamanca Health Care Complex, Spain

Reviewed by:
Gail Horton, Florida Atlantic University, United States
Silvia Salcuni, University of Padova, Italy

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Specialty section:
This article was submitted to Addictive Disorders, a section of the journal Frontiers in Psychiatry

Received: *25 April 2019*
Accepted: *23 July 2019*
Published: *27 August 2019*

Citation:
Hiebler-Ragger M and Unterrainer H-F (2019) The Role of Attachment in Poly-Drug Use Disorder: An Overview of the Literature, Recent Findings and Clinical Implications. Front. Psychiatry 10:579. doi: 10.3389/fpsyt.2019.00579

INTRODUCTION

As it has been suggested that individuals with polydrug use disorder (PUD) differ from individuals with other substance use disorders (SUDs) (1) and that they consequently may need different treatment settings (2), we dedicated five studies to the exploration of attachment and related parameters in inpatients with PUD. In this review, we summarize current theoretical models and empirical results related to the conceptualization of addiction as an attachment disorder before discussing our results on PUD and their implications for future research and clinical practice.

SUDs represent a worldwide public health problem [e.g., Ref. (3)]. As the social, occupational, mental, and physical problems connected to these disorders often persist even after abstinence is achieved, the direct and indirect costs of SUD to the individual and to society are extensive (4). Polydrug use is especially common among drug users worldwide (1). Furthermore, most individuals in treatment for SUD report a PUD (2). As previous studies have suggested numerous differences between PUD and Mono-SUD regarding personality (e.g., impulsivity) as well as etiological (e.g., emotional neglect in childhood) factors (5), it has been suggested that individuals with PUD might even need different treatment settings (2). However, while countless studies have focused on understanding the multifactorial and complex nature of different SUD in order to optimize prevention and treatment, "many challenges remain to understand and treat drug addiction" (p.1) (6).

Bowlby (7) already noted that insecure attachment patterns can help to explain "the many forms of emotional distress and personality disturbances, including anxiety, anger, depression, and emotional detachment, to which unwilling separations and loss give rise" (p. 201). Accordingly, insecure attachment patterns have been extensively discussed as contributing to different facets of personality pathology (8, 9) as well as a large number of other psychiatric diseases, including affective disorders in addition to SUD (10).

Importantly, attachment theory offers the great advantage of not only informing our understanding of the development of psychopathology but also of the development of mental health and well-being. **Figure 1** gives a short overview regarding the mechanisms underlying the development and treatment of SUD that will be described in this review.

Consequently, this review aims to describe how insecure attachment (developed in response to negative childhood experiences) leads to diverse vulnerabilities (e.g., impairments in emotion regulation and neural parameters) that may contribute to the development of SUD and that are in turn influenced by the dynamics of SUD. On the other hand, positive social experiences during treatment may promote the development of more secure attachment (including for example improvement in emotion regulation) that supports an increased independence from psychoactive substances (see **Figure 1**).

In this paper, we will therefore first provide a concise summary of the background relevant for our research on PUD (i.e., attachment theory and its relationship with personality structure, conceptualization of SUD and its relation to attachment in general, neural parameters underlying attachment and emotion regulation, treatment of SUD with a focus on the therapeutic community). Consequently, we will discuss five studies focused on inpatients with PUD undergoing treatment in a therapeutic community setting. Lastly, we will discuss the results of these studies in relation to current research and theoretical models with a special focus on attachment-related parameters (e.g., emotion regulation) and treatment approaches.

Attachment Theory

As "adaptations to early experiences set the stage for negotiating later experiences" (11), the development of adult psychopathology has to be considered in light of the interactions between earlier experiences, the resulting adaptation, and current contextual parameters (12). Furthermore, most theories of development include the fundamental concept that social relationships both influence and are influenced by the development of psychopathology: Therein, secure attachment is generally thought to act as a protective factor, while insecure attachment is thought to increase the vulnerability for psychopathology [for an overview, see Ref. (13)]. Importantly, however, the possible influence of attachment always has to be considered in the context of other risk factors (14–16) as pathology is unlikely to be caused by a single risk factor.

According to attachment theory, attachment is not a mere secondary drive but has to be seen as a fundamental primary motivation with its own dynamics (17). As it—ideally—establishes a "secure base" from which the individual can explore

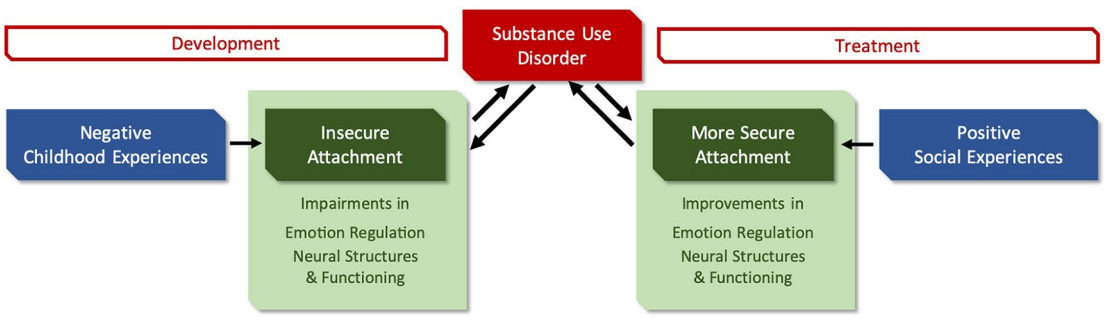

FIGURE 1 | Brief overview of the influence of attachment on SUD. The figure details the role of attachment patterns that form through social experiences, as well as related parameters on the development and treatment of substance use disorders (SUDs).

the world as well as a "safe haven" to retreat to in times of distress (18), the attachment system has an important impact on everyday person–environment interactions (19).

Dynamics and Styles of Attachment

Attachment theory (17, 18, 20) differentiates between a secure attachment style that is established through a sensitive, supportive, and caregiving environment and insecure attachment styles that are the result of an inconsistent, insensitive, or dismissive attachment figure. Mikulincer and Shaver (21) differentiate between two basic attachment dimensions: Anxious attachment and avoidant attachment. Accordingly, secure attachment (low anxious and avoidant attachment) allows the individual to deal with stressful experiences by relying upon mental representations of previously received support or by actively seeking support in the present (22). Individuals with high levels of anxious attachment, characterized by the use of hyperactivating strategies, actively demand support even though they may feel unworthy of love (21). For individuals with high levels of avoidant attachment, characterized by the use of deactivating strategies, they pride themselves on their self-reliance, which in turn can lead to a denial of personal imperfections and weaknesses (23).

Lastly, fearful attachment is defined by high levels of anxious attachment and avoidant attachment (21, 24). While "normal" samples mostly contain individuals with secure attachment (about 70%) (25), individuals with extremely high scores on both anxious attachment and avoidant attachment (i.e., fearful attachment) are most likely to be found in abused or clinical samples [for an overview, see Ref. (26)]. Fearful attachment can furthermore be described as disorganized, since individuals with this attachment style seem unable to develop an organized strategy, whether to rely on hyperactivating or deactivating behaviors to get their attachment needs met [e.g., Ref (22)]. Therefore, rather than enacting and habituating reliable clinging/whining/attention-seeking (hyperactivating) or withdrawing/dissociative (deactivation) behaviors, they simply erupt into some kind of behavior in an effort to relieve stress and may even combine hyper- and deactivation strategies into odd and ineffective responses.

Attachment and Personality Structure

Bowlby, describing the long-lasting effects of attachment across the lifespan (7), has already named early attachment experiences as an important factor influencing personality structure. Essentially, while the internal working models defined by attachment theory have a strong focus on the content and behavioral consequences of mental representations, the concept of personality structure extends this model by adding the complexity of their structural organization and integration. Therefore, individuals with similar attachment patterns might vary regarding the level of integration and differentiation of their internal working models (27, 28). In general, however, more insecure attachment patterns seem to be associated with lower levels of structural integration (i.e., more impairments in personality structure) (29).

A good structural integration is defined by a relatively autonomous self that shows stability as well as flexibility when adequately processing impulses, emotions, and conflicts (30). A moderate structural integration is defined by a tendency towards overcontrolling as well as an increased occurrence of self-destructive impulses. A low structural integration is defined by impaired regulatory functions, which leads to repetitive flooding with intense negative affect as well as (self-) destructive impulses (30). Lastly, a disintegrated structure is defined by the central fear that the sense of self vanishes due to a symbiotic merging of the self and objects (30). Consequently, patients with a low level of structural integration seem to be more likely to experience psychotic symptoms (31), to have a longer duration of mental illness (32), and to be recommended psychiatric instead of psychotherapeutic treatment (33). Conversely, both patients and therapists rate a higher level of structural integration as advantageous for the success of treatment and a change in symptoms (32, 34).

Attachment and Emotion Regulation

Various forms of SUD, including PUD, have been linked to impairments in the cognitive control of emotions [for an overview, see Ref. (35)].

Importantly, deficiencies in emotion processing and regulation are a known "liability spectrum that underlies many different mental disorders" (p. 154) (36). Developing the capacity for healthy interpersonal affect regulation requires the development of a secure attachment style, as individuals with secure attachment are willing and able to acknowledge and communicate their emotions (37). Therefore, the primary function of adult attachment relationships may be seen in the social regulation of emotions (38).

Consequently, the use of psychotropic substances has been connected to anxious attachment (39, 40), avoidant attachment (41, 42) and disorganized attachment (39, 43, 44). This indicates that the deprivation of developmental needs generally can result in vulnerabilities that in turn lead to misguided attempts at self-repair, leaving the individual "constantly searching for something 'out there' that can be substituted for what is missing 'in there'" (p. 7) (45). This coincides with the psychodynamic point of view that substance abuse "represents a failure to negotiate the transition from helplessness to competence in the social world" (p. 2004) (10). Importantly, the conceptualization of SUDs as an "Attachment Disorder" does recognize that SUDs are not a one-dimensional phenomenon: While substance abuse is initially used by the individual to deal with difficulties in interpersonal relationships, it consequently gradually increases the impairments in "an already fragile capacity for attachment" (p. 2) (45).

Neural Structures Related to Attachment and Emotion Regulation

Although numerous neurobiological studies in the past few decades focused on attachment in nonhuman animals, such research in humans is relatively limited (46). Consequently, neural circuits underlying attachment are as yet relatively unknown (47). In addition, one has to keep in mind that the attachment behavioral system is highly unlikely to be related to a singly, dedicated attachment circuit, as this higher-order construct makes use of multiple subsystems (e.g., emotion, memory, perception,

motivation) (46). In light of these multiple subsystems involved in attachment, it may even be suitable to "think of the entire human brain as an attachment system" (p. 244) (46).

As one of the most important brain structures associated with emotion (48), the amygdala reacts to both unconditioned and conditioned signs of threat (46) and is highly sensitive to facial social signals (49, 50). Together with the hippocampus that is involved in the formation of associations between internal states and environmental stimuli (51), the amygdala consequently enables the identification and consolidation of important interactions with attachment figures as well as emotionally salient situations (46).

Strongly connected to these brain structures, the prefrontal cortex plays an important role in motivation as well as emotion regulation (46, 52, 53). In detail, the prefrontal cortex seems to be connected to attachment through the encoding of "automatic" (conditioned through threat related stimuli) responses to the attachment figures as well as the "effortful" modulation of cognitive operations involving the attachment figures (46).

While secure attachment is generally thought to be associated with less reactivity to distress, insecure attachment seems to be connected to increased neural activation throughout the brain under conditions of distress (e.g., pain or threat) (46). Furthermore, individuals with avoidant attachment seem less able to profit from the presence of others in times of distress but rather tend to perceive them as an additional burden (46). Among these processes, social affect regulation can be seen as a bottom-up mechanism, while affect regulation without support from others can be seen as a top-down mechanism. These top-down mechanisms include effortful cognitive and attentional emotion regulation strategies, such as suppression or cognitive reappraisal, that rely heavily on the prefrontal cortex (46).

Substance Use Disorders

Definition and Diagnostic Criteria

In the literature on SUD, various terms are used to describe the relation between a psychotropic substance and its user. Consequently, a SUD can be described as chronic, relapsing disorders defined by 1) the compulsive seeking and taking of psychotropic substances, 2) a loss of control regarding these behaviors, as well as 3) the emergence of withdrawal symptoms that include negative emotions (e.g., irritability, anxiety) when these behaviors are unfruitful.

While similar criteria for SUD can be found in Diagnostic and Statistical Manual of Mental Disorders IV (DSM-IV) (54) and International Classification of Diseases in 10th revision (ICD-10) (55), conceptual and diagnostic changes have been made in the DSM-V (56): Here, the criteria for substance abuse and substance dependence have been merged into one continuum of SUDs, ranging from mild to moderate to severe, based on the number of criteria met.

Development of Substance Use Disorders

Diverse pathways and multiple, interacting processes may lead to SUD, with the individuals abusing or dependent on one or more of these substances consequently representing a highly heterogeneous group: Differences might be present, for example, in social development, comorbidity, neurobiological processes and genetics (57). The importance of applying a developmental perspective—as provided for example by attachment theory—to the study of SUD is underlined by various aspects: Epidemiological data reveal characteristic age-related trajectories for SUD, progressing from the typical onset of substance use and SUD during adolescence to peak rates in young adults and to a decline in later life (58).

Regarding the development of a PUD, developmental progression may not only apply to the stages of use—ranging from occasional use to dependence—but also across substances: For example, individuals often seem to progress from "gateway" substances (e.g., tobacco, alcohol, cannabis) to the use of other psychotropic substances (59–62). This progression might be attributed to several factors, including a common propensity to use psychotropic substances, a sensitization for the use of other substances due to the use of a previous substance, or a connection to a social network that promotes the use of several substances (61, 63, 64).

Neural Parameters of SUD

Several studies using magnetic resonance imaging (MRI) techniques have reported altered brain morphology in various SUDs [for an overview, see Ref. (65)]: Regarding gray matter, impairments have particularly been reported in the frontal lobes, the amygdala, and the insula. Regarding white matter, impairments have especially been reported in the genu and the corpus callosum as well as in prefrontal regions. In general, these impairments seem to be relevant for various cognitive dysfunctions relevant in SUD (e.g., increased impulsivity and impaired executive functions) [for an overview, see Ref. (65)]. However, there is still some debate as to how and to what extent SUDs are connected to impairments in white matter integrity (66, 67). For example, impairments in self-regulation and executive functions, connected to dysfunctions or pathologies in the frontal lobes, represent a risk factor not only for SUD but several psychiatric disorders (68). Regarding white matter tracts, a healthy development is necessary for an efficient communication between brain regions, higher order cognitive functioning, as well as several complex behaviors (69). Consequently, substance abuse is likely particularly harmful during adolescence, when white matter is still developing (66, 70–72).

In general, neural impairments connected to SUD seem to be especially prevalent in the above described structures related to attachment and emotion regulation (e.g., in the amygdala or the prefrontal regions).

Treatment of SUD

Most specialists for the treatment of SUD (intuitively) recognize the importance of attachment in addiction, independent of whether interpersonal problems are the cause or the consequence of drug use (45). However, before an attachment to treatment (e.g., a therapeutic alliance) can be established, individuals with a SUD must first become detached from the substances they abuse (45). Therefore, the consideration of attachment theory in the treatment of SUD highlights the importance of the therapeutic alliance (73).

While there have been significant advances in the development and validation of psychosocial treatment strategies for SUD in

the past few decades, the parameters for the success of these approaches have yet to be fully explored. A meta-analytic review by Dutra and colleagues (74) found moderate effect sizes for psychosocial treatments, but these effect sizes varied considerably dependent on the SUD and the treatment strategy under study; although individuals with Cannabis Use Disorder appeared to profit considerably from psychosocial interventions, individuals with PUD seem to profit the least. Drop-out rates were high (around one third) across all psychosocial interventions, but approximately the same percentage of participants achieved posttreatment and/or clinically significant abstinence (74).

Since the establishment of opioid substitution in the 1960s, this treatment strategy for opioid use—that is highly prevalent in PUD (75)—went hand-in-hand with psychosocial interventions. Accordingly, international clinical guidelines list psychosocial rehabilitation as crucial in this area (76). However, while several randomized controlled trials and systematic reviews conclude that opioid substitution is just as effective or even more effective when provided on its own, some large outcome studies have concluded that treatment providers with a higher frequency and quality of psychosocial interventions are better able to achieve positive outcomes [for an overview, see Ref. (76)].

Contrary to the classic psychodynamic developmental model, attachment-oriented treatment does not equate mental health and maturity with independence (45, 73). In line with Bowlby (20), normal development is seen as a movement from immature dependence towards mature interdependence and mutuality (73). Consequently, group therapy has been an important component of the treatment for SUD ever since the establishment of Alcoholics Anonymous (AA) in the 1930s (73). This can be attributed to the interpersonal conception of group therapy (human beings are always considered as social and as being situated in relation to others) that is more likely to promote attachment than other treatment strategies (73).

Interestingly, spirituality is also considered to be a helpful factor in the treatment of SUD (77). While it is closely connected to the AA program, it has also been incorporated in other treatment strategies (78, 79). This is not surprising, given that the relationship between believers and a higher power (e.g., God or other divine figures) frequently fulfils the criteria of an attachment bond and can consequently be assumed to enable similar psychological advantages (80). As the sense of having a secure attachment bond with a higher power is associated with higher spiritual well-being (81), spirituality can be conceptualized as the "ability to experience and integrate meaning and purpose in existence through a connectedness with self, others or a power greater than oneself" (p. 117) (82). Consequently, more secure attachment seems to be related to lower levels of mood pathology in general and in individuals with SUD (81, 83).

As an extension of group therapies, therapeutic communities were established in the 1960s as long-term (several months) residential programs for individuals with SUD (84). According to their conceptual groundings, the extent of impairments in psychological dysfunction and social deficits is more important than a certain pattern of drug use. Considering "community as method," the most important psychological treatment goals are to restructure the negative patterns of behavior, thinking and feeling using self-help, mutual self-help, and social learning (84). A long-term stay within this caregiving, abstinence promoting environment should encourage alternative emotional experiences and, consequently, stimulate a kind of subsequent maturation of former inadequate attachment patterns (45).

Implications of PUD

While several studies report high levels of PUD in patients with SUD as well as a greater SUD severity in patients with PUD (e.g., 2, 85), comparatively few studies consider a wide range of drug types and/or classes, thereby neglecting the issue of polydrug use and PUD (86). Furthermore, the different definitions of polydrug use applied in SUD research often make it difficult to compare studies (87). These tendencies may lead to research results that provide little relevant information for clinicians involved in SUD treatment programs. On the other hand, explicit evaluations of polydrug use could have a high clinical as well as public health relevance (60).

In general, especially adolescents with self-perceived low social standing and lower parental socioeconomic status seem to be at risk to develop this pattern of drug use (88). Therein, polydrug use seems to be more prevalent in young men than young women (89, 90) and comorbid mental disorders seem to be more prevalent in young adults with PUD compared to those with another SUD (91). Importantly, while polydrug use is highly prevalent in individuals with opioid use disorder, individuals with this pattern of drug use also show a high prevalence of comorbid posttraumatic stress disorder (PTSD) (75). Therein, PTSD and PUD may be connected by "an 'additive' self-medication model" (p. 39) (92). In addition, the number of polysubstance opioid overdoses seems to be increasing in certain areas (93) and SUD persistence rates seem to be consistently higher in PUD than in other SUD (94). These recent findings further underline the need for addressing polydrug use and related characteristics in SUD research and clinical practices.

While this review focuses mainly on PUD, the reported mechanisms related to attachment and emotion regulation as well as their neural correlates may be largely seen as liabilities relevant to SUD in general. In line with this, recent findings suggest that treatment strategies should target these broader liabilities instead of focusing on specific SUD (95). However, several studies also highlight the need for a closer examination of the characteristics and treatment requirements of individuals with PUD (92, 96, 97).

RESEARCH FOCUSED ON POLY DRUG USE DISORDER

Based on the above described theoretical and empirical background, our research group conceptualized five studies—three of which used (f)MRI—that aimed at further exploring attachment and related parameters in PUD. A concise overview on the methods and results of each study can be found in **Table 1**. Additional information on the presented studies (e.g., statistical analyses, sample characteristics) can be found in the related publications (98–102) or obtained from the authors.

TABLE 1 | Methods and results of studies on PUD.

	Sample		Methods		Results
	SUD	**Controls**	**Questionnaires and tests**	**(f)MRI parameters**	
Attachment and neural parameters					
Study 1 (100)	PUDa: *n* = 18 PUDm: *n* = 15	*n* = 16	AAS, BSI-18, NEO-FFI, IPO-16, WPT	White Matter: FA, RD	PUD showed - more insecure attachment, - more impairments in personality structure, - more neuroticism and agreeableness. In addition, PUD showed - reductions in FA and - increases in RD in mainly the same white matter tracts.
Study 2 (99)	PUD: *n* = 19	RUC: *n* = 20 NUC: *n* = 20	AAS, MI-RSWB, BANPS WPT	White Matter: FA ROIs: SLF, SCR	PUD showed - more insecure attachment, - more negative primary emotions. In addition, PUD showed - reductions in FA.
Study 3 (101)	PUD: *n* = 18	n = 16	RIT, ERQ, OPD-SQ, BSI-18, WPT	RGT	PUD showed - more insecure attachment, - more impairments in personality structure, - more mood pathology, - poorer emotion regulation skills. No group differences in reappraisal-related neural activation were found.
Attachment and treatment adherence					
Study 4 (98)	AUD: *n* = 66 PUD: *n* = 57	n = 114	ASQ, BPI	–	AUD or PUD showed - more aspects of borderline personality structure, - different attachment patterns than CG. No differences could be observed between AUD and PUD inpatients.
Study 5 (102)	AUD: *n* = 66 PUD: *n* = 57	–	ASQ, BPI At treatment entry and after six weeks	–	Inpatients with more "Confidence in Self and Others" were more likely to drop out of treatment.

PUDa, inpatients with a PUD that were abstinent; PUDm, inpatients with a PUD undergoing maintenance therapy; AAS, Adult Attachment Scale; BSI-18, Brief Symptom Inventory; NEO-FFI, Neuroticism Extraversion Openness Five Factor Inventory; IPO-16, 16-Item Inventory of Personality Organization; WPT, Wonderlic Personnel Test; FA, Fractional Anisotropy; RD, Radial Diffusivity; RUC, controls with recreational drug use; NUC, non-drug-using controls; MI-RSWB, Multidimensional Inventory for Religious/Spiritual Well-Being; BANPS, Brief Affective Neuroscience Personality Scale; ROI, Region of Interest; SLF, superior longitudinal fasciculus; SCR, superior corona radiata; RIT, Reappraisal Inventiveness Test; RGT, Reappraisal Generation Task; ERQ, Emotion Regulation Questionnaire; OPD-SQ, OPD Structure Questionnaire; AUD, Alcohol Use Disorder; ASQ, Attachment Style Questionnaire; BPI, Borderline Personality Inventory. Additional information on the presented studies (e.g., statistical analyses, sample characteristics) can be found in the related publications (98–102) or obtained from the authors.

Attachment and Neural Parameters

Regarding attachment and neural parameters in PUD, two studies focused on the relevance of potential impairments in white matter integrity, while one study explored neural activation patterns during a novel emotion regulation task. The aim was to gain new insights into the bio-psycho-social interactions underlying PUD.

Study 1

As previous studies indicated that a drug substitute (e.g., Methadone) could artificially alter the attachment status so that insecure individuals would appear secure (10, 103), our first study (100) explored whether inpatients with PUD, who were either abstinent or in maintenance treatment, differed regarding white matter structure (assessed by means of diffusion tensor imaging) as well as cognitive ability, attachment style, and personality/mood pathology.

Methods and Results

In the first study (100), the sample of 49 men included inpatients with a PUD who were either abstinent (PUDa; *n* = 18) or undergoing maintenance therapy (PUDm; *n* = 15) as well as a control group of healthy students (CG; *n* = 16). In addition to the *Adult Attachment Scale* (AAS) [Ref. (104, 105), and the *Brief Symptom Inventory* (BSI-18) (106), participants completed the *Neuroticism Extraversion Openness Five Factor Inventory* (NEO-FFI) (107) assessing Extraversion, Agreeableness, Conscientiousness, Neuroticism, Openness to Experience, and the *16-Item Inventory of Personality Organization* (IPO-16) (108) assessing Identity Diffusion, Primitive Defense, and Reality Testing as potential impairments in personality structure. Lastly, the *Wonderlic Personnel Test* (WPT) was used as a rough screening instrument for intelligence (109). White matter integrity was assessed through diffusion tensor imaging (DTI) that is based on the directionality and rate of diffusion of

water within tissue. Consequently, a higher fractional anisotropy indicates for example that diffusion is restricted by the myelin sheaths of axons (110).

Regarding personality characteristics, PUD showed a higher amount of insecure attachment, a higher total amount of impairments in personality structure, indicating a higher risk for personality disorders (108), as well as higher amounts of neuroticism and agreeableness. Regarding white matter integrity, group differences in FA and radial diffusivity (RD) were generally more pronounced between CG and PUDa than between CG and PUDm, with both clinical groups showing widespread reductions in FA and increases in RD mainly in the same white matter tracts (mostly the superior corona radiata and the superior longitudinal fasciculus of the right hemisphere) (100). In general, lower FA and higher RD indicate a higher probability for white matter impairments (111). Interestingly, more insecure attachment and more impairments in personality structure were related to lower FA (r = -.36 to -.41) and higher RD (r = .31; all $p < .05$) over all participants.

Discussion of Results

The results of the first study (100) indicate that impairments in white matter structure are present in inpatients with PUD and that these impairments are paralleled by a higher amount of mood and personality pathology. In line with the conceptualization of SUD as "Attachment Disorders" (112) and in accordance with previous work (42), substituted inpatients with PUD seem to show the highest amount of anxious attachment.

Contrary to our assumptions, no significant differences in white matter integrity between abstinent and substituted inpatients with PUD were found. However, differences in white matter parameters were more pronounced between abstinent inpatients with PUD and healthy controls than between substituted inpatients with PUD and healthy controls (100). This may indicate that white matter integrity deteriorates more under abstinence, as the brain struggles to regain homeostasis (100). As impairments in the superior corona radiata and the superior longitudinal fasciculus have also been observed in adolescent substance abusers, they may be partly premorbid or a very early occurrence in SUD (66). Furthermore, impairments in the superior corona radiata and the superior longitudinal fasciculus appear to be linked with impaired decision-making (113), while impairments in the superior corona radiata can also be linked to higher risk taking in adolescents (69).

Study 2

In the second study (99), we focused on the superior corona radiata and the superior longitudinal fasciculus, as deficiencies in these tracts have been linked to SUD in several studies (66, 100, 114). In addition, we hypothesized that higher amounts of existential fear and despair would be connected to more insecure attachment and decreased spiritual well-being in inpatients with PUD (115). Furthermore, following the concept of a severity continuum in SUD (56), we differentiated between non-drug-using controls, recreational drug-using controls, and inpatients with PUD.

Methods and Results

In the second study (99), the sample of 59 men included inpatients diagnosed with PUD (PUD; n = 19) as well as controls with recreational drug use (RUC; n = 20) and non-drug-using controls (NUC; n = 20). All participants completed the *Adult Attachment Scale* (AAS) [Ref. (104, 105), the *Multidimensional Inventory for Religious/Spiritual Well-Being* (MI-RSWB) (116) and the *Wonderlic Personnel Test* (WPT) (109) as well as the *Brief Affective Neuroscience Personality Scale* (BANPS) (117) assessing the primary emotions SEEKING, SADNESS, FEAR, ANGER, CARE, and PLAY (118).

Regarding behavioral parameters, PUD showed higher levels of attachment related Anxiety than NUC and RUC as well as higher levels of negative primary emotions than NUC. No differences were found regarding the other variables. To explore possible connections between the behavioral parameters and white matter integrity, a regions-of-interest (ROIs) analysis including the superior longitudinal fasciculus and the superior corona radiata of both hemispheres focused on fractional anisotropy (FA), the most widely used DTI parameter (111). Here, PUD showed a lower FA compared to NUC and RUC in the right and left superior longitudinal fasciculus as well as a lower FA compared to NUC in the right and left superior corona radiata. Furthermore, FA in the right superior corona radiata was related to more secure attachment (r = .58) and less FEAR (r = -.46; both $p < .05$) (99).

Discussion of Results

While the second study (99) also supports the presence of white matter impairments and insecure attachment in inpatients with PUD, some additional insights could be gathered, as increased levels of certain primary emotions also seem to be connected to diminished white matter integrity. As in previous research (119, 120), inpatients with PUD in this study demonstrated a higher amount of ANGER, FEAR, and SADNESS compared to non-using controls (99). However, no differences were found regarding SEEKING, which previously has been theorized to be pathologically abridged in SUD (121, 122). This may be attributed to the fact that the inpatients with PUD in this study were enrolled in a therapeutic community (123, 124) during data acquisition. This treatment approach is theorized to act like a substitution drug, thereby balancing the abridged SEEKING dimension that would otherwise heighten drug craving and the possibility of relapse (121, 125). In addition, the high level of SADNESS in inpatients with PUD may underline the close connection between SUD and depression (10). The tentative connections between attachment, primary emotions, religious/spiritual well-being, and white matter integrity in inpatients with PUD that were found in this study (99) are in line with the notion of including religious/spiritual aspects in addiction treatment. As stated before, this may allow for more secure attachment experiences and could consequently increase the ability for emotion regulation (45, 115, 124).

Study 3

In the third study (101), we aimed to generate new information regarding impaired emotion regulation abilities in SUD by the

exploratory use of an fMRI paradigm focusing on cognitive reappraisal. This strategy refers to a deliberate re-interpretation in order to modulate emotional impact (126).

Methods and Results

The third study (101) tested 34 right-handed men, divided into two groups, one clinical inpatient group (PUD; n = 18) diagnosed with PUD and one group of healthy controls (HC; n = 16) who reported very little or no experience with illegal substances. Cognitive reappraisal capacity was assessed outside the scanner with the Reappraisal Inventiveness Test (RIT) (127) as well as with the similar Reappraisal Generation Task (RGT) during fMRI: In each test, subjects are instructed to empathize with anger-eliciting situations and to consequently generate different reappraisals in order to downregulate anger. In addition, participants completed the *Emotion Regulation Questionnaire* (ERQ) (128), German version by Abler and Kessler (129), the *OPD Structure Questionnaire* (OPD-SQ) (130) assessing impairments in personality structure with four dimensions (131) that each comprises a self-related and an object-related subdomain: 1) Perception; 2) Regulation; 3) Communication; 4) Bonding, as well as the *Adult Attachment Scale* (AAS) [Ref. (104, 105), the *Brief Symptom Inventory* (BSI-18) (106), and the *Wonderlic Personnel Test* (WPT) (109).

Group comparisons revealed several differences with generally large (eta^2 > .14) effect sizes (132) between PUD and HC: PUD reported more impairments in personality structure, mood pathology, and insecure attachment. Concerning emotion regulation, PUD reported a less frequent use of reappraisal but a more frequent use of suppression. Regarding cognitive reappraisal, PUD showed lower fluency and flexibility of ideas as well as more induced anger than HC. In line with this, their reappraisals during fMRI were rated as less effective than those of HC. Regarding the reappraisal-related neural activation, remarkably similar patterns were observed for both PUD and HC: They included a rather left-lateralized network of inferior, superior, and middle frontal gyri, supplemental motor areas, as well as pre- and postcentral gyri.

A consequent conjunction analysis on voxels significantly activated in PUD and HC showed in more detail that both groups activated the left inferior and superior frontal gyri, the right cerebellum, as well as the right middle temporal cortex. No group differences in neural activation were found.

Discussion of Results

The results of the third study (101) not only underlined our previous findings of insecure attachment and impaired personality structure in SUD but also highlighted the prevalence of impaired emotion regulation abilities in PUD. Although we did not find the expected differences in neural activation patterns during cognitive reappraisal between inpatients with PUD and healthy controls, the pattern of neural activation assessed for both groups highlights the crucial role of the frontal cortex and therefore of executive functions in this emotion regulation strategy (127, 133). Considered together with the poorer behavioral results in cognitive reappraisal in inpatients with PUD, the discrepancy between neural and behavioral results may point towards a third parameter connecting these two levels (101): As our previous two studies (99, 100) found extensive white matter impairments in inpatients with PUD, efforts in cognitive reappraisal could generate the required activation in gray matter structures in inpatients with PUD, but white matter impairments may prevent an adequate interaction between these gray matter structures, which could result in a lower capacity for cognitive reappraisal. In addition, as the contrary strategies underlying different types of insecure attachment—hyperactivating strategies in anxious attachment and deactivating strategies in avoidant attachment (134)—appear to be connected to different or contrary patterns of neural activation during emotion regulation (135), a mixture of these patterns could mask possible differences to healthy controls (101). Importantly, the various possible mechanisms of cognitive reappraisal in SUD need to be explored in more detail in future studies, as reappraisal may be directed at the meaning or the self-relevance of a potentially emotion-eliciting situation in order to increase or decrease negative or positive emotions (136). Furthermore, there is some indication that cognitive reappraisal is only adaptive when dealing with uncontrollable stress (where the only option is self-regulation) but not controllable stress (where the situation can be influenced) (137).

Attachment and Treatment Adherence

Two studies sought to explore parameters of attachment and personality structure in patients at the beginning of treatment for SUDs. Given the high rates of drop-outs [e.g., Ref. (74)] and the often-discussed differences between SUD [e.g., Ref. (2)], the results of these studies may help improve treatment adherence and consequently treatment outcomes.

Study 4

As there is still some debate about whether various forms of SUD differ regarding their association with insecure attachment [e.g., Ref. (42)] and impairments in personality structure [e.g., Ref. (138)], we examined these parameters in inpatients with either a PUD or an Alcohol Use Disorder (AUD) in comparison to a non-drug-using control group (98).

Methods and Results

In the first study (98), 66 inpatients diagnosed with AUD, 57 inpatients diagnosed with PUD, as well as 114 non-drug-using control subjects (CS) completed the *Attachment Style Questionnaire* (ASQ) [Ref. (139, 140), and the *Borderline Personality Inventory* (BPI) (141).

Compared to CS, inpatients with AUD or PUD showed higher levels in every facet of borderline personality structure and the attachment facet "Relationships as Secondary" as well as lower levels in every other facet of attachment. These differences were especially distinctive in the area "Confidence in Self and Others" (eta^2 = .22), which indicates secure attachment and in the total amount of borderline pathology (eta^2 = .30), respectively. No differences could be observed between AUD and PUD inpatients. Separate correlation analyses revealed that attachment and personality structure were unrelated in each group.

Discussion of Results

While the results of this study (98) confirmed that SUDs are linked to deficient attachment (42, 100) and increased borderline pathology (100, 142), they furthermore indicate that impairments in those areas are similar for AUDs and PUDs. However, although psychodynamic theory closely links early attachment experiences to personality structure (7), no distinctive link between impairments in those areas could be observed. Interestingly, inpatients with a SUD showed lower levels in several facets of attachment deficiencies (e.g., Need for Approval) than healthy controls (140). However, we argue that lower and higher than average levels in these areas could be considered problematic as they might indicate rigid patterns in interpersonal experiences. Correspondingly, from a psychodynamic perspective, one of the major therapeutic aims is described as "greater flexibility in interpersonal relationships and an enhanced capacity to meet interpersonal needs" (p. 99) (143). The increased borderline pathology we detected in inpatients with an SUD (98) suggests that impairments in personality structure can be present independent of comorbid personality disorders. In line with research on the dual diagnosis of SUD and personality disorders (142), we therefore support a dimensional approach in the study and treatment of personality pathology with an SUD.

Study 5

Building on Study 4, a second study (102) focused on the role of attachment in treatment adherence during the first 6 weeks of a residential treatment program.

Methods and Results

One hundred twenty-two inpatients (34 female), diagnosed with AUD (n = 66) or PUD (n = 57), were tested at treatment entry. After 6 weeks, the 47 inpatients remaining in treatment were tested for a second time. Both times participants completed the ASQ [Ref. (139, 140).

Using all ASQ subscales, agglomerative cluster analysis on the total sample suggested a two-cluster solution: Cluster I was defined by higher scores in "Confidence in Self and Others," while Cluster II was defined by higher scores in "Need for Approval" and "Relationships as Secondary." Further analyses showed that inpatients in Cluster I were more likely to drop out of treatment during the first 6 weeks. In hierarchical regression analyses predicting treatment adherence, with the control variables sex and psychiatric comorbidity at Step 2, attachment security (Cluster I vs Cluster II) added approximately 6% of variance at Step 3.

Discussion of Results

The results of the fifth study (102) indicate that self-reported secure attachment might be linked to lower treatment adherence in patients with SUDs. This unexpected finding might be attributed to the influence of self-reflection, with a lower ability for self-reflection resulting in more secure self-appraisal but also to an increased likelihood of treatment drop-out. In line with this, self-report measures of adult attachment—in comparison to attachment interviews—are considered to be more likely influenced by distorted self-images while insufficiently assessing repressed information (144).

Consequently, self-reported attachment security may be attributed to an idealized self-view defined by primitive defense mechanisms (e.g., splitting or denial) (102). Furthermore, our findings potentially reflect a unique attribute of therapeutic communities (124) that threatens such narcissistically distorted self-appraisals: In patients with this form of self-appraisal, the high amount of group cohesion potentially leads to increased cognitive dissonances that consequently increase the likelihood of treatment drop-out (123). The reduction of narcissism in the therapeutic community might also explain the decrease in Confidence in Self and Others after 6 weeks of treatment (102). This is also part of the concept of the therapeutic community itself, as patients are encouraged to explore their interpersonal deficits (124). Furthermore, the decrease in Confidence in Self and Others likely also mirrors the decline of an initial euphoria experienced when entering treatment and being sober after severe substance use (102).

CONCLUSION AND OUTLOOK

While the application of attachment theory always implies a developmental approach, this article focused on the basis from which individuals diagnosed with a PUD might progress towards recovery. Furthermore, although research focused on attachment already contributed important insights into the characteristics of our social nature, "an important enterprise for the future is to consider how attachment is differentiated from, and integrated with, other features of development" (p. 25) (145).

Consequently, the characteristics and treatment requirements connected to PUDs especially need to be addressed in more detail, as this diagnosis is highly common in individuals seeking treatment while simultaneously being associated with poor treatment success [e.g., Ref. (2)]. Several important conclusions regarding SUD—particularly PUD—and their treatment can be drawn from the original research presented above.

Implications for Clinical Practice

Although the completion of treatment is closely linked to favorable treatment outcome, it is more likely for a patient to drop out of treatment than to complete it: According to a systematic review by Brorson and colleagues (146), the most consistent risk factors for dropping out were cognitive deficits, younger age, personality disorders, and low treatment alliance. Conversely, the effects of treatment are dose related: While more and longer treatments usually lead to a better outcome, disruptions in attachment to the program or the clinical staff increased the likelihood of relapse and drop out (73). Considering the largely insecure attachment status of inpatients with PUD (98–102) may consequently improve treatment adherence.

As mentioned above, the primary function of adult attachment relationships may be seen in the regulation of emotions (38). The regulation of emotions through social interactions is a key function of the attachment system, as

the quality of the attachment bond influences emotional functioning and regulation capabilities as well as styles of interpersonal relating from childhood on into adulthood (46, 147). While impairment in cognitive reappraisal, an explicit emotion regulation strategy, seems to be relevant in PUD (101), implicit, i.e., automatic and largely unconscious emotion regulation strategies, may be of even greater relevance, as they are likely more closely connected to the mental representations of self and others included in attachment and personality structure (148).

Furthermore, future studies on PUD may also consider the connections between boredom and substance use: Boredom, which is connected to an emptiness stemming from social isolation as well as a lack of attachment to others (149), represents a critical factor in relapse (149) among others through its connection to increased risk-taking behaviors (150). Boys and colleagues (151) found that close to 90% of young (16–22 years) poly-substance users consumed illicit substances to enhance an activity with 83% consuming the substances to decrease boredom.

Interestingly, while the studies on PUD described in detail above (98–102) focused on inpatients in therapeutic communities, the relation between attachment and psychological distress can also be found in SUD outpatients (152): Here, an insecure attachment is again more common than in healthy controls. Furthermore, fearful attachment appears to be associated with higher levels of psychological distress. Importantly, psychological treatments with a directive, reflective, or supportive orientation appear to result in more patients having a secure attachment style by the end of treatment (152).

While the consideration of different emotions and their role in SUD is of great importance, the absence of these emotions or of their perception has to be considered as well: For example, a recent study (153) found that insecure attachment also seems to be associated with dissociation and alexithymia in individuals with SUD. As they inhibit the identification and verbalization of emotions, dissociation and alexithymia also impair the communication with others and thus the mutual understanding (153).

A change from insecure to secure attachment style might therefore be considered an important goal in SUD treatment, as it could prevent patients from applying defense strategies involving substance use to regulate their emotions and interpersonal relationships (152).

Implications for Research

Given that a meta-analytic review by Dutra and colleagues (74) found that individuals with PUD—compared to other SUD—appear to profit the least from treatment interventions, more research on the characteristics and treatment requirements of individuals with PUD is still very much needed. Therein, attachment theory provides a bio-psycho-social model for human behaviors and experiences in relation to the regulation of stress and emotion in social situations (154). Following this approach, the presented results (98–102) underline the conceptualization of PUD as an "Attachment Disorder" as well as the value of the bio-psycho-social perspective in this research area. As the influence of attachment always has to be considered in the context of other risk factors (13), exploring and integrating the clinical characteristics of individuals with PUD are of vital importance for future research on treatment approaches. For example, polydrug use can frequently be found in connection to sexual behaviors (155–158). However, few studies to date seem to have explored the role of sexual behaviors in PUD (159) and no study seems to have explored their romantic relationships.

In addition. the above described studies on inpatients with PUD (99, 100) highlight the fact that insecure attachment and other behavioral impairments in inpatients with PUD are paralleled by extensive impairments in white matter integrity (99, 100), most notably in tracts connected to facets of emotion regulation (e.g., impaired decision-making and higher risk taking behavior) (69, 113). Consequently, a potential neuroplasticity during the treatment of SUD in general—and the long-term stay in a therapeutic community in particular—should be explored in future research.

Furthermore, the results of the above described studies (98, 100, 101) suggest that future research on the treatment for SUD would benefit from the assessment of personality structure and related psychodynamic interventions. Therein, Kohut's (160) theory that a specific substance can be seen as a "replacement for a defect in the psychological structure" matches with the widespread impairments in personality structure found in inpatients with PUD (101). Furthermore, the influence of traumatic experiences in childhood on the amount of addictive behaviors displayed in young adulthood (161) seems to be mediated by impairments in personality structure and insecure attachment (162–164).

While the above described studies on inpatients with PUD focused on primary emotions and certain emotion regulation strategies (99, 101), there is vast potential for additional contributing factors in PUD related to emotions and their regulation. Among emotion regulation processes, social affect regulation can be seen as a bottom-up mechanism, while affect regulation without support from others can be seen as a top-down mechanism. These top-down mechanisms include effortful cognitive and attentional emotion regulation strategies, such as suppression or cognitive reappraisal, that rely heavily on the prefrontal cortex (46). Consequently, an examination of the neural correlates of bottom-up mechanisms in PUD would generate further important insights.

The importance of research on SUD—and especially PUD—as well as the need for evidence-based effective treatment strategies is further underlined by the consideration of transgenerational effects: For example, in a recent study by Tuhkanen and colleagues (165), only 7% of infants born to mothers with recent or current substance use showed no neurological impairments during their first days of life.

Limitations

As different definitions of polydrug use are applied in SUD research, the comparison and integration of results can be difficult (87). These tendencies may lead to research results that

provide little relevant information for clinicians involved in SUD treatment programs. On the other hand, explicit and systematic evaluations of polydrug use could have a high clinical as well as public health relevance (60). Consequently, the possibility of concurrent use of other substances should always be taken into consideration, even when only the use of one particular psychotropic substance is the focus of a study (57). For example, while polydrug use is often considered a barrier in the prevention of hepatitis C virus (HCV) transmission in individuals who inject prescription opioids, research on the underlying mechanisms is relatively sparse (166).

Furthermore, the results of different studies on attachment in adults are also often hard to compare or to summarize (148). In general, self-report measures—as used in the presented studies (98–102)—are thought to be limited in their ability to assess all areas of attachment patterns, as they solely rely on conscious attitudes and behaviors (144). However, they are also considered to be more focused on current attachment patterns in various relationships, while the Adult Attachment Interview (167) solely focuses on the relationship with the parents.

As inpatient participants in the described studies were enrolled in a therapeutic community at the time of data acquisition (98–102), this may have influenced the results in various areas. Among others, the decline in reported attachment security after the initial treatment phase (102) could also—at least partly—be attributable to this treatment approach. However, to date, hardly any empirical studies have investigated the role of attachment theory and related parameters (e.g., therapeutic alliance) for the conceptual framework and success of the therapeutic community [e.g., Ref. (168)]. Consequently, further research is very much needed to explore these mechanisms.

The high levels of comorbid mental disorders in inpatients with SUD in general [for an overview, see Ref. (169)] and PUD in particular also have to be considered in the interpretation of research results. Conversely, deficiencies in emotion processing and regulation are a known "liability spectrum that underlies many different mental disorders" (p. 154) (36). Internationally, this high risk of co-occurrence appears in both directions: While between 40% and 50% of individuals with a SUD also have at least one other psychiatric diagnosis, other psychiatric diagnoses also show a high rate of comorbid SUD [for an overview, see Ref. (169)]. The question of how co-occurring psychiatric disorders influence the participation and outcome of treatment in SUD has also not yet been fully answered (170). Overall, treating co-occurring affective and personality disorders as diagnoses in their own right generally seems to lead to better outcomes than only treating SUD and an integrated treatment approach can therefore be considered evidence based (170).

In line with this, maltreatment, and especially cumulative abuse, during childhood is associated with several related mental disorders, including SUD and PUD (171, 172). Therefore, a more extensive assessment of traumatic experiences might reveal different profiles among individuals with SUD that could profit from different treatment strategies.

While our research highlights the presence of white matter impairments in inpatients with PUD (99, 100), we did not specifically investigate possible influences of the number of abused substances or the intensity of abuse. This may be an interesting area for future research, as recent findings suggest that some neural impairments may be related to specific substances while others are related to the amount of poly drug use (173).

Lastly, many different approaches may have been taken to explore the current theoretical and empirical literature on PUD from an attachment perspective. Therein, different types of reviews are known to have specific strengths and weaknesses (174).

Future Directions

The focus on PUD is now more important than ever, given that the diversification of certain products (e.g., nicotine, marijuana, prescription drugs) in recent years seems to have contributed to an increased polydrug use in adolescents (88, 89). In turn, polydrug use is strongly associated with later SUD and related health issues (175, 176).

The studies on PUD described above and in additional publications (98–102) clearly highlight the importance of attachment and related parameters in PUD as well as their bio-psycho-social integration. Future studies might more closely focus on the influence of attachment-based interventions on emotion regulation abilities as well as a potentially related neuroplasticity.

While recovery represents an important paradigm in the treatment of SUD, the definition of recovery has been extended beyond a reduction in use or sustained abstinence and now also includes the enhancement of global well-being as well as a reintegration into a prosocial community. To date, few studies have incorporated this broadened definition of recovery into their design (79). The most commonly used outcome measure, i.e., treatment retention and abstinence from the primary psychotropic substance (177), might not be able to fully assess the effects of psychosocial interventions, e.g., changes in emotion regulation and other attachment parameters. Especially in long-term inpatient PUD treatment settings (e.g., therapeutic communities), neuroplastic changes, which are still rather unexplored, might represent important additional parameters for the assessment of treatment outcomes.

AUTHOR CONTRIBUTIONS

MH-R and H-FU conceptualized the study. MH-R wrote the draft. H-FU proofread the manuscript. Both authors gave their consent for publication.

ACKNOWLEDGMENTS

We would like to acknowledge the work of Nikolas Bonatos for making helpful and invaluable critical comments about the manuscript.

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychiatry

ORIGINAL RESEARCH
published: 30 August 2019
doi: 10.3389/fpsyt.2019.00610

Do Primary Emotions Predict Psychopathological Symptoms? A Multigroup Path Analysis

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OPEN ACCESS

Edited by:
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Specialty section:
This article was submitted to Addictive Disorders, a section of the journal Frontiers in Psychiatry

Received: *12 May 2019*
Accepted: *31 July 2019*
Published: *30 August 2019*

Citation:
Fuchshuber J, Hiebler-Ragger M, Kresse A, Kapfhammer H-P and Unterrainer HF (2019) Do Primary Emotions Predict Psychopathological Symptoms? A Multigroup Path Analysis. Front. Psychiatry 10:610. doi: 10.3389/fpsyt.2019.00610

Background: Research involving animal models has repeatedly proposed dysregulations in subcortically rooted affective systems as a crucial etiological factor in the development of a variety of psychiatric disorders. However, empirical studies with human participants testing these hypotheses have been sparse. Associations between primary emotions systems and different psychiatric symptoms were investigated in order to gain insights into the influence of evolutionary-rooted primary emotions on psychopathology.

Material and Methods: The community sample included 616 adults (61.9% female). 243 reported a psychiatric lifetime diagnosis. By applying path analysis, we estimated paths between SEEKING, ANGER, FEAR, SADNESS, CARE, and PLAY (Affective Neuroscience Personality Scales; ANPS) and symptoms of substance abuse (Alcohol, Smoking, and Substance Involvement Screening Test; ASSIST) as well as depression, anxiety, and somatization (Brief Symptom Inventory; BSI-18). To examine the moderator effects of gender and psychiatric lifetime diagnosis, multigroup analysis was applied.

Results: Substance abuse was associated with male sex ($\beta = -.25$), SADNESS ($\beta = .25$), and ANGER ($\beta = .10$). Depression was associated with SADNESS ($\beta = .53$), FEAR ($\beta = .10$), SEEKING ($\beta = -.10$), and PLAY ($\beta = -.15$). Anxiety was linked to SADNESS ($\beta = .33$), FEAR ($\beta = .21$) and PLAY ($\beta = -.10$). Somatization was associated with SADNESS ($\beta = .26$) and PLAY ($\beta = -.12$; all $p < .001$). Multigroup analysis revealed no differences in paths between tested groups (all $p > .01$). The model explained 14% of the variance of substance abuse, 52% of depression, 32% of anxiety, and 14% of somatization.

Conclusions: The results further our understanding of the differential role of primary emotions in the development of psychopathology. In this, the general assumption that primary emotion functioning might be a valuable target in mental health care is underlined.

Keywords: primary emotions, path analysis, depression, substance use disorder, anxiety disorder, somatization

INTRODUCTION

Substance use disorder (SUD) is generally defined as a chronic and pathological and compelling urge to consume one or more psychoactive substances despite harmful effects for oneself and others (1). According to the World Drug Report 2017, problematic substance use and SUDs currently affect about 29.5 million people (2). Hence, they pose a serious threat not only to individual health but also significantly burden public health systems. Furthermore, SUDs show substantial comorbidities with a wide range of psychiatric disorders (3). An exceptionally prevalent relationship seems to exist with regards to mood disorders like depression and anxiety disorders (4). Moreover, despite considerable overlap between withdrawal symptoms related to SUDs and somatoform disorders, few studies have investigated the comorbidity between SUDs and somatization (5). However, several studies report a substantial association between both disorders (5, 6).

Predominantly based on animal models, affective neuroscience (AN) theory proposes dysregulations in subcortical affective systems as an important factor in the etiology of a variety of psychiatric disorders (7, 8). Currently AN and neuropsychoanalytic researchers distinguish seven primary emotion networks which arise from the periaqueductal gray and expand into the limbic forebrain (8, 9). Four of those systems have evolved from reptilian roots (10). These phylogenetically oldest networks consist of the SEEKING, FEAR, LUST, and ANGER systems. Moreover, three primary emotion networks specifically manifest in evolutionarily higher species like mammalians and certain birds (10). These networks include the PANIC/GRIEF or SADNESS, CARE, and PLAY systems (8, 10, 11).

With regard to personality psychology, the Affective Neuroscience Personality Scales (ANPS) (12) have been developed to measure individual dispositions toward Panksepp, (11) primary emotions circuits. The ANPS assesses six facets of primary emotion dispositions, including SEEKING, CARE, PLAY, FEAR, SADNESS, and ANGER but does not measure LUST due to conceptual concerns (12, 13). In line with Panksepp (7), it might be argued that individual differences in primary emotion dispositions are able to explain clinically significant aspects in the development of psychiatric disorders.

Largely in consensus with Berridge (14, 15), AN theory proposes that SUD is characterized by pathological changes within the SEEKING/mesolimbic-dopamine system. In the course of this disorder, the SEEKING network is increasingly and, ultimately, predominantly activated in association with substance-related appetitive memories, substance consumption, and the desire to alleviate negative affective states (16–18). Furthermore, there is strong evidence that certain individuals may be predisposed to addiction through certain psychological and neural parameters, such as hyperexcitability of the brain stress system or depressiveness. In turn, this might promote the reorganization of SEEKING toward drugs or other addictive behaviors like gambling (16).

In addition, it is assumed that SUDs are associated with perturbations within the LUST and PANIC/GRIEF network (18, 19). In correspondence to this, dopamine surges of the artificially excited SEEKING system might not be the primary object of addiction, but rather the feeling of reward itself, mediated in large part by the predominantly opioid controlled LUST and PANIC/GRIEF systems. Furthermore, the neurobiology of attachment in mammalians, primarily mediated by the PANIC/GRIEF system, and SUDs share striking similarities which are mirrored by a significant overlap in behavioral aspects of both social dependence and addiction (11, 18, 20–22). Common neurochemical sites of action and change regarding attachment and addiction development include dopamine D1 and D2 receptors; mu-, delta-, and kappa-opioid receptors; and corticotropin-releasing factor (20).

Behavioral similarities between attachment/loss and addiction/withdrawal include: social bonding/drug dependence, drug tolerance/estrangement, and drug withdrawal/separation distress (11). Therefore, addiction is often conceptualized as a deranged form of attachment (18, 19). Furthermore, the behavioral aspects of opioid withdrawal show especially strong resemblances to separation distress, comprising psychological and somatic pain, crying, loss of appetite, depression, insomnia, and aggressiveness (11). In this context, addiction might be understood as a dysfunctional attempt to compensate for overwhelming feelings of isolation, loss, and sadness mediated by an overactive PANIC/GRIEF system.

Until now the role of other primary emotion systems in the emergence of addiction cycles has been largely neglected in AN theory and research. However, Unterrainer et al. (23) were able to show increased SADNESS, FEAR, and ANGER in patients suffering from polydrug use disorder compared to healthy controls. Moreover, very little is known about the role of PLAY and CARE in addiction etiology. With regard to the neurochemistry of PLAY, which relies on the endogenous cannabinoid system (8), it might be plausible to assume that PLAY is involved in cannabis addiction. However, this assumption lacks empirical support. Similarly, so far, there is no data suggesting the significance of CARE in SUD development in humans (23). Nevertheless, animal research showed that lactating dams exhibited reduced brain activity in the mesolimbic-dopamine system—compared to virgin females—if the animals were exposed to cocaine (24). In general, it is still unclear if addiction might be a self-medication strategy against negative affects in general, as suggested by other authors [e.g., Ref. (25)], rather than a more specific coping mechanism against increased PANIC/GRIEF and decreased SEEKING as proposed in AN theory (18, 19). In this context, SUD patients might use drugs as an artificial defense mechanism against overwhelming, often undifferentiated, perceived affects in general. Hence, the tendency toward depression and anxiety—frequently observed in SUD patients—is often somatized, unverbalized, and experienced as physical pain (26, 27).

In correspondence to this, AN theory conceptualizes depression as an evolutionarily conserved mechanism in which the overactive PANIC/GRIEF system shuts down the acute panic or protest phase of separation distress and triggers a state of *despair* which is characterized by sustained overactive GRIEF and discontinuation of the SEEKING system, experienced

as intense dysphoria (28). Furthermore, a study by Montag et al. (29), applying the ANPS, suggested associations between depression and increased dispositions to SADNESS and FEAR, as well as decreased SEEKING and PLAY. With regard to anxiety disorders, Panksepp (7, 30) proposes a hyperactivation of the FEAR system, which is related to either pathologically increased activation of the amygdala or a corresponding deactivation of the prefrontal cortex (31). Moreover, Panksepp (11) suggests a clinically significant relationship between the emergence of anxiety disorders and hypoactivity of the PANIC/GRIEF or SADNESS network. However, until now, quantitative-empirical research regarding the relationship between primary emotion dispositions and anxiety disorders has been largely neglected.

Similarly, to the best of our knowledge, primary emotion networks underlying somatization have not been investigated yet by studies applying standardized questionnaires. From a psychodynamic point of view, somatization is understood as a defense against otherwise unbearable affects (32, 33). With regard to the shared neuronal architecture of pain processing and social isolation, somatization has been linked to increased activity of the SADNESS system (32, 34). To further investigate the clinical significance of AN framework, the present study applied path analysis to examine the relationship between psychopathological symptoms (SUD, depression, anxiety disorder, and somatization) and different dimensions of primary emotions (SEEKING, FEAR, ANGER, SADNESS, PLAY, and CARE). The conceptual framework is outlined in **Figure 1**. Furthermore, by applying multigroup path analysis, this study tested possible moderator effects of gender and psychiatric lifetime diagnosis.

MATERIAL AND METHODS

Procedure

Participants were recruited through advertising on social networks, including public forums and announcements at the University of Graz, Austria. After declaring informed consent, each participant was asked to fill out a range of demographic questions (e.g., age, sex, education status, and lifetime psychiatric diagnosis) as well as a variety of standardized questionnaires, including the Affective Neuroscience Personality Scales, the Brief Symptom Inventory, and the Alcohol, Smoking, and Substance Involvement Screening Test. The data was acquired *via* the online-survey platform LimeSurvey©. Participants were included if they spoke German fluently, filled in all questionnaires and were aged between 18 and 69 years. In correspondence to this, 874 discontinued the participation before completion while 12 participants did not meet the required age for participation. The study was carried out in accordance with the Declaration of Helsinki. Ethical approval was granted by the Ethics Committee of the Medical University of Graz, Austria. The recruitment of participants was carried out between April 2017 and March 2018.

PSYCHOMETRIC ASSESSMENT

Primary Emotions

The Affective Neuroscience Personality Scales (ANPS) (12) [German version by Reuter and Hennig (35)] [see Ref. (36) for a more recent version] is a self-report measurement which operationalizes behavioral traits related to the concept of subcortical primary emotion circuits, developed by Panksepp (11). The questionnaire

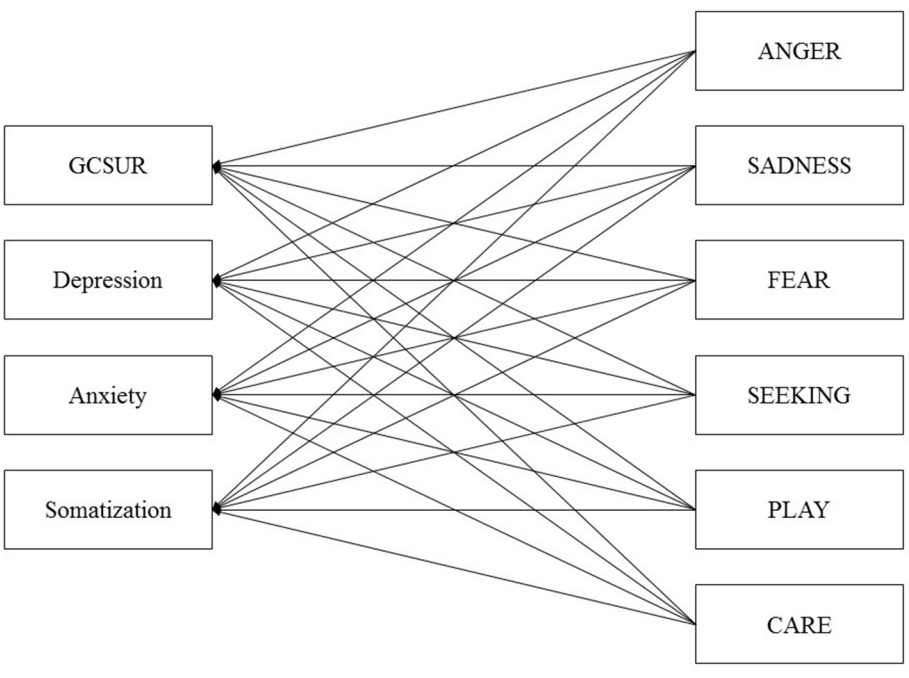

FIGURE 1 | Initial model of primary emotions and psychiatric symptoms controlled for Age and Sex. GCSUR, Global Continuum of Substance Use Risk.

includes the following subscales: SEEKING, SADNESS, FEAR, RAGE, CARE, and PLAY. The additional scale for "spirituality" was not analyzed in the course of this study. The ANPS is comprised of, overall, 110 items with 14 items for each subscale and is rated on a four-point Likert scale ranging from 1 ("strongly disagree") to 4 ("strongly agree"). SEEKING summarizes the disposition toward feelings of positive curiosity toward new experiences, the tendency to explore, and a sense of being able to achieve relevant goals. ANGER is conceptualized by the trait of being easily frustrated and irritated, the frequent expression of anger in a verbal or physical way, the experience of being angry due to frustrations, and being unable to calm down. FEAR measures the individuals' tendency toward feelings of anxiety, tenseness, worries, and ruminations. SADNESS operationalizes the tendency of feeling separation distress, loneliness, and sorrow. CARE operationalizes the individual's tendency toward feelings of empathy, caring for children, people in need and animals, and a general enjoyment of being needed by others. PLAY measures the trait of being protracted toward games with physical contact, laughter, fun, as well as being generally happy and joyful. All scales showed acceptable to good internal consistencies, with Cronbach's alpha ranging from 0.78 (SADNESS) to 0.89 (SEEKING).

Psychiatric Symptoms

The *Alcohol, Smoking, and Substance Involvement Screening Test* (ASSIST) (37) is a standardized interview which is used to assess psychoactive substance use and related problems. This questionnaire measures lifetime use and substance-related symptoms of 10 substance groups including tobacco, alcohol, cannabis, cocaine, amphetamines, inhalants, sedatives, hallucinogens, opioids, and "other drugs." Questions 2–5 are rated on a seven-point Likert scale ranging from 0 ("never") to 6 ("daily or almost daily"). These scales assess the "frequency of drug use," "craving to use the drug," "problems" (health, social, legal, or financial) because of drug use, and "failed expectations." Moreover, questions 6, 7, and 8 are rated on a three-point scale (0 = "no, never"; 3 = "yes, but not in the past 3 months"; 6 = "yes, in the past 3 months") and cover "expressed concerns by relatives or friends," "failed attempts to cut down drug use," and "drug injection." For this study, the total score "Global Continuum of Substance Use Risk" (GCSUR) was calculated. This scale showed an acceptable internal consistency with Cronbach's alpha = 0.78.

The *Brief Symptom Inventory* (BSI-18) (38) [German version: Ref. (39)]. The BSI-18 consists 18 items assessing the amount of symptom burden over the past 7 days. The BSI-18 includes the subscales depression, anxiety, and somatization. Items are rated on a five-point Likert scale ranging from 0 "absolutely not" to 4 "very strong." A total score "Global Severity Index" can be generated by adding the scores of every item. All scales showed good internal consistencies, with Cronbach's alpha ranging from 0.80 (somatization) to 0.91 (depression).

Statistical Analysis and Analysis Strategy

The path analysis estimations and multigroup path analysis were conducted *via* AMOS 18. SPSS 21.0 was used for data management and descriptive statistics. Initially, bivariate correlations were calculated to assess the strength of relations among all variables. In a next step data was fitted to an initial path model that included the following paths: all primary emotions to GCSUR, depression, anxiety, and somatization (**Figure 1**). This model was controlled for age and sex. Furthermore, correlations between the disturbance terms amongst individual primary emotions and psychiatric symptoms were assigned. After the initial model was fitted, a pruning strategy was applied by removing non-significant paths from primary emotions to psychiatric symptoms. The path models were estimated using the maximum likelihood method in AMOS.

In accordance with Kline (40), the following fit indices were considered as markers for an acceptable model fit: (a) the comparative fit index (*CFI*) > 0.90, (b) Tucker-Lewis index (*TLI*) relative fit index > 0.90, (c) the square root error of approximation (*RMSEA*) < 0.08, and the upper bound of its 90% confidence interval < 0.1. For the comparison of competing models, the Akaike's information criterion (*AIC*) was used, with the smaller value indicating better fit. The alpha-level was set to 0.01. To test for possible moderator effects of sex and self-reported psychiatric lifetime diagnosis, multigroup analysis was performed (41). In order to statistically evaluate the differences in path coefficients across the groups, tests of invariance with a chi-square difference test were performed. A chi-square corresponding to a probability level of less than.01 was the criterion by which the null hypothesis that the relevant parameters were equal across the groups (female *vs*. male; participants without a lifetime psychiatric diagnosis *vs*. participants reporting a lifetime psychiatric diagnosis) was rejected.

RESULTS

Sample Characteristics and Descriptive Statistics

The investigated community sample was comprised of 616 German-speaking adults (381 female, 61.9%), ranging in age from 18 to 69 years (M = 30; SD = 9.53). In this study, 231 (37.5%) participants declared a university degree as their highest educational level. Two hundred fourteen (34.7%) stated a general qualification for university entrance, 46 (7.4%) a high school degree, and 96 (15.5%) participants stated a completed apprenticeship as their highest educational level. Twenty-nine (4.7%) participants stated that they left school without graduation. Regarding the current occupation of participants, 222 (36%) were in employment, 313 (50.8%) in education, 57 (9.2%) were unemployed, and 24 (3.8%) were on pensions. Concerning the current relationship status, 59 (9.6%) were married, 259 (42.0%) in a relationship, and 298 (48.4%) were single. The nationality of most participants was either German (n = 334; 54.5%), Austrian (n = 218; 35.5%), or Swiss (n = 30; 4.8%), while 34 (5.5%) had other nationalities. Finally, 243 (39.4%) participants declared that they had been diagnosed with a (lifetime) psychiatric disorder. The majority of these participants were diagnosed with depression (n = 147; 60%) and 50 (21%) with other affective disorders, and 46 (19%) participants were diagnosed with other psychiatric disorders. As shown in **Table 1**, participants with and without a psychiatric diagnosis differed ($p < 0.001$; $\eta^2 = 0.03–0.15$) in every examined variable with the exception of CARE (p = n.s.).

TABLE 1 | Descriptive statistics, sex differences, and differences between healthy and diagnosed participants and interaction effects among examined variables.

		Female		Male		Healthy		Diagnosis		Sex	Health	Gender x health
Measure	**α**	***M***	***SD***	***M***	***SD***	***M***	***SD***	**M**	**SD**	**F(3, 612)**	**F(3, 612)**	**F(3, 612)**
BSI-18												
Depression	0.91	13.55	6.77	13.39	6.67	11.39	5.61	16.71	7.03	0.18	96.67**	0.27
Anxiety	0.81	12.24	5.12	11.37	4.51	10.81	4.24	13.60	5.37	3.08	42.42**	0.67
Somatization	0.80	10.70	4.41	9.88	4.07	9.63	4.04	11.56	4.43	3.22	27.14**	0.02
ASSIST												
GCSUR	0.78	34.26	32.31	48.99	37.82	33.56	34.51	49.57	34.13	31.40**	36.17**	0.02
ANPS												
SEEKING	0.75	2.82	0.42	2.80	0.37	2.89	0.38	2.70	0.42	2.13	35.91**	1.51
FEAR	0.89	2.86	0.55	2.71	0.55	2.64	0.52	3.06	0.51	7.54*	86.21**	0.06
ANGER	0.85	2.62	0.52	2.56	0.49	2.53	0.48	2.71	0.53	1.44	15.36**	0.01
SADNESS	0.78	2.72	0.45	2.57	0.45	2.52	0.41	2.87	0.43	12.72**	79.87**	2.46
PLAY	0.76	2.79	0.49	2.76	0.47	2.89	0.45	2.60	0.48	1.71	53.82**	0.04
CARE	0.83	2.99	0.42	2.69	0.40	2.90	0.41	2.85	0.47	81.87**	5.62	1.67

*n = 616; * p < .01; **p < .001; BSI-18, Brief Symptom Inventory; ASSIST, The Alcohol, Smoking and Substance Involvement Screening Test; ANPS, Affective Neuroscience Questionnaire Scales.*

As shown in **Table 2**, all negative primary emotion dispositions (SADNESS, FEAR, and ANGER) showed positive correlations with every assessed psychiatric variable (GCSUR, depressive symptoms, anxiety symptoms, and somatization) (all $p < 0.001$), whereas CARE did not correlate with any clinical marker (all $p > 0.01$). Moreover, PLAY and SEEKING, which showed substantial intercorrelations (r = .56; $p < 0.001$), were negatively correlated with depressive symptoms, anxiety symptoms, and somatization ($p < 0.001$); however, neither were correlated with GCSUR ($p > 0.01$). Finally, male sex was positively correlated with GCSUR ($r = .20$; $p < 0.001$), while sex had no significant relationship to other investigated psychiatric symptoms ($p > 0.01$).

Path Analysis

The initially proposed model (see **Figure 1**), which was controlled for sex and age, showed a poor fit due to insufficient RMSEA values: *RMSEA* = 0.07 (90% CI: 0.03, 0.12), *TLI* = 0.92, *CFI* = 1.00, and *AIC* = 186.60. Therefore, a second model was tested which excluded CARE, as this dimension of primary emotions did not correlate with the clinical variables. The second model showed a poor fit as well: *RMSEA* = 0.09 (90% CI: 0.04, 0.14), *TLI* = 0.90, *CFI* = 1.00, and *AIC* = 160.95. As a third step, the second model was trimmed by deleting all non-significant paths between variables (see **Figure 2**). This included: (a) paths between ANGER, depressive symptoms, and anxiety symptoms; (b) paths between SEEKING, GCSUR, anxiety symptoms, and somatization; (c) paths between FEAR, global continuum of substance risk and somatization; and (d) paths between PLAY and global continuum of substance risk.

The third model showed an acceptable fit: RMSEA = 0.05 (90% CI: 0.03, 0.08), TLI = 0.97, and CFI = 0.99 *AIC* = 159.74. The trimmed model suggested the following associations: GCSUR was associated with male sex (β = −.25), SADNESS (β = .25), and ANGER (β = .10); depressive symptoms were associated with increased SADNESS (β = .53) and FEAR (β = .10) and decreased dispositions to SEEKING (β = −.10) and PLAY (β = −.15); anxiety symptoms were related to increased SADNESS (β = .33), FEAR (β = .21), and decreased PLAY (β = −.10); and somatization was linked to increased SADNESS (β = .26) and ANGER (β = .09) and decreased PLAY (β = −.12) (all $p < .01$).

In summary, the final model was able to explain 14% of the variance of global substance risk, 52% of depressive symptoms, 32% of anxiety symptoms, and 14% of somatization.

Furthermore, to examine the possible moderation effects of psychiatric lifetime diagnosis and sex, additional multigroup analysis was conducted. The comparison between groups—which were conducted *via* chi-square difference tests (female *vs*. male; participants without a lifetime psychiatric diagnosis *vs*. participants reporting a lifetime psychiatric diagnosis)—revealed no statistically significant difference between paths ($\chi^2 = 0–4.788$; all $p > 0.01$). The unconstrained multigroup analysis model exhibited the following fit indices: *RMSEA* = 0.02 (90% CI: 0.01, 0.03), *TLI* = 0.98, and *CFI* 0.99; *AIC* = 505.94.

TABLE 2 | Descriptive statistics and correlations among examined variables.

Variable	1	2	3	4	6	7	8	9	10	11	12
1. Global continuum of substance risk	–										
2. Depression	.44*	–									
3. Anxiety	.40*	.69*	–								
4. Somatization	.38*	.52*	.67*	–							
5. SEEK	−.12	−.37*	−.19*	−.15*	–						
6. FEAR	.19*	.59*	.53*	.33*	−.33*	–					
7. ANGER	.19*	.25*	.27*	.24*	−.09	.34*	–				
8. SADNESS	.26*	.69*	.53*	.35*	−.32*	.73*	.37	–			
9. CARE	−.08	−.08	.01	.01	.28*	.09	−.06	.06	–		
10. PLAY	−.10	−.45*	−.29*	−.22*	.56*	−.39*	−.11	−.41*	.41*	–	
11. Sex	−.20*	−.01	.08	.00	.03	.14*	.06	.15*	.34*	.03	–
M or N	39.89	13.49	11.91	10.39	2.81	2.81	2.60	2.66	2.88	2.78	381
SD or %	35.22	6.72	4.91	4.30	0.40	0.55	0.51	0.45	0.43	0.48	61.9

*n = 616; * p < .001; Sex was coded as: 0 = male; 1 = female.*

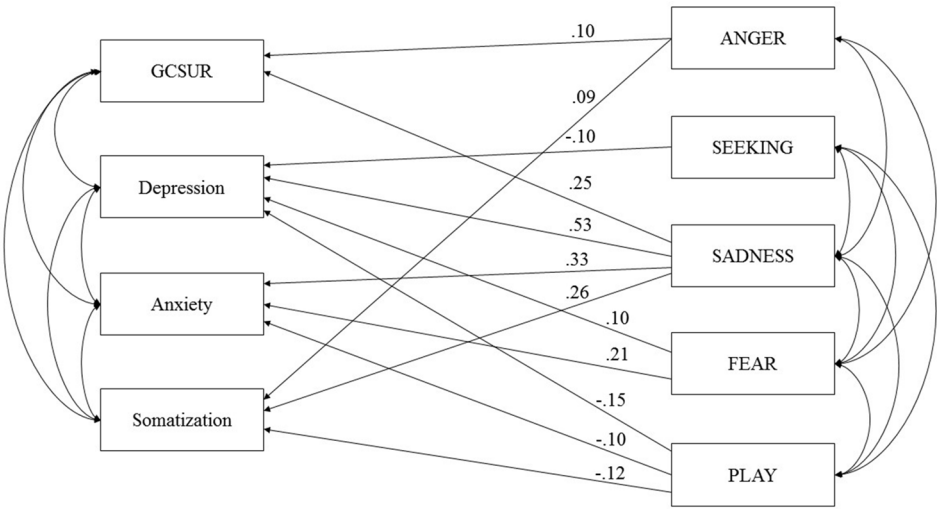

FIGURE 2 | Final model of primary emotions and psychiatric symptoms controlled for Age and Sex. GCSUR, Global Continuum of Substance Use Risk; *p < 0.001; curved arrows indicate significant correlations (p < 0.001).

DISCUSSION

This study investigated the relationship between symptoms of psychiatric disorders and primary emotions. In contrast to Fuchshuber et al. (42), which followed a confirmatory approach focusing on the role of the primary emotion despair in SUDs and depressive symptoms (18), the present study applied path analysis to investigate the relationship between all primary emotion dimensions, SUD, and other psychiatric disorders in a more exploratory manner.

Our results suggest that SUD symptoms are associated with increased SADNESS and, to a lesser extent, with increased ANGER. These findings echo previous results by Unterrainer et al. (23) which indicated increased SADNESS, FEAR, and ANGER dispositions in SUD inpatients. However, with regard to the relatively small percentage of overall explained variance, SUD might be less related to primary emotions than previously expected. This is particularly the case for SEEKING, which, in line with Unterrainer et al. (23), did not show significant associations with SUD symptoms. This finding, which contradicts evidence from neuroscientific research (16, 17, 43), might be explained by conceptual differences between functional aspects of the ML-DA or SEEKING system and the general disposition toward SEEKING measured by the ANPS. More specifically, with regards to its role in reinforcement learning, the ML-DA/SEEKING network seems crucial in the development of SUD. However, this might not be reflected in the individual's disposition toward decreased SEEKING. Furthermore, our results were gathered in the course of a cross-sectional study; hence, it is impossible to infer causal conclusions based on our results. Therefore, it is conceivable that many forms of SUD can be understood as dysfunctional coping strategies against a hypoactive SEEKING system as outlined by Zellner et al. (18) and Solms et al. (19). Yet, owing to the cross-sectional study

design, we might have been unable to detect this association, as problematic consumption of psychoactive substances might have artificially increased the individual's SEEKING disposition (8). Thus, in order to sufficiently investigate the relationship between SEEKING and SUD, it will be necessary to conduct longitudinal studies assessing SEEKING prior to the onset of problematic substance use.

In contrast, our findings highlight the role of SADNESS and ANGER in SUD. In line with the results of Unterrainer et al. (23), this partly supports assumptions of AN theory (18, 19) and reaffirms observations of object relations theory emphasizing the etiological role of aggression in SUD (44, 45). This finding further supports the notion of substance abuse as a function of artificial affect regulation (26). By taking drugs, the addicted individual tries to seal gaps in a corrosive personality structure (42), which is linked to increased negative affects (46, 47). Specifically, addictive behaviors seem to be associated with increased feelings of loneliness and isolation but also with heightened feelings of rage and aggression, which both are experienced by the SUD patient as intensely unpleasurable and ultimately overwhelming (8, 11).

The observed relationship between SUD and SADNESS further highlights the conceptualization of addiction as an attachment disorder, specifically linked to dysregulations within the endogenous opioid system (20, 21, 48). Furthermore, the association between SUD and ANGER may support psychoanalytic theories that relate substance abuse to auto-aggressive behavior, which is presumably directed against malicious inner self and object representations (44, 45, 49).

Moreover, our findings suggest a differential role of primary emotions in the development of psychopathology. Thereby, SADNESS seems to play a substantial role in all investigated disorders. However, in contrast to SUD, depressive symptoms were also predicted by decreased PLAY and SEEKING and increased FEAR, which is largely in line with findings from Montag et al. (29). These findings highlight the basic assumption of AN depression theory regarding the central role of a negative cascade between hyperactive SADNESS and hypoactive SEEKING system in depression etiology, as well as amplify the affective and neurophysiological complexity of depression (28, 50).

In addition, a similar pattern was found for anxiety symptoms, which were associated with increased SADNESS, FEAR, and decreased PLAY. In correspondence to this, the observed association between SADNESS and symptoms of anxiety disorders reflect results of a recent meta-analysis by Kossowsky et al. (51), which concluded that separation anxiety disorder in childhood significantly increases the risk of anxiety disorders in adulthood. With regard to Panksepp (9), conceptualization of the neuroarchitecture of the SADNESS system, the link between SADNESS, and anxiety disorders might be based on similar neurological correlates, including the amygdala and the anterior cingulate cortex (52, 53). Additionally, our results not only support Panksepp (7) hypothesis regarding the importance of the PANIC/GRIEF or SADNESS system in anxiety disorders, but also highlight his emphasis on the clinical significance of PLAY, which has been traditionally neglected in psychiatric research (8, 9).

Likewise, this assumption is reaffirmed in the observed association between PLAY and somatization symptoms. Taken together, these findings might be linked to the predominance of negative primary emotions, which inhibit the functional activity of the PLAY circuit (8, 29). Furthermore, the significant relationship between increased SADNESS and somatization might reflect the relationship between SADNESS and the endogenous opioid system, as a hypoactivity of mu and delta opioid network—correlated to increased SADNESS—is known to promote feelings of bodily discomfort (9, 20). Nevertheless, self-rated primary emotion dispositions explained only a small fraction of the somatization symptom variance. This finding resonates with several studies indicating that somatization patients showed increased alexithymia scores (54–56).

In addition, the results of the multigroup analysis indicated no significant sex differences as well as no differences between healthy and diagnosed participants regarding the strength and direction of the relationship between symptoms and primary emotion functioning. These results support and expand findings by Montag et al. (29), which suggested a continuum model regarding the relationship between primary emotions and depression in healthy participants as well as clinically treated patients. Moreover, our findings suggest that there are no sex specific differences between the associations of the ANPS and symptoms of SUD, depression, anxiety, and somatization.

LIMITATIONS

The present study reanalyzed an extended sample partially already investigated in Fuchshuber et al. (42). Therefore, the results of our analysis should not be interpreted as independent evidence. Moreover, a question asked the participants to report if they have ever been diagnosed with a psychiatric disorder by a licensed psychiatrist and a follow-up question assessed the specific diagnosis, which limits the descriptive value of our data regarding psychiatric diagnoses. Therefore, future research should aim at assessing psychiatric diagnoses in more detail by applying standardized interviews.

Furthermore, as there is no validated measure for the assessment of LUST currently available, it is impossible to estimate the clinical relevance of this primary emotion system. Despite having a key role in AN- and neuropsychoanalytic theory, LUST was not included in the ANPS, as its authors claimed that people would not be open enough to report about their sexuality (12). However, this assumption seems questionable, especially with regards to the variety of self-report measures of sexuality already existing. Hence, future research should aim at developing a self-report measure for LUST, to fully map the AN framework and its role in psychiatric etiology.

In addition, the present study assessed substance-related problems by means of the global continuum of substance use

risk (37). However, problematic consumption of different substance classes might be associated with differential primary emotion dysregulations (18). Hence, future studies should investigate the affective profiles for specific substance-related problems. Moreover, it should be kept in mind that our results suggest substantial intercorrelations between SUD and symptoms of mood disorders, as well as between different dimensions of primary emotions. Therefore, the interplay between other psychiatric symptoms and primary emotions underlying SUD should be understood as a complex and interdependent phenomenon. Finally, due to the cross-sectional design of this study, the results of the path analytic models presented herein are associative in nature and do not allow for causal interpretations.

CONCLUSION

The present study was able to gather empirical evidence for the psychiatric significance of primary emotion dispositions. Our results indicate that specific pattern of primary emotion dispositions underlie symptoms of SUDs and other psychiatric disorders. Hence, primary emotions might serve as a valuable target in the psychotherapeutic process. In correspondence to this, our findings present a tentative roadmap for neuroscientists as well as clinical researchers, underscoring primary emotion networks which might deserve attention in future research.

DATA AVAILABILITY

The raw data supporting the conclusions of this manuscript will be made available by the authors, without undue reservation, to any qualified researcher.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of the ethics guidelines of the Medical University of Graz. The protocol was approved by the ethics committee of the Medical University of Graz. All subjects gave written informed consent in accordance with the Declaration of Helsinki.

AUTHOR CONTRIBUTIONS

JF and HU conceptualized the study. JF conducted data collection and data evaluation. JF wrote the manuscript draft. HU, AK, MH-R and H-PK supervised the drafting of the manuscript. All authors proofread the final version of the manuscript and gave their consent for publication.

ACKNOWLEDGMENTS

We would like to acknowledge the work of Nikolas Bonatos for making helpful and invaluable critical comments about the manuscript.

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychiatry

ORIGINAL RESEARCH
published: 05 September 2019
doi: 10.3389/fpsyt.2019.00643

The Influence of Attachment Styles and Personality Organization on Emotional Functioning After Childhood Trauma

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Background: Current literature suggests a tenuous link among childhood trauma, personality organization, adult attachment, and emotional functioning in various psychiatric disorders. However, empirical research focusing on the interaction of these concepts is sparse. Therefore, this study intends to investigate the influence of personality organization and attachment dimensions on the relationship between childhood maltreatment and emotional functioning in adult life. To assess emotional functioning, we adopted the Affective Neuroscience model of primary emotions, comprising SEEKING, FEAR, ANGER, SADNESS, CARE, and PLAY.

Methods: The total sample consisted of 616 nonclinical adults (Age: $M = 30$; $SD = 9.53$; 61.9% female). Path analysis was applied to investigate interactions among childhood trauma, personality organization, adult attachment, and primary emotion dispositions.

Results: The findings suggest that childhood trauma significantly predicted deficits in personality organization and insecure attachment (all $p < 0.001$). Furthermore, a reduced level of personality organization was significantly associated with increased ANGER ($p < 0.001$), whereas adult attachment substantially predicted primary emotion dispositions in general. Moreover, the results indicate significant mediational effects of personality organization and attachment dimensions on the relationship between childhood trauma and primary emotions ($p < 0.01$). The final model was able to explain 48% of the variance in SADNESS, 38% in PLAY, 35% in FEAR, 28% in CARE, 14% in ANGER, and 13% in SEEKING.

Discussion: The findings contribute to the understanding of the relationship between childhood maltreatment and impaired emotional functioning in adult life. Furthermore, the importance of personality organization and attachment dimensions for emotion regulation is underlined. Consequently, the treatment of patients with childhood trauma should focus on facilitating the development of more secure attachment patterns and increased personality functioning to improve overall emotional functioning.

Keywords: adult attachment, personality organization, structural equation modeling, childhood trauma, primary emotions, affect regulation, mediation

OPEN ACCESS

Edited by:
Luigi Janiri, Catholic University of the Sacred Heart, Italy

Reviewed by:
Martin Zack, Centre for Addiction and Mental Health (CAMH), Canada
Lorenzo Moccia, Agostino Gemelli University Polyclinic, Italy

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Specialty section:
This article was submitted to Addictive Disorders, a section of the journal Frontiers in Psychiatry

Received: *08 November 2018*
Accepted: *08 August 2019*
Published: *05 September 2019*

Citation:
Fuchshuber J, Hiebler-Ragger M, Kresse A, Kapfhammer H-P and Unterrainer HF (2019) The Influence of Attachment Styles and Personality Organization on Emotional Functioning After Childhood Trauma. Front. Psychiatry 10:643. doi: 10.3389/fpsyt.2019.00643

INTRODUCTION

There is considerable evidence linking childhood maltreatment to a wide range of adult psychopathology (1). In accordance with this, a recent review by Teicher and Samson (2) suggested that childhood trauma is substantially related with morphological alterations in a number of brain regions, specifically the anterior cingulate, dorsal lateral prefrontal and orbitofrontal cortexes, the corpus callosum, and the hippocampus. Furthermore, childhood trauma is linked with enhanced amygdala response to emotional cues and conflict processing as well as diminished striatal response to anticipated rewards. In this context, converging results suggest that the association between childhood trauma and adult psychopathology might be mediated by disturbances in the neurobiological development related to cognitive control and emotion regulation (3–5). Empirically, childhood trauma is often assessed by the retrospective amount of emotional, physical, and sexual abuse, as well as emotional and physical neglect and deprivation (6).

With regard to emotional functioning, Affective Neuroscience (AN) proposes a framework of interdependently connected structures composed of primary, secondary, and tertiary processes (7–9). Primary processes consist of largely subcortically located basic emotions, serving as the primary motivational system of behavior. Secondary processes are linked to the limbic system and basal ganglia. These include unconscious and conditioned behavioral traits, like personality functions, object relations, and attachment patterns. Tertiary processes are predominantly neocortically based and summarize a broad spectrum of higher order cognitive functions like mentalization, mindfulness, and spirituality. Regarding the primary process foundation of personality, AN emphasizes the importance of seven neurobiologically discrete basic emotion circuits, bridging the boundary between physiological and psychological experience (7). These include SEEKING, LUST, ANGER, FEAR, SADNESS (or PANIC/GRIEF), PLAY, and CARE. With the exception of LUST, these primary emotion systems can be measured on a language-based conscious level with the Affective Neuroscience Personality Scales (ANPS) developed by Davis, Panksepp, and Normansell (10). The clinical importance of these primary emotions is underlined by their role in a multitude of psychiatric disorders, including depression (11–13), substance use disorders (14), Internet addiction (15), and autism (16). Furthermore, a recent twin study by Melchers et al. (17) implies a significant heritability of primary emotion dispositions and emphasizes the influence of environmental factors. Recent findings by Fuchshuber et al. (12) suggested a substantial association between childhood trauma and despair, which was composed of low SEEKING and high SADNESS, as proposed by Watt and Panksepp (18) and Zellner et al. (19).

Traditionally, the development of secure attachment has been linked to the genesis of emotional functioning (20). Thereby, Bowlby (21) observed that infants who were not able to establish a secure attachment to their caregiver were at higher risk for the emergence of developmental disorders, severe depression, and delinquent behavior. In accordance with this, attachment theory assumes that the development of affect regulation is linked to the early nonverbal communication between infant and primary caregiver (22, 23). Ideally, primary caregivers perceive the nonverbal affective expressions of the infant and coregulate these through symbolic mirroring and by providing physical as well as verbal comfort. This process helps the infant to tolerate its intense and primary nonverbal emotions. The repeated experience of this process is gradually internalized by the infant, which leads to the development of a positive inner working model of the self and others. These inner working models provide an internalized secure base, which enables the individual to regulate emotions in a relatively autonomous and functional way (24). Furthermore, secure attachment helps the individual to form stable and functional relationships, allowing the individual to regulate emotions with the help of others (25). In accordance with this, a secure adult attachment style might be defined by a pattern of comfortableness with intimacy, low anxiety of being rejected and unloved, as well as the ability to depend on others and having others depending on oneself (26). However, internalized traumatic early experiences lead to corresponding inner working models and insecure attachment patterns that obstruct the functional regulation of emotions (23, 27–29).

In line with this, (9, 30) proposed internalized object relations as the building blocks of the mind. Therefore, object relations consist of self-representations and object representations and affects connecting both. Similar to the inner working model of self and others in attachment theory, in Kernberg's view, object relations are conceptualized as influenced by early relationship experiences (9, 24). Yet, in contrast to attachment theory, Kernberg assumes that memories of early relationship experiences in adults are distorted by elements of fantasy regarding the primary caregiver. Furthermore, he emphasizes the interaction between the infants temperament and its environment (9, 31, 32). In accordance with this, the process of internalization of object relations gradually shapes mental structures and personality organization through consecutive layering sequences.

Kernberg's (32, 33) model of personality organization differentiates among three dimensions of dysfunctioning: (1) identity diffusion, which describes deficits regarding the coherence of internalized representations of oneself and others; (2) primitive defense mechanisms, meaning the dominance of early defense formations related to splitting; and (3) reality testing, indicating the ability to separate between the internal and external world. Moreover, he suggested that personality organization might be differentiated into three broad categories termed the neurotic, borderline, and psychotic level of organization. In this context, "borderline organization," which is conceptually related but not identical with borderline personality disorder (BPD), is linked to increased identity diffusion and predominant primitive defense mechanisms, combined with a mostly intact reality testing. In contrast, a decreased ability for reality testing is linked to a psychotic organization. However, all three concepts are theoretically interlocked and display an overall continuum of personality functioning (34). Research suggests that a low level of personality organization is associated with increased aggressive dyscontrol and negative affect as well as decreased positive affect and dysphoria (35).

It might be expected, because of similar theoretical foundations and implications, that both adult attachment and personality organization are significantly interrelated. Nonetheless, research investigating the link between self-rating measures of both concepts has been sparse and studies have been made predominantly on theoretical grounds (36–38). Most empirical studies focused on the relationship between BPD and adult attachment. Their results suggested robust associations between BPD and insecure attachment patterns (39), but they did not reveal a single attachment style specifically predicting BPD (40). Moreover, deficits within the attachment system are seen as core features of BPD (28). Regarding borderline personality organization, a study by Fischer-Kern et al. (41), which investigated links between reflective functioning (42), measured by the Adult Attachment interview (43), and personality organization, measured by the Structured Interview of Personality Organization (44), found moderate associations between deficits in reflective functioning and personality organization. In addition, Hiebler-Ragger et al. (45) reported significant correlations between borderline organization and adult attachment operationalized with self-rating measurements.

Research Question and Hypothesis

To map the relationship among childhood trauma, attachment, personality organization, and emotional functioning, this study applied path analysis. This statistical technique enables the investigation of simultaneous links between different concepts. Based on the research outlined above, the following hypotheses were formulated. Increased childhood trauma predicts more unsecure attachment patterns, deficits in personality organization, and decreased emotional functioning, as measured by basic emotion dispositions. Furthermore, unsecure attachment patterns and deficits in personality organization were expected to be associated with decreased emotional functioning. Therefore, we tested the hypothesis that attachment styles and personality organizations have a mediational role in the relationship between childhood trauma and emotional functioning. The conceptual framework for the hypotheses is outlined in **Figure 1**. Furthermore, we applied a multigroup path analysis approach to test if healthy participants differed from participants with a psychiatric diagnosis regarding the relationships in the path model.

MATERIALS AND METHODS

Procedure

The sample was recruited through various social networks. Informed consent was acquired before each participant filled in the test form that included demographic questions as well as the standardized questionnaires described below. The data were acquired *via* the online-survey platform LimeSurvey©. Data were analyzed from all participants who were aged between 18 and 69 years, spoke German fluently, and filled in every questionnaire. Overall, 1,502 individuals responded to the online survey, however, 874 discontinued the participation before completion, whereas 12 participants did not meet the required age for participation. The study was carried out in accordance with the Declaration of Helsinki. Ethical approval was granted by the Ethics Committee of the Medical University of Graz, Graz, Austria. The recruitment of participants was carried out between 02.04.2017 and 19.03.2018.

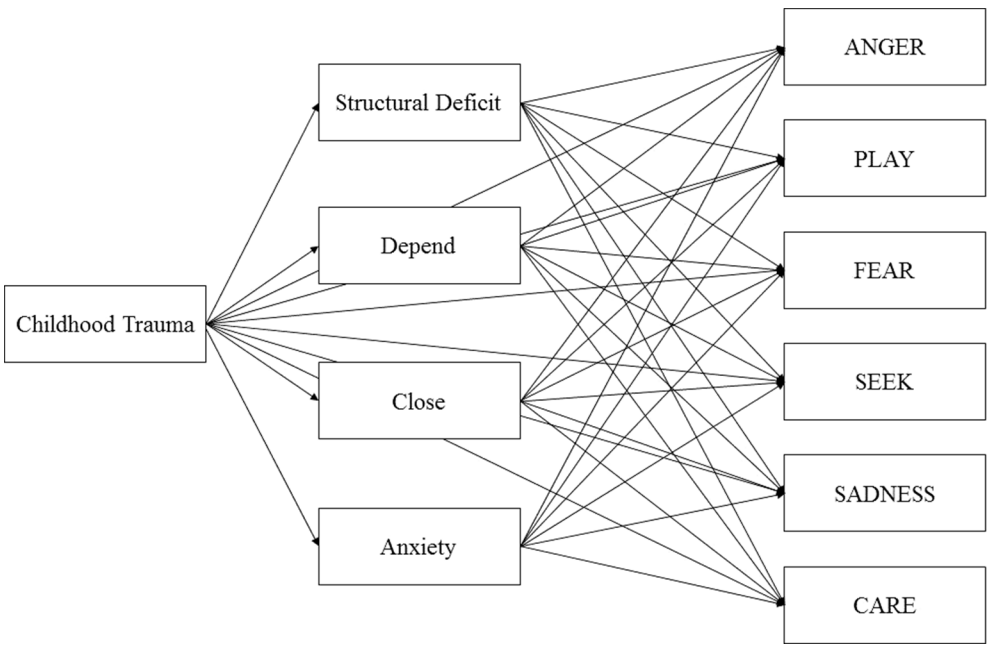

FIGURE 1 | Initial model of Childhood Trauma, Structural Deficit, Adult Attachment, and Primary Emotions controlled for Age and Sex.

Psychometric Assessment

Childhood Trauma

The Childhood Trauma Questionnaire (CTQ) (6) [German version by Wingenfeld et al. (46)] is a 28-item self-report measure of traumatizing childhood experiences, comprising "Emotional Abuse," "Physical Abuse," "Sexual Abuse," and "Emotional Neglect." A total "Childhood Trauma" score can be calculated based on answers to the questionnaire. Because of poor reliability, the subscale "Physical Neglect" was excluded in this study (47). It employs a 1 ("never") to 5 ("very often") Likert scale, with higher scores indicating more severe abuse or neglect. The subscales showed good to excellent internal consistencies with Cronbach's alpha ranging from 0.74 to 0.91. The total score exhibited an excellent internal consistency with Cronbach's alpha of 0.93.

Emotional Functioning

The ANPS (10) [German version by Ref. (48); see Ref. (49), for the most recent version] is a self-report questionnaire that measures behavioral traits related to the concept of subcortical primary emotion circuits developed by Panksepp (50). Therefore, this questionnaire comprises the subscales SEEKING, SADNESS, FEAR, RAGE, CARE, and PLAY and an additional scale for "Spirituality." It consists of, overall, 110 items, with 14 items for each subscale and is rated on a 4-point scale ranging from 1 ("strongly disagree") to 4 ("strongly agree"). SEEKING summarizes the disposition toward feelings of positive curiosity toward new experiences, the tendency to explore, and a sense of being able to achieve relevant goals. PLAY measures the trait of being protracted toward games with physical contact, laughter, fun, as well as being generally happy and joyful. SADNESS operationalizes the tendency of feeling separation distress, loneliness, and sorrow. CARE operationalizes the individual's tendency toward feelings of empathy, caring for children, people in need and animals, and a general enjoyment of being needed by others. FEAR measures the individuals' tendency toward feelings of anxiety, tenseness, worries, and ruminations. ANGER is conceptualized as being easily frustrated and irritated, the frequent expression of anger in a verbal or physical way, the experience of being angry due to frustrations, and being unable to calm down. All scales showed acceptable to good internal consistencies, with Cronbach's alpha ranging from 0.78 (SADNESS) to 0.89 (SEEKING). Because of our hypotheses, the subscale Spirituality was not analyzed in this study.

Personality Organization

The 16-Item Inventory of Personality Organization (IPO-16) [German version by Wingenfeld et al. (34)], is a self-report measurement of deficits within personality structure. The questionnaire is theoretically grounded in Otto Kernberg`s (32) model of personality organization. The IPO-16 is composed of three subscales: (1) "Identity Diffusion," which measures the integrity of the representations of oneself and others; (2) Dominance of primitive defense mechanisms, such as splitting, denial, projection, and dissociation ("Primitive Defense"); and (3) the capacity to differentiate between internal and external stimuli ("Reality Testing"). A total score of structural deficits can be generated with this instrument. The items are rated on a 5-point Likert scale ranging from 1 ("never") to 5 ("always"). Internal consistencies for the subscales were acceptable ranging from $\alpha = 0.74$ to $\alpha = 0.80$. The total score showed good internal consistency with a Cronbach's alpha of 0.88.

Adult Attachment

The Adult Attachment Scale (AAS) (51) is a self-report questionnaire based on the assumption that early attachment experiences form relatively stable inner attachment working models that influence individual needs and behavior in later relationships (21). The AAS consists of three subscales measuring anxiety about being rejected or unloved ("Anxiety"), comfort with closeness ("Close"), and comfort with depending on others ("Depend"). The German version of the AAS (26) is composed of 15 items (five items per subscale) and is rated on a 5-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). Cronbach's alpha for the subscales ranged between 0.81 and 0.87.

Statistical Analysis and Analysis Strategy

The path analysis and multigroup path analysis were conducted with AMOS 18. SPSS 17.0 was used for data management, descriptive statistics, and bivariate correlations, which assessed the strength of the relations among all variables. In the next step, data were fitted to an initial path model that included the following paths: Childhood Trauma to the attachment scales Depend, Anxiety, and Close; Childhood Trauma to Structural Deficit; Childhood Trauma to all primary emotions; attachment scales to all primary emotions; and Structural Deficit to all primary emotions (**Figure 1**). The model was controlled for age and sex. Furthermore, correlations between the disturbance terms of Personality Organization and attachment scales; between Depend, Anxiety, and Close; and between individual primary emotions were assigned.

After the initial model was fitted, a pruning strategy was applied in which nonsignificant paths were removed. First, nonsignificant correlations between the error terms of the individual variables were removed. Second, nonsignificant paths from Childhood Trauma to primary emotions were removed. Third, nonsignificant paths from Structural Deficit and the attachment scales to primary emotions were removed. Goodness-of-fit was assessed with a maximum likelihood estimation in AMOS. To test for mediation and indirect effects, a bootstrap was performed with a bias-corrected confidence interval of 95% and 1,000 bootstrap samples (52).

In accordance with Kline (53), the following fit indices were considered as markers for an acceptable model fit: (a) The comparative fit index (CFI) >0.90; (b) Tucker-Lewis index (TLI) relative fit index >0.90; (c) the square root error of approximation (RMSEA) <0.08 and the upper bound of its 90% confidence interval <1. For the comparison of competing models, the Bayesian information criterion (BIC) was used, with the smaller value indicating better fit.

RESULTS

Sample Characteristics and Descriptive Statistics

The investigated sample consisted of 616 German-speaking adults (381 female, 61.9%). The participants ranged in age from 18 to

69 years (M = 30; SD = 9.53). A total of 231 (37.5%) participants declared a university degree as their highest educational level, 214 (34.7%) a general qualification for university entrance, 46 (7.4%) a high school degree, and 96 (15.5%) participants stated a completed apprenticeship as their highest educational level. Twenty-nine (4.7%) participants stated that they left school without graduation. Regarding the current occupation of participants, 222 (36%) were in employment, 313 (50.8%) in education, 57 (9.2%) were unemployed, and 24 (3.8%) were on pension. Concerning the current relationship status, 59 (9.6%) were married, 259 (42.0%) in a relationship, and 298 (48.4%) were single. The nationality of most participants was either German (n = 334; 54.5%), Austrian (n = 218; 35.5%), or Swiss (n = 30; 4.8%), whereas 34 (5.5%) had other nationalities. Finally, 243 (39.4%) participants declared that they had been diagnosed with a (lifetime) psychiatric disorder. The majority of these participants were diagnosed with depression (n = 147; 60%), 50 (21%) with other affective disorders, and 46 (19%) participants were diagnosed with other psychiatric disorders. As shown in **Table 1**, participants with and without a psychiatric diagnosis differed ($p < 0.001$; $\eta^2 = 0.03–0.15$) in every examined variable, with the exception of CARE (p = n.s.). This included higher attachment security, less structural deficit, and less experienced childhood maltreatment in participants without psychiatric diagnosis.

As shown in **Table 2**, descriptive results suggested that the sample reported overall moderate exposure to childhood maltreatment (M = 36.50; SD = 15.22) (46). Furthermore, bivariate correlations between the examined variables suggested that the Childhood Trauma total score was significantly positively related to Structural Deficit, Anxiety, ANGER, FEAR, and SADNESS (all $p < 0.001$). Moreover, Childhood Trauma was negatively correlated with Depend, Close, SEEK, CARE, and PLAY (all $p < 0.001$) but not to sex (p = n.s.) (see **Table 2**). In addition, Structural Deficit was associated with every attachment

TABLE 1 | Descriptive statistics and differences between participants with psychiatric diagnosis (N = 243) and without (N = 373).

Measure	α	Healthy		Diagnosis		$F_{(1, 614)}$	p	η^2
		M	SD	M	SD			
AAS								
Depend	0.85	15.87	4.57	11.90	4.95	103.89	0.000	0.15
Close	0.87	13.18	4.82	10.30	5.17	49.83	0.000	0.08
Anxiety	0.81	11.07	4.52	13.68	5.12	44.38	0.000	0.07
IPO								
Structural Deficit	0.88	33.25	10.72	39.68	11.49	49.91	0.000	0.08
CTQ								
Childhood Trauma	0.93	32.64	12.84	42.44	16.65	67.52	0.000	0.10
ANPS								
SEEK	0.75	2.89	0.38	2.70	0.42	33.62	0.000	0.05
FEAR	0.89	2.64	0.52	3.06	0.51	96.66	0.000	0.14
ANGER	0.85	2.53	0.48	2.71	0.53	17.89	0.000	0.03
SADNESS	0.78	2.52	0.48	2.87	0.43	99.73	0.000	0.14
CARE	0.76	2.90	0.45	2.85	0.47	1.53	0.216	0.00
PLAY	0.83	2.89	0.45	2.60	0.48	57.70	0.000	0.09

AAS, Adult Attachment Scales; IPO, Inventory of Personality Organization; CTQ, Childhood Trauma Questionnaire; ANPS, Affective Neuroscience Personality Scales.

TABLE 2 | Descriptive statistics, sex differences, and correlations among examined variables.

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. Childhood Trauma	–											
2. Structural Deficit	0.37*	–										
3. Close	-0.44*	-0.48*	–									
4. Depend	-0.55*	-0.50*	0.60*	–								
5. Anxiety	0.35*	0.67*	-0.37*	-0.53*	–							
6. SEEK	-0.24*	-0.17*	0.28*	0.34*	-0.20*	–						
7. FEAR	0.25*	0.46*	-0.32*	-0.44*	0.55*	-0.33*	–					
8. ANGER	0.20*	0.34*	-0.20*	-0.32*	0.28*	-0.09	0.34*	–				
9. SADNESS	0.36*	0.51*	-0.36*	-0.54*	0.65*	-0.32*	0.73*	0.37	–			
10. CARE	-0.14*	0.08	0.28*	0.25*	0.07	0.28*	0.09	-0.06	0.06	–		
11. PLAY	-0.34*	-0.23*	0.53*	0.53*	-0.25*	0.56*	-0.39*	-0.11	-0.41*	0.41*	–	
12. Sex	0.09	-0.01	0.04	0.00	0.06	0.03	0.14*	0.06	0.15*	0.34*	0.03	–
M or *n*	36.50	35.79	12.04	14.30	12.10	2.81	2.81	2.60	2.66	2.88	2.78	381
SD or %	15.22	11.47	5.15	5.10	4.93	0.40	0.55	0.51	0.45	0.43	0.48	61.9

*n = 616; *p < 0.001; Sex was coded as 0 = male; 1 = female.*

scale ($p < 0.001$) and every primary emotion ($p < 0.001$) with the exception of CARE (p = n.s.). Finally, all attachment scales were significantly related to every primary emotion scale ($p < 0.001$).

Path Analysis Regarding the Relationship Between Childhood Trauma, Structural Deficit, Adult Attachment, and Primary Emotions

An initial model proposed direct effects from Childhood Trauma to Structural Deficit, attachment dimensions, and the individual primary emotions, as well as direct effects from Structural Deficit and attachment scales to primary emotions (**Figure 1**). The model, which was corrected for age and sex, was saturated; hence, it was not possible to compute the probability level. The model was then pruned by deleting nonsignificant correlations between disturbance terms of the individual primary emotions. This included correlations between ANGER and SEEK, ANGER and CARE, and ANGER and PLAY.

This procedure yielded a model that fit the data well: RMSEA = 0.00 (90% CI: 0.00, 0.05); TLI = 1.00; CFI = 1.00; BIC = 535.63. In a further step, the model was pruned by removing nonsignificant paths. First, nonsignificant paths from Childhood Trauma to primary emotions were deleted. This included every association between Childhood Trauma and primary emotions. Second, nonsignificant paths from Structural Deficit and attachment dimensions to primary emotions were removed. This included (1) paths from Structural Deficit to SADNESS, FEAR, CARE, and SEEK; (2) paths from Close to FEAR, SADNESS, and ANGER; and (3) paths from Anxiety to ANGER, SEEK, and PLAY.

The trimmed model is presented in **Figure 2**. This model showed good fit: RMSEA = 0.03 (90% CI: 0.01, 0.05); TLI = 0.99; CFI = 1.00; BIC = 490.35. The reduction in BIC score was Δ 45, which indicated that this model was significantly more parsimonious than the initial model and therefore a better fit for the data.

Direct Effects

As shown in **Figure 2**, this model suggested that Childhood Trauma is significantly related to Structural Deficit (β = 0.39; $p < 0.001$), Depend (β = -0.56; $p < 0.001$), Close (β = -0.44; $p < 0.001$), and Anxiety (β = 0.36; $p < 0.001$). Moreover, Structural Deficit showed a significant positive correlation with Anxiety (r = 0.60) and significant negative correlations with Depend (r = -0.38) and Close (r = -0.39; all $p < 0.001$). Moreover, every attachment scale was correlated with each other ($p < 0.001$). In detail, Anxiety was negatively linked to Depend (r = -0.43) and Close (r = -0.26), whereas Depend was positively linked to Close (r = 0.47). Furthermore, Structural Deficit was associated with ANGER (β = 0.21; $p < 0.001$) and PLAY (β = 0.12; $p < 0.001$). Meanwhile, Depend was associated with ANGER (β = -0.21; $p < 0.001$), SADNESS (β = -0.29; $p < 0.001$), SEEK (β = 0.29; $p < 0.001$), FEAR (β = -0.25; $p < 0.001$), PLAY (β = 0.41; $p < 0.001$), and CARE (β = 0.24; $p < 0.001$). In addition, Close was associated with PLAY (β = 0.33; $p < 0.001$), SEEK (β = 0.10; $p < 0.02$), and CARE (β = 0.25; $p < 0.001$). Finally, Anxiety was associated with FEAR (β = 0.37; $p < 0.001$), SADNESS (β = 0.47; $p < 0.001$) and CARE (β = 0.27; $p < 0.001$).

With regard to the control variables, female sex was positively associated with FEAR (β = 0.12; $p < 0.001$) and CARE (β = 0.33; $p < 0.001$), whereas age was negatively associated with Structural Deficit (β = -0.25; $p < 0.001$), Anxiety (β = -0.24; $p < 0.001$), FEAR (β = -0.13; $p < 0.001$), and PLAY (β = -0.13; $p < 0.001$).

In summary, this model was able to explain 14% of the variance of ANGER, 48% of SADNESS, 13% of SEEK, 35% of FEAR, 38% of PLAY, and 28% of CARE.

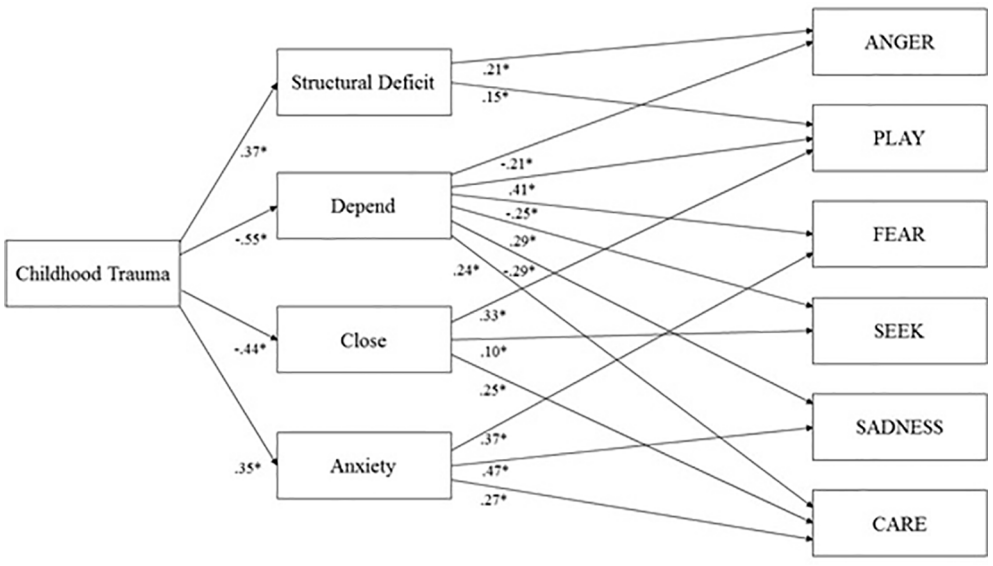

FIGURE 2 | Final model of Childhood Trauma, Structural Deficit, Adult attachment, and Primary Emotions controlled for Age and Sex; *$p < 0.001$.

Indirect Effects

Furthermore, bootstrap analysis revealed significant indirect effects of childhood trauma on primary emotions, mediated through its association with Structural Deficit and adult attachment. Significant indirect effects of Childhood Trauma include associations with CARE ($\beta = -0.15$; $p < 0.01$), mediated *via* Anxiety, Depend, and Close; SEEK ($\beta = -0.18$; $p < 0.01$), mediated by Close and Depend; ANGER ($\beta = 0.20$; $p < 0.01$), mediated by Structural Deficit and Depend; PLAY ($\beta = -0.31$; $p < 0.01$), mediated by Structural Deficit, Depend, and Close; FEAR ($\beta = 0.29$; $p < 0.01$), mediated by Structural Deficit, Depend, and Anxiety; and SADNESS ($\beta = 0.31$; $p < 0.01$), mediated by Depend and Anxiety.

Multigroup Path Analysis

We further tested if healthy participants differed from participants with a psychiatric diagnosis regarding the relationships in the path model. The results revealed that both groups showed no significant differences in their path associations regarding the global model ($\chi^2_{(19)} = 23.66$; p = n.s.).

DISCUSSION

This study investigated the role of adult attachment and personality organization regarding the relationship between childhood trauma and adult life primary emotion functioning. Path analytic estimations concerning the indirect relationship between childhood trauma and primary emotions support the assumption that the influence of childhood trauma on primary emotion dispositions in adults is mediated by deficits in personality organization and insecure attachment. These results are largely in accordance with a growing field of research studies linking childhood trauma to emotion dysregulation and emotional dysfunctioning (3–5). Moreover, the results of the estimated direct effects suggest that the relationship between emotional dysfunctioning and childhood trauma might be the result of dysfunctional internalization processes related to traumatic early object relations, which lead to deficits in personality organization and insecure attachment patterns in the adult mental apparatus (9, 24). Furthermore, this study was able to gather evidence for the clinical significance of the AN-framework. In accordance with this, participants diagnosed with a psychiatric disorder not only exhibited more childhood trauma but also showed more deficits, in comparison to healthy participants, in all secondary order concepts as well as increased negative primary emotion dispositions and decreased dispositions in almost all positive primary emotions.

Our results underline the assumed importance of personality organization and adult attachment in emotional functioning proposed in psychodynamic literature (9, 20, 23, 54) and deepen the understanding of this connection. When computed within a single model, we find that structural deficit is significantly associated with increased PLAY and ANGER, whereas attachment dimensions are related to the measured primary emotion dispositions in general. More specifically, comfort with dependence on others shows several associations to decreased ANGER, FEAR, and SADNESS and increased PLAY, SEEK, and CARE. Comfort with closeness is linked with increased PLAY, SEEK, and CARE, and anxiety about being rejected or unloved predicts increased FEAR, SADNESS, and CARE. These results suggest that deficits in personality organization and insecure attachment mainly foster primary emotional traits, which are experienced as unpleasant (ANGER, FEAR, and SADNESS), whereas secure attachment predominately fosters pleasant primary emotion dispositions (SEEK, PLAY, and CARE). This is with the exception of "anxiety of being rejected," which is linked to increased CARE, reflecting the relationship of this concept with the insecure ambivalent or preoccupied attachment style, which is characterized by excessive clinging to attachment figures (55, 56). Furthermore, the rather small relationship between deficits in personality organization and increased PLAY might be caused by a suppression effect in our path model, as correlation analysis suggested an inverse relationship between these two concepts. In summary, the relationship among attachment, personality organization, and emotional functioning might be explained, in accordance with basic assumptions of attachment and object relations theory, by the affect-integrating role of underlying internalized working models and object relations (9, 20, 54, 57).

Notably, deficits in personality organization are predominantly related to increased levels of ANGER compared to adult attachment. This result echoes Kernberg's (9, 32, 58) conceptualization of personality organization, which (in line with Kleinian object relation theory) (59) emphasizes its crucial role in the integration and neutralization of aggressive affects. In contrast, adult attachment demonstrated stronger relations with every other facet of primary emotion dispositions, highlighting the importance of secure attachment in affect regulation and emotional functioning (20, 60).

With regard to proposed neural correlates of affect regulation, linked to the prefrontal and anterior cingulate cortex (61, 62), future studies might further investigate the functional and structural relationship between these neocortical areas and childhood trauma, adult attachment patterns, as well as personality organization. Furthermore, with regard to ANGER, which according to Panksepp (63) is mediated largely by a complex neural network, including the medial amygdala, the bed nucleus of the stria terminalis, the medial and perifornical hypothalamus, and dorsolateral parts of the periaqueductal gray, it seems plausible that the individual's personality organization might also impact functional properties of these structures. Therefore, future studies might aim to examine the influence of therapeutic interventions directed at the improvement of personality organization based on their effect on these subcortical regions. Specifically, this might include research on neurofunctional effects of psychodynamic and attachment oriented intervention strategies like Mentalization Based Therapy (64) or Transference Focused Psychotherapy (65). Furthermore,

another good example might be Mindfulness meditation techniques, which were observed to positively influence feelings of anger and anxiety in clinical patient groups (7, 66, 67). Moreover, there is a plethora of pharmacological compounds that were found to be effective in anger treatment, including mood stabilizers, serotonergic medication, and antipsychotics (68). Therefore, future research might aim to investigate the differential psychodynamic effects of psychopharmacological medications.

The direct paths of the investigated model increased the understanding of the relationship between personality organization and adult attachment. In line with previous theoretical and empirical studies (23, 36, 38, 41, 45) correlation analysis revealed substantial links between personality organization and adult attachment, which reflects conceptual similarities of both concepts. The strength of the relationships ranged from medium negative correlations with "comfort with dependence and closeness" to a large positive correlation with "anxiety of being rejected" (69). Moreover, correlation analysis revealed substantial links between emotional functioning and personality organization in addition to adult attachment. However, because of the substantial correlations between both personality organization and adult attachment, the influence of personality organization on primary emotions is diminished by adult attachment, if both concepts are considered within a single model.

The results of the multigroup analysis indicated no significant difference between healthy and diagnosed participants regarding the strength and direction of the relationship between childhood trauma, adult attachment, structural deficit, and primary emotion functioning. Therefore, this finding suggested a continuum model regarding the relationship between childhood trauma and adult personality and psychopathology.

Some limitations of this study should be noted. Despite applying path analysis, the design of this study was cross-sectional. Therefore, the investigated pathways among adult attachment, personality organization, and primary emotions cannot be seen as strictly causal. Future research might therefore conduct longitudinal studies to explore the predictive links between these concepts. Furthermore, our sample contained a rather large proportion of participants with a wide range of psychiatric disorders. This might have led to confounding effects within our model. Although multigroup analysis regarding differences between participants with and without psychiatric disorders revealed no significant difference between these groups, future work should focus on differences within the relationships between these concepts in relation to groups differing in psychopathology. Therefore, psychiatric disorders should be assessed more thoroughly by means of standardized clinical interviews. Nevertheless, it seemed reasonable for this explorative study to investigate a continuum between health and pathology. Furthermore, the attrition rate within our sample was relatively high (58%), which might suggest a certain amount of reactivity to the questions and could a have had an impact on the representativeness of the data. Moreover, the use of self-rating measures in regard to concepts, which are at least partly regarded as unconscious (61), might be seen as insufficient because they only map the conscious surface structures of these concepts. Therefore, future studies applying structured interviews should be conducted to strengthen the validity of our results. Lastly, this study did not apply measurements to assess possible self-presentation bias, hence, we cannot rule out that diminished abilities of self-reflection or tendencies toward distorted self-presentation might have influenced our results.

CONCLUSION

The current study contributes to the knowledge of how childhood trauma, attachment insecurity, and deficits in personality organization influence emotional functioning. Our results suggest that both attachment and personality organization explain the association between abuse experienced in childhood and primary emotion functioning in adult life. These findings indicate that the AN-framework, assuming linked primary and higher order processes (7), might be valuable avenues to understand the pathogenic effects of childhood trauma. Therefore, this work underlines the importance of attachment and personality organization for the treatment of psychiatric disorders associated with emotional dysfunctioning (57, 70). In accordance with this, psychotherapeutic interventions might focus on traumatically damaged object relations and the restructuring of dysfunctional personality organization and attachment patterns to foster increased self-regulation and emotional functioning in patients.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of the ethics guidelines of the Medical University of Graz. The protocol was approved by the ethics committee of the Medical University of Graz. All subjects gave written informed consent in accordance with the Declaration of Helsinki.

AUTHOR CONTRIBUTIONS

JF and HU conceptualized the study. JF collected, analyzed and interpreted the data. JF, HU, and MH-R drafted the manuscript. AK and H-PK critically reviewed the manuscript. All authors gave their final approval of the manuscript.

ACKNOWLEDGMENTS

We would like to acknowledge the work of Nikolas Bonatos for making helpful and invaluable critical comments about the manuscript.

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychiatry

BRIEF RESEARCH REPORT
published: 06 September 2019
doi: 10.3389/fpsyt.2019.00602

Testing a Neuro-Evolutionary Theory of Social Bonds and Addiction: Methadone Associated With Lower Attachment Anxiety, Comfort With Closeness, and Proximity Maintenance

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OPEN ACCESS

Edited by:
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Reviewed by:
Hugo Senra, University of Essex, United Kingdom
Daniela Flores Mosri, Universidad Intercontinental, Mexico

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Specialty section:
This article was submitted to Addictive Disorders, a section of the journal Frontiers in Psychiatry

Received: *03 June 2019*
Accepted: *30 July 2019*
Published: *06 September 2019*

Citation:
Torres N (2019) Testing a Neuro-Evolutionary Theory of Social Bonds and Addiction: Methadone Associated With Lower Attachment Anxiety, Comfort With Closeness, and Proximity Maintenance. Front. Psychiatry 10:602. doi: 10.3389/fpsyt.2019.00602

Evidence from non-human mammals for the involvement of the endogenous opioid system in prosocial behavior is reasonably extensive and robust; however, studies in humans are lacking. This study tests the neuro-evolutionary hypothesis that exogenous opiates, including morphine, heroine, and methadone, decrease separation anxiety and proximity by hijacking the neuro-peptide endogenous opioid system modulating social bonds. Participants were 486 subjects, 43% male, with ages between 18 and 62 years (M = 26.4; SD = 9.4), divided in three naturalistic groups: 1: addicts in drug-free treatment; 2: addicts in methadone programs; 3: normative non-clinical controls.

Instruments: 1) Adult Attachment Scale (AAS) composed of three subscales: Anxiety about being rejected (α = 0.83), Comfort with Intimacy (α = 0.68), and Comfort Depending on Others (α = 0.70). 2) Caregiving Questionnaire composed of four subscales: Proximity Maintenance: (α = 0.83), Sensitivity: (α = 0.76), Controlling Caregiving (α = 0.77) and Compulsive Caregiving (α = 0.68).

Results: Multivariate Analysis of Co-variance (MANCOVA) models were computed; gender, age, and education were included in the models. Methadone patients and drug-free treatment addicts were equivalent and reported significantly lower Comfort Depending on Others, Comfort with Intimacy, and Caregiving Proximity. However, methadone users reported significantly lower Anxiety about being rejected than drug-free addicts and were equivalent to non-clinical controls. In addition, correlations between the methadone intake dose and the questionnaires' scales showed that dose was significantly and negatively correlated with Comfort with Closeness (rs = –0.36; $p < 0.01$) and with Caregiving Proximity (rs = –0.28; $p < 0.05$).

Keywords: addiction, attachment, opioids, opiates, methadone, caregiving

INTRODUCTION

Humans need intimate relationships of great depths of emotional, psychological and physical intensity for survival, and emotional well-being across the life cycle. Young children exhibit intense crying when helpless, lonely, or lost, alerting caretakers to attend to their needs. Adolescents and adults look for support, emotional and sexual bonding in social interactions and relationships, without which they feel empty and alienated. Social mammals need these affiliative interactions in order to get relief from negative emotions but also to get pleasure and joy (1).

It is now widely consensual that being able to form positive socio-emotional bonds has implications for physical and mental health as well as for greater social competence. Dysfunctional relationships, social rejection, and withdrawal are associated with a wide range of psychopathologies including drug abuse, anxiety, and depression (2, 3).

Research evidence in the last decades showed that the need for social bonding is neurologically hard wired in socially dependent animals, including humans (4, 5). Specifically, there has been vast research on the neurochemical bases of parental and romantic social bonds focused on the neuropeptides oxytocin, vasopressin, dopamine, and serotonin (6, 7).

Additionally, and based upon the homologies between opioid drug addiction and romantic bonding (8, 9), some authors have pointed out the endogenous opioids as another group of neurochemical mechanism motivating parental and relationship behavior in humans. These homologies are quite remarkable: they are both characterized by an initial strong attraction (i.e., the euphoria stage), which then decreases with exposure (i.e. the tolerance stage). After the emergence of tolerance, the system adapts to a new "set point" whereby absence of the partner/substance leads to negative affect and distress symptoms that are similar for opiate withdrawal and for social loss (10, 11).

Several studies with rodents using self-administration showed that the lack of social bonding due to isolation enhanced the consumption of opiates (12, 13). Also, opiates and opioids have shown to be effective in reducing separation distress, in puppies, young guinea pigs, and chicks, while opiate antagonists increase vocalizations induced by separation (14).

Additionally, it is now established by the concept of "social pain" that social bonding/rejection and physical pain share similar neuronal pathways (15). This area of research suggested that responses to positive and negative events on social interactions are regulated by endogenous opioid peptides and the μ-opioid receptor, which also alleviates physical pain (16). The μ-opioid receptor (MOR) system has also been shown to interact with oxytocin and dopamine in social bonding and social reward (17, 18). This is likely explained by the adaptive value of the social attachment system, which keeps young close to parents, and may have evolved to enhance biological fitness in social animals (19).

Starting from this brain opioid theory of social attachment, Panksepp et al. (10, 11, 20) suggested that opiate addiction (morphine, heroin, etc.) could be neurologically motivated in part by the capacity of these drugs to reduce the pain and the lack of joy of inadequate social bonding and attachments. On the other hand, opiates' consumption reduces the drive for social interactions in animals, including humans, while small doses increase feelings of confidence and social dominance (10, 11). It is also known that the repeated use of opiates in its turn induces alterations in neurotransmitter and neuropeptide systems in brain circuits that regulate mood and affect (21).

The attachment theory (22, 23) has been applied widely as a theoretical framework for understanding how close interpersonal bonds can shape both normal and abnormal development. According to this tradition, humans are innately equipped with behavioral systems for social attachment and caregiving, since being emotionally bonded to parents, friends, romantic partners, and providing care for dependent individuals enhanced genetic success or inclusive fitness (24).

The attachment theory tradition has provided several measurement methods such as the Adult Attachment Interview (AAI) and a series of self-report questionnaires, such as the Adult Attachment Scale (AAS) (25) and the Caregiving Questionnaire (26), to access individual differences in psycho-social close relationships.

Translating these notions to human addiction studies, in previous works, we found that addicts vs controls recalled a significantly greater number of traumatic events in childhood and adolescence (such as parental death, child abuse, and early separation), which are known to severely disrupt the attachment system (27). They also had higher scores on attachment Anxiety and Avoidance of close relationships, and additionally, these scores were significantly correlated with the number of traumatic family events in childhood and adolescence (28).

Recently, a meta-analysis found both cross sectional and prospective significant correlations between attachment and (later) substance use, albeit both of small magnitude; these results indicate that lower attachment security is concurrent to and temporally preceded increases in substance use (29). Additionally, the study found no evidence of a moderation effect of the type of attachment measure—e.g., AAI, AAS—on the correlation between attachment and substance use.

Although there is today a vast amount of studies showing a robust association between subjects with a diagnosis of drug addiction and severe problems in close relationships, there is not to our knowledge a comparative study between addicts in opiate abstinence vs addicts consuming the opiate methadone, vs non-addicted controls. There is also a lack of studies focusing specifically on individual differences in profiles of the caregiving system (25).

OBJECTIVES

In the present cross-sectional comparative study, we aimed to test the effect of the opiate agonist methadone use and dosage on measures of two behavioral systems hypothesized by Bowlby (23) to regulate close social bonds (the Attachment system and the Caregiving system).

HYPOTHESES

1) Opiate-addicted subjects have close relationship profiles characterized by higher avoidance of close proximity in social bonds and higher attachment-related anxiety than non-clinical controls.
2) Methadone intake and dosage are associated with lower self-reported attachment-related anxiety and higher avoidance of proximity maintenance in close relationships

PARTICIPANTS

A total of 486 subjects participated in the study; 43% were male, their age ranging from 18 to 62 years (M = 26.4; SD = 9.4). Participants were members of three naturalistic groups: Group 1: addicts in drug-free (DF) treatment therapeutic communities (n = 56); Group 2: addicts in MMT-Methadone maintenance treatment (n = 88); Group 3: normative non-clinical controls (n = 342). The participants in group 1 were residents of three therapeutic communities (TC) in Portugal that adhere strictly to total abstinence and drug-free policies, with few exceptions for a minority of patients that could not withdraw methadone (the patients taking methadone in the TC were excluded from the study statistics). Participants in group 2 were addicts in outpatient treatment and outreach programs in Lisbon, taking daily doses of methadone under medical supervision. The methadone dose ranged from 5 to 215 mg (M = 65.8 mg; SD = 38.6 mg); these dose values are of similar range and average to other studies [e.g., Ref. (30)]. Participants in group 3 were Psychology university students in Lisbon.

Due to the lack of previous studies comparing attachment variables on methadone users, abstinent substance abusers, and non-clinical subjects, it was impossible to rely on a reasonably expected effect size. This fact prevented us from doing an a priori power analysis to estimate the minimum N of the sample. Hence, we used rules of thumb from the literature according to which, in a variety of settings, the minimum number of subjects per variable lies in the range of 15 to 20 (31, 32). The non-clinical group subjects were part of a larger study on attachment and caregiving in university students; for that reason, the number of subjects was substantially higher.

Groups 1 and 2 were not significantly different in gender, educational level, age started abusing drugs, percentage of father, mother, and siblings with substance abuse problems, and total number of relatives with substance abuse problems. Group 1 was slightly older than group 2, and group 3 was younger, had more years of education, and contained more females than the other two groups (all differences $p < 0.05$). **Table 1** shows the demographic characteristics of the participants. **Supplementary Table 1** shows additional characteristics of the addiction subjects. The two groups of addicts were equivalent in all variables except "Father with addiction" and Methadone intake.

TABLE 1 | Demographic characteristics of participants.

	Group		
	Addicts in DF Treatment	**Addicts in Metadone MT**	**Non-clinical**
Sex (% male)	65[a]	69[b]	32[c]
Age	34,5[a]	38,1[a]	22,1[b]
Education (years of)	8,9[a]	8,5[a]	13,1[b]

Values with different letters are significantly different at $p < 0.05$.

ETHICAL APPROVAL

All participants provided written informed consent to participate in the study. All procedures were approved by the Research Ethics Committee of the university (ISPA—Instituto Universitário, Lisbon, Portugal) and in accord with the ethical principles of psychologists and code of conduct of the American Psychological Association.

INSTRUMENTS

Subjects completed a battery of two self-report questionnaires. The order of the questionnaires was randomly counterbalanced:

1) Adult Attachment Scale (AAS) (26) consists of 18 items scored on a 5-point Likert-type scale. We used the Portuguese version, adapted by Canavarro, Dias and Lima (33). The questionnaire contains three subscales, each composed of six items. The three subscales are CLOSE, DEPEND, and ANXIETY. The CLOSE scale measures the extent to which a person is comfortable with closeness and intimacy (e.g., "I do not worry about someone getting too close to me"). The DEPEND scale measures the extent to which a person feels he/she can depend on others to be available when needed (e.g., "I know that people will be there when I need them."). The ANXIETY subscale measures the extent to which a person is worried about being abandoned or unloved (e.g., "I do worry about being abandoned".). The psychometric consistency of the scales in the present study was as follows: ANXIETY about being rejected or unloved ($\alpha = 0.83$), CLOSE—Comfort with Closeness and Intimacy ($\alpha = 0.65$) and DEPEND—Comfort Depending on others ($\alpha = .70$).
2) Caregiving Questionnaire (1) consists of 32 items scored on a 6-point Likert scale, assessing caregiving behaviors in romantic and marital relationships. We used the Portuguese version, adapted by Torres and Oliveira (34). It is composed of four subscales: The Proximity maintenance (or Proximity vs Distance) subscale assesses the degree to which subjects make themselves available to their partner when comfort is needed (e.g., "When my partner seems to want or need a hug, I'm glad to provide it"). The Sensitivity subscale assesses the degree to which subjects recognize when their partner needs support (e.g., "I can always tell when my partner needs comforting, even when s/he doesn't ask for it"). The Controlling subscale measures the degree to which subjects exert control to help their partners solve problems (e.g., "I tend to be too domineering when trying to help my partner"). Finally, the Compulsive subscale measures the extent to which subjects get over-involved in their partners problems (e.g., "I sometimes create problems by taking on my

partner's troubles as if they were my own"). The psychometric consistency of the scales in the present study was as follows: Proximity Maintenance: (α = 0.83), Sensitivity: (α = 0.76), Controlling Caregiving (α = 0.77), and Compulsive Caregiving (α = 0.68).

The addicted subjects further completed the section D of Portuguese ASI-6 (Addiction Severity Index, Version 6) by a clinical psychologist member of the research team in order to check if all them had heroin as a drug of addiction, which was the case.

DATA ANALYSIS PLAN

All statistics were performed using the IBM SPSS Statistics package Version 21.0. Preliminary inspection of the data showed that the AAS and Caregiving questionnaires' scales were normally distributed, while the methadone intake variable significantly differed from the normal distribution.

First, we performed Pearson correlations between all questionnaire scales in study, in order to test for theoretically congruent associations between attachment and caregiving constructs, and to detect potential multicollinearity (which was not present: all correlation coefficients were below .50). Second, in order to test for differences between the three groups, two Multivariate Analysis of Co-variance (MANCOVA) models were computed, one with the AAS and one with the Caregiving scales as dependent variables; the three groups of subjects were included as the independent variable. The variables Sex, Age, and Education were also included in the models as covariates to statistically control for the demographic differences between the three groups.

Finally, we tested the association between methadone dosage in milligrams and all the questionnaire scales using Spearman non-parametric correlations since methadone dosage had a non-normal distribution.

RESULTS

The intercorrelation matrix, presented in **Supplementary Table 2**, shows theoretically congruent significant correlations between the constructs of attachment and caregiving.

Two MANCOVA models were computed, one with the AAS scales as dependent variables and the other with the Caregiving scales as dependent variables. In both models, the three groups of subjects were the levels of the independent variable, and the variables Sex, Age, and Education were included in both models. All MANCOVA assumptions were tested and met by the data except the equality of variances, which were significantly different in the AAS Capacity to be Close scale ($F = 3.45$; $p = 0.004$) and the Caregiving Controlling scale ($F = 2.90$; $p = 0.013$). For this reason, we performed the MANCOVAs using a bootstrap method (35) with the number of samples = 1,000, available in the SPSS package. In both models, multivariate tests showed significant effects of the group variable only, no significant main effects of the demographic variables, and no interaction effects between the variables in the model. **Table 2** shows the mean differences for each group on all the questionnaires' scales, the value of F statistic, and contrasts for both models.

As can be seen in **Table 2**, the Methadone intakers and Drug-free treatment addicts were statistically equivalent on all questionnaire scales, except for the AAS scale "Anxiety about being rejected or unloved": in this scale, the Methadone MT subjects had significantly lower scores than drug-free addicts and were equivalent to non-clinical controls.

Finally, we tested the association between methadone dosage in milligrams and all the questionnaire scales using Spearman non-parametric correlations.

TABLE 2 | MANCOVA models' results and differences between groups on Attachment and Caregiving variables.

	Addicts in DF Treatment	Addicts in Metadone MT	Non-clinical Subjects	$F_{2.451}$	*p*	Partial Eta Squared
Model 1: AAS						
Anxiety about rejection	3.42[a]	2.39[b]	2.44[b]	29.91	0.000	0.116
	(0.83)	(0.76)	(0.78)			
Capacity to be Close	3.03[a]	2.88[a]	3.68[b]	18.77	0.000	0.076
	(0.51)	(0.68)	(0.49)			
Comfort Depending on others	2.82[a]	2.72[a]	3.19[b]	7.68	0.001	0.033
	(0.58)	(0.66)	(0.57)			
Model 2: CAREGIVING						
4. Proximity maintenance	3.91[a]	3.95[a]	4.81[b]	6.68	0.001	0.029
	(0.65)	(0.99)	(0.88)			
5. Sensitivity	3,65[a]	3.86[a]	4.32[b]	5.47	0.005	0.024
	(0.65)	(0.98)	(0.73)			
6. Controlling Caregiving	3.97[a]	3.61[a]	2.88[b]	21.83	0.000	0.090
	(0.66)	(1.01)	(0.82)			
7. Compulsive Caregiving	3.65[a]	3.41[a]	3.19[b]	3.53	0.030	0.016
	(0.75)	(0.97)	(0.76)			

Values with different superscripted letters are post hoc *significantly different at $p < 0.05$.*
Standard Deviations in parenthesis below means.

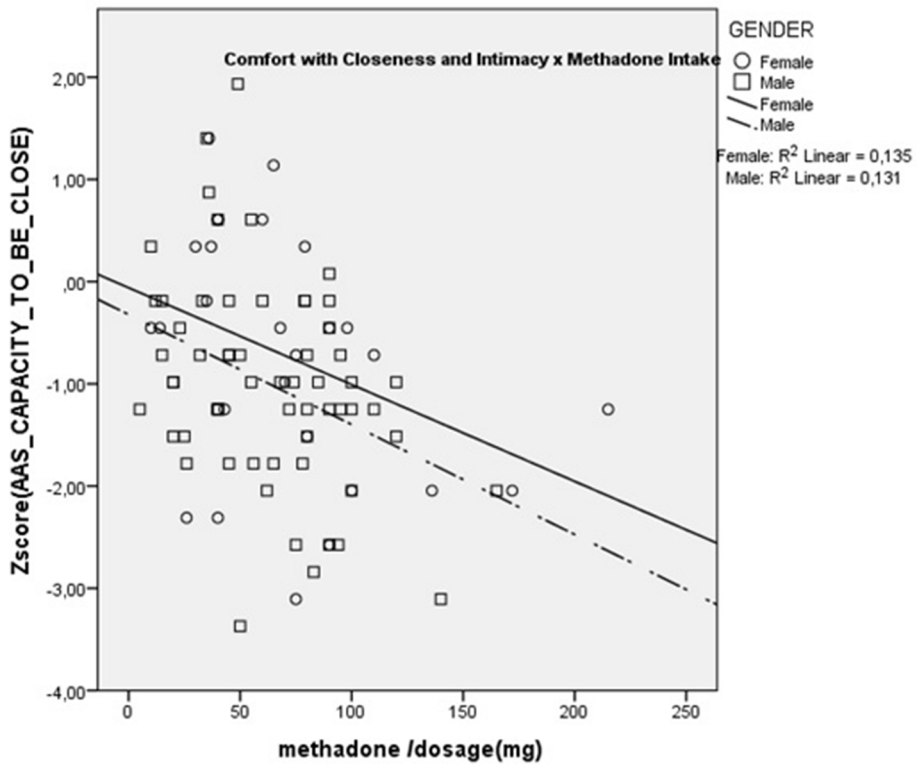

FIGURE 1 | Scatterplot of Correlation between methadone dose and Capacity to be Close.

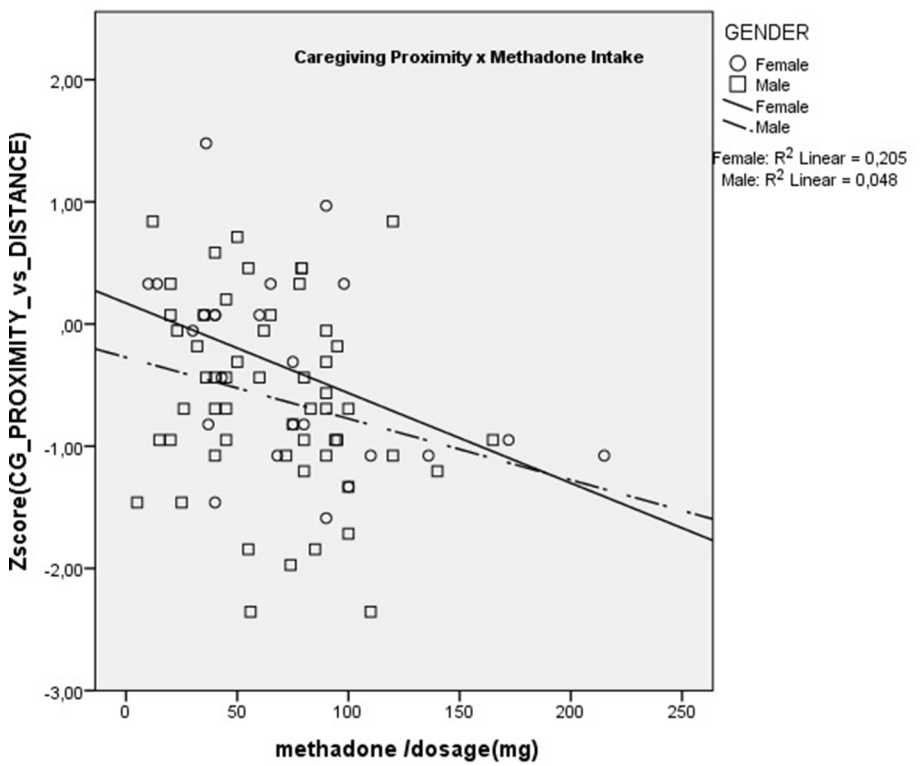

FIGURE 2 | Scatterplot of Correlation between methadone dose and Caregiving Proximity.

Results showed that dose was significantly and negatively correlated with AAS Comfort with Closeness ($r_s = -0.36$; $p < 0.01$) and with Caregiving Proximity ($r_s = -0.28$; $p < 0.05$). There were no significant correlations with any of the other scales. These are presented in **Figures 1** and **2**. These results show that increasing methadone doses were associated with diminished capacity for, and diminished comfort with, emotional and physical closeness with partners.

DISCUSSION

The results of our study show support for the neuro-evolutionary theory of social bonds and addiction [also known as Brain Opioid Theory of Social Attachment (BOTSA)] (4), according to which exogenous opiates decrease separation anxiety and proximity maintenance in humans, as in animal models, by hijacking the neuro-peptide endogenous opioid system modulating social bonds (12).

In our sample, both groups of drug addicts—more than 95% reported the opiate heroin as their main addiction—showed lower levels of adaptive profiles of attachment and caregiving compared with non-clinical controls. This result is congruent with more than 20 cross-sectional studies, which have reported that as attachment security decreases, substance use increases (29). Similarly to these previous studies, in the present study, the estimated effect sizes were in the small-to-medium range (the Partial Eta Squared ranged from 0.016 to 0.116).

We had the possibility of comparing two groups of subjects with equivalent histories of opiate addictions: 1—addicts currently in abstinence of opiates and 2—methadone intakers. Methadone is a synthetic opioid that acts on the same opioid receptors as morphine and heroin. It is commonly used to treat opiate addictions, especially addiction to heroin, and has been considered by some as the "gold standard" for treating opiate addiction (36). The abstinent drug addicts were inpatients at therapeutic communities' residential treatment with strict abstinence rules for all drugs including alcohol, undergoing regular urine analyses to detect drugs. For this reason, we can have a high degree of confidence that they were actually abstinent of opioids. In this way, we had the opportunity to compare in a quasi-experimental way, the effect of an opiate drug on self-reported psychological states related to intimate social bonds and attachment.

Results showed that the methadone users reported significantly less feelings of attachment anxiety, i.e., anxiety about being abandoned or unloved, than their abstinent counterparts. Furthermore, this association had the stonger effect size of all questionnaire scales (Partial Eta Squared = 0.116), which represents a medium size effect. This result is congruent with experimental work on animal models, which showed that opiate agonists decreased observable signs of anxiety due to separation and isolation (14, 37). In a range of mammals, including rats, mice, chicks, sheep, guinea pigs, dogs, non-human primates, and humans, separation from the mother leads the young to emit distress vocalizations. There is considerable evidence from a range of species that administration of morphine reduces these vocalizations, while the opioid antagonist naloxone increases them (4). The fact that in our study the methadone intakers were statistically equivalent to the abstinent addicts, except for the lower score of AAS separation anxiety, gives us some grounds to suggest a possible homology with the opioid-mediated separation distress paradigm in animal models.

Additionally, we were able to correlate methadone dosage with the attachment and caregiving scales, within the methadone intakers group. Results showed that higher methadone dosage was associated with lower levels of Caregiving Proximity and Comfort with Closeness. The Caregiving Proximity maintenance subscale is a measure of the degree to which subjects make themselves available to their partners when comfort is needed and, hence, is an important part of parental-like behaviors. The negative correlation with methadone dosage is congruent with previous animal studies showing that morphine significantly impairs parental behavior such as retrieving, grouping, licking, and nursing the young, while naloxone, an opiate antagonist, restores it (38). Opiates, in particular mu-receptor ligands, disrupt maternal behavior in a very selective, naloxone-reversible fashion (39). Additionally, the negative correlation of Comfort with closeness suggests that methadone might decrease the rewarding aspect of physical contact characteristic of parental and affiliative behaviors, a phenomenon that was previously suggested for other opiates (40). These results with the notion that patients maintained on opioids relate autistically (e.g., "with coldness in human interactions and gaze avoidance) which are reversed by detoxification from opioids" (41).

The absence of significant correlation between higher methadone doses and lower attachment anxiety might at first sight be seen as counter-intuitive and contradicting the other results. However the mean value of AAS-Anxiety in the MMT group was below the total sample mean (as the non-clinical subjects), which reduces statistical variance and may contribute to a non-significant correlation. On the other hand, it is also likely that methadone can reduce attachment-anxiety/separation distress at low doses, and hence, increasing the dosage does not have a proportional effect due to a ceiling effect. Indeed, it has been reported in psychiatric patients that "opiates at low doses can powerfully counteract feelings of social loss and despair" (p. 645) (12), in rodents "low doses of morphine inhibit separation distress of infants" (4), as well as low doses of opiates (down to 0.5 mg/kg) can reduce motivation to social contact (40). These results converge with previous literature suggesting that provision of exogenous opioids, such as methadone, may have significant long-term consequences of degrading the endogenous opioid system such as avoidance of social interactions "that are not currently accounted for in medical practice" (41).

It is worth noting that as in previous studies, the obtained effect sizes were in the small-to-medium range. This fact is congruent with the notion that opiate drugs' abuse/addiction is a multifactorial phenomenona with a great number of both genetical and environmental determinants. For this reason, effect sizes for specific biopsychosocial risk factors may often emerge as small in magnitude (29, 42). Another possible reason for the small effect sizes is that there might be moderators of the attachment–drug abuse association at several levels of analysis (biological, genetic, psycho-social, geographical, macro-social). However, in

this study, we did not find significant interactions between gender, education or age and drug abuse status. A meta-analysis by Fairbairn et al. (29) tested a large number of potential moderators (age, gender, racial composition, geographic region, substance use pattern, attachment figure, attachment measures, and others) and found only age to be a moderator in prospective studies but not in cross-sectional studies, like the present one. We need more multilevel studies that can address the interactions between genetic, epigenetic, neurobiological factors, and experiences of psychosocial and relationship adversity at several stages of development, to reframe our understanding of how attachment/close relationship variables are moderated by other phenomena in the development, severity, and maintenance of addiction (43).

The present study has a number of limitations. First, the ones which are typical of cross-sectional correlational and quasi-experimental designs: it is not possible to determine or infer directional causality from the data. Additionally, the use of self-report questionnaires to measure attachment-theory constructs has its own limitations and has drawn criticism: on the one hand, some of the psychological processes are supposed to take place implicitly or unconsciously and, hence, cannot be measured by explicit self-report measures; on the other hand, previous research showed that the correlations between implicit measures of attachment such as in-depth interviews and self-report questionnaires are typically low (44). Furthermore, it is possible that respondents manipulate some of their answers, either in a conscious or unconscious way. However, the meta-analysis by Fairbairn et al. (29) did not found any significant influence of the different attachment measures (i.e., implicit measures such as the AAI and explicit measures such as the AAS questionnaire) on the results, which gives us some reassurance that the present results may be robust.

DATA AVAILABILITY

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by ISPA-IU: Comité de Ética do Centro de Investigação. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

FUNDING

This research was funded by grants from the Foundation for Science and Technology of Portugal: UID/PSI/04810/2019.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2019.00602/full#supplementary-material

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Conflict of Interest Statement: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychiatry

MINI REVIEW
published: 17 September 2019
doi: 10.3389/fpsyt.2019.00662

Addiction and the Dark Triad of Personality

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In this article, we review associations between the Dark Triad of personality (narcissism, Machiavellianism, and psychopathy) and addictive behaviors, both substance-related and non-substance-related. We summarize evidence from personality and clinical research and integrate it with prevailing models of addiction. Specifically, we discuss addictive behavior in the light of affect regulation, which is likely more relevant in narcissism, as well as inhibitory deficits, a putative mechanism in psychopathy. These mechanisms can be related to central motives of the respective personality constructs, such as stabilization of self-esteem in narcissism and impulsive stimulation seeking in psychopathy. We conclude that different mechanisms might lead to similar observable behavior in narcissism and psychopathy at earlier stages of the addiction cycle, but psychopathic disinhibition might be particularly relevant at later stages. This underpins the importance of considering personality factors for the understanding and treatment of addiction.

Keywords: Dark Triad, narcissism, Machiavellianism, psychopathy, substance use, substance use disorder, addiction

OPEN ACCESS

Edited by:
Andreas Schindler, University Medical Center Hamburg-Eppendorf, Germany

Reviewed by:
Jürgen Fuchshuber, Medical University of Graz, Austria
Mark J Ferris, Wake Forest School of Medicine, United States

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Specialty section:
This article was submitted to Addictive Disorders, a section of the journal Frontiers in Psychiatry

Received: *02 June 2019*
Accepted: *15 August 2019*
Published: *17 September 2019*

Citation:
Jauk E and Dieterich R (2019) Addiction and the Dark Triad of Personality. Front. Psychiatry 10:662. doi: 10.3389/fpsyt.2019.00662

THE DARK TRIAD

The Dark Triad of personality—narcissism, Machiavellianism, and psychopathy (1)—attracted enormous research interest in the past decades. Given that the three traits are tied together by antagonism as a marker of emotionally cold interpersonal behavior (2), much of the pertinent literature focuses on intrinsically interpersonal topics such as workplace behavior, interpersonal attraction, or generally competitive contexts (3). The socially aversive, "dark" personality characteristics are partially related to short-term individual benefits in these contexts, such as vocational success [e.g., Ref. (4)] or mating success [e.g., Ref. (5)]. Besides these benefits, there are also significant costs. These encompass avoidant attachment [e.g., Ref. (6)]; dissatisfaction regarding needs for relatedness, competence, and autonomy; feelings of inauthenticity (7); reduced mental health[1]; risk-taking behavior; and—most important for the present review—substance use (8, 9).

We describe contemporary models of the three traits and review their associations with addictive behavior (substance-related and non-substance-related). We adopt a dimensional perspective, which assumes that the three traits display continuous distributions bending into clinically relevant personality configurations towards the upper ends. Additionally, we highlight findings from clinical groups with substance use disorders and/or personality disorders. The amount of available literature on the three traits differs substantially, with some literature for narcissism, little for Machiavellianism, and most for psychopathy. Among the three, it is mostly narcissism and

[1] It needs to be noted, though, that the effects are heterogeneous for the three traits, and particularly narcissism, is also related to reports of subjective well-being.

psychopathy that display associations to substance use [e.g., Ref. (10), see **Table 1**]. Comorbidities of substance use disorders and the respective personality disorders are also well documented in community samples (11) and clinical groups (12, 13). The mechanisms promoting addictive behaviors in narcissism and psychopathy might differ and potentially target different phases of the addiction cycle: on the one hand, initially, instrumental use, driven by self-stabilizing motives, and on the other hand, compulsive use, characterized by loss of control despite negative consequences, which circumscribe fully developed substance use disorders (14).

NARCISSISM

Structural models of narcissism place self-importance and entitlement—both aspects of antagonism—at the core of the construct (15, 16). Beyond that, a grandiose form, a socially dominant, agentic–antagonistic interpersonal style, and a vulnerable form, a neurotic–antagonistic style, can be distinguished (16). In the general population, the grandiose and the vulnerable forms of narcissism are unrelated and display opposing characteristics with respect to psychological functioning and mental health, with grandiosity displaying (mostly) adaptive adjustment in self-report studies and vulnerability displaying signs of maladaptive adjustment and mental illness [cf. Ref. (17)]. Our recent studies suggest that both aspects might be intertwined at high grandiosity (18, 19). Concurrent grandiosity and vulnerability are referred to as pathological narcissism (20).

Grandiose narcissism is associated with substance use—particularly alcohol—in nonclinical groups (10, 21–25) and is elevated in substance use disorder groups (26). Vulnerable narcissism is also associated with substance use in nonclinical groups (21). Accordingly, pathological narcissism (concurrent grandiosity and vulnerability) was found to be substantially associated with alcohol and drug use (27, 28). Individuals with substance use disorders, compared to controls, display higher pathological narcissism, particularly in aspects of vulnerability such as entitlement rage,[2] devaluing, hiding the self, and self-esteem contingency (30). Narcissistic personality disorder (defined as extreme grandiosity) is comorbid with alcohol and drug dependence (13). However, regarding dependence, narcissistic personality disorder does not necessarily have higher rates of comorbidity than other personality disorders (31, 32). Comorbidities might be explained by general functional impairment rather than specific characteristics of narcissism (33).

The putative mechanisms mediating substance use in narcissism are seen in self-regulatory functions, particularly the stabilization of self-esteem, which is high but instable in grandiose narcissism (34) and low in vulnerable narcissism (35). Drinking is related to grandiose narcissism and self-esteem contingency (such as need for approval) (23). Grandiose narcissism predicts drinking behavior independently of impulsivity, which indicates that other mechanisms might be relevant (24). This becomes even more apparent when grandiosity is accompanied by vulnerability, for which increased feelings of shame explain the association with problematic alcohol use (21).

Interestingly, in a recent study, an interpersonal aspect of pathological narcissism, *devaluing*, again turned out to be among the strongest predictors of impaired control over drinking and associated problems (36). Devaluing reflects "disinterest in others who do not provide needed admiration and shame over needing recognition from disappointing others" (37, p. 368). It could thus be speculated that this particular pattern of interpersonal avoidance goes hand in hand with substituting "real" others for "ideal" experiential states induced by the drug, such as long posited by psychoanalytic theorists: "Actually, the very term, 'drug dependency' reminds us of what we are dealing with, namely an archaic passive dependency on an all-giving, sempiternal, though narcissistically perceived—i.e., hugely inflated—object"[3] (38, p. 838).

Beyond substance-related behavior, grandiose narcissism is linked to addictive social media use (24, 39–41), compulsive smartphone use (42), compulsive buying (43), pathological gambling (44), or compulsive working (45). Studies comparing grandiose narcissism to the other Dark Triad traits, however, do not always find effects for narcissism, but also point to the role of psychopathic or Machiavellian traits instead (46–49). The mechanisms that likely mediate the relationship between grandiose narcissism and problematic social media use are similar to those for substance use: grandiose narcissism is related to addictive Facebook usage via the need to be admired and—to a lesser extent—the need to belong (50). If their need for admiration is not satisfied, individuals with grandiose traits display more risk-taking behavior (51). In contrast to substance-related behavior (drinking), however, the associations between grandiose narcissism and disordered social media use can be explained by increased reward sensitivity (24), which points to the stronger involvement of approach-orientation.

Interestingly, in social anxiety disorder and avoidant personality disorder—which are highly comorbid with alcohol use disorder (52, 53)—interpersonal coping is also a frequently encountered motive for initial drinking. This highlights further parallels between social anxiety and vulnerable narcissism, which display substantial conceptual and empirical overlaps (54). Recent evidence suggests that socially anxious individuals who develop problematic or addictive drinking patterns may belong to a highly impulsive subtype of social anxiety disorder (55, 56). Future research on narcissism and addiction could integrate these findings to elucidate more fine-grained predictors of problematic or addictive substance use in narcissism.

Taken together, self-regulatory mechanisms—particularly the regulation of a chronically instable self-esteem—play a major role in the relation between narcissism and addictive behavior. For substance-related behaviors, this is most evident in substance use

[2] Entitlement rage was considered a facet of grandiosity or vulnerability in different studies [see Ref. (29)].

[3] The object, in psychoanalytic terms, refers to a real or imagined other, as a counterpart to the subject.

to cope with negative affect due to lack of others' admiration and feelings of shame related to narcissistic vulnerability. For non-substance-related behaviors, using social media to feel admired might be a central mechanism.

MACHIAVELLIANISM

The concept of Machiavellianism was derived from Niccolò Machiavelli's writings by the social psychologists Richard Christie and Florence Geis (57). In their conception, individuals displaying Machiavellian tendencies are characterized by instrumental and strategic interpersonal behavior alongside low orientation towards moral standards. In the Five Factor Model framework, Machiavellianism is—like narcissism and psychopathy—primarily characterized by interpersonal antagonism (58).

Christie and Geis (57) postulated that "Machs" should be characterized by the absence of psychopathology to allow for effective reality testing. This suggests that, among the three socially aversive traits, Machiavellianism should show no associations, or even negative associations, with addictive behavior. While empirical studies are scarce, Machiavellianism is indeed not significantly associated with global indices of substance use (10). Machiavellianism is, however, higher in cocaine users (59) and positively associated with indicators of problematic or addictive internet use (41, 47, 49), though not all studies find such associations (46, 48).

Beyond addictive behavior, empirical findings show that Machiavellianism is—depending on the scale and factor structure—not generally independent of psychopathology (60). However, some of these associations might be due to the multifaceted nature of the traditional Machiavellianism inventory, which also assesses low conscientiousness (58, 61). Recently, a new Machiavellianism scale was designed to assess the core characteristics in a purer fashion. Machiavellianism was uncorrelated with substance use and gambling; the "planful" aspect of Machiavellianism (positively associated with conscientiousness) was even negatively related to both (61), as could be expected on the basis of the original construct definition. To sum up, while more research will be needed for a comprehensive picture, existing studies do not point to a pivotal role of Machiavellianism in substance use, but suggest some associations with problematic internet use. Results may strongly depend on the operationalization of Machiavellianism, particularly the extent to which it draws on disinhibited (low-conscientious) aspects.

PSYCHOPATHY

Structural models conceive psychopathy as a syndrome of interpersonal–affective and antisocial–deviant personality and behavior characteristics (62). These encompass, amongst others, an interpersonal style of superficial charm, grandiose self-worth (linking psychopathy to narcissism), manipulative behavior, shallow affect, and lack of empathy, as well as delinquency, stimulation seeking, and impulsivity. Regarding broad traits, psychopathy can be characterized mainly by interpersonal antagonism and aspects of low conscientiousness (disinhibition) (63–66). Traditional models of psychopathic traits in the general population also build upon the distinction between interpersonal–affective characteristics, also called factor 1 or primary psychopathic traits, and antisocial–deviant aspects, also referred to as factor 2 or secondary psychopathic traits (67). Alternative models propose two or three factors named fearless dominance/boldness, self-centered impulsivity/disinhibition, and coldheartedness/meanness (63, 68).

Psychopathic traits are reliably associated with substance use and addiction in forensic populations (12, 69–71) and also in the general population (10, 72, 73). The mechanisms that foster substance use and addiction in relation to psychopathic traits might differ from those of narcissism. Psychopathy—as outlined above—is associated with stimulation seeking and reduced inhibitory control with regard to potentially risky behavior [e.g., Ref. (10)]. Among the two factors, it is thus mainly the antisocial–deviant behavior, or secondary psychopathy, which is associated with substance use (12, 69, 71).

Neuroimaging work suggests that psychopathic—particularly antisocial–deviant—traits among healthy individuals are positively associated with striatal brain activity during monetary reward anticipation and application of amphetamine (74, 75), even when controlling for impulsivity. Given that similarly altered brain responses can predict problematic drug involvement (76), striatal hyperreactivity might facilitate drug use in highly risk-prone psychopathic individuals (but see evidence for striatal hyporeactivity as predictor of problematic drug use), (77). Drug users develop a sensitivity to substance cues, manifesting in increased activity in a circuit mediating reward, value, emotion, and salience processing, which is also related to subjective craving (78, 79). This is consistent with the incentive sensitization theory of addiction, which posits that pathologically high attribution of incentive salience to drug cues ("wanting/craving"), rather than the pleasurable effect of drugs ("liking"), drives compulsive drug use (80).

Interestingly, a neuroimaging study of the effects of drug cues in criminal offenders with a history of substance use disorders showed that characteristics of psychopathy negatively modulated brain responses to substance cues in this cue reactivity circuit (81). Modulation of brain responses was more pronounced for factor 2 (antisocial–deviant) than factor 1 (interpersonal–affective) psychopathy. A similar finding was recently obtained for adolescents: psychopathic characteristics negatively modulated neural cue reactivity, though in the youth sample, the negative association was more pronounced for factor 1 (82). However, most recently, a study on adult parolees with substance use disorder found evidence for a positive modulation of brain activation to drug cues by psychopathic traits (factor 1) (83). An important difference between this study and the prior investigations is the use of food cues rather than neutral stimuli as a control condition. The authors argue that individuals with higher psychopathic traits display stronger desensitization of non-drug-related cues. However, this effect was moderated by drug use history in such a way that highly psychopathic individuals with a longer drug use history showed lower sensitivity to drug cues (83).

TABLE 1 | Summary of the reviewed literature on Dark Triad traits in relation to substance use and addictive behaviors.

	Narcissism	Machiavellianism	Psychopathy
Central characteristics	Self-importance and entitlement	Instrumental and manipulative behavior	Interpersonal–affective and antisocial–deviant traits
Primary broad trait	Antagonism	Antagonism	Antagonism
Secondary broad trait	Extraversion (grandiose)/neuroticism (vulnerable)	Unclear	Disinhibition (low conscientiousness)
Associations with substance use	+	~	++
Motives for substance use	Regulation of self-esteem (grandiose and vulnerable), negative affect reduction (vulnerable)	Unclear	Stimulation seeking
Associations with substance use disorder	~	Unclear	++
Associations with non-substance-related addictive behavior	++ (Robust evidence for problematic social media use)	Unclear	+ (Evidence for internet use and gambling)

"+" indicates evidence for positive association, "++" strong evidence for positive association, "~" no evidence for association.

Together, these findings suggest an interaction between psychopathic personality disposition and substance use: while those without a history of substance use display increased sensitivity to monetary and drug rewards, those with a longer history of substance use display decreased reactivity to drug cues. While it needs to be noted that these phenomena tap into different aspects of the addiction cycle, tentatively speaking, these studies suggest that cue reactivity or craving might not be the primary driving force of compulsive drug use in psychopathy. Other processes such as impulsivity or insensitivity to punishment, i.e., reduced behavioral control when assessing short-term benefits versus long-term risks or the implications of immediate negative feedback, might play a more prominent role. This would be consistent with recent longitudinal work (77) and addiction models conceptualizing compulsive drug use as the result of dysfunctional decision-making and learning processes (84, 85).

Psychopathic traits are also associated with non-substance-related addictive behaviors such as problematic social media or internet use (46–49) or problematic gambling (86–88) in the general population and in select populations, such as pathological gamblers [antisocial traits (89); for trait-level meta-analysis, see Ref. (90)]. In contrast to narcissism, there is little evidence for self-esteem stabilization or psychosocial coping as a functional mechanism.

Taken together, there is robust evidence for associations of substance use and addiction with psychopathic traits not only in forensic samples but also in the general population. Interestingly, these associations reflect a historic account to the classification of "anti-" as well as "dyssocial reactions" and alcohol/substance addictions, which were both subsumed under "sociopathic personality disturbance" in the first edition of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM*) [(91); see also Ref. (92)]. Unlike narcissism, there is little evidence for drug use as affect regulation in psychopathy. This aligns with the idea that individuals with psychopathic traits experience low levels of stress and anxiety, as for instance manifest in the negative correlations with neuroticism (64, 66). Substance use and addiction might be more related to stimulation seeking and impulsivity.

CONCLUSION

As summarized in **Table 1**, narcissism and psychopathy are associated with substance-related and non-substance-related addictive behavior across nonclinical and clinical populations, whereas Machiavellianism is not. This aligns well with the view that narcissism and psychopathy can be placed on the *externalizing spectrum* of mental disorders alongside substance use disorders, as expressed in the Hierarchical Taxonomy of Psychopathology (HiTOP) (93). Beyond that, the HiTOP differentiates antagonistic-externalizing behavior, which characterizes narcissistic as well as antisocial traits, from disinhibited-externalizing behavior, which characterizes substance use disorders and antisocial traits. This model thus conceives antisocial traits in closer proximity to substance use than narcissistic traits, as they are tied together by disinhibited behavior (94). While this view is supported by clinical and nonclinical studies on psychopathic traits and addictive behavior, research on narcissism suggests links with substance use as well. This is in line with meta-analytic findings demonstrating that both disinhibition (linked to psychopathy) and antagonism (linked to narcissism and psychopathy) are related to substance-use disorders (95). The mechanisms promoting addictive behavior in association with narcissism and psychopathy might differ: individuals with narcissistic traits might be primarily driven by self-regulatory goals (i.e., affect regulation, stabilization of self-esteem), whereas disinhibition might foster substance use in relation to psychopathy. These mechanisms presumably target different phases of the addiction cycle. Self-regulatory goals might play a larger role in initial stages; impulsivity might be crucia to the development of fully developed substance use disorders.

AUTHOR CONTRIBUTIONS

Both authors contributed to the conceptualization and writing of this manuscript.

ACKNOWLEDGEMENT

We acknowledge open access funding by the Publication Fund of the TU Dresden.

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychiatry

ORIGINAL RESEARCH
published: 18 September 2019
doi: 10.3389/fpsyt.2019.00681

Comparison of Students With and Without Problematic Smartphone Use in Light of Attachment Style

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Background: Nowadays, media addictions are especially of high relevance to psychotherapeutic practice. More recently, this particularly includes excessive smartphone usage. Even though a growing number of scientific literature and also mainstream media highlight problematic smartphone use as a serious health problem, there is only little research on this issue.

Objective: The aim of this study was to examine this phenomenon with a focus on attachment-specific differences between students with and without problematic smartphone use.

Method: A survey was carried out on all enrolled students of the Sigmund Freud University Vienna. The Smartphone Addiction Scale (SPAS) was used to differentiate between students with and without problematic smartphone use. The attachment style was assessed using the Bielefeld Partnership Expectations Questionnaire (BFPE).

Results: Of the total sample, 75 of the students (15.1%) showed a problematic smartphone use. A positive correlation between excessive smartphone usage and an insecure attachment style was found.

Discussion: Therapy for problematic smartphone use should be carried out in light of patient's attachment style. Further research into other factors of mental stress and personality is needed to better understand problematic smartphone use.

Keywords: smartphone, Internet, addiction, attachment style, online

OPEN ACCESS

Edited by:
Human Friedrich Unterrainer, University of Vienna, Austria

Reviewed by:
Diego Luiz Rovaris, Federal University of Rio Grande do Sul, Brazil
Jürgen Fuchshuber, Medical University of Graz, Austria

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Specialty section:
This article was submitted to Addictive Disorders, a section of the journal Frontiers in Psychiatry

Received: *17 May 2019*
Accepted: *23 August 2019*
Published: *18 September 2019*

Citation:
Eichenberg C, Schott M and Schroiff A (2019) Comparison of Students With and Without Problematic Smartphone Use in Light of Attachment Style. Front. Psychiatry 10:681. doi: 10.3389/fpsyt.2019.00681

INTRODUCTION

We spend more time with our smartphone than with any other human. Nearly everyone has their mobile device either directly on the body or at least in close vicinity around-the-clock. Teenagers between the age of 18 and 24 years look at their smartphone an average of 214 times a day (1). Not only do people use their smartphone more and more frequently but also (almost) everywhere: at work, at the home on the couch, while shopping, during the commute in buses and trains, and at lunch or dinner. Smartphone use is regulated by law for drivers, but not for pedestrians in traffic.

So far, smartphone addiction has no independent diagnosis in the current classification systems for mental disorders, *International Classification of Diseases*, 10th revision (ICD-10) (2), and *Diagnostic and Statistical Manual of Mental Disorders*, 5th Edition (DSM-5) (3); and, furthermore, it is a controversial term in this field of research (4). Therefore, in this study, the more neutral term

"problematic smartphone use" will be applied. According to Biang and Leung (5), characteristics of a problematic smartphone use are similar to the diagnostic criteria of the more researched Internet addiction. Therefore, as the smartphone can be seen as a medium that offers many possibilities and functions to access the Internet, theoretical models for excessive media use and Internet addiction can be transferred to problematic smartphone use (6). Still, even this diagnosis is problematic as behavioral addictions can only be found to a very limited extent in the ICD-10 and DSM-IV-TR (7). The core diagnostic characteristics of Internet addiction, although not yet uniformly defined, consist of the following: mental preoccupation with the Internet; development of tolerance; social withdrawal; frustrations with relapse; withdrawal symptoms (irritability, anxiety, and sadness); loss of interest in previous hobbies or activities; continuation of excessive consumption despite the knowledge of the resulting psychosocial problems; dysfunctional affect regulation; lying to friends, family members, or therapists to conceal actual consumption; and the loss of a meaningful relationship, job, or apprenticeship or career opportunities (8–11).

Similar diagnostic criteria for problematic smartphone use are proposed: compulsive behavior, functional impairment, withdrawal, and tolerance (12). Surveys report problematic smartphone use in 24% to 50% of the respondents (13). Prevalence of problematic smartphone use among students is as high as 24.8% to 27.8% and is steadily increasing every year (14). There are adverse effects on physical and mental health due to problematic smartphone use. Negative physical effects include neck pain (15), eye problems, and muscular pain (16). Regarding mental health, recent studies showed a connection between increased smartphone use and sleep disturbances (17) and problems with interpersonal relationships (18). Unfortunately, little is known about etiopathogenetic factors contributing to problematic smartphone use. Smartphones offer a wide variety of additional possibilities and functions that even further amplify the likelihood to develop obsessive behaviors (19). In this context, Autenrieth (20) emphasized the constant availability of the Internet. In particular, social networks, such as Facebook, Instagram, and Snapchat, play a major role in increasing the addictive potential. Roberts et al. (21) found that females reported spending significantly more time with their smartphones than males, and that particularly texting, sending e-mails, and using social media were the most time-consuming activities. In another study, Smetaniuk (22) reported that lower age, depression, and extraversion were correlated with higher scores on measures of problematic smartphone use. A Korean study (23) demonstrated that individuals with lower education levels were more likely to be diagnosed with problematic smartphone use.

Attachment theory offers a possible model to explain the development of problematic smartphone use. Attachment theory is based on the work of John Bowlby and Mary Ainsworth (24). The attachment system can be understood as a biologically and evolutionarily anchored motivational and behavioral system, which is mediated through interaction with attachment figures and in turn influences affect regulation, relationships, and their neurobiological correlates. According to Bartholomew and Horowitz (25), there are one "secure" and three "insecure" attachment styles: "avoidant-closed," "ambivalent-clingy," and "ambivalent-closed." Attachment style as a key feature in explaining various psychopathologies in the context of affective and interpersonal problems has been well documented (26, 27). Schuhler et al. (28) emphasized the connection between insecure attachment styles, long-lasting crises and conflicts in close relationships, anxiety in a social context, and Internet addiction. Schuhler (29) highlighted that the Internet offers a virtual world of relationships in which problematic real-world attachment experiences can be compensated. This assumption is similar to Brisch's (30) model of the reference object as a key component to addictions. Problematic smartphone use in contrast to other addiction disorders, such as the gambling addiction, not only replaces negative feelings by intoxication but also offers a replacement for a lack in secure social relationship due to insecure attachment styles (30). Smartphones offer numerous opportunities to communicate and establish relationships through social networks as well as a more easy way to manage one's self-presentation. This is a particularly important factor for the smartphones' addictive potential, considering that insecure attachment styles often accompany a disturbed self-perception (31). Even if the smartphone is used for other reasons, for example, as a place to retreat, it still offers numerous opportunities to engage in social relationships than do other non-substance and substance addictions. In summary, excessive smartphone use can be understood as a dysfunctional attempt to compensate for deficits in social relationship due to insecure attachment styles (32, 33). An association between attachment style and addiction was confirmed by Eichenberg et al. (34), Unterrainer et al. (35), and Hiebler-Ragger et al. (36). In light of the discussed research, the purpose of this study was to investigate whether insecure attachment styles are also positively associated with problematic smartphone use.

METHOD

Study Design

An online survey was carried out on all active students currently enrolled at Sigmund Freud University Vienna (N = 1,836). Students were contacted to participate through mail. Research data were collected with Unipark, a web-based survey software. A pretest was carried out with nine participants. Returns were analyzed, and the instrument was revised regarding its practicability, comprehensibility, and completeness of item formulation. The survey was online and available between 17 March 2017 and 13 May 2017. Before participants could start the questionnaire, information about study design and confidentiality was provided. The survey was viewed 843 times during the survey period. Most participants (23%) quit the questionnaire at the first page. Only about 8% of participants did not continue the questionnaire after the second page. Therefore, the overall dropout rate of 40.04% is acceptable (37). In total, there were 497 completed records. Completing the questionnaire took about 15 min. Ethical approval was obtained from the Sigmund Freud University Vienna ethics committee.

Material

Data on age, gender, nationality of participants, and field of study were collected. In addition, participants were asked to indicate how much they used their smartphone and for what services. Participants could choose between four categories: information search, utilities (make photos/videos, e-mail, and dictionary), entertainment (games, listening to music, and e-book), and socializing/communication (sms and calls). Each category was rated on a 5-point Likert scale ranging from "never" to "daily." Subsequently, the following questionnaires were collected in the following order.

Smartphone Addiction Scale (SPAS)

The Smartphone Addiction Scale (SPAS) (5) was used to assess symptoms of problematic smartphone use. This instrument assesses five primary symptoms: ignoring harmful consequences, excessive thinking about using the smartphone, inability to control desire, loss of productivity, and anxiety (5). The questionnaire consists of 19 items and three inventories: Mobile Phone Problematic Use Scale (MPPUS), Internet Addiction Test, and the Television Addiction Scale. The authors report a reliability coefficient of 0.70.

For this study, only a differentiation between participants with and without problematic smartphone use was needed. Therefore, only the eight items directly assessing problematic smartphone use were used. Items assessing Internet or television addiction were not used in the current study. For data analysis, the five-point Likert scale was dichotomized. Answers were summed up, resulting in overall values between 0 and 8. Subjects with a score of 5 or more were diagnosed with a problematic smartphone use.

Bielefeld Partnership Expectations Questionnaire (BFPE)

The Bielefeld Partnership Expectations Questionnaire (BFPE) was used to assess the attachment style of participants. This inventory consists of 31 items that are rated on a 5-point Likert scale ranging from 0 ("completely disagree") to 4 ("completely agree"). The questionnaire assesses five attachment styles. While the "secure" attachment style (25) is divided into two further categories ("secure" and "conditionally secure"), the remaining three ("avoidant-closed," "ambivalent-clingy," and "ambivalent-closed") are equivalent to the ones originally described. The reliability of the scales (Cronbach alpha = .77 to.89) is satisfactory.

The Bielefeld questionnaire is different from the others in two ways: (1) attachment style is operationalized as configurations of scale scores, which allow qualitative distinctions in terms of functioning, and (2) five empirically identified attachment styles are distinguished. Nonetheless, validation of the classifications with a German translation of the "Adult Attachment Scale" (AAS) yielded good results (38).

Statistical Analysis

The Statistical Package for the Social Sciences Program (SPSS Version 24) was used for data input, processing, and statistical analyses. Based on the data obtained with the BFPE (38), a cluster analysis was performed. Accordingly, the individuals were allocated to the five attachment styles "secure," "conditionally secure," "ambivalent-clingy," "ambivalent-closed," and "avoidant-closed." Subsequently, the five attachment styles were dichotomized into the variables "safe" and "insecure" attachment styles. Finally, using the chi-square test, attachment style and smartphone use were tested for significant differences.

RESULTS

Sample

The total sample of $N = 497$ consisted of $n = 120$ men (24.2%) and $n = 377$ women (75.8%). The majority of the surveyed subjects (72.8%) were from Germany, 13.6% from Austria, and only 3% from other countries. Some respondents (10.6%) did not report their nationality. Participants were between 17 and 70 years old, with average age being $M = 19.38$ years ($SD = 16.50$). Most participants studied either psychotherapy ($n = 286$, 57.5%) or psychology ($n = 125$, 25.2%). Only 16.5% studied medicine ($n = 82$) and 0.6% law ($n = 4$). This distribution was expected considering the composition of active students at the Sigmund Freud University.

Smartphone Use

For $n = 19$ subjects (1.4%), essential data were missing for a comprehensive analysis. According to the criteria and the cutoff of the SPAS, $n = 75$ (15.1%) participants were diagnosed with a problematic smartphone use. Of these participants, 86.7% were female and only 13.3% male. However, this gender ratio is in line with the gender distribution of the total sample.

Smartphone Services

All presented services were used approximately to the same extent. The most commonly used smartphone service was "communication" ($M = 4.9$, $SD = .5$). The least used service was "entertainment" ($M = 4.4$, $SD = 1.02$). Participants used their smartphone for information research and other utilities equally often ($M = 4.6$, $SD = .77$).

Attachment Style

About one third of the total sample (37%) had an "ambivalent-clingy" attachment style; 41% had an "ambivalent-closed" attachment style. Only 8.7% of the subjects showed a "secure" attachment style; similarly, only few participants could be classified as "conditionally secure" (5.6%) or "avoidance-closed" (7.6%) attached. These results are not consistent with the distribution reported by Höger and Buschkämper (38). Therefore, there is no balance between safe and insecure attached subjects. To ease statistical analyses and to create more balanced groups, the five attachment styles were dichotomized into "secure attachment style" and "insecure attachment style."

Smartphone Use and Attachment Style

Interference statistical analysis of the data showed that students with a problematic smartphone use differed significantly

from students without a problematic smartphone use in their attachment style ($\chi^2(1) = 7.43$; $p = .006$) (see **Table 1**). Students with a problematic smartphone use ($n = 75$) mostly had an "insecure" attachment style ($n = 72$), and only few ($n = 3$) had a "secure" attachment style. Considering individuals without a problematic smartphone use ($n = 415$), it can be seen that more subjects ($n = 66$) than expected ($n = 58.4$) showed a secure attachment style and less than expected an insecure attachment style.

Accordingly, significantly more than expected students with a problematic smartphone use had an insecure attachment style and significantly more students without a problematic smartphone use a secure attachment style. The contingency coefficient of $C = .12$ indicates a weak effect.

As expected, significant differences were also found with respect to individual attachment styles ($C = .18$, Ckorr = .22, $\chi^2(4) = 16.31$, $p = .003$) (see **Table 2**). Findings show that participants with a problematic smartphone use had a significant higher likelihood to have an "ambivalent-closed" attachment style ($K = 2.3$). In addition, there were significantly less participants with a problematic smartphone use that had a "conditionally secure" attachment style ($z = -2.0$).

In summary, according to the available data, the "ambivalent-close" attachment style is associated with excessive smartphone use. Out of 75 subjects classified with a problematic smartphone use, a large majority ($n = 70$, 93.3%) were located in this attachment category.

DISCUSSION

Even though a growing number of scientific literature and also mainstream media highlight problematic smartphone use as a serious health problem, only little research investigates possible etiopathogenetic factors. Since an association between attachment style and substance dependence has been widely demonstrated (29, 34), the aim of the present study was to investigate how people differ in their attachment style in regard to their tendency to problematically use smartphone. In this study, 15.1% of the participants showed problematic smartphone use. This result is comparable with prevalence rates reported in the available literature (39, 40).

A small part of the random sample (8.7%) showed a "secure" attachment style; similar numbers of participants could be classified as "conditionally secure" (5.6%) or "avoidance-closed" (7.6%). One third of the total sample (37%) showed an "ambivalent-clingy" attachment style and 41% an "ambivalent-closed" attachment style. These findings are not consistent with the distribution of attachment styles reported by Höger and Buschkämper (38). It has been reported in several other studies that the proportion of students with a secure attachment style is decreasing recently (41). There are various explanations for this difference, especially with regard to older prevalence numbers. For example, recent economic uncertainties can have an influence on interpersonal development. Furthermore, changes and particularly an increase in media use can influence the development of participants' attachment styles (41). Overall, the assumption that insecure people more often show an increased tendency to problematically use smartphones was confirmed; "ambivalent-closed" attachment styles were especially associated with a problematic smartphone use. Similar results are reported in a study by Eichenberg et al. (34), which found a significant relationship between Internet addiction and an insecure attachment style. As individuals with an "ambivalent-closed" attachment style particularly demonstrate difficulties with social acceptance and opening up to others and simultaneously show a distinct desire to connect with others, it can be assumed that in particular the social compensatory component plays a significant role in the context of excessive smartphone use. Individuals with an "ambivalent-closed" attachment style use the smartphone to compensate for their "real" deficits regarding interpersonal relationships. The anonymity of the Internet allows to create a new representation of the self, which could allow these individuals to compensate for dreaded "real" acceptance problems.

Based on the finding that primary attachment styles in individuals differ depending on substance abused, Schindler et al. (42) argued that an attempt may possibly be made to compensate for specific attachment deficits by using different substances. On the other hand, Eichenberg et al. (34) showed

TABLE 1 | Problematic smartphone use and dichotomized attachment style.

		Insecure	Secure
Unproblematic smartphone use	*n*	349	66
	Expected	356.6	58.4
Problematic smartphone use	*n*	72	3
	Expected	64.4	10.6
Total	*n*	421	69
	Expected	421	69

TABLE 2 | Problematic smartphone use and individual attachment styles.

		Avoidant-closed	Conditionally secure	Secure	Ambivalent-clingy	Ambivalent-closed
Unproblematic smartphone use	*n*	35	27	39	155	159
	Expected	31.3	22.9	35.6	153.3	171.9
Problematic smartphone use	*n*	2	0	3	26	44
	Expected	5.7	4.1	6.4	27.7	31.1
Total	*n*	37	27	42	181	203
	Expected	37.0	27.0	42.0	181.0	203.0

that attachment styles do not explain differences in regard to online services used. Accordingly, the question arises as to whether primarily the medium or the content has an influence on the addictive potential and how this relates to the attachment style. Future research into smartphone or Internet addiction needs to consider the context of different services used. In light of the discussion on etiopathogenetic factors of problematic smartphone use in various areas as well as the influence of media on the style of attachment, long-term research of users with a problematic smartphone use is needed. As a result, it can be concluded whether the attachment style can act as a disposition and thus favors such a development. Furthermore, it is necessary to identify additional risk factors that favor the development of a problematic smartphone use. For example, various studies underline that excessive media consumption is associated with certain personality traits. In particular, Love and Kewly (43) found that extroversion is related to how subjects used their mobile phone in public places.

There are some methodological limitations to this study. Recruitment method limits the validity of the study. With the method designed as an online survey, possible self-selection processes should be noted. Online surveys are predisposed to an inherent selection bias. It can be hypothesized that smartphone users in particular found it appealing to participate in the survey, who are trying to relativize the negative image of smartphone dependency. As a further limitation, subjects were mainly psychology/psychotherapy students, and as a consequence, age distribution was very narrow. Female participants contributed disproportionately to the respondent data set. However, this gender bias in online surveys has been frequently observed in the literature (44). Further studies with a broader recruitment method are needed to generate more representative data and confirm discussed results.

In conclusion, results emphasize the importance of attachment-based therapeutic intervention techniques in addiction therapy (45–47). Psychotherapeutic interventions aiming at the attachment style can be helpful in dealing with emotional stress and thereby prevent using the smartphone dysfunctionally to influence emotions. Perhaps the most important and hitherto most widely accepted therapeutic implication of attachment theory is the reference to the importance of the therapeutic relationship. The importance of the therapeutic relationship at the beginning of an addiction therapy for the further course of a treatment has been shown in a plethora of research (32). At best, this can become a corrective relationship experience that leads to a more secure attachment style.

DATA AVAILABILITY

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Commission of the Faculty of Psychotherapy Science and the Faculty of Psychology. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

CE was involved in planning and supervising the work. AS processed the experimental data, performed the analysis, and drafted the manuscript. MS took the lead in writing the manuscript. All authors provided critical feedback and helped shape the research, analysis, and manuscript.

FUNDING

This work was supported by the German Research Foundation (DFG) and the Technical University of Munich (TUM) in the framework of the Open Access Publishing Program.

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychiatry

ORIGINAL RESEARCH
published: 20 September 2019
doi: 10.3389/fpsyt.2019.00667

Brain Structure Alterations in Poly-Drug Use: Reduced Cortical Thickness and White Matter Impairments in Regions Associated With Affective, Cognitive, and Motor Functions

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OPEN ACCESS

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Reviewed by:
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Specialty section:
This article was submitted to Addictive Disorders, a section of the journal Frontiers in Psychiatry

Received: 30 January 2019
Accepted: 19 August 2019
Published: 20 September 2019

Citation:
Unterrainer HF, Hiebler-Ragger M, Koschutnig K, Fuchshuber J, Ragger K, Perchtold CM, Papousek I, Weiss EM and Fink A (2019) Brain Structure Alterations in Poly-Drug Use: Reduced Cortical Thickness and White Matter Impairments in Regions Associated With Affective, Cognitive, and Motor Functions. Front. Psychiatry 10:667. doi: 10.3389/fpsyt.2019.00667

Substance use disorders (SUDs) are defined by obsessive and uncontrolled consumption, which is related to neurobiological changes. Based on previous work, this study investigated potential alterations in brain structure in poly-drug use disordered (PUD) patients in comparison to controls from the normal population. This study involved a sample of 153 right-handed men aged between 18 and 41 years, comprising a clinical group of 78 PUD and a group of 75 healthy controls. Group differences in gray matter (GM) and white matter (WM), as well as cortical thickness (CT), were investigated by means of diffusion tensor imaging using automated fiber quantification (AFQ) and voxel-based morphometry. We observed significant WM impairments in PUD, especially in the bilateral corticospinal tracts and the inferior longitudinal fasciculi. Furthermore, we found reduced CT in the PUD group especially in the left insular and left lateral orbitofrontal cortex. There were no group differences in GM. In addition, PUD exhibited a higher amount of psychiatric symptoms (Brief Symptom Inventory) and impairments in cognitive functions (Wonderlic Personnel Test). In line with previous research, this study revealed substantial impairments in brain structure in the PUD group in areas linked with affective, cognitive, and motor functions. We therefore hypothesize a neurologically informed treatment approach for SUD. Future studies should consequently explore a potential positive neuroplasticity in relation to a better therapeutic outcome.

Keywords: DTI, gray matter, neuroplasticity, poly-drug use, VBM, white matter

INTRODUCTION

Within the European Union, a lifetime prevalence of up to 3% for substance use disorders (SUDs) has been shown for the general population (1, 2). Correspondingly, SUD represent a significant burden on society and healthcare systems. In addition to this, the treatment of SUD has been reported to be extremely difficult due to a high proportion of therapy dropouts (3). SUD have been most prominently

described as a chronic, relapsing brain disorder characterized by compulsive drug use, which produces long-term changes in the reward circuitry of the brain (4–6). Therefore, it is now widely accepted that many drugs may "hijack" the reward centers of the brain, setting in motion a downward spiral towards SUD (7). Notably, some authors have challenged this view by arguing that the complex mechanisms underlying SUD cannot be explained by neural dysfunction alone (8). In that sense, SUD have also been widely discussed in relation to dysfunctional attempts of self-medication (9) and misled attachment needs (10). Furthermore, it should be noted that premorbid brain abnormalities might also lead to severe psychiatric disturbances such as SUD (11, 12).

From a developmental perspective, childhood and adolescence represent critical periods of cortical development related to lifelong adult characteristics. This development is likely interrupted by drug misuse since most people usually start abusing drugs in puberty (13). Although acute drug intake increases dopamine neurotransmission, chronic drug consumption results in a significant decline of dopamine activity, associated with, among other things, dysregulation of the orbitofrontal cortex and the cingulate gyrus (14), which in turn is linked to maladaptive decision making (15) and increased drug craving (16) in SUD. However, because SUD patients usually show a more or less haphazard kind of poly-drug use, it is as yet largely unclear which detrimental effects are caused by the abuse of which drug (17, 18). In addition, all drugs have similar direct or indirect effects on the mesolimbic reward system. This system extends from the ventral tegmentum to the nucleus accumbens and projects to areas such as the limbic system and the orbitofrontal cortex (6).

Furthermore, different kinds of drugs have been observed as being associated with impairments of white matter (WM) (19) as well as gray matter (GM) (20, 21) in the brain. Here, a special focus has been placed on the detrimental effects of drug use (especially cannabis) on brain structure and functioning in adults and adolescents (22, 23). There is substantial evidence that heavy substance abuse might be particularly harmful to the development of WM during adolescence (19, 24–27). Correspondingly, cognitive deficits were reported in a group of methamphetamine users, which in turn were related to lower whole-brain cortical thickness (CT) (12). Therefore, chronic drug use might cause deficits in and/or a failure to develop normative cognitive abilities (12).

Numerous studies on SUD have observed positive as well as negative neuroplasticity, which generally means the alteration of the brain's structure, as the result of various learning templates (28–30). This is consistent with the assumption that SUD represent a pathological but powerful form of learning and memory (31). Notably, numerous studies on structural neural parameters in SUD has shown impairments in various networks of the brain (Hiebler-Ragger et al., submitted, 32–34), in particular those linked with frontal volitional control and the reward-salience centers (35). In correspondence to this, recovery from SUD was observed to correlate with positive neuroplasticity, such as the return to more gyral volumes (36) and enlargement of GM after mindfulness therapy (37). Taken together, a broad knowledge of the neurobiological alterations linked with SUD, along with the brain networks associated with successful abstinence, can hence improve our understanding of SUD and its treatment in general (17).

To date, most of the research in this area has investigated the role of WM, GM, or CT and their relation to SUD independently from one another, resulting in a rather isolated picture of findings on structural brain deficits in poly-drug use disorder (PUD). Therefore, the goal of the present study was a comprehensive investigation of potential differences in WM, GM, and CT in a large sample of PUD patients compared to healthy controls. Following recent developments in the field of WM analysis, we used automated fiber quantification (AFQ) for a more detailed assessment of WM differences between PUD patients and controls. The particular strength of this study could be seen in the application of a multimodal imaging approach, assessing different characteristics of brain structure and related functions within one and the same sample of participants. Such an approach is particularly motivated by the fact that different characteristics of GM or WM morphology (such as CT, GM volume, or myelination), each of them subserving different cognitive, affective, and motor functions, may be affected in PUD in different ways. On the basis of previous work indicating that heavy substance abuse might be particularly harmful to the development of WM during adolescence (19, 24–27), and on the basis of our previous studies with PUD patients (33, 34), we expected substantial differences especially in WM integrity between PUD patients and the control group from the normal population. Available evidence (12, 20, 21) leads us to assume that different parameters of GM morphology (volume and CT) are affected as well.

METHODS AND MATERIALS

Participants

A total sample of 153 right-handed men between 18 and 41 years of age, composed of one clinical and one nonclinical group, was investigated. This sample integrated data from three different studies related to other research questions regarding PUD (Hiebler-Ragger et al., submitted, 33, 34). In detail, 45 participants (PUD patients: $n = 29$) were included from the first study (34) that focused on WM integrity in relation to attachment and personality. Sixty-five participants (PUD patients: $n = 25$) were included from the second study (33) that focused on WM integrity in relation to negative affective states, and 43 participants (PUD patients: $n = 24$) were included from the second study (Hiebler-Ragger et al., submitted) that focused on neural activation during emotion regulation efforts. Data acquisition took place over a time span of 4 years, starting in January 2014 and ending in November 2016. The clinical group ($n = 78$) was diagnosed for PUD (F19.2) by a licensed psychiatrist (a medical doctor specialized in psychiatry with 20 years of experience of treating SUD patients) according to the International Classification of Diseases version 10 (38). The nonclinical comparison group was comprised of students from various faculties (CG; $n = 75$). Students were included in the nonclinical groups if they were free from any past or present psychiatric disorder or chronic disease. With regards to the use of psychotropic substances, CG included 47 nonsmoking students who reported either no experience with illegal substances or to have tried them just a few times in their life, as well as 28 nicotine smoking students who reported using

illegal substances primarily for recreation at least once a week during the last month. Psychometric assessment of the clinical participants took place in two therapeutic facilities of the "Grüner Kreis" society, where these participants were undergoing long-term SUD treatment based on the "Therapeutic Community" concept (39). The "Grüner Kreis" society (founded in 1983) is Austria's biggest institution for long-term drug therapy. Usually, the patients stay from 6 to 18 months within the Therapeutic Community. All behavioral assessments were conducted *via* group testing. Participants' consent was obtained according to the Declaration of Helsinki. Individuals were only included in the study if they did not report general MRI contraindications (e.g., head injuries, metal implants), major physical disorders, or severe cognitive impairments including acute psychotic episodes. The study was approved by the authorized ethics committee. See **Table 1** for detailed demographic information.

MRI Acquisition

Imaging data were acquired on a 3T Siemens Skyra (Siemens Healtheneers, Erlangen, Germany) with a 32-channel head coil. Since the sample of this study consists of three different studies, two different sequence protocols were used, with slight variations in sequencing parameters. For all participants, T1-weighted images as well as diffusion-weighted images were acquired. Details of imaging parameters are itemized in **Table 2**.

MRI Data Preprocessing and Analysis

Diffusion

Data preprocessing was performed using the software package MRtrix (40) and FSL (41). First, data were visually inspected for artifacts and then denoised with the MRtrix command "dwidenoise" (42). Estimation and correction of geometric distortion was carried out with FSL's "top up" and "eddy" using the nondiffusion-weighted images (b value = 0) collected with reverse-phase encoding direction (43). Datasets with no reverse encoding direction image available were corrected with eddy_ correct. Next, individual B0 images were coregistered to the structural image using SPM12 (v7219; Wellcome Trust Centre for Neuroimaging). The coregistered T1-images were then segmented into five tissues using the "5ttgen" algorithm (44). This step is necessary to allow the estimation of the response function for each tissue-class separately. The response function was estimated for GM, WM, and cerebrospinal fluid. Fiber orientation distributions (FODs) were computed

TABLE 1 | Group differences (ANOVAs) in demographics and behavioral measures.

Measure	α	CG (n = 75)		PUD (n = 78)		$F_{(1,34)}$	η^2
		M	*SD*	*M*	*SD*		
Age	–	25.28	3.37	28.71	5.15	23.48**	0.14
Education (years)	–	13.92	2.82	11.51	2.58	30.39**	0.17
Treatment (weeks)	–	–	–	24.88	18.46	–	–
WPT	–	28.95	6.02	17.51	7.16	113.89**	0.43
BSI							
GSI	0.88	10.32	7.66	15.47	11.01	11.22**	0.07
Anxiety	0.73	4.67	3.56	5.85	3.92	3.79	0.02
Depression	0.78	3.45	3.67	6.08	4.67	15.79**	0.10
Somatization	0.72	2.22	2.77	3.55	3.94	5.79*	0.04

*$p < 0.05$, ** $p < 0.01$, CG , control group; PUD , poly-drug users; BIS, Brief Symptom Inventory; GSI, Global Severity Index; WPT, Wonderlic Personnel Test.*

TABLE 2 | Details of imaging parameters.

	T1		Diffusion tensor imaging (DTI)	
	Study 1 & 2	**Study 3**	**Study 1 & 2**	**Study 3**
	44	100	44	100
TR (repetition time, ms)	2,300	1,680	8,500	3,036
TE (echo time, ms)	2.96	1.89	83	104.6
TI (inversion time, ms)	900	1,000	–	–
FoV (field of view, mm)	256	224	256	240
Slices (#)	176	192	64	66
Slice—thickness (mm)	1.2	0.88	2	2.5
Gap (mm)	0.5	0.44	0	0
Matr.size	256	256	128	96
Flip angle (°)	9	8	90	86
Voxel (mm)	1 iso	0.88 iso	2 iso	2.5 iso
Directions	–	–	64	64
PAT (Parallel Acquisition Techniques)	0	0	Grappa	Multiband factor = 3
b value	–	–	1,000	2,000
Reverse b0	–	–	No	Yes

using these multitissue-constrained spherical deconvolutions (45). FODs were then used to compute whole-brain fiber tractography with 5 million tracks. As a last preprocessing step, the scale-invariant feature transform algorithm was used to reduce tractogram biases (46) reducing the number of tracks to 1 million.

Tract Quantification

Whole-brain tractography data were imported into the AFQ software package (https://github.jyeatman/AFQ) (47) running on MATLAB (2017b, The Mathworks, Natick, MA, USA), which identifies 20 major fiber tracts, including the right and left thalamic radiations, forceps major and minor of corpus callosum, right and left inferior fronto-occipital, inferior longitudinal, arcuate and uncinate fasciculi, corticospinal tract, and cingulum. To assess differences in tensor-based indices along each pathway, whole-brain tractography was normalized into the MNI space, and each fiber pathway was evenly spaced into 100 cross-sectional nodes. The mean fractional anisotropy (FA) in each node was calculated, and group differences were analyzed for each node within each pathway. Multiple comparison corrections were conducted using the AFQ software package script AFQ_MultiCompCorrection.m, which is based on Nichols and Holmes (48). Using this script, the family wise error corrected alpha value for pointwise comparison was computed for each tract to correct for multiple comparison. As a result, p values below a threshold of <0.0025 (0.05/20 tracts) were considered significant.

Voxel-Based Morphometry

Structural scans were analyzed using the Computational Anatomy Toolbox (CAT12; r 1274) implemented in SPM12, running under Matlab 2017b, to assess voxel-wise comparison of GM volume (GMV) differences. Data were visually checked and the segmented, modulated, and normalized into the MNI space (1.5mm). The sample homogeneity was checked, and the total intracranial volume (TIV) was estimated. Finally, data were smoothed with a Gaussian kernel with a full width at half maximum of 8 mm.

Cortical Thickness

The CAT12 toolbox was again used to extract CT. This fully automated method uses tissue segmentation as already done in the voxel-based morphometry (VBM) analysis and uses a projection-based algorithm to compute CT (49). Finally, surface data were smoothed with a Gaussian kernel with a full width at half maximum of 15 mm.

For statistical analysis of GMV and CT parametric-free permutation tests (TFCE toolbox, number of permutations = 10,000) were used. Age and TIV (only VBM) were included in the statistical model as regressors of no interest. Results were considered statistically significant with $p < 0.05$ corrected for family-wise error.

Behavioral Measures

Psychiatric Symptoms

The Brief Symptom Inventory-18 (BSI-18) (German adaptation by (50) is a short version of the highly established Symptom Checklist SCL-90-R (51). The amount of psychiatric burden for the preceding 7 days for three dimensions of psychiatric symptoms (Somatization, Depressiveness, and Anxiety) is assessed by means of 18 items (6 items for each subscale). The BSI-18 employs a 5-point rating form ranging from 1 (absolutely not) to 5 (very strong). It is also possible to sum up the 18 items into a total score: The Global Severity Index (GSI) of psychiatric symptoms. In previous research, Cronbach's alpha was observed to be at least 0.79 for all the subdimensions (33). See **Table 1** for details.

Cognitive Ability

Participants also completed the Wonderlic Personnel Test (WPT), a rough screening instrument for the assessment of intelligence (52). This test requires the processing of disordered sentences, analogies, number series, word and sentence comparisons, and geometrical figures within a given time period of 12 min. The WPT contains 50 items with increasing difficulty. The total score is generated from the number of correct responses. See **Table 1** for details.

Behavioral Data Analysis

For group comparisons, one-way analyses of variance were conducted. Post hoc comparisons were conducted with Tukey's honest significant difference test. Pearson`s correlations were calculated to investigate the relationship between neural and behavioral parameters. Alpha was set to $p < 0.05$. Eta squared (η^2) is given as estimate of effect sizes.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

RESULTS

Demographics and Clinical Characteristics

As shown in **Table 1**, PUD patients were older than the controls (PUD: $M = 28.71$, SD = 5.15; CG: $M = 25.28$, SD = 3.37; $p < 0.001$; $\eta^2 = 0.14$). Analyses also revealed significant differences in education, with the CG reporting an average of 14 years (SD = 2.82) of education, whereas the PUD patients' average was 12 years (SD = 2.58) of education ($p < 0.001$; $\eta^2 = 0.17$). At the time of data acquisition, the PUD patients were undergoing inpatient SUD treatment within a therapeutic community for a mean time of 25 weeks (SD = 18.46). They reported a history of drug abuse over an average period of 12 years (SD = 5.57; range, 2–27 years; missing values, 24). Forty-eight PUD patients were undergoing maintenance therapy, while 30 PUD participants reported living in abstinence. Fifty-three PUD patients received psychopharmacological medication (antidepressant: $n = 20$; antipsychotic: $n = 23$; anxiolytic: $n = 5$; other: $n = 20$).

PUD exhibited a significantly higher amount of Depressiveness ($p < 0.01$; $\eta^2 = 0.10$), Somatization ($p < 0.05$; $\eta^2 = 0.04$) as well as a higher score for the total Global Severity Index in the BSI-18 ($p < 0.01$; $\eta^2 = 0.07$). Accordingly, PUD

patients showed no differences when compared to normative data for psychiatric inpatients (50), while CG participants exhibited less Depressiveness and a lower score in the Global Severity Index (for both $p < 0.01$). The intercorrelations between demographic and behavioral parameters in PUD can be retrieved from **Table 3**. Age was positively related to cognitive abilities ($p < 0.01$) as well as depression ($p < 0.05$) and the duration of treatment ($p < 0.05$).

Differences in White Matter, Gray Matter, and Cortical Thickness Between PUD and Controls

White Matter Fiber Tracts

As shown in **Figure 1**, PUD patients exhibited significant reductions in FA relative to controls across the entire left and the majority of nodes of the right corticospinal tract. In addition, there were significant FA reductions in posterior portions of the bilateral inferior longitudinal fasciculi and in smaller portions of the left thalamic radiation, the right inferior fronto-occipital fasciculus, and the right arcuate fasciculus.

Gray Matter Volume

Voxel-based morphometry analyses revealed no significant differences in GMV between PUD and controls.

Cortical Thickness

Analyses revealed brain regions with significant reductions of CT in PUD relative to controls, while there were no brain regions with higher CT in the patient group (see **Figure 2**). The largest cluster comprised the left insular and the left lateral orbitofrontal cortex. There were also significant CT reductions in the right orbitofrontal cortex. Generally, as is the case for the lateral orbitofrontal cortex, CT reductions were bilateral. This particularly applies to regions of the inferior frontal gyri (pars opercularis) and the precentral gyri. In addition, analyses revealed CT reductions in a cluster involving the left postcentral gyrus and small portions of the supramarginal gyrus in addition to a cluster in the right inferior temporal lobe.

DISCUSSION

This study investigated alterations in brain structure in an unprecedented large sample of PUD patients compared to controls from the general population. Analyses revealed impaired WM integrity along with reduced CT in the PUD sample but no alterations in GM. These findings were mirrored by significant differences between PUD and healthy controls regarding behavioral measures, such as a higher amount of psychiatric symptom burden as well as lower cognitive abilities. Furthermore, our results confirm previous research indicating substantial deficits especially in WM circuitry in PUD patients (25, 26, 33, 34, 53).

Deficits in WM structure might represent a valid predictor for negative therapeutic outcome. For instance, Moeller et al. (44) reported that deficits in WM integrity are related to an increased amount of impulsivity in cocaine-dependent patients. A high amount of impulsivity has been widely shown as being a risk factor for the development of SUD (54) as well as a substantial predictor for a negative SUD therapy outcome (55). Furthermore, we observed lower CT in PUD patients, which has been linked to higher memory deficits (12) as well as reduced effortful attention performance (56). CT abnormalities have been observed to be associated with SUD such as alcohol dependence (57), marijuana misuse (58), and nicotine smoking (59), as well as nonsubstance-related disorders such as excessive internet use (60) and online gaming (61). Moreover, significant abnormalities in CT were reported in individuals with heavy prenatal alcohol exposure. These abnormalities were found to be linked with impairments in verbal recall and visuospatial dysfunction (62).

Notably, we did not find any significant differences in GM between PUD patients and healthy controls. This is in clear contrast to previous research, where disrupted GM was observed to be related with several SUD, for example alcoholism (63), cocaine use (20), and cannabis use (23). We interpret our conflicting findings as showing that, in our rather young PUD sample, WM paths might be among the first to become affected by PUD. In fact, previous work suggested that heavy substance abuse might be particularly harmful to the development of WM during adolescence (19, 24–27). In this regard, it is conceivable that, in its earlier stages, PUD already compromises more basic "hardware" processes, e.g., motor functions as indicated by the substantial WM deficits in the bilateral corticospinal tract, while further impairments in higher order cognitive functions only result after prolonged consumption. Accordingly, at this point,

TABLE 3 | Correlations between demographic and behavioral characteristics in PUD (n = 78).

	1.	2.	3.	4.	5.	6.	7.	8.
1. Age	–	0.22	0.30**	0.14	0.24*	0.06	0.17	0.25*
2. Education (years)		–	0.20	0.17	0.20	0.04	0.16	0.08
3. WPT			–	0.04	0.02	–0.05	0.01	0.19
BSI								
4. Anxiety				–	0.68**	0.67**	0.88**	0.14
5. Depression					–	0.63**	0.89**	0.11
6. Somatization						–	0.86**	0.07
7. GSI							–	0.12
8. Treatment								–

*$p < 0.05$, **$p < 0.01$, PUD, poly-drug users; WPT, Wonderlic Personnel Test; BIS, Brief Symptom Inventory; GSI, Global Severity Index; Treatment, treatment duration.*

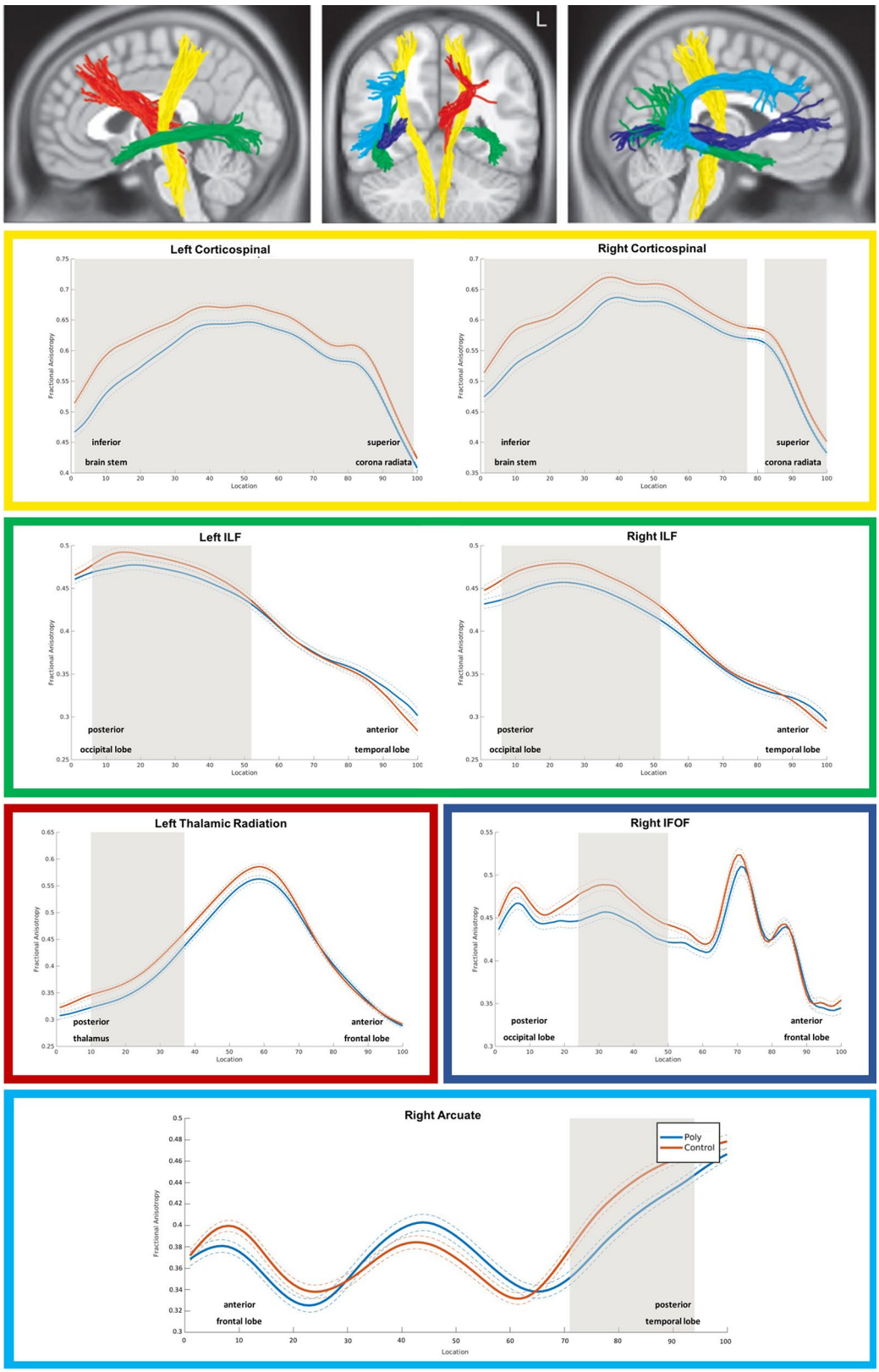
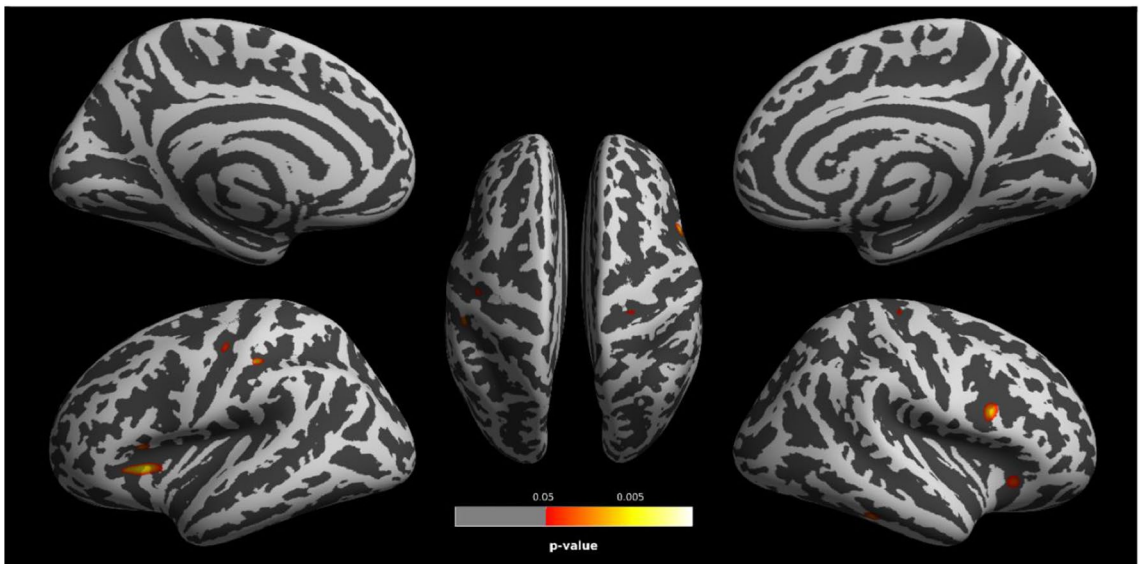


FIGURE 1 | 3D visualization and tract diffusion profiles for white matter fiber tracts showing significant differences between PUD and controls. Note. Yellow = left and right corticospinal tract; green = left and right inferiore longitudinale fasciculus (ILF); red = left thalamic radiation; blue = right inferior fronto-occipital fasciculus IFOF; cyan = right arcuate fasciculus; shades of gray in the profiles indicate nodes with significant group differences. PUD, patients with poly-drug use disorder.



Contrast	Region	H	Vertices	*p*-value
Control > PUD	Insula, lateral orbitofrontal, pars triangularis	L	379	.0037
	Postcentral, supramarginal	L	126	.0083
	Pars opercularis	L	111	.0121
	Precentral	L	98	.0265
	Pars opercularis, precentral	L	18	.0417
	Pars opercularis	R	214	.0068
	Lateral orbitofrontal, Insula	R	123	.0249
	Inferior temporal	R	96	.0154
	Precentral	R	49	.0402

FIGURE 2 | Brain regions with significant (red–yellow) group differences in cortical thickness between PUD and controls. *Note*. PUD, poly-drug users; H, hemisphere; L, left; R, right; brain regions are derived from Desikan–Killiany DK40 Atlas. Reported *p* values are TFCE corrected for family-wise error ($p < 0.05$).

we can only assume that, later in life, GM might become damaged, too. For instance, in a study of Qiu et al. (64), the mean age of the group of heroin dependents was considerably higher (M = 35 years, SD = 4.2). Here, the authors reported a progressive deterioration of WM microstructure dependent on the duration of heroin use.

From a developmental perspective, the finding of diminished CT in PUD fits nicely with the literature. For instance, Hilton Jr (29) described lower CT as a kind of premorbid cortical weakness, which leads to poor cognitive performance and could pave the way to develop a SUD later in life. In support of this notion, we observed a significantly lower level of cognitive ability, along with a lower educational status in the group of PUD patients. Even more importantly, in PUD patients, reduced CT, especially in regions of the insular and the orbitofrontal cortex, may suggest that these structural alterations mirror difficulties in affective processing, specifically emotional awareness (65) and emotional regulation (66), which are known to be compromised in SUD (67–69). This is further supported by the fact that we found pronounced WM impairments in the bilateral inferior longitudinal fasciculi and in the right inferior fronto-occipital fasciculus, which are both known as key components of a face processing network (70), with an important role in facilitating the ability to discriminate between emotional expressions in faces (71). In accordance with the general notion of impaired affective processing and emotion regulation in PUD, we previously observed a significantly reduced capacity for using cognitive reappraisal to regulate anger in PUD patients when compared to controls from the normal population (Hiebler-Ragger et al., submitted).

According to Kalivas and O'Brien (72), SUD is based on pathological changes in brain function, which are produced by a repeated pharmacological assault on the brain circuits that regulate how a person behaviorally responds to certain stimuli. Since recovery from SUD has been correlated with positive neuroplastic changes (36), neuroplasticity might therefore constitute a highly important indicator for the evaluation of therapeutic outcome. Especially for long-term treatment of SUD, neurologically informed therapeutic interventions may represent an important resource (33). Changes in cognitive and affective abilities in SUD patients during long-term treatment might be intertwined with neuroplastic effects (5, 10). Strikingly, (73) reported beneficial effects of transcranial

stimulation (TMS) for the treatment of SUD, as TMS seems to facilitate long-term neurophysiological changes which have the potential to affect behaviors relating to drug craving, intake and relapse. Accordingly, a respective research focus on neuroplasticity in SUD patients may provide additional valuable information for the clinical outcome evaluation.

LIMITATIONS AND FUTURE PERSPECTIVES

The study of PUD populations has previously been discussed as being too unspecific (18). However, as a counter argument, from a clinical perspective, it is evident that a high rate of SUD patients is diagnosed with PUD because of a completely chaotic pattern of consumption (74). In this study, we did not further control for maintenance therapy since previous research revealed no differences in neural and behavioral parameters between PUD patients in maintenance therapy and abstinent patients (34). Furthermore, there was no perfect age match between the two groups, as the healthy control group was significantly younger than the SUD patients [3.43 years (see **Table 1**)]. However, we observed age to be weakly related with behavioral characteristics, such as Intelligence, Depression, and Duration of Treatment (**Table 3**). In addition, in the analysis of GM and CT, age was considered as a regressor of no interest in the statistical model. Additionally, in future research, potential gender differences might be considered another factor of study, as, for instance, Sawyer et al. (75) reported sex differences in alcoholism-related abnormalities of WM connectivity. Furthermore, in this study, we sought to focus primarily on potential differences between PUD patients and a nonsubstance use disordered control sample regarding the areas of WM and GM as well as CT, based on an enhanced sample. In further analysis, we intend to investigate potential connections between neural parameters and an extended set of behavioral parameters in PUD more in detail, which might reveal further insights concerning individual differences in PUD. These findings will be published somewhere else. The cross-sectional design in this study limits the possibilities of interpretation. Thus, we can only speculate on the causal relationship between impairments in brain structure and the development of PUD as well as on potential neuroplastic effects during PUD treatment. While the combined analyses of several neural and behavioral parameters in the rather large sample of this study reveals important insights into the clinical profile of PUD patients, a longitudinal research approach comprised of several measurement points is highly warranted in order to be able to say more about the clinical relevance of neuroplasticity for patient treatment.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of Ethic guidelines, Ethics Board, University of Graz; with written informed consent from all subjects. All subjects gave written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by the Ethics board, University of Graz.

AUTHOR CONTRIBUTIONS

HU and AF conceptualized the study. MH-R, JF, KK, KR, CP, HU, and AF collected, analyzed, and interpreted the data. HU and MH-R drafted the manuscript. CP, IP, EW, and AF critically reviewed the manuscript. All authors gave their final approval of the manuscript.

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychiatry

ORIGINAL RESEARCH
published: 24 September 2019
doi: 10.3389/fpsyt.2019.00640

Anxiety-Related Coping Styles, Social Support, and Internet Use Disorder

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Objective: The Internet can offer a seemingly safe haven for those being disappointed by relationships in the "offline world". Although the Internet can provide lonely people with opportunities to seek for help and support online, complete withdrawal from the offline world comes with costs. It is discussed if people can even become "addicted" to the Internet. Of note, meanwhile, many researchers prefer the term *Internet use disorder* (IUD) instead of using the term "Internet addiction". To illustrate the importance of one's own social network supporting a person in everyday life, we investigated, for the first time to our knowledge, how social resources in terms of quality and quantity might represent a buffer against the development of IUD. Furthermore, anxiety related coping styles are investigated as a further independent variable likely impacting on the development of an IUD.

Method: In the present work, N = 567 participants (n = 164 males and n = 403 females; M_{age} = 23.236; SD_{age} = 8.334) filled in a personality questionnaire assessing individual differences in cognitive avoidant and vigilant anxiety processing, ergo, traits describing individual differences in everyday coping styles/modes. Moreover, all participants provided information on individual differences in tendencies toward IUD, the perceived quality of social support received, and the size of their social network (hence a quantity measure).

Results: Participants with larger social networks and higher scores in the received social support reported the lowest tendencies toward IUD in our data. A vigilant coping style was positively correlated with tendencies toward IUD, whereas no robust associations could be observed between a cognitive avoidant coping style and tendencies toward IUD. Hierarchical linear regression underlined an important predictive role of the interaction term of vigilance in ego-threat scenarios and perceived quality of social support.

Conclusion: The current study not only yields support for the hypothesis that the size of one's own social network as well as the perceived quality of social support received in everyday life present putative resilience factors against developing IUD. It also supports the approach that special coping styles are needed to make use of the social support offered.

Keywords: addiction, Internet use disorder, social support, social network, vigilance

OPEN ACCESS

Edited by:
Human Friedrich Unterrainer, University of Vienna, Austria

Reviewed by:
C. Eichenberg, Sigmund Freud University Vienna, Austria
Michaela Hiebler-Ragger, Medical University of Graz, Austria

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Specialty section:
This article was submitted to Addictive Disorders, a section of the journal Frontiers in Psychiatry

Received: *03 June 2019*
Accepted: *08 August 2019*
Published: *24 September 2019*

Citation:
Jung S, Sindermann C, Li M, Wernicke J, Quan L, Ko H-C and Montag C (2019) Anxiety-Related Coping Styles, Social Support, and Internet Use Disorder. Front. Psychiatry 10:640. doi: 10.3389/fpsyt.2019.00640

INTRODUCTION

For some persons, the "offline world" is full of frustrations, mortifications, and disappointing relationships. This might be, in particular, the case for lonely, shy, and/or socially anxious individuals. For these groups of persons, the "online world" might offer a promising alternative with its abundant possibilities to cope with one's own disappointments in everyday life [e.g., Refs. (1–6)]: In detail, social media and messenger applications offer possibilities to connect with other humans and to seek for approval and acceptance (3, 7, 8). Gaming platforms can provide fun but can also be a cathartic outlet to release aggression (9) and an escape from real-life challenges (10). From this perspective, for some individuals, the online world could be perceived as more attractive than the offline world. Therefore, the online world might resemble a safe refuge from disappointments of the offline life and may even function as a short-term remedy but with the risk of developing addictive Internet use [see, for example, *Model of Compensatory Internet Use* by Kardefelt-Winther (11)].

On the Nomenclature Debate on "Internet Addiction": Does the Term Internet Use Disorder Represent a Solution?

A potential diagnosis called "Internet addiction" has been discussed for more than 20 year [e.g., Refs. (12–14)]. Given the controversy with this term, please note that "Internet addiction" is mentioned in quotation marks in this work. And we explain in the following why we currently prefer the term *Internet use disorder* (IUD): In May 2019, the World Health Organization (15) ultimately ratified their decision to include *Gaming Disorder* as a distinct diagnosis in the *International Classification of Diseases, 11th Revision* (*ICD-11*) [see also Ref. (16)]. This diagnosis can be found under 6C51 in the category "disorder due to addictive behaviour" and can be diagnosed for online and offline gaming behavior. Of note, also, the American Psychiatric Association (17) included *Internet gaming disorder* in the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (*DSM-5*) in 2013 (18). But in contrast to *ICD-11*, the term *Internet gaming disorder* was "only" included as an emerging disorder in its appendix but stimulated a lot of research. This was clearly of relevance for the recent decision to implement *Gaming Disorder* as an official diagnosis in *ICD-11*. Of importance, this new diagnosis might function as a blueprint for other online addictive behaviors, now. Using *Gaming Disorder* as a guideline, from our perspective, the research field has the chance to aim at a unification of nomenclatures used to study the field of online addictive behaviors. It is also noteworthy that the term *Internet use disorders* has been put forward in the Interaction of Person–Affect–Cognition–Execution (I-PACE) model by Brand et al. (19) [for a recent, update see Ref. (20)]. This term, on the one hand, orients itself toward the recent nomenclature *(Internet) Gaming Disorder* but also points toward the relevant point, that the pathological *use* of the Internet is at the center of psychologists' and psychiatrists' observations. The I-PACE model is a theoretical approach to describe the underlying processes of development and maintenance of IUD (19). The model describes the interplay between predisposing factors (e.g., neurobiological features and social cognition), moderators (e.g., coping styles), and mediators (e.g., affective and cognitive factors) as determinants of the development of specific forms of IUD (19). Perceived social support is sorted into the field of the predisposing factors that determine the core characteristics of a person; coping style is seen as a moderator in this process, underlining the important role of these two factors in the development of IUD (19).

Beyond the I-PACE model and recent developments in *DSM-5*/*ICD-11*, many researchers argue that it is better to use the term *problematic Internet use* (PIU) compared to "Internet addiction" in the literature [see a review by Yellowlees and Marks (21)]. Although this is valid from our perspective, the term PIU comes also with problems because it is not clear if PIU represents the end of the spectrum to be investigated or a transit zone for a person going from healthy *via* problematic toward pathological use. These arguments convince us to use, at the current moment, the term IUD. For a recent overview (also on neuroscientific aspects of IUD), see the review by Montag and Becker (22).

Criteria and Prevalences of Internet Use Disorder

Possible diagnostic criteria for IUD were proposed, for example, by Tao et al. (23) (the term "Internet addiction disorder" was used in this work). Among others, they discussed symptoms like: preoccupation with the Internet, withdrawal when not being online for several days, tolerance, and difficulty controlling Internet usage behavior (23). The Gaming Disorder diagnosis, as a specific form of IUD, among others goes along with loss of control over gaming, continuing with gaming despite negative consequences, and, perhaps most important, significant impairments in private and/or business life due to excessive gaming (15). In the work of Müller et al. (24), 2.1% of a German sample (N = 2,512, aged 14–94 years) met criteria for IUD [but were diagnosed with the *Scale for the Assessment of Internet and Computer Game Addiction* (AICA-S) based on the *Skala zu Computerspielverhalten* (CSV-S), designed by Woelfling et al. (25)]. In the sample (N = 1,723 adolescent Germans, aged 14–17 years) of Wartberg et al. (26), even 3.2% showed signs of IUD [here measured with the *Compulsive Internet Use Scale* (CIUS) designed by Khazaal et al. (27)]. A higher prevalence of IUD for adolescents, for example, is in line with the work of Rumpf et al. (28) and Wu et al. (29), accentuating the importance of taking age into account as a relevant factor in IUD research. Aside from age, another important influence factor seems to be gender: males seem to be more vulnerable to developing IUD than females [see, for example, Refs. (29–31)]; but this view is more and more challenged given that one has to take a closer look at the specific forms of IUD.

Unspecified and Specific Forms of Internet Use Disorder

As mentioned, beyond the broad term IUD, also, specific forms of IUD such as social media use disorder or Internet communication disorder (ICD) are currently hotly debated (32–37). In this realm, it is noteworthy that Montag et al. (38) already found support for

the existence of different forms of IUD in a cross-cultural study. Testing the idea of Davis' model on pathological Internet use (39), Montag et al. (38) observed that unspecified (then called *generalized*) IUD correlated to varying degrees with different forms of specific IUD. In the work by Montag et al. (38), the areas of excessive online pornography use, online video gaming, online shopping, and online social network use were covered. The unspecified form of IUD (including among others aimless browsing) was, in particular, highly correlated with ICD [see also a newer work by Müller et al. (40)]. This observed robust association between unspecified IUD and ICD may underline the importance of taking a closer look into social processes and social motivations (like the need for attachment, belonging, and connecting with others) to understand the developmental processes of IUD. In this context, it is also of relevance to see that mobile IUD (in the form of smartphone use disorder) is robustly associated with WhatsApp use disorder (41).

On the Importance of Social Support in Human Life

Mikulincer and Shaver (42) postulated the idea of "*Homo auxiliator vel accipio auxilium* (one who helps or receives help)" (p. 8) (42). This idea focuses on the human need for (social) support, providing the band of *sapiens* with higher chances for survival, especially in childhood and adolescence (see also Bowlby's attachment theory) (43, 44). Despite *sapiens*' higher need for support in the early years of human life, the need for support and encouragement seems not to vanish in adulthood, but also, individual differences can be observed in its connection to different attachment styles [e.g., Refs. (45–47)]. In more modern psychoanalytic approaches, early attachment experiences are proposed to play a key role in the development of personality structure and psychopathology (as an example, see object relations theory [e.g., Ref. (48)]). In line with this view, addiction is described as an attachment disorder by some authors [e.g., Refs. (49, 50)], something also highlighted in affective neuroscience theory (ANT) by Jaak Panksepp (51). For an overview on selected principles of the Pankseppian ANT, see the recent work by Davis and Montag (52). Social bonds seem to play an important role in IUD, too. To illustrate this Milani (53) related Internet overuse in adolescents with dysfunctional coping strategies and dysfunctional interpersonal relationships. For links between Panksepp's ANT and IUD, see the work by Montag et al. (54).

Social support and social network can be summarized as "social resource" [e.g., Ref. (55)] and are seen as potential protective or buffering factors in the context of psychological [e.g., Refs. (56, 57)] and/or physical health [e.g., Refs. (58, 59)]. Different effects of quantitative (social network) and qualitative facets (perceived social support) of social resource/interaction are also investigated individually in terms of being resilience factors for psychological distress (60). To illustrate this, in a meta-analysis Pinquart and Duberstein (59) described different effects of perceived social support and social network size (SNS) on cancer mortality when the variables of age and cancer type also have been considered. In the field of addiction, research on a potential protective role of the social resource concerning the onset of addictive behavior and a potential supportive role concerning withdrawal on one side and maintenance of abstinence on the other side has already been a matter of interest: For example, in a longitudinal study, Peirce et al. (61) described a buffering role of tangible social support with respect to the relationship between financial stress and the tendency to cope with alcohol. The positive outcome for maintenance of abstinence in members of Alcoholics Anonymous (AA) is often seen as a result of social support [see, for example, a review by Groh et al. (62)] and social network mechanisms (63). Nevertheless, we also mention that an "unhealthy" social network can also be a risk factor for addictive behavior: Schroeder et al. (64) found drug use in one's social network to be a strong predictor for continuing drug use. These findings underline the importance of taking a closer look at network characteristics, too.

A study by Rotry et al. (65) also makes a case to distinguish between the quantitative and the qualitative facet of the social resource to understand psychiatric outcomes. Comparing patients still suffering from bulimia nervosa with individuals in remission from bulimia nervosa, they found that both investigated groups showed the same number of people in their network to offer advice, but individuals in remission had significantly more people in their network providing emotional support (65).

In the field of IUD, research on the protective role of the social resource is a matter of interest as well. Here, Zhang et al. (66) described a direct effect of subjective perceived support on the IUD dimensions *development of tolerance* and *time-management problems*. Furthermore, it is discussed in the literature if online forms of social support are comparable to offline forms of social support and if these online forms of social support may prove to be protective against the development of IUD. So far, results are contradicting, and mechanisms explaining such associations are not well understood [e.g., Refs. (67–70)].

The Relevance of Taking Into Account Individual Differences in Coping Styles to Better Understand Internet Use Disorders

Alcohol, drugs, and unhealthy eating strategies are often used in a maladaptive way to cope with different forms of stress and challenges in life [e.g., Ref. (61)]. This might be, in particular, the case when everyday-used coping strategies or defense mechanisms prove to be insufficient, fail, or are maladaptive per se [e.g., Refs. (71–77)]. As a consequence, a closer look at individual differences in coping styles is of relevance to better understand protective and risk factors of IUD. Waqas et al. (78) described positive associations between the defense mechanisms projection, denial, autistic fantasy, passive aggression, as well as displacement and IUD scores, whereas they found negative associations between sublimation and IUD scores (78). Sublimation describes a mature form of defense where inacceptable instincts are redirected to a socially more approved behavior, for example, aggressive impulses are acted out in a creative way, for instance, by painting pictures [e.g., Ref. (79)]. In the current

study, we investigated, for the first time to our knowledge, a potential role of the anxiety-related coping styles called vigilance and cognitive avoidance in the context of IUD [these coping styles are described in detail here: Refs. (80, 81)]. As a link between (social) anxiety and IUD often has been shown [see also a recent work (82)], a main focus on anxiety-related coping in the present work seems to be expedient [e.g., Refs. (1, 4, 83)]. The concept of these strategies is grounded in the psychoanalytic tradition with a close connection to the defense mechanisms proposed by Sigmund Freud (84) and his daughter Anna Freud (85). Vigilance describes a tendency to turn the attention to anxiety-provoking stimuli and an enhanced processing of them, whereas cognitive avoidance describes the tendency to turn the attention away from information that triggers anxiety (80). When connected with the psychoanalytic concepts of defense mechanisms, cognitive avoidance can be associated with repression or even suppression (considering the conscious character), whereas vigilance is associated with intellectualization (86, 87). We saw a closer link of cognitive avoidance with suppression than with repression. In the classic approaches to repression/sensitization that form the background of the cognitive avoidance/vigilance concepts we use in our work, an experiment with tachistoscopic presentation of emotional stimuli was used to measure unconscious processes (88). As we are working with self-report questionnaires, we cannot claim to measure unconscious processes; therefore, we believe that we did not measure repression but suppression. Suppression (in this context, cognitive avoidance) is seen as a mature defense mechanism that is used in a conscious way to suppress unwanted impulses (85, 79, 87). Intellectualization (in this context, vigilance) is seen as a more immature but neurotic form of defense that is usually seen as a defense mechanism prominent in adolescence (85, 87). The idea that defense mechanisms change with age [e.g., Ref. (89)] falls into the debate asking if different coping styles prevail in different age groups [e.g., Refs. (90–93)].

Vigilance (or *sensitization*) (94) is often found to be associated with undesirable psychological outcomes such as higher anxiety scores [e.g., Refs. (95, 96)], higher self-reported stress [e.g., Refs. (97, 98)], or higher degrees of depression [e.g., Ref. (99)]. In contrast, a cognitive avoidant copying style (or *repression*) (94) has been associated with lower anxiety, stress, and depression scores [e.g., Refs. (95, 97, 99)]. Gender differences in the use of coping strategies have been described earlier [see a meta-analytic review by Ref. (100)]. Among others, Egloff and Krohne (80) and Jung et al. (101) observed significantly higher vigilance scores for women compared to males, whereas male participants showed significantly higher cognitive avoidance scores than female participants.

As vigilance seems to be associated with a higher psychological vulnerability (stress, depression, anxiety; see above), we expect, in our first hypothesis, a vigilant coping style to be associated with higher tendencies toward IUD, whereas a cognitive avoidant style (comparable to the mature defense mechanism of suppression) should be associated with lower tendencies toward IUD. This would be in line with the results of Waqas et al. (78), who only found a negative association with IUD for the mature defense mechanism of sublimation.

As a second hypothesis, we expect high perceived social support and a larger social network to be associated with lower tendencies toward IUD.

In addition, and as a third hypothesis, we propose that the associations between coping styles and IUD are influenced by the different forms of social resource. In detail: We propose an interaction effect of anxiety-related coping styles and the social resource on IUD. This means that a positive association of higher vigilance and higher IUD can be softened by high perceived social support and a larger social network. In contrast, the proposed negative association between a higher cognitive avoidant coping style and lower IUD is expected to be even stronger for individuals with high social support and larger SNS. In sum, we expect that individuals scoring higher on cognitive avoidance together with available social resources show the lowest tendency to develop an IUD. In line with the findings of Rotry et al. (65), we expect a higher impact of social support (quality) than of SNS (quantity) on IUD.

METHODS AND MATERIALS

Participants

German Sample

N = 581 participants (n = 165 males and n = 416 females; M_{age} = 23.165; SD_{age} = 8.253), mostly students (85.71%), gave electronic informed consent and completed the following self-report questionnaires: *"Angstbewältigungs-Inventar"* (ABI, English: Anxiety Coping Inventory) (80), Generalized Problematic Internet Use Scale 2 (GPIUS2) (102), the social support subscale of the "*Fragebogen zur Erfassung von Ressourcen und Selbstmanagementfähigkeiten*" (FERUS, English: Questionnaire Assessing Resources and Self-Management Skills) (103), and a single-shot item measuring the size of the social network (104). Four participants were younger than 18 years. Those participants provided a declaration of consent of their legal guardian additional to the standard informed consent. All participants are part of the Ulm Gene Brain Behavior Project (UGBBP). The study was approved by the local ethics committee at Ulm University, Ulm, Germany. Fourteen participants had to be excluded due to missing questionnaire data. The final data set consisted of 567 participants (n = 164 males and n = 403 females; M_{age} = 23.236; SD_{age} = 8.334).

Chinese/Taiwanese Samples

It was also planned to recruit a sufficiently large Asian sample. Unfortunately, this did not work. N = 104 from Taichung, Taiwan, and N = 34 from Beijing, China, could be recruited. Unfortunately, these samples are too small in terms of power analysis to detect the expected effects (we also do not want to mix the participants from both sites given differences in the characters applied in the questionnaire etc.).

For complete transparency, we provide readers with descriptive statistics and Spearman correlations between GPIUS2, vigilance, cognitive avoidance, social support, social network, and age in the Taiwanese sample, which are provided in the **Supplementary Material**. This Taiwanese

sample is, at least, beyond 100 participants. The reader will see that findings are, in part, in line with what we observe in the German sample. Some differences might occur due to the smaller power for statistical testing. Finally, some findings might not be replicated given the differences in the cultural background of Germany and East Asian culture. That said, with the appropriate power available, we often were able to replicate findings across Western and Eastern sites [e.g., Refs. (105, 106); even when taking into account biological variables, see Ref. (107) or (108)]. For an overview on tackling the replication crisis in psychology using cross-cultural work, see a recent work by Montag (109).

We want to mention that the questionnaires for data collection in China and Taiwan have been back-and-forth translated by bilingual Chinese-speaking psychologists and yielded acceptable internal consistencies (Cronbach's alpha ranging between .660 and .927). If translations of these questionnaires are needed, we are happy to share them with the community.

Questionnaires

Generalized Problematic Internet Use Scale 2 (GPIUS2)

IUD was assessed *via* the 15-item-long GPIUS2 (102). This instrument consists of the following five subscales: *Preference for Online Social Interaction*, *Mood Regulation*, *Cognitive Preoccupation*, *Compulsive Internet Use*, and *Negative Outcome*. Each subscale consists of three statements, e.g., "*I prefer communicating with people online rather than face-to-face*". All items are rated on an eight-point Likert scale indicating the degree of agreement from 1 = "definitely disagree" to 8 = "definitely agree". For further analyses an overall index was calculated *via* a sum score. A good internal consistency with a Cronbach's alpha of .900 was found in the German sample. Note that this version of the questionnaire has been used also in older works from our group, such as Montag et al. (38) and Peterka-Bonetta et al. (110).

Angstbewältigungs-Inventar (ABI)

To measure individual differences in the coping styles of vigilance and cognitive avoidance, we used a stimulus–response inventory in both samples. German participants filled in the ABI (English: anxiety coping inventory) (80), the German version of the *Mainz Coping Inventory* (MCI) (111). The inventory consists of two subscales: ABI-E (four ego-threat scenarios, e.g., a job interview) and ABI-P (four physical threat scenarios, e.g., visiting the dentist). For each of the different scenarios [all used scenarios can be found in Ref. (111), in English language], participants need to rate which of 10 different coping styles they would use (1 = "applicable" or 0 = "not applicable"). For each fictitious scenario, five vigilant (e.g., "information search" or "anticipation of negative events" (p.192) (80)) and five cognitive avoidant coping strategies (e.g., "diversion" or "trivialization" (p. 192) (80)) are presented to allow separate assessments of the coping styles: vigilance in the ego-threat scenario (VIG-E) as well as the physical threat scenarios (VIG-P) and cognitive avoidance in the ego-threat scenarios (CAV-E) and in the physical threat scenarios (CAV-P). Total scores for both styles can be calculated: a total score for vigilance (VIG-T) and a total score for cognitive avoidance (CAV-T). The internal consistencies of all subscales and the total scores were acceptable. Cronbach's alphas lied between .734 and .855 in the German sample.

Fragebogen zur Erfassung von Ressourcen und Selbstmanagementfähigkeiten (FERUS)/Social Support Scale

In order to assess the construct of social support, we used a slightly adjusted version of the FERUS (English: questionnaire assessing resources and self-management skills) Social Support Scale (103). The scale was once adjusted for a study conducted with cancer patients in our department; that version was used in this study, too. Only one FERUS item was slightly changed in our adjusted version ("(…) if I am ill" was changed to "(…) if I don´t feel well" with respect to the situation of cancer patients). As the changes were only minor and we already checked reliability of the German and Chinese versions of this adjusted FERUS, we found it reasonable to use this version in our current study, as well. The FERUS (103) is a German questionnaire to assess individual *resources*, like *social support* and *motivation to change*, as well as skills in *self-management*, like *coping, introspection, self-efficacy, self-verbalization*, and *hope*. This self-report is generally used to detect psychotherapeutic progress. For the current study, only the Social Support Scale of the FERUS was used. This scale consists of 10 items designed as statements concerning the helpfulness of the social background of the individual, e.g., *"If I want to talk about a problem, I know to whom I can go"*. The degree of consent to each statement is rated on a five-point Likert scale from 1 = "not true" to 5 = "very true". A sum score of all 10 items was calculated. An excellent internal consistency with a Cronbach's alpha of .910 was found in the German sample.

Social Network Size

To assess the size of one's social network, we used the following single-shot item: *"How many people do you have near you that you can readily count on for help in times of difficulty, such as watch over children or pets, give rides to hospital or store, or help when you are sick?"*. The item is based on the work by Blake and McKay (104) and was used, for example, by Koopman et al. (112) as a single item measure of social support.

In the current work, it is used as a measure for the size of the social network as its focus lies more on the quantitative than the qualitative aspect of the social resource. Participants had to state whether they have "0", "1", "2 to 5", "6 to 9", or "10 or more" close people they can count on.

Statistical Analyses

Both the inspection of the histograms and the Shapiro–Wilk tests ($p < .001$) indicated non-normal distributions of the GPIUS2 overall score. Therefore, a Blom-rank transformation was carried out. The Blom-transformed GPIUS2 overall score was used in all conducted analyses (for histograms of the distribution of the GPIUS2 scores before and after Blom transformation, see **Supplementary Material**). For correlations between the GPIUS2 subscales, social support, social network, coping styles, and age, please see **Supplementary Material**. Hierarchical linear regression was

carried out for all variables that were associated with the GPIUS2 scores and all interaction terms that conformed to the hypotheses. For reasons of conciseness and comparability, two regression models are calculated, one regarding social support (Model 1) and one SNS (Model 2). The regression analyses were conducted block-wise. The first block consisted of age and gender, the second block consisted of all coping variables and social resource variables (in Model 1: FERUS score for social support; in Model 2: dummy-coded SNS) that were correlated with the GPIUS2 score, and the third block consisted of interaction terms with relevance to our hypotheses. The SNS variable was included dummy-coded in the regression model, with "0 people" as the reference group. To take the problem of multiple testing into account, confidence intervals (CIs) were calculated using bootstrap analysis, which were bias corrected and accelerared; 1000 samples). When significant interaction terms could be observed, we used median splits of the respective data to allow an easy interpretable graphical presentation of the main results.

As general alpha level of .05 was used. All statistical analyses were conducted using SPSS 24.

Preselection of the Potential Predictors

A preselection of potential predictors to include in the regression models was conducted *via* correlation analyses (Spearman correlation) and, in the case of gender, with a t-test.

The potential predictors were only included into the regression models if significant associations with the transformed GPIUS2 score were found. All tests were performed two-tailed.

RESULTS

Descriptive Statistics

Mean scores and standard deviations of the GPIUS2, vigilance, cognitive avoidance, social support, and SNS are presented in **Table 1**.

TABLE 1 | Mean scores (standard deviations) of GPIUS2, all ABI variables, social support and SNS, and percentages for each SNS category for the total sample and for the male and female subsamples with mean differences and Cohen's *d*.

	Total (N = 567)	Male (n = 164)	Female (n = 403)	*MD*	*Cohen's d*
GPIUS2	37.07 (16.20)	39.76 (17.46)	35.98 (15.55)	3.78	.23
CAV-E	10.09 (4.04)	11.37 (3.95)	9.56 (3.96)	1.81	.46
CAV-P	12.11 (3.63)	12.93 (3.40)	11.77 (3.67)	1.16	.32
CAV-T	22.19 (6.58)	24.30 (6.43)	21.34 (6.45)	2.97	.46
VIG-E	13.73 (3.90)	12.62 (4.15)	14.18 (3.71)	–1.57	.41
VIG-P	10.47 (4.02)	8.99 (3.87)	11.07 (3.93)	–2.08	.53
VIG-T	24.20 (6.95)	21.61 (7.17)	25.26 (6.58)	–3.65	.54
Social support	44.84 (5.97)	43.01 (7.13)	45.59 (5.25)	–2.59	.44
SNS (score)	3.32 (0.72)	3.27 (0.71)	3.34 (0.72)	–.07	.10
SNS (0)	0.88%	1.83%	0.50%	–	–
SNS (1)	4.76%	3.66%	5.21%	–	–
SNS (2–5)	62.61%	65.85%	61.29%	–	–
SNS (6–9)	24.51%	22.56%	25.31%	–	–
SNS (10 or more)	7.23%	6.10%	7.69%	–	–

GPIUS2, Generalized Problematic Internet Use Scale 2; ABI, Angstbewältigungs-Inventar; CAV-E, cognitive avoidance (ego threat); CAV-P, cognitive avoidance (physical threat); CAV-T, cognitive avoidance (total score); VIG-E, vigilance (ego threat); VIG-P, vigilance (physical threat); VIG-T, vigilance (total score); SNS, social network size; MD, mean difference.

GPIUS2 scores are untransformed in this table for easier interpretation. Percentages do not add up to 100% in the total sample due to rounding inaccuracies.

Preselection of Predictors

A significant effect of gender on the GPIUS2 score was found ($t(565) = 2.382$, $p = .018$) with males having higher scores than females. Significant positive correlations with the GPIUS2 score were also found for all vigilance variables (VIG-E, VIG-P, VIG-T), and significant negative correlations with cognitive avoidance in the ego-threat scenario (CAV-E), social support (FERUS), SNS, and age. Spearman correlations are presented in **Table 2**. Correlation coefficients of the putative prognostic variables that are taken into the model are bolded.

The first variables entered into the regression model as potential predictors were age and gender. In the second block, vigilance (VIG-E, VIG-P), cognitive avoidance (CAV-E), and social support (Model 1) or dummy-coded SNS (Model 2) were included. In the last block, the interaction terms of cognitive avoidance (CAV-E) with social support (Model 1) or dummy-coded SNS (Model 2) as well as the interaction terms of vigilance (VIG-E and VIG-P) with social support (Model 1) or dummy-coded SNS (Model 2) were included in the respective model.

Hierarchical Linear Regression

Model 1

Hierarchical linear regression showed for the Model 1 [Block 1 + Block 2 + Block 3] including all potential predictors the highest adjusted $R^2 = .266$ ($F(9, 557) = 23.747$, $p < .001$). The first block (Model 1 [Block 1]) including only age and gender (adjusted $R^2 = .114$) and the Model 1 [Block 1 + Block 2] including CAV-E, VIG-E, VIG-P, and social support (adjusted $R^2 = .258$) showed smaller adjusted R^2s compared to the Model with all three blocks and therefore a minor prediction of the GPIUS2 score. The changes in R^2 between Model 1 [Block 1] and Model 1 [Block 1 + Block 2] ($p < .001$) and Model 1 [Block 1 + Block 2] and Model 1 [Block 1 + Block 2 + Block 3] ($p = .029$) were significant. The results for each potential predictor in the Model 1 [Block 1 + Block 2 + Block 3] are listed in **Table 3**. Significant predictors are bolded. Bootstrapping analysis verified the significance of age (CI: [−.045; −.033]), gender (CI: [−.409; −.107]), VIG-P (CI: [.006; .202]), social support (CI: [−.419; −.261]),

TABLE 2 | Spearman correlations between GPIUS2 (Blom-transformed), cognitive avoidance (CAV), vigilance (VIG), social support, social network size (SNS), and age in the German sample (N = 567).

	Correlation coefficients									
	GPIUS2	**CAV-E**	**CAV-P**	**CAV-T**	**VIG-E**	**VIG-P**	**VIG-T**	**Social support**	**SNS**	**Age**
GPIUS2	1	**−.105***	−.026	−.086*	**.160*****	**.127****	.164***	**−.340*****	**−.137****	**−.136****
CAV-E		.437***	.866***	−.373***	−.172***	−.318***	.017	.024	.054	
CAV-P			.811***	−.094*	−.388***	−.277***	.049	.073	−.076	
CAV-T				−.286***	−.317***	−.350***	.043	.059	−.013	
VIG-E					.509***	.863***	−.043	−.068	−.017	
VIG-P						.865***	−.039	−.088*	−.018	
VIG-T							−.044	−.088*	−.016	
Social support								.345***	−.039	
SNS									−.057	

*$p < .05$; **$p < .01$; ***$p < .001$ (two-tailed tested). Potential predictors are highlighted by bolded correlation coefficients. Only subscales of the ABI were considered as potential predictors.*

the interaction term of VIG-E and social support (CI: [.017; .247]) with the GPIUS2 variable.

To facilitate interpretation of the interaction between VIG-E and social support, a graphic (**Figure 1**) was designed using median splits for the variables social support and VIG-E.

Model 2

Hierarchical linear regression showed for Model 2 [Block 1 + Block 2] including age, gender, CAV-E, VIG-E, VIG-P, and dummy-coded SNS the best prediction for the GPIUS2 score, with an adjusted $R^2 = .173$ ($F(9,557) = 14.183$, $p < .001$). The adjusted R^2 of Model 2 [Block 1] with age and gender as predictors was .114, and the adjusted R^2 of the Model 2 [Block 1 + Block 2 + Block 3] with all potential predictors was .171. The changes in R^2 between Model 2 [Block 1] and Model 2 [Block 1 + Block 2] ($p < .001$) were significant, whereas the changes in R^2 between Model 2 [Block 1 + Block 2] and Model 2 [Block 1 + Block 2 + Block 3] ($p = .583$) were not significant. The results for the potential predictors of the Model 2 [Block 1 + Block 2] are listed in **Table 4**. Significant predictors are bolded. Bootstrapping analysis verified the significance of age (CI: [−.046; −.032]), gender (CI: [−.558; −.225]), VIG-P (CI: [.014; .194]), SNS (2–5 individuals) (CI: [−1.351; −.271]), SNS (6–9 individuals) (CI: [−1.590; −.444]), and SNS (10 or more individuals) (CI: [−1.526; −.398]).

TABLE 3 | Model 1 [Block 1 + Block 2 + Block 3]: hierarchical linear regression with GPIUS2 score as dependent variable and age, gender, cognitive avoidance, vigilance, social support and the respective interaction terms as potential predictors.

Variable	*B*	*SE of B*	*Beta*	*P*	*CI*
Age[a]	−.326	.036	−.331	<.001	[−.045; −.033]
Gender[a]	−.254	.084	−.117	.003	[−.409; −.107]
CAV-E	−.062	.039	−.063	.115	[−.144; .015]
VIG-E	.090	.045	.091	.045	[-.005; .173]
VIG-P[a]	.103	.043	.104	.018	[.006; .202]
Social Support[a]	−.337	.037	−.342	<.001	[−.419; −.261]
CAV-E × Social Support	.048	.032	.059	.132	[−.032; .114]
VIG-E × Social Support[a]	.120	.048	.121	.012	[.017; .247]
VIG-P × Social Support	−.024	.042	−.027	.568	[−.118; .048]

All predictors except gender in z-standardized form; gender coded: 1 = male, 2 = female; [a]significant after bootstrapping analysis, such significant predictors are presented in bold letters.

DISCUSSION

The aim of the current study was to investigate the role of anxiety-related coping styles in the development of IUD taking into account the qualitative and quantitative facets of the social resource. We did not find the proposed negative associations between cognitive avoidance and IUD in a hierarchical linear regression. Nevertheless, these results are in line with Waqas et al. (78), who only observed a relevant negative association between

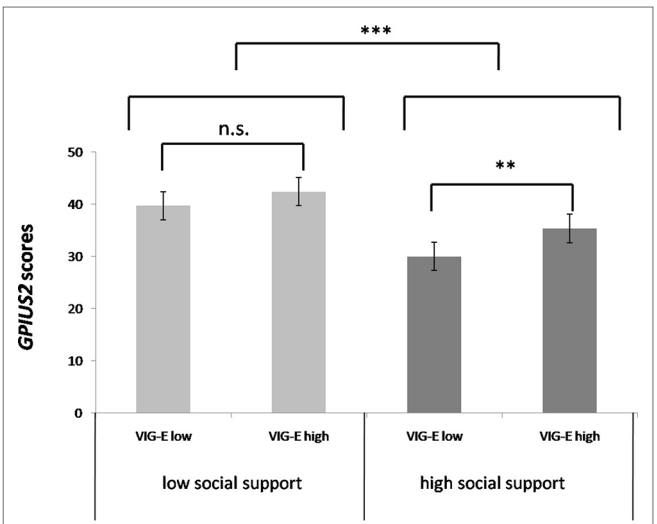

FIGURE 1 | GPIUS2 scores according to social support and vigilance in the ego-threat scenario [brackets indicating significance of group differences; **$p < .01$ for median-splited vigilance in the group of high social support; ***$p < .001$ for the main effect of social support; derived from *post-hoc* test; n.s., not significant; error bars indicate -/+ 1 standard error].

TABLE 4 | Model 2 [Block 1 + Block 2]: hierarchical linear regression with GPIUS2 score as dependent variable and age, gender, cognitive avoidance, vigilance, and dummy-coded SNS as potential predictors.

Variable	*B*	*SE of B*	*Beta*	*P*	*CI*
Age[a]	−.332	.038	−.337	<.001	[−.046; −.032]
Gender[a]	−.387	.087	−.178	<.001	[−.558; −.225]
CAV-E	−.073	.041	−.074	.075	[−.159; .015]
VIG-E	.096	.048	.097	.045	[−.011; .195]
VIG-P[a]	.109	.046	.111	.017	[.014; .194]
SNS (1)	−.525	.439	−.114	.231	[−1.217; .213]
SNS (2–5)[a]	−.833	.406	−.409	.041	[−1.351; −.271]
SNS (6–9)[a]	−1.039	.410	−.454	.012	[−1.590; −.444]
SNS (10 or more)[a]	−.970	.426	−.255	.023	[−1.526; −.398]

All predictors except gender in z-standardized form; gender coded: 1 = male, 2 = female; [a]significant after bootstrapping analysis; number of people in the social network in parentheses. Significant predictors are presented in bold letters.

IUD and sublimation but no other mature defense style measured *via* the Defense Style Questionnaire (DSQ-40) (113). Especially, no associations between suppression (comparable to the here-measured cognitive avoidance) and IUD were found in their work. Instead, we detected significant positive correlations between IUD and vigilance in both scenarios. This is in line with our hypothesis. Individuals with tendencies to mainly cope in a vigilant way seem to be more vulnerable, e.g., to stress, depression, and anxious reactions [e.g., Refs. (95, 97, 99)]. Associations between IUD and, e.g., social anxiety [e.g., Refs. (1, 83)], stress [e.g., Ref. (114)], and depression (115) have been described before. It is imaginable that anxiety-related coping styles play a key role in IUD comorbidity and are also of importance in the understanding of risk factors and the development of therapeutic approaches. Moreover, individuals easily feeling unease in situations that could cause physical harm or challenge one's own self-worth might show a tendency to flee into physically harmless adventures of the online world. Interaction with real people and real-world social situations could be seen as potential physical or self-worth-challenging dangers. Potential harmful social interactions are therefore something that should be avoided and not something that can be experienced as helpful or supportive. In line with this idea, Lee and Stapinski (4) described the importance of *fear of negative evaluations* during face-to-face contacts for a better understanding of the positive association between social anxiety and IUD. Moreover, in the model proposed by Caplan (116), individuals with deficits in social skills are described to prefer online interactions above face-to-face contact.

As proposed, we found negative correlations between social support and IUD, as well as a negative association between SNS and IUD. This may underline the potential protective character of the social resource in the development of IUD. As expected, the detected correlation for social support and IUD was stronger than the correlation found for SNS and IUD (social support: −.340 vs. SNS: −.137), supporting the idea of a special role of perceived social support in comparison to SNS in the search for protective factors. This result is in line with the work of Rorty et al. (65). In the regression models, the model with social support (Model 1) as well as the model with SNS as a predictor (Model 2) showed significant results. We were not able to find any interactions between vigilance measured in the physical threat scenario and the variables dealing with social resources. But availability of social resources (in terms of quality) seems to play a different role for individuals with a tendency to cope mainly vigilant in situations where the self/ego is challenged. We only found an interaction for vigilance in the ego-threat scenario and social support (see Model 1). These results may again underline the proposed superordinate role of social support when compared to SNS. Taking a closer look at this interesting interaction term, it seems as if individuals with the lowest tendencies to cope in a vigilant way in ego-threat scenarios can benefit the most from the social support that is offered to them. Maybe a focus on the anxiety-provoking content of a situation makes the individual kind of blind to available (social) help in this situation (80). To understand this interaction, a closer look at the maturity of the defense mechanism seems to be a necessary step. Defense mechanisms are described to change across the life span [e.g., Ref. (89)] and are especially associated with mental disorders, when used rigidly (e.g., 117) and not in accordance with the current developmental step (79). Malone et al. (118) already underlined the importance of defense maturity in the building of social bonds. Therefore, whether offered social support can be used in a helpful way by an afflicted person seems to depend on the kind of defense mechanism/coping strategy used. Malone et al. (118) observed a partially mediating role of social support in the association between adaptive (mature) defenses and physical health. In contrast, our data are more supporting the idea of a moderating role of the coping strategies proposed in the I-PACE model (18). Mature defense mechanisms are needed to ask for, accept, and profit from social support. That is where psychotherapy comes into play. The change of defense mechanisms can be seen as an aim or one of the positive effects of psychodynamic psychotherapy [see, for example, Ref. (119)]. Our results may underline the importance of psychodynamic psychotherapeutic approaches not only in the treatment of IUD but also in the prevention of it. A closer look at different coping styles could represent a promising new approach in the development of screening tools and therapeutic manuals because current existing therapeutic approaches and manuals for the treatment of IUD are mostly grounded in cognitive behavioral therapy (CBT) [e.g., Refs. (120–125)]. In line with this, so far, only a few empirical works have dealt with psychodynamic approaches in the treatment of IUD [see, for example, a case study by Essig (126), and a multi-centric study by Lindenberg et al. (127)]. In sum, diagnosing dominant coping styles/defense mechanisms (e.g., *via* specialized screening tools) could help to detect persons at high risk to develop an IUD.

Another promising therapeutic approach to treat persons afflicted with IUD could be the inclusion of mindfulness-based concepts where patients learn, among other things, to control and focus their attention in a conscious way [e.g., Ref. (128)]. Individuals with tendencies to cope mainly vigilant may be able to learn through mindfulness to willingly remove their focus from anxiety-provoking material to the available help and support from one's own peer group. Of note, observations of Arslan (129) are in line with this idea,

demonstrating the importance of mindfulness as a mediator between psychological maltreatment (here: experience of psychologically abusive parental behavior) and IUD (129). Beyond that, mindfulness-based interventions have already been described to be a promising therapeutic approach in the broader field of behavioral addictions [e.g., Ref. (130)].

The maturity of defense mechanisms can additionally offer an explanation of why adolescents seem to be more vulnerable to developing IUD (26, 131), as Anna Freud (85) saw intellectualization (in our work, comparable with vigilance) as a defense mechanism of adolescence. Using social support personally in a helpful way might be something to be learned first.

A limitation of the current study is the unbalanced sample composition with respect to age, gender, and professional background. As we expect defense mechanisms to change with age [e.g., Ref. (132)], a sample with a broader age range, with the possibility to build different age categories, would have helped to confirm the idea of an association between defense maturity and IUD. In addition, a balanced sample with respect to gender and professional background would confirm generalizability of the results. Furthermore, gender differences in the association between social support and IUD have been described by Yeh et al. (133) to be mediated by depressive symptoms. A gender-balanced sample should therefore include psychological symptoms to consider these clinically important potential mediation.

Furthermore, we did not take a closer look at social network characteristics, even though we did mention possible negative consequences of an unhealthy network in the context of addictive behaviors [e.g., Ref. (64)]. Future studies concerning the association between social network and IUD should take a closer look at these characteristics. It seems to be possible that an unhealthy network (e.g., consisting of somehow less supportive individuals), perhaps also with addictive tendendiens toward IUD vs. a healthy network (e.g., consisting of individuals with low addictive tendencies and caring characters) can end up in completely contrary effects. In addition, we mention that the item of Blake and McKay (104) measuring SNS in our work strongly focuses on assessing people in one's own social network with close physical proximity to the individual. Therefore, it is possible that applying a broader concept of the term *social network* in the administered item of interest would have led to different results (e.g., "If I am sad, I have someone I can call").

Another limitation of our study is our focus on offline social support. Online social support has been described, for example, by Leung (68) to be comparable to offline social support in its stress-buffering capacity in adolescents and children. In line with that, Ybarra et al. (70) pointed out the importance of both online and offline social support in the group of lesbians, gays, bisexuals, and transgenders. They found different positive effects of both online and offline social support, discussing that one cannot be simply replaced by the other (70). In contrast, Hardie and Tee (67) reported a higher profit from social support *via* Internet social networks for Internet over-users. That said, we need to mention that the FERUS items used to assess social support in the present work (and the item assessing the SNS) is formulated in a broad sense. Hence, some participants might have thought about their lives in the online and/or offline world, while answering the items. Again, future studies need to implement more inventories explicitly asking about social support/ SNS in the online and offline world. Without such a clear distinction, researchers will not be able to carve out potential different effects of online vs. offline social support. Beyond that, associations between (online and offline) social support and IUD ultimately will be influenced by many mediating and moderating factors. The aforementioned I-PACE model by Brand et al. (19, 20) gives a good overview on the complex nature of IUD and how moderators and mediators might impact on the development of IUD. As mentioned earlier in this work, according to Brand's model, such moderators/ mediators involve the here-investigated coping styles but also the range of affective and cognitive factors.

Moreover, we have to point out the correlative nature of our work. Therefore, the reported associations prove no causality, and longitudinal studies are needed to follow up on the here-presented results. Even though the interaction between vigilance (ego-threat) and social support is very interesting and fits into the psychodynamic approach, we must highlight that the intake of the interaction terms in Model 1 only improved the explained variance (as compared to Model 1 [Block 1 + Block 2]) for 1%. Furthermore, all variables that were taken into account were measured *via* self-report questionnaires. This approach comes with its own limitations; especially in the case of the measurement of anxiety-related styles, we must assume moderate reflective functioning of the participants and consciousness of the strategies. In the case of the measure concerning the assessment of IUD, we again assume a certain ability level on the participant's side to reflect on one's own life. In particular, in the early phase of developing addictive tendencies toward the Internet, it is questionable that such abilities can be expected. Finally, the readers will see that the data set from East Asia did not support all of our present conclusions based on the German sample. That said, the many limitations coming with this data set are presented both in the methods and in the **Supplementary Material**. Still, we believe it to be of importance for reasons of transparency to report these data.

Despite these limitations, we believe that our study is able to underline the importance of quality of social support and special forms of coping in the search for protective factors to not suffer from IUD. As demonstrated, it might not be sufficient to just have social resources at hand. A person's individual needs, the right strategies to actually profit from the support offered, and quality seem to be more important than mere quantity.

DATA AVAILABILITY

The datasets generated for this study will not be made publicly available; not all participants gave consent for sharing the data.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics committee at Ulm University, Ulm, Germany. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

SJ and CM designed the present study. SJ drafted the first version of the manuscript, which was revised by CM. SJ carried out all statistical analyses, which independently were checked by CS and JW. The German sample was collected by SJ, CS, and CM. The Chinese/Taiwanese sample was collected by CS, SJ, CM, ML and HC-K. Translation of Chinese measures was conducted by LQ and ML. Taiwanese translation was conducted by HC-K. All authors worked on the final draft and approved the final version of the manuscript.

FUNDING

The position of CM is funded by a Heisenberg grant awarded to him by the German Research Foundation (MO 2363/3-2). JW has a stipend from the German Academic Scholarship Foundation (Studienstiftung des deutschen Volkes).

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2019.00640/full#supplementary-material

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychology

BOOK REVIEW
published: 04 October 2019
doi: 10.3389/fpsyg.2019.02170

Book Review: Addictions From an Attachment Perspective: Do Broken Bonds and Early Trauma Lead to Addictive Behavior?

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Keywords: addiction, alcoholism, self-harm, psychotherapy, self-medication

A Book Review on

Addictions From an Attachment Perspective: Do Broken Bonds and Early Trauma Lead to Addictive Behavior?

Richard Gill (New York, NY: Routledge), 2017, 156 pages, ISBN: 9781782201076

The development of addiction through poor attachments during childhood is a crucial area of research. John Bowlby, who created the Attachment Theory, inspired Richard Gill to gather together relevant scholarly papers in his honor (Gill, 2017). These unique papers formed a book known as *Addictions from an Attachment Perspective*, which is targeted for a broad audience of clinical psychologists and psychoanalysts. Richard Gill works at St. Joseph's hospital while providing treatment programs for various addictive behaviors in the United Kingdom. He is the director of London's Action on Addiction program, which has helped serve individuals who struggle with substance use disorders for half a decade.

John Bowlby emphasized that healthy attachments are needed "from the cradle to the grave" (Gill, 2017). Bowlby conducted research in psychoanalysis, which is how he discovered his theory on attachment in the early 1900s. He enlightened the world with his theories on the relation between addiction and negative emotions, such as loss and deprivation (Gill, 2017). Bowlby started his extraordinary work with orphaned children who had lost their parents through war (Gill, 2017). Bowlby is one of the best minds of the 20th century to discover the clear relationship between traumatic experience and human development (Gill, 2017).

The book covers attachment's relation to personal identity, gender, and culture. The goal of this book, in the exact words of the author, is to provide an "in-depth understanding that addictions are a response to, and hold the pain of, broken attachments and are best treated within healthy interpersonal relationships" (Gill, 2017). A quick summary of the book includes the topics of treating addiction, coping with self-medication, and using alcohol (Gill, 2017). Other topics also arise, such as avoiding self-harm, abstaining from drugs, and seeking help with gambling addictions (Gill, 2017). The main theme throughout the pages is promoting healthy attachments and healing those with addictions.

The book jumps into the lively discussion of the Attachment Theory. A key notion promoted in the book explains that the reason that addiction occurs is to "provide the soothing and safety which are the features of an internalized secure base and from which the person can emerge and engage in exploration" (Gill, 2017). After all, it has been well-known for decades that many of the young adults or high school students who try drugs may claim that they are only "experimenting" with substances (Swadi, 1990). This theory acts as if their drug use is supposed to be a one-time occurrence, which ignores the fact that this special occasion can turn into a daily habit and possibly

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This article was submitted to Psychoanalysis and Neuropsychoanalysis, a section of the journal Frontiers in Psychology

Received: *30 April 2019*
Accepted: *09 September 2019*
Published: *04 October 2019*

Citation:
Rinker K (2019) Book Review: Addictions From an Attachment Perspective: Do Broken Bonds and Early Trauma Lead to Addictive Behavior? Front. Psychol. 10:2170. doi: 10.3389/fpsyg.2019.02170

drug dependence. According to Omu et al. (2017), adolescents are the population who is most likely to use drugs. So health concerns are raised when looking at young populations and their risk of drug use.

Addictions from an Attachment Perspective claims that broken attachments, such as the loss of a loved one in the time of war, may lead to addiction (Gill, 2017). Edward Khantizan was the first to mention this theory of the "Self-Medication hypothesis" when witnessed soldiers using drugs or alcohol to numb their pain (Gill, 2017). The soldiers' discomfort extended long past the battlefield as they brought their distress back home with them in the form of Post-traumatic Stress Disorder (Gill, 2017). This psychiatric condition forced the soldiers to relive their horrific experiences of extreme loss.

Self-medication can be a reason for alcoholism. Chronic alcohol use can negatively impact attachments by altering the roles of caregiving, affection, and comfort in relationships (Gill, 2017). These relationships may be romantic interferences or family obligations. The book by Gill states that heavy alcohol use affects attachments because the individual begins to "rely on alcohol before people and to trust alcohol to "look after them" more reliably than any person could or might" (Gill, 2017). Alcoholic behavior replaces the need for love or belonging, which previously had acted as a motivation to find new attachments or build current ones. The individual who struggles with alcohol addiction distances themselves off from emotional attachments. This lack of emotion creates an "absent or dead" relationship between husband and wife, or mother and child (Gill, 2017). Or apathy can end relationships and break attachments due to this cold perspective.

Psychotherapy can be helpful for allowing those with alcoholism to connect with their spouse or family (Gill, 2017). But this treatment needs to include exploration of emotion and engagement in the curiosity behind their personal relationships (Gill, 2017). It also requires a heightened sense of empathy, along with the willingness to seek out the emotional experiences of their partner or family member (Gill, 2017). And lastly, the psychotherapy session needs a calm atmosphere (Gill, 2017). A peaceful environment may allow for the focus of treatment to be on forming healthy relationships that can be used instead of alcohol.

Other types of addiction can include the overuse of technology, gambling, or promiscuous behaviors (Gill, 2017). Hypersexuality is a problematic behavior that relies on attachments *too much*, which is the same as excessive technology use through social media (Gill, 2017). Researchers who published in the *Clinical Neuropsychiatry* journal suggest that gambling involves lack of self-control that is similar to a drug addiction (Terrone et al., 2018). Impulsivity is especially high among individuals with substance abuse disorder.

Bowlby's theories paved the road for new psychoanalysts who would later contribute to the vast fields of developmental psychology, sociology, and psychoanalysis. Research that is inspired by Bowlby includes studies on attachment and addictive behavior. These studies promote the theory that inadequate childhood attachments, which develop from neglect or lack of parent-child bonding, may lead to drug dependence (Musetti et al., 2016). One study, published by *Frontiers in Psychology*, looked at 57 participants with poor attachments during childhood, and 47 of them were prone to drug use (Musetti et al., 2016). Drug use takes the place of a true relationship. Further research on attachment and addiction is encouraged to shed light on the importance of relationships during human development.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

ACKNOWLEDGMENTS

Frontiers Journals deserves the highest praise for taking the time to publish this paper. I deeply appreciate all of their effort. I also wish to thank Washington State University, who continues to provide me with a challenging and meaningful college education.

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Conflict of Interest: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychiatry

REVIEW
published: 15 October 2019
doi: 10.3389/fpsyt.2019.00727

Attachment and Substance Use Disorders—Theoretical Models, Empirical Evidence, and Implications for Treatment

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Introduction: The article reviews attachment-oriented research in individuals with substance use disorders (SUDs). Based on attachment theory, substance abuse can be understood as "self-medication," as an attempt to compensate for lacking attachment strategies. Attachment theory suggests a developmental pathway from insecure attachment to SUD and, on the other hand, a negative impact of substance abuse on attachment security. Earlier reviews have indicated a general link but have been inconclusive with regard to other aspects. In the light of a growing body of research, this review is looking for evidence for the general link, for its direction, for differences due to different patterns of attachment, different substances and severities, comorbid psychiatric disorders, and age groups.

Methods: Using medical and psychological databases, 34 cross-sectional studies, three longitudinal studies, and a systematic meta-analysis were identified. Methodological problems such as poor assessment of SUD and the use of different measures of attachment limit comparability.

Results: All cross-sectional studies in the review confirm a link between insecure attachment and SUD. Results of longitudinal studies show insecure attachment to be a risk factor for SUD, while continued substance abuse impairs the ability to form close relationships. With regard to specific patterns of attachment, results mainly point toward very insecure patterns. They indicate different patterns of attachment in different groups of substance abusers, suggesting different developmental pathways. Fearful–avoidant attachment was frequent in heroin addicts, while alcohol abusers displayed more heterogeneous patterns. Comorbid mental disorders and severity of SUD seem to be important factors, but data are still inconclusive. The link between insecure attachment and SUD seems to be stronger in adolescence compared to adulthood.

Discussion: The last decades have seen a substantial growth in studies on attachment and SUDs. Despite methodological problems, the general link between insecure attachment and SUD today is well established. Attachment theory might contribute to

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Specialty section:
This article was submitted to Addictive Disorders, a section of the journal Frontiers in Psychiatry

Received: *30 April 2019*
Accepted: *10 September 2019*
Published: *15 October 2019*

Citation:
Schindler A (2019) Attachment and Substance Use Disorders—Theoretical Models, Empirical Evidence, and Implications for Treatment. Front. Psychiatry 10:727. doi: 10.3389/fpsyt.2019.00727

the understanding and treatment of SUDs in a significant way. But to do so, a lot of open questions have to be answered. We will need more carefully designed longitudinal studies, more studies connecting psychological data with brain processes, and more clinical trials.

Keywords: Attachment, attachment theory, patterns of attachment, substance use disorders, substance abuse, addiction

INTRODUCTION

Over the last decades, attachment theory (see **BOX 1** for a brief description of attachment theory) has been applied to a lot of developmental and clinical fields, including substance use disorders (SUDs). A growing number of attachment-based studies have tried to contribute to the understanding of SUDs. In 2005, a first review tried to structure the field (1). It contained two main questions:

1. Is there a link between attachment and SUD?
2. Is there a link between one or several specific attachment patterns and SUD?

Additionally, it asked for the direction of these possible links, that is, for developmental pathways between attachment and SUD. It looked for differences between different age groups, between users of different substances, due to different levels of severity of SUD (use, abuse, addiction) and due to different comorbid psychiatric disorders. This first review identified 12 studies published between1990 and 2005. Results indicated a link between insecure attachment and SUD, but they were inconclusive with regard to any other question. In the light of a growing body of research, this article is going to readdress the questions of the 2005 review. It tries to give a concise overview over what we know today about individual patterns of attachment among consumers of psychotropic substances. This might help to prepare the ground for a possible later integration of attachment in a multifactorial model of SUDs [see West and Brown (2), for an overview over addiction theories] and in the treatment of SUDs. Note that this review will not cover the topic of addictive behaviors such as gambling disorder or internet gaming disorder. And it will not cover the vast body of research on attachment in children of substance-abusing parents. This article will first give a theoretical introduction and sum up what we know from earlier reviews. It will then move on to methodological issues and to a review of the evidence represented in empirical studies today.

BOX 1 | What is attachment?

"Attachment is a motivational, behavioral, and interactional system that provides security for immature offspring in a variety of species. The attachment system regulates distance and closeness of parents (or 'attachment figures') and children. The child will seek closeness to his/her parents whenever he/she feels in danger. Ideally, parents will then comfort the child, calm him/her down, and give him/her a rewarding feeling of security. This feeling of security or 'secure base' created in early attachment experiences helps the child to regulate his/her emotions and is an important step on the way to acquiring own coping strategies when facing fear or distress. Against the backdrop of a 'secure base', the child can explore his/her environment (3–5). At the same time, secure attachment is the base for an exploration of his/her own inner world and that of others, that is, for the ability to 'mentalize' and to gain a coherent picture of mental processes (6). Over time, experiences with attachment figures are internalized. The child develops cognitive representations ['inner working models' ('IWMs')] of himself/herself and of his/her attachment figures. If positive IWMs are developed, other persons than the original attachment figures can also become a secure base. Additionally, positive IWMs make it possible to regulate affective states autonomously without depending on another person. In this sense, 'secure attachment liberates' (7)." (8, p. 305).

Insecure Attachment and Substance Use Disorders

Human beings who do not experience a sufficiently secure base develop insecure patterns of attachment, including negative IWMs of themselves and others, and negative expectations with regard to relationships (this includes therapeutic relationships, making it more difficult to establish a treatment alliance). Although insecure attachment is not a pathological condition in itself, it is related to mental disorders. Its ratio in clinical samples is 86%, in contrast to 42% in the general population (9). It is seen as an important risk factor not only for SUD, but also for mental disorders in general (10). With increasing insecurity, individuals will face more difficulties in regulating emotions and stress. This regulation will not function either with the help of attachment figures or with the use of IWMs. At the same time, insecure individuals will face difficulties in forming and maintaining relationships with others. Psychotropic substances then might become attractive as one way to "self-medicate" attachment needs, to regulate emotions, to cope with stress, and to replace relationships (8, 11, 12). Earlier reviews have shown cross-sectional evidence for a link between insecure attachment and SUDs (1, 8, 10, 13, 14). Additionally, they have reported preliminary longitudinal evidence for insecure attachment being a risk factor for later substance abuse. This review will look for a replication of the general link and for more longitudinal data.

Although most theoretical and empirical work has focused on insecure attachment as a risk factor for the development of SUDs, it is likely that substance abuse has an effect on attachment, too. The consequences of substance abuse are a host of well-known developmental risks and neurological impairments (15). From an attachment perspective, four mental processes might be directly affected by substance abuse. First, exploration of the environment is reduced or distorted, or risks are taken that would never have been taken in a state of sobriety (16). Second, mentalization, the exploration of the inner, mental world of oneself and others is reduced (17). This might even be a possible motivation for substance abuse: nonmentalization and

nonperception of distress and painful memories. Third, age-appropriate experiences in relationships often are inhibited or even prevented (18). Fourth, affect regulation and reward might be replaced by substance abuse (19). Further indirect evidence comes from the host of studies in samples of substance-abusing parents. These parents are hardly able to establish secure attachment relationships with their offspring (20). In sum, substance abuse might well have a negative impact on the ability to attach and form close relationships. Earlier reviews failed to provide empirical evidence regarding this point. This review will look for longitudinal evidence for an impact of substance abuse on attachment.

Individual Patterns of Attachment and SUDs

Attachment theory describes different patterns, which are based on the specific experiences in attachment relationships. They involve different levels of security, different strategies of coping with negative experiences in close relationships, and different means of regulating negative affect and expressing attachment needs. Individuals with preoccupied (sometimes called ambivalent/enmeshed/anxious) patterns use affectively hyperactivating strategies and are seeking closeness to important others. They are preoccupied with their own distress and the availability of attachment figures. Individuals with dismissing–avoidant strategies, on the other hand, tend to use distancing, affectively deactivating strategies. They defensively turn their attention away from their emotional distress and their attachment figures. A third group of patterns is characterized by a lack of functioning coping strategies and the highest risk for the development of severe psychopathology: disorganized patterns of attachment. These are associated with parental psychopathology (SUDs among others), with traumatic experiences (sexual abuse and maltreatment) as well as loss and neglect (21). While attachment originally described these patterns as categories, a dimensional approach seems to represent the existing data more precisely (22). **Figure 1** presents a two-dimensional model of attachment patterns, trying to integrate the different constructs. Note that this model is only meant to give a rough orientation. The dimension secure–insecure is well established. Especially the definition of secure attachment is common ground. However, there are very different concepts describing the insecure end of this dimension (disorganized, unresolved, fearful–avoidant, hostile–helpless). Although these concepts are different, they share the lack of adaptive coping strategies and a high risk for developing mental disorders. The second dimension is generally labeled "coping style" with preoccupied patterns on the left-hand side and dismissing–avoidant patterns on the right-hand side. Two-dimensional models of attachment patterns often use the dimensions of anxiety and avoidance (23). This is a factor solution that is rotated by 45° to the one described here (**Figure 1**). For more detailed discussions of these concepts, see Ravitz et al. (24) and Shaver and Mikulincer (22).

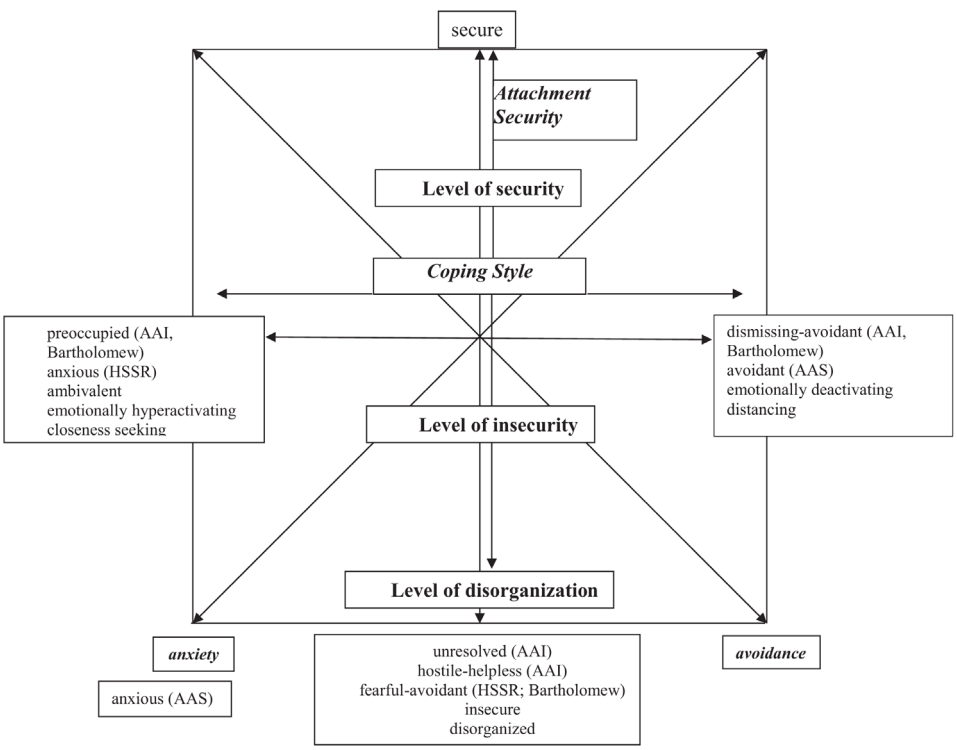

FIGURE 1 | Two-dimensional model of attachment.

Evidence presented in earlier reviews was inconclusive with regard to specific patterns of attachment. While some studies pointed to more avoidant patterns in substance abusers (1), others indicated links with different patterns (8, 10, 14). There had not been any longitudinal data on possible developmental pathways from specific patterns toward SUD. The relation between specific patterns and SUD is still an open question to be addressed in this review.

The Use of Different Substances

According to the "self-medication hypothesis" (12), the abuse of specific substances might be an attempt to cope with specific forms of emotional distress. For example, the abuse of stimulants might be linked to more hyperactivating, closeness-seeking attachment strategies, while the use of sedatives might be linked to deactivating, distancing strategies. Following the opioid deficit hypothesis (25; see **Box 2**), abuse of heroin and other opioids might be linked to extremely insecure attachment.

Despite some data from studies in alcohol and heroin using samples, earlier reviews have been inconclusive. The question of attachment-related differences between users of different substances will have to be addressed in this article.

Severity of Substance Use

In theory, more insecure individuals face a higher risk for developing SUDs. This does not necessarily imply that they develop more severe forms of SUDs. But if substance abuse impaired the attachment system, severity of abuse might be linked to severity of impairment. The review by Iglesias et al. (14) reported some evidence for a difference between experimental substance *use* and substance *abuse* in adolescent samples. The evidence in earlier reviews is limited, so it is still an open question: Does severity of substances use (use, abuse, addiction) make a difference with regard to attachment?

BOX 2 | Neurobiological research and the reward–deficiency hypothesis.

Neurobiological research has focused on motivational processes of both attachment and substance abuse (26–29). Both are transmitted by the same mesolimbic and mesocortical circuits, and for both, dopamine, endorphins, oxytocin, and vasopressin play important roles. This line of research mainly relies on the reward–deficiency hypothesis of addiction (30, 31), assuming that psychotropic substances can substitute other "deficient" sources of reward. Attachment theory posits that insecure individuals have not sufficiently experienced the reward of a secure base. Their reward system tends to be insufficiently conditioned to satisfaction by social contact (29). Based on a host of animal studies on endorphins and opioids, Trigo et al. (25) have operationalized reward–deficiency as an opioid deficit. They assume that insecure attachment and insufficient conditioning to reward by social contact lead to a lack of endorphins in the VTA. As a consequence, dopaminergic reward processing in the limbic system cannot be released. This leads to a reward deficiency and increases the risk for addictive behaviors. Especially opioids might be a potent substitute for lacking attachment strategies. Recently, Alvarez-Monjaras et al. (19) have presented a multifactorial developmental model of attachment and addiction. The model basically assumes a functional interchangeability of attachment processes and substance use. According to this model, positive attachment experiences and secure patterns strengthen reward from social contact and decrease the risk for addictive behaviors. Negative attachment experiences and insecurity, on the other hand, lead to insufficient reward from social contact and to a heightened risk to replace it with addictive behavior (19).

Comorbid Psychiatric Disorders

Comorbid psychiatric disorders are common in samples of substance abusers. Insecure attachment is not exclusively related to SUDs but to psychiatric disorders in general (10). Comorbidity might well be an important mediator of findings in this area. At the same time, it makes research very complex, because individuals with different comorbid disorders might use different substances for different reasons.

Schindler et al. (1) presented some limited evidence for different patterns of attachment in substance-abusing adolescents with different comorbid disorders. However, the question of the role of comorbid disorders in the relation between attachment and SUDs has to be readdressed.

Age: Substance Abuse in Adolescence Vs. Adulthood

The use and abuse of psychotropic substances usually begin and peak in adolescence. It is a crucial phase for the development of SUDs (11). At the same time, adolescence is important in the development of attachment. It is a transitional period when autonomy from parents, from the "secure family base," is developed (32, 33). This might suggest a closer relation between attachment and SUD in adolescence than in adulthood. Two earlier reviews have discussed these complex topics in detail (8, 14) but have not presented any data comparing adolescent and adult samples. This review will look for age-related effects with regard to attachment and SUDs.

METHODS

Literature for this review was scanned in PubMed/MEDLINE, Web of Science, PsycARTICLES/PsycINFO, PSYNDEX, EMBASE, and CINAHL databases for "all years" with a final update on April 4, 2019, using the following keywords: "attachment," "attachment theory," "patterns of attachment," "substance use disorders," "substance abuse," and "addiction." Additionally, references in articles and presentations were tracked. Criteria for inclusion were original empirical studies; basic research standards are met (which was not the case in studies earlier than 1990); use of validated measures of attachment; study based on attachment theory; focus on attachment of substance using individuals (this excluded studies focusing on children of substance users); and assessment of substance use, abuse, or addiction. Five hundred forty-six publications were scanned. After removing duplicates and studies not meeting the criteria, we included 37 original studies on attachment and SUD and one quantitative meta-analysis. Three of the original studies were longitudinal. Two further studies had a longitudinal design, but reported only cross-sectional data for the question at hand. See **Figure 2** for a flowchart of the selection process.

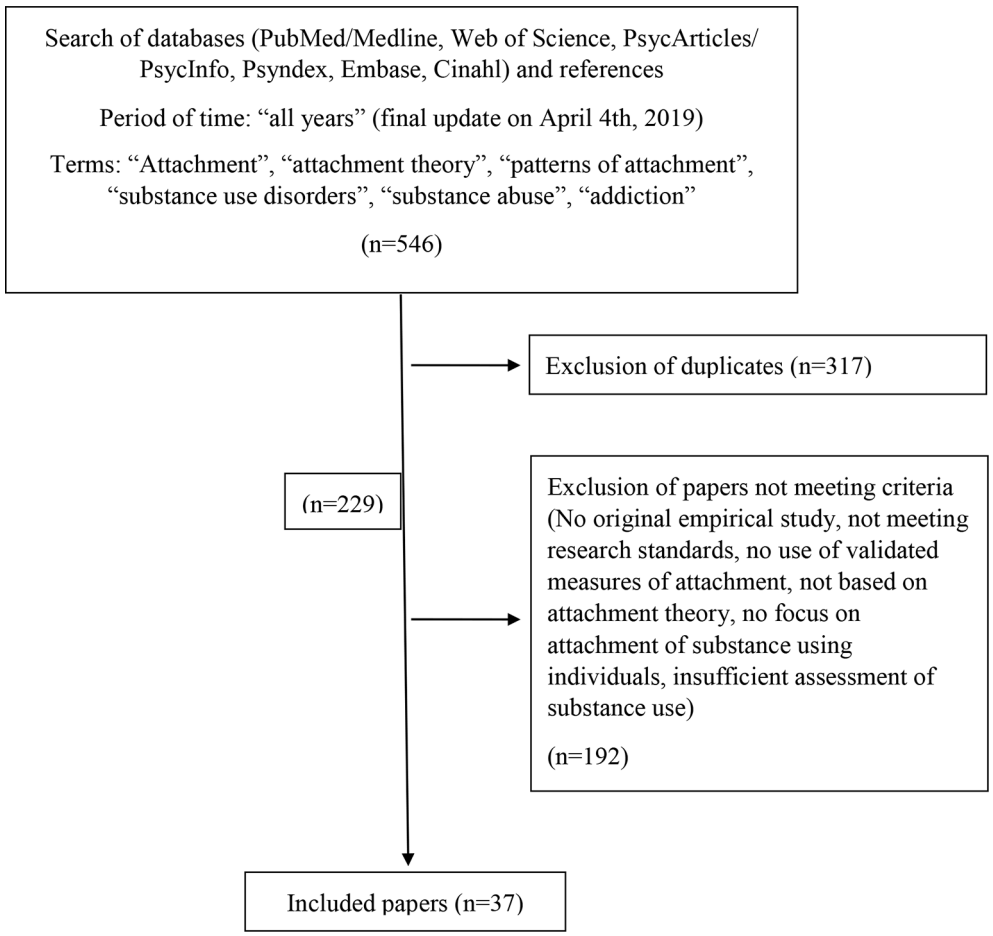

FIGURE 2 | Flowchart study selection.

Although we only included studies grounded in attachment theory, the use of different attachment measures makes results difficult to compare results. Additional methodological problems arise from flaws in the assessment of substance abuse and in sample selection. Samples were very heterogeneous, including different substances and different stages of severity. Most studies relied on self-report measures of substance use, with urinalyses or similar physical measures being rare.

Measures of Attachment Patterns

Attachment research has developed different measures. These share the basic distinction between secure and insecure attachment, but differ in the definition and labeling of specific patterns. While attachment interviews assess attachment representations, defined as the state of mind with regard to early attachment experiences, self-report questionnaires assess attachment styles, defined as experiences and behavior in close relationships (including romantic relationships). Although attachment theory assumes that these patterns develop in early childhood, both types of measures assess the current state of the attachment system. Attachment questionnaires and interviews show moderate correlations. The majority of studies use self-reports, which are seen as "surface indicators" of attachment representations (22, 24). The Adult Attachment Interview (AAI) (34) is a semistructured interview with four categories: secure–autonomous, preoccupied, dismissing, and unresolved. The category "hostile–helpless" was added later to describe special patterns mainly occurring in clinical samples (35). The Adult Attachment Projective (AAP) (36) is a projective test designed to produce narratives that can be categorized in the same way as the AAI. The Hazan and Shaver Self-report (HSSR) (37) is a simple measure consisting of brief descriptions of three attachment styles with respect to experiences in romantic relationships. Attachment styles are called secure, anxious–ambivalent, and avoidant. Note that avoidance is rather defined as fearful–avoidance in the Bartholomew model (high insecurity, no coping) and not as dismissing avoidance in the AAI. The Adult Attachment Scales (AAS) (38) is a multi-item scale based on the HSSR. It assesses secure, anxious, and avoidant attachment styles. Note that anxious attachment here is defined as the high end of the anxiety scale. Bartholomew and Horowitz (23) developed a model of four attachment categories, based on positive and negative internal working models of the self and of others. Bartholomew differentiated between two avoidant categories: fearful–avoidant

(according to the HSSR) and dismissing–avoidant (according to the AAI) (**Figure 1**). Based on this model, several self-report measures such as the Relationship Questionnaire, the Relationship Scale Questionnaire (39), the Experiences in Close Relationships (40), and an Attachment Interview have been developed (23).

RESULTS

Insecure Attachment and SUDs

All studies in this review report a link between insecure attachment and substance abuse or addiction (**Table 1**). Secure attachment was typically found in healthy controls in all studies including a control group. Cooper et al. (41) additionally showed a relation with experimental substance use in adolescence.

Three longitudinal studies indicate that attachment in an earlier age has an impact on later substance abuse. Branstetter et al. (44) demonstrated that securely attached adolescents at age 14 years consumed fewer substances at age 16 years. Danielsson et al. (77) showed that attachment security at age 13 years prevented heavy drinking episodes at age 15 years. In a study by Zhai et al. (76), insecure attachment at age 10 to 12 years led to dysregulation at age 16 years and substance abuse at age 22 years. In a meta-analytic calculation, Jordan and Sack (78) calculated that secure attachment decreases the risk for substance abuse by odds ratios ranging from 0.60 to 0.70. Thus, the risk for substance abuse is about one-third lower for securely attached adolescents.

The impact of substance abuse on attachment security has been studied less frequently. Unterrainer et al. (57) found such an impact with a strong neurotoxic effect in a clinical study of long-term addicts. Nonclinical studies have been less conclusive (79). A recent quantitative meta-analysis of prospective longitudinal studies (80) analyzed 34 original studies with as many as 56,721 participants. Studies mainly investigated community or college samples with a mean age of 15 years (range, 7–30 years); they covered a mean period of time of 3.8 years, and they mainly used attachment self-reports. The analysis yielded significant prospective relations in both directions with a significantly stronger effect of insecure attachment on substance abuse than *vice versa*.

Individual Patterns of Attachment: Styles and Representations

Data from longitudinal studies do not provide any information about different developmental pathways of individuals with specific patterns of attachment. However, the last three decades have seen a substantial growth of cross-sectional studies. Eight studies were carried out with the AAI/AAP. Six used the HSSR, and another six the AAS. Fourteen studies used measures based on the Bartholomew model. Three studies used other measures Attachment and Clinical Issues Questionnaire, Youth Attachment to Parents Scale, Inventory of Parent and Peer Attachment (ACIQ, YAPS, IPPA). Before describing results in detail, here is a brief overview:

- AAI/AAP studies mainly show dismissing and unresolved representations.
- In HSSR studies, fearful attachment was the most frequent style.
- AAS studies mainly report anxious attachment styles.

The majority of studies used the Bartholomew model point toward fearful–avoidance, with some evidence for a link with the anxiety dimension.

AAI/AAP Studies

A small German study (43) found dismissing and unresolved representations in adolescent drug addicts using multiple substances. Two other studies examined samples of adolescents in psychiatric inpatient treatment with SUD and other psychiatric diagnoses. Rosenstein and Horowitz (50) found partly dismissing and partly preoccupied representations in substance abusers with different comorbid disorders. Allen et al. (51) report a relation between "hard drug use" and dismissing attachment. Although this study had a longitudinal design, results concerning attachment and SUD were cross-sectional. Studies in adult samples found hostile–helpless representations (35, 45) among African American mothers in methadone maintenance treatment, a general link to insecurity in a sample of adults who had been adopted in childhood (46, 47) and unresolved representations among expecting parents (48), among substance-abusing psychiatric inpatients (49), and among adult drug addicts (using the AAP; 42).

HSSR Studies

HSSR studies mainly examined nonclinical samples. While a high-school study reported a link between anxious attachment and "problematic" substance abuse (41), the majority of substance abusers in a large representative US-wide sample described themselves as avoidant (53). So did the majority of "heavy drinkers" in college (54) and young adult samples (55), as well as adult long-term heroin addicts in Israel (52).

AAS Studies

Most AAS studies report anxious attachment in substance-abusing college students (60), in alcohol abusers in Korea (59), in alcohol addicts (61), and heroin addicts (57). An exception is the study by Durjava (56), which reports heightened scores on all insecure scales in heroin addicts.

Studies Using Measures Based on the Bartholomew Model

Studies in college samples mainly found links between alcohol abuse and fearful–avoidant patterns, while preoccupied and dismissing patterns occurred less frequently (68, 73, 74). The same constellation of patterns were found in clinical samples of substance-dependent individuals (18, 62, 64, 72). In samples of heroin addicts, fearful–avoidant attachment was the main pattern (1, 52, 71), while alcohol addicts showed either preoccupied (67) or generally insecure attachment (65, 69, 70). A study in adults in primary care found hazardous drinking to be linked to the anxiety dimension (63). Jenkins and Tonigan (66) found elevated attachment anxiety in an Alcoholics Anonymous (AA) sample. Although this study had a longitudinal design, results concerning attachment, and SUD were cross-sectional.

Different Substances

Only two studies compare users of different substances systematically. Zeid et al. (75) did not find any differences

TABLE 1 | Studies on attachment and substance use disorders.

Authors, Year	Age group	Sample	N/controls	Substances	Severity	Method	Measure of attachment	Main attachment pattern
Delvecchio et al. (42)	Adult	Clinical, TSUD	40/—	Illicit drugs	Addiction	CS	AAP	Unresolved
Amman (43)	Adolescent	Clinical, TSUD	15/15	Unspec.	Addiction	CS	AAI	Dismissing, cannot classify, unresolved
Branstetter et al. (44)	Adolescent	Nonclinical	200/—	Unspec.	Abuse	Long.	AAI, HSSR	Insecure (mediated by maternal monitoring)
Melnick et al. (35), Finger (45)	Adult	Clinical, TSUD	62/87	Heroin	Addiction	CS	AAI	Hostile–helpless
Caspers et al. (46), Caspers et al. (47)	Adult	Nonclinical, adoptees	208/—	Unspec.	Use/abuse	CS	AAI	Insecure
Riggs and Jacobvitz (48)	Adult	Nonclinical, expect. parents	233/26	Unspec.	Abuse	CS	AAI	Unresolved
Fonaghy et al. (49)	Adult	Clinical, psychiatric	82/37	Unspec.	Abuse	CS	AAI	Unresolved, preoccupied
Rosenstein and Horowitz (50)	Adolescent	Clinical, psychiatric	60/29	Unspec.	Abuse	CS	AAI	Dismissing, preoccupied
Allen et al. (51)	Adolescent	Clinical, psychiatric	66/76	Illicit dr.	Abuse	CS (Long.)	AAI	Dismissing
Finzi-Dottan et al. (52)	Adult	Clinical, TSUD	56/56	Heroin	Addiction	CS	HSSR	Avoidant
Cooper et al. (41)	Adolescent	Nonclinical	2011/1151	Unspec.	Use/abuse	CS	HSSR	Secure vs. anxious
Mickelson et al. (53)	15–54 y	Nonclinical, representative	8089/2876	Unspec.	Abuse	CS	HSSR	Avoidant (anxious)
Brennan and Shaver (54)	Young adult	Nonclinical, college	242/178	Alcohol	Use	CS	HSSR	Avoidant
Senchak and Leonard (55)	Young adult	Nonclinical	644/—	Alcohol	Use/abuse	CS	HSSR	Men: avoidant, women: unrelated
Durjava (56)	Adult	Clinical, TSUD	54/54	Heroin	Addiction	CS	AAS	Insecure
Unterrainer et al. (57)	Adult	Clinical, TSUD	19/40	Heroin	Addiction	CS	AAS	Anxious
Mortazavi et al. (58)	Adult	Clinical, TSUD	60/60	Opium	Addiction	CS	AAS	Insecure
Shin et al. (59)	Adult	Nonclinical, male	141/—	Alcohol	Abuse	CS	AAS	Anxious
Kassel et al. (60)	Young adult	Nonclinical, college	212/—	Unspec.	Abuse	CS	AAS	Anxious
Vaz-Serra et al. (61)	Adult	Clinical, TSUD, male	56/56	Alcohol	Addiction	CS	AAS	Anxious
Gidhagen et al. (62)	Adult	Clinical, TSUD	108/—	Unspec.	Addiction	CS	BSR	Fearful (preoccupied, dismissing)
Le et al. (63)	Adult	Primary care	348/—	Alcohol	Abuse	CS	BSR	Anxiety dimension
Schindler and Sack (64)	Adult	Clinical, psychiatric	36/21	Unspec.	Abuse/Addiction	CS	BAI	Fearful (dismissing)
Wedekind et al. (65)	Adult	Clinical, TSUD	59/—	Alcohol	Addiction	CS	BSR	Insecure
Jenkins and Tonigan (66)	Adult	Alcoholics Anonymous	253/—	Alcohol	Addiction	CS (Long.)	BSR	Anxiety dimension
Harnic et al. (67)	Adult	Clinical, TSUD	40/—	Alcohol	Addiction	CS	BSR	Preoccupied
Molnar et al. (68)	Young adult	Clinical, TSUD	213/696	Alcohol	Abuse	CS	BSR	Fearful (preoccupied, dismissing)
DeRick and Vanhuele (69), DeRick et al. (70)	Adult	Clinical, TSUD	101/—	Alcohol	Addiction	CS	BSR	Insecure
Schindler et al. (71)	14–29 y	Clinical, TSUD	94/72	Heroin/XTC/THC	Addiction/abuse	CS	BAI	Fearful vs. insecure vs. dismissing
Doumas et al. (72)	Adult	Clinical, TSUD	46/—	Unspec.	Addiction	CS	BSR	Fearful (preoccupied, dismissing)
Thorberg and Livers (18)	Adult	Clinical, TSUD	99/58	Unspec.	Addiction	CS	BSR	Fearful (preoccupied, dismissing)
Schindler et al. (1)	14–25 y	Clinical, TSUD	71/71	Heroin	Addiction	CS	BAI	Fearful
Vungkhanching et al. (73)	Young adult	Nonclinical, College	369/—	Alcohol	Abuse	CS	BSR	Fearful (preoccupied, dismissing)
McNally et al. (74)	Young adult	Nonclinical, College	366/366	Alcohol	Use	CS	BSR	Fearful (preoccupied)
Zeid et al. (75)	Adult	Clinical, TSUD	149/92	Alcohol/. opiates	Addiction	CS	ACIQ	Insecure (no difference between groups)
Zhai et al. (76)	10–22 y	Nonclinical	694/—	Unspec.	Abuse	Long.	YAPS	Insecure
Danielsson et al. (77)	Adolescent	Nonclinical, community	1222/—	Unspec.	Use/abuse	Long.	IPPA	Insecure

TSUD, treatment of SUD; Unspec., substances not specified; CS, cross-sectional; Long., longitudinal; XTC, ecstasy; THC, cannabis; AAI, Adult Attachment Interview; AAP, Adult Attachment Projective; AAS, Adult Attachment Scale; ACIQ, Attachment and Clinical Issues Questionnaire; BSR, Bartholomew Self-report (RQ, RSQ, ECR); BAI, Bartholomew Attachment Interview; HSSR, Hazan & Shaver Self-report; IPPA, Inventory of Parent and Peer Attachment; YAPS, Youth Attachment to Parents Scale.

between alcohol and opiate addicts. In contrast to this study, Schindler et al. (71) did find significant differences between heroin, ecstasy, and cannabis users and nonclinical controls. While heroin addicts were mainly fearful–avoidant, controls were mainly secure, and cannabis abusers tended to be dismissing–avoidant. Ecstasy (MDMA) abuse was related

to insecure attachment, but not to a specific attachment pattern.

Studies in specific groups provide some additional information about heroin, alcohol, and cigarette smoking. With regard to heroin addiction, they indicate fearful–avoidance (1, 52), as well as hostile–helpless representations in the AAI (45) and insecurity in general in the AAS (56). Studies in samples of alcohol users also showed avoidant and highly insecure patterns, but higher rates of preoccupied/ambivalent attachment (67) and a relation with the anxiety dimension, too (59, 61, 63, 66). The meta-analysis of Fairbairn et al. (80) shows a close relation between attachment-based emotion regulation and cigarette smoking.

Severity of Substance Use

A comparison of studies in clinical versus nonclinical samples does not show any systematic differences in attachment patterns. Especially alcohol use, abuse, and addiction have been studied repeatedly without finding different patterns of attachment. However, results show a correlation between severity of opioid addiction and attachment insecurity. Opiate addicts in Iran were more insecure than nonaddicted opiate users (58). Severity of heroin use correlated with fearful–avoidant attachment (1, 62).

Comorbid Psychiatric Disorders

Rosenstein and Horowitz (50) report mainly dismissing classifications in adolescent substance abusers with comorbid conduct disorders but partly dismissing and partly preoccupied classifications in those with affective disorders. In a study of Schindler and Sack (64), comorbid patients with SUD and borderline personality disorder (BPD) were similar to other BPD patients in several psychiatric measures, but closer to SUD patients with regard to attachment. They were more avoidant and less preoccupied than other BPD patients. With regard to PTBS, three studies found a link between SUDs and unresolved attachment (43, 48, 49), while two other studies did not find this relation in adolescent samples (50, 51).

Age: Adolescent vs. Adult Samples

The meta-analysis by Fairbairn et al. (80) shows a closer relation between insecure attachment and substance abuse in adolescents than in adults. In AAI studies in adolescent samples, dismissing attachment seems to be the most frequent representation, while adult samples mainly showed unresolved and hostile–helpless representations. Other studies do not indicate any systematic differences between adolescent and adult samples.

DISCUSSION: IMPLICATIONS FOR RESEARCH AND TREATMENT

Insecure Attachment and SUDs

A host of cross-sectional studies consistently replicated the finding of a general link between insecure attachment and SUDs. Secure attachment is only occurring in experimental substance users and in healthy controls. Evidence from psychological studies is in tune with neurobiological findings. Longitudinal studies and meta-analyses indicate that secure attachment is a protective factor against substance abuse, and insecure attachment is a risk factor for substance abuse. Taken together, the general link between insecure attachment and SUDs today is well established, and there is moderate to strong evidence for the assumption of insecure attachment being a risk factor for SUD.

Additionally, there is moderate meta-analytic longitudinal evidence for a negative impact of substance abuse on attachment. This effect might be linked to the severity of substance abuse. The study by Unterrainer et al. (57) suggests that it might be, at least in part, an unspecific effect of neurotoxic impairments caused by substance abuse. The negative psychological effects described above might have an impact, too, but there is no direct evidence in the studies reviewed. Indirect evidence comes from parenting studies, showing that substance abusers have serious problems to provide secure attachment for their offspring (20). In the light of existing data, a vicious circle between insecure attachment and substance abuse seems likely. But we will need more longitudinal studies to gain a more detailed picture of this interaction. Studies will have to use psychological as well as neurobiological measures to control for possible confounds.

Different Patterns of Attachment

It is more difficult to summarize the results of the 37 studies analyzing attachment patterns.

Their results mainly point toward very insecure patterns (unresolved–disorganized and hostile–helpless in the AAI, fearful–avoidant in the Bartholomew model). This supports the hypothesis of substance abuse as a substitute for deficient attachment strategies. But there is some evidence for other patterns as well, with avoidant patterns occurring more frequently than preoccupied or anxious ones. We still lack longitudinal data on developmental pathways from specific patterns toward SUD. Additionally, the selection of very different samples and the use of different measures make it difficult to draw conclusions. Differences between studies using different measures suggest a methodological bias. We need studies comparing different measures in one sample to discern these effects. Nonetheless, a lot of studies report different patterns within one sample, assessed with one measure. This suggests that different patterns are linked to SUD. From an attachment theory point of view, it seems likely that individuals with different patterns of attachment use psychotropic substances for different reasons. Individuals with preoccupied attachment might use substances to minimize social fears and to make it easier to get in touch with others. Individuals with avoidant patterns might use substances to avoid feeling negative emotions, attachment needs, and loneliness. Individuals with disorganized patterns might use substances to cope with fear and posttraumatic symptoms. Future research will have to consider different and complex pathways in a longitudinal design.

Different Substances

Results from two systematic comparisons of users of different samples are inconclusive. There is some evidence for a link between heroin use and extremely insecure patterns. Although studies used different measures, all found these extremely insecure

patterns, ranging on the level of disorganization (**Figure 1**). This is in tune with the endorphin-deficit hypothesis (25), assuming that opioids might be especially attractive for highly insecure individuals. Preliminary data on alcohol abuse point to different patterns. Studies found relations with avoidant and highly insecure as well as preoccupied/ambivalent patterns. It seems possible that alcohol abuse can have different functions. It might be used to reduce social fears and support closeness seeking in preoccupied individuals. Avoidant or fearful individuals, on the other hand, might use higher doses to avoid contact and deactivate emotions. The only study exploring ecstasy (MDMA) expected a relation with preoccupied attachment but found generally insecure patterns. The "entactogenous" effect of ecstasy does not seem to be related to closeness seeking in the sense of attachment. Meta-analytic data point toward a relation between nicotine and affect–regulation in adolescence. In mainly nonclinical samples, cigarettes might be the drug of choice for those with insecure attachment and problems to regulate emotions. Research on different substances is still fragmentary. Several important substances (e.g., cocaine, benzodiazepines, methamphetamines, etc.) have not even been studied. Systematic comparisons are rare. Although it is too early to report any definite relations, there does not seem to be a general link between substance abuse and a single specific pattern of attachment. This renders future research more complex, facing a variety of substances and patterns of consumption. We will need more systematic comparisons of different groups. Studies should include neurobiological data, considering different substance-related effects.

Severity of Substance Abuse

Data on the severity of substance abuse are inconclusive, too. Whereas a comparison of samples of alcohol abusers versus addicts did not show any systematic differences, three studies report a correlation between severity of opioid addiction and attachment insecurity. This is in tune with theoretical models, and it might hint at the special role of opioids. However, we need more studies to draw conclusions.

Comorbidity

Studies have addressed depressive, anxiety, conduct, borderline, and posttraumatic disorders, but we still lack knowledge from other important fields such as psychotic or bipolar disorders. Some studies showed different attachment patterns in substance abusers with comorbid conduct versus affective disorders. Another study reported differences between borderline patients with or without SUD. Posttraumatic stress disorders are special because they are linked to the concept of unresolved attachment and because clinical SUD samples show high rates of traumatic experiences (81). However, existing data on unresolved attachment and SUD are inconclusive. We still lack systematic studies on the relations between SUD, trauma, and unresolved attachment. Results on comorbid disorders in general show their relevance and the complexity of possible interrelations between attachment, SUDs, and comorbid disorders. But it is too early to draw any specific conclusions. Future research in clinical samples will generally have to take comorbidity into account.

Age

Cross-sectional studies do not indicate any systematic differences in attachment patterns between adolescent and adult samples. The differences found in AAI studies are difficult to explain. However, meta-analytic findings of a closer relation between attachment and SUD in adolescence are more conclusive and more in tune with expectations. They underpin the importance of the developmental phase. Adolescence should be a focus of future research within a developmental framework. Because of the significance of the family background, this research will have to include a family systems perspective (**Table 2**).

Implications for Treatment

Based on the results of this review, some implications for the treatment and prevention of SUD will be discussed. We still are at an early stage, lacking an integration of attachment in a model of SUD, lacking treatment concepts, and clinical trials.

Results suggest that treatment approaches should consider insecure attachment in SUD patients. Since there seem to be different types of insecure attachment, these should be assessed and become part of individual treatment planning in the same way as information about consumed substances, level of severity, and comorbidities is used. Attachment theory stresses the therapeutic alliance as a means to develop more attachment security. However, establishing such a relationship with insecure substance abusers is difficult. It will often require specific engagement strategies, and it needs to be adapted to the individual pattern of attachment. Fowler et al. (82) found higher rates of treatment retention in addicts with preoccupied patterns. It seems to be more difficult to establish a therapeutic relationship with avoidant or unresolved individuals. Data show that substance-abusing patients with BPD are more avoidant and more difficult to reach for treatment (64).

Abstinence is a precondition for most treatments and for forming a therapeutic relationship. From an attachment point of view, abstinence means that substance abusers have to do without their usual coping strategy, leaving them without any functioning strategy. At the same time they are asked to open up to others, a subjectively dangerous step, considering negative relationship expectations. So therapists need to monitor their patients' limited ability to get and stay in touch. From this perspective, relapses and treatment dropouts can be seen as avoidance of relationships.

Attachment-based approaches of individual treatment could be adopted for the treatment of SUD. To date, the most promising approach is mentalization-based therapy (MBT) (6). MBT is fostering the ability to mentalize, that is, to explore inner states of oneself and others. Preconditions of this ability are abstinence and felt security. The problem is that substance abusers usually do not feel secure at all when they reach abstinence. MBT for SUDs then has to take careful small steps, fostering security, keeping abstinence, and slowly exploring feelings and inner worlds. An ongoing RCT is currently evaluating MBT in a sample of opioid dependent adults in Sweden (17).

TABLE 2 | Review: questions, results, and implications.

Question	Results	Level of evidence	Research implications	Treatment implications
Is there a general link between insecure attachment and SUDs?	Yes	Strong (36 studies, meta-analytic data)	Explore underlying mechanisms	Consider insecure attachment in the treatment of SUD
Is insecure attachment a risk factor for SUDs?	Yes	Moderate–strong (three longitudinal studies, meta-analytic data)	Prospective longitudinal studies to explore developmental pathways	Attachment-oriented prevention for high-risk groups
Is substance abuse a risk factor for insecure attachment?	Yes, possible confound: neurotoxicity	Moderate (meta-analytic data, one additional study)	Prospective longitudinal studies to explore developmental pathways. Consider neurotoxic impairment	Reduce harms of substance abuse, foster abstinence, prevention for children of substance abusers
Which patterns are linked to SUD?	Different patterns, mainly very insecure	Conflicting (33 cross-sectional studies, biased by use of different measures)	Prospective longitudinal studies to explore different developmental pathways and brain correlates	Consider different patterns in the treatment of SUD
Do users of different substances differ?	Hints at differences, opioid users extremely insecure	Insufficient	Systematic comparisons of users of different substances, consider substance related effects	Consider different substances in the treatment of SUD
Is severity of SUD linked to insecurity?	Inconclusive, no difference between studies in abuse vs. addiction samples, possible link in opioid abusers	Conflicting (36 studies, no systematic assessment of severity)	Systematic assessment and comparison of severity	Assess and consider severity in the treatment of SUD
What is the role of comorbid disorders?	Seem to be highly relevant, but data are inconclusive	Conflicting (seven studies)	Systematic assessment and comparison of comorbid disorders and brain correlates	Assess and consider comorbid disorders in the treatment of SUD
Are there differences in different age groups?	Closer relation in adolescence, inconclusive with regard to attachment patterns	Moderate (meta-analytic data)	Focus on adolescence, developmental processes, use family systems framework	Early intervention in adolescence, family systems approach

Longitudinal data show a bidirectional relation between insecure attachment and SUDs. This might have implications for treatment as well as prevention. It might become a vicious circle worsening both problems and a very challenging task to break this circle. Treatment has to focus on two goals that might reinforce each other in a negative or in a positive way. Quitting substance abuse will be easier when attachment security is fostered. The development of security, on the other hand, will benefit from abstinence. Gidhagen et al. (62) showed that it is possible to approach both goals successfully. They found an increase in attachment security in the course of addiction treatment.

The treatment of SUDs might help to prevent the development of even more insecure attachment. This should have a positive effect on relationships of substance abusers, including caregiving relationships with their children. Attachment-based prevention programs for children of substance-abusing parents are among the most elaborated and best evaluated approaches in the field (20). With regard to the prevention of SUDs, results suggest that fostering attachment security in childhood and adolescence might be effective. The importance of adolescence in the development of both attachment and SUD calls for early interventions designed for this age group. Among other things, this will need a family systems framework [Lewis (in this *Frontiers Research Topic)*]. Family treatments give a chance to treat attachment-related disorders in the context in which they have developed. Family therapy approaches for adolescent substance abusers are among the best evaluated treatments (83, 84). To date, there are two explicitly attachment-based approaches, attachment-based family therapy (85) and mentalization-based family therapy (MBFT) (86). Although neither of these focuses on SUDs, it seems possible to integrate attachment-focused work into family therapy approaches for SUDs (87).

Finally, attachment research has stimulated the search for new medications, pointing toward the importance of oxytocin. This substance is now considered a promising therapeutic agent for alcohol use disorders (88).

Strengths and Limitations

This review has tried to give a concise overview over 30 years of research in the field. Since 2005, the number of studies has tripled, providing strong evidence for the general link between attachment and SUD. Meta-analytic and longitudinal evidence shows the interaction between attachment and SUD. Although results are still inconclusive in many regards, they indicate the need to differentiate between different patterns of attachment, different substances, comorbidities, and age groups. Results show the potential relevance of attachment within a multifactorial model of SUDs. But there will still be a lot of theoretical and empirical work to be done to integrate it into a concise model. Methodological problems in the assessment of attachment and substance abuse limit comparability. There is a tendency in many studies to focus on attachment as a single variable and to disregard its context and possible confounds. Future research will have to compare different groups of substance abusers systematically, including

severity of substance use and comorbid disorders, linking psychological and neurobiological measures. We will need more longitudinal studies covering longer periods of time to completely understand the developmental pathways from attachment to SUDs. This review has not considered family systems of substance abusers or preventive aspects for children of substance-abusing parents. We will have to move to the level of systems and integrate family contexts into the study of attachment, linking attachment representations with relationship behavior and substance abuse.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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Conflict of Interest: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychology

HYPOTHESIS AND THEORY
published: 17 October 2019
doi: 10.3389/fpsyg.2019.02318

Affective Features Underlying Depression in Addiction: Understanding What It Feels Like

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Addiction poses a complex challenge in spite of all the progress made toward understanding and treating it. A multidisciplinary approach is needed and this paper attempts to integrate relevant neurobiological, behavioral, and subjective data under a common denominator described as a latent type of depression. It is called latent because it remains a silent syndrome due to two main reasons. The first one relates to the natural use of defenses against a predominant effect of chronic subjective pain, which arises from an ambivalent type of separation distress that compromises opioid regulation (PANIC system). Furthermore, it provokes a neurochemical cascade that impacts several neuromodulatory systems. The second reason is that such chronic subjective pain usually exhausts the natural defensive system, frequently leading the person to look for other resources such as the neurochemical manipulation of psychic pain. Thus, both the use of defenses and of psychotoxic drugs make the underlying depression hard to assess, even for the very person suffering from it. The causes, course and treatment of this type of affective configuration are discussed in this paper as an attempt to explain some of the difficulties so far encountered and to contribute to potential alternative lines of treatment.

Keywords: addiction, depression, affect, defense, subjective pain

OPEN ACCESS

Edited by:
Human Friedrich Unterrainer, University of Vienna, Austria

Reviewed by:
Gerald Wiest, Medical University of Vienna, Austria
Kenneth L. Davis, Pegasus International, Inc., United States

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Specialty section:
This article was submitted to Psychoanalysis and Neuropsychoanalysis, a section of the journal Frontiers in Psychology

Received: *17 June 2019*
Accepted: *27 September 2019*
Published: *17 October 2019*

Citation:
Flores Mosri D (2019) Affective Features Underlying Depression in Addiction: Understanding What It Feels Like. Front. Psychol. 10:2318. doi: 10.3389/fpsyg.2019.02318

INTRODUCTION

There are many valuable approaches to understand addiction. Different perspectives explain its psychiatric, social, medical, historical, and psychological aspects. Addiction is about a behavior that goes beyond control. Neurobiological models explain craving, tolerance, withdrawal syndromes, kindling and its chronic relapsing vulnerability. Yet, seldom do they take into account the subjective states associated with the different stages of addiction. Addiction feels like something; affect should be used as a bridge concept to attempt an integration of some of the findings coming from different perspectives. Affect is felt subjectively and it can also be studied from a neurobiological point of view. It provides meanings that guide behaviors and thoughts. Emotions favor survival (Panksepp, 1998) and their regulation is compromised in addiction. This paper suggests the

Abbreviations: ACC, anterior cingulate cortex; BNST, bed nucleus of the stria terminalis; CRF, corticotropin-releasing factor; EOS, endogenous opioid system; HPA, hypothalamic-pituitary-adrenal axis; KOR, kappa opioid receptor; LTD, long term depression; LTP, long term potentiation; NAcc, nucleus accumbens; PAG, periaqueductal gray; PFC, prefrontal cortex; VTA, ventral tegmental area.

hypothesis that depression constitutes a key emotional configuration that can contribute to the initial voluntary decision of a person to use drugs. Some of those depressions may be apparently asymptomatic and thus remain undiagnosed. In general terms, if they do not meet clinical criteria (e.g., DSM or ICD), they do not exist. A psychodynamic exploration of a person's emotional life can contribute to an early detection of problems that can later become clinical syndromes. The earlier they can be worked with, the fewer risks for the person. From a psychoanalytic point of view, these depressions can be called "latent." If they are felt, there are neurobiological correlates that should be used to better understand them.

This latent type of depression is proposed to exist prior to addiction and to contribute to its etiology. It relates to early experiences of ambivalence with the primary caretaker that lead to chronic separation distress. This paper will not use clinical materials to illustrate its hypotheses; the reader can find examples in the literature (e.g., Fine, 1972; Gustafson, 1976; Johnson, 2009, 2010; Flores Mosri, 2017a). Only a few examples will be used to illustrate some of the hypotheses and theory described throughout the paper. I suggest that ambivalent affective experiences with the primary caregiving object may result in neurochemical and subjective dysregulations that could contribute to help explain the use of psychotoxic drugs and its implicated behaviors. Such dysregulations work in cascades in which one dysregulation leads to another connection within a spiral loop that relates to depressive feelings. Some alternative aspects for treatment will be briefly discussed.

THE IMPELLING NEED OF AN INTEGRATIVE APPROACH AND ITS CAVEATS

Addiction is a complex topic. It has been studied from different perspectives resulting in a plethora of knowledge that has been helpful to design different lines of treatment. Yet, it still constitutes a major health problem. It is a disease that poses challenges and questions that can hardly be answered from one perspective. Addictive disorders can be studied from behavioral, psychiatric, social, anthropological, and neurobiological perspectives amongst others. If such an endeavor is done separately, the result is that the topic of study is split and thus only partially understood. An integrative approach attempts to bring together as many findings as possible. This challenge comes with enormous methodological difficulties. Epistemologically, the different viewpoints may seem separate and impossible to bring together. As much as that may seem reasonable, the loss in such a position is to give up on potential dialogs between disciplines. If addiction was only a behavioral, neurobiological, or psychiatric disease, then it would be appropriate to stay faithful to each of the discipline's methods. This paper attempts a dialectical perspective by highlighting the most commonly neglected aspect of addiction, which is its subjective experience. Its neglect does not seem casual. It is about the most difficult part to study, precisely because subjectivity is not an object, but an experience, referred to by Solms and Turnbull (2002, 2011) as the first-person perspective that should accompany third-person perspectives when it comes to understanding the mind. Describing subjective aspects can be difficult and not generalizable, but patients suffering from addictive disorders are people who experience and feel through the whole process, ranging from the premorbid stages to the morbid and deadly ones. Partial understandings may contribute to more people losing their lives. Studying addiction separately strengthens scientific coherence, but if that knowledge is not brought together at some point, it also flaws its comprehension and suggested treatments.

Hence, this paper attempts to present a potential dialog between disciplines that study addiction. It is a disease that affects behavior, brain, body, and mind. All of these components have an effect on one another. I take a dual-aspect monist position (Solms and Turnbull, 2002, 2011; Panksepp and Solms, 2011). The mind needs the brain to exist. Panksepp (2011a) proposed the term "BrainMind" or "MindBrain" to emphasize that mental processes or internal experiences are linked to neural dynamics. Such a position allows for improved understanding of behaviors and their motivations from a monistic perspective, that acknowledges that the brain is a feeling organ and the seat of the mind. Studying addiction is a good example of the latter. It is seen in behaviors that relate to neurochemical circuits whose modifications produce feelings. Panksepp (1998) devoted his life to the study of affective neuroscience. He claimed that all mammalian organisms share subcortical basic emotion circuits that guide instinctual behaviors. He distinguished systems and capitalized their names to highlight that words that can be used in a colloquial way, in the context of affective neuroscience, mean the activation of a specific neural network that relates to affective feelings and specific behaviors. He named those seven circuits, the SEEKING, PANIC/GRIEF, RAGE, FEAR, LUST, CARE, and PLAY systems. These words are used in that same way throughout this paper and I will explain their features in more detail when necessary for the purposes of this manuscript. All of them aim at enhancing the chance to survive. For a thorough description of each circuit, the reader is referred to Panksepp's (1998) book *Affective Neuroscience*. Since this paper is about the subjective experience of addicted people, the correct understanding of these neurobiological circuits is crucial.

This paper focuses on three different categories to study addiction: the behavioral, the neurobiological, and the subjective. The challenge is to try to integrate indicators that belong to different levels of analysis. This paper represents only an attempt to propose hypotheses that respond to the many people suffering and dying from addictive disorders. We can no longer ignore the neurobiological and subjective aspects that display in their pathological behaviors. They all relate to one another and the least we can do is to try to suggest some hypotheses to be further researched.

The Stages of Addiction and the Importance of Subjectivity

Addictive behaviors usually start with the voluntary decision to use a drug (Panksepp et al., 2002; Volkow and Morales, 2015).

For the drug to be reinforcing, it must change a subjective state quickly, so that a direct association is established between the consumption of the drug and mood modifications. An emotional memory will be formed and reinforced as long as the effects of the drug either produce a positive feeling or reduce a negative feeling. Adding genetic, developmental and environmental vulnerabilities, a person who has tried drugs may or may not develop an addictive disorder (see **Figure 1**). Drugs of abuse increase the release of mesolimbic dopamine involving the VTA and the NAcc pathway. This initial phase of trying the effects of a psychotoxic drug may be followed by repeated and frequent use that may eventually lead to a gradual urge to use the drug, which slowly results in an involuntary decision guided by regulatory brain modifications. Despite other factors being present, the frequent repetition of the consumption of a drug of abuse can be enough to modify the VTA-NAcc pathway and to produce a chronic acquired brain disease (Volkow et al., 2016). At this stage, an addictive disorder can be diagnosed, characterized by a psychological and/or neurobiological dependence. Addicted people will prioritize the drug consumption over other rewarding behaviors, stimulating the mesolimbic dopamine pathway even to the point of death (Olds, 1977; Panksepp et al., 2002).

According to Volkow et al. (2016), three stages of addiction can be distinguished: (1) binge and intoxication, (2) withdrawal and negative affect, and (3) preoccupation and anticipation. The stage of binge and intoxication is characterized by an increase in dopaminergic activity; all addictive drugs increase the release of dopamine which has been interpreted as a reward signal linked to associative learning. Dopamine is released to anticipate a response which eventually strengthens synaptic connections, leading to LTP and LTD, involving glutamatergic activity (Wright and Panksepp, 2012). The course then goes from experimentation with drugs to addiction, which implies progressive neuroadaptations in the brain, i.e., an acquired disease of the brain (Volkow and Koob, 2015). Conditioning leads to sensitized learning and memory formation recruiting the VTA and the NAcc, which establishes habits and routines along with the dorsal striatum. Other key structures that regulate dopaminergic activity include the amygdala and the hippocampus (Wright and Panksepp, 2012). The mesolimbic dopamine pathway is modified by the repeated use of drugs resulting in craving, which will motivate the patient to look for the drug and to use it. The brain is gradually changing and getting ill. Addiction weakens brain regions involved in executive functions, such as decision making, inhibitory control, and self-regulation. This prefrontal function impairment contributes to repeated relapse. The patient's will is compromised (Johnson, 2013) and there is loss of self-control. From the subjective perspective, the users experiencing those modifications do their best to try to explain these new feelings to themselves. They initially try to deny the loss of self-control. They frequently state that they can quit using drugs whenever they want to. But they also clarify that they do not want to stop. This type of sentence is a clinical indicator that the patient has lost control and that the dopamine mesolimbic system may have suffered neuroadaptive modifications. As seen in Olds (1977) findings, the users' predominant goal becomes to stimulate this pathway. Negative consequences of drug abuse will be ignored and previous interests will be left behind. Dopamine release in addictive disorders starts to feel bad when it gives the experience of a positive expectancy of satisfaction that never actually comes (Panksepp et al., 2002). The prediction never meets real sensory input and satisfaction (Schultz, 2006, 2016). Dopaminergic neurons keep firing due to the effects of drugs. This constitutes a pathological activity that means that the drug in itself is not rewarding.

Hence, the constant firing of dopamine does not mean pleasure and object-finding; it means expectation of finding satisfaction. Dopamine release then turns into a frustrating experience, yet users continue their neurochemical stimulation. From Panksepp's view of a SEEKING system, only the actual finding and consumption of the satisfying object stops dopaminergic release in the mesolimbic dopamine pathway (Panksepp, 1998; Schultz, 2002), meaning that dopamine firing will only stop when the object is being consumed. Then a different pathway is activated, a "liking" system (Berridge et al., 2009) that is different from a "wanting" dopaminergic system. The satisfaction is related to the activity of several neurochemicals, including increases in opioid activity (Panksepp et al., 2002; Burgdorf and Panksepp, 2006). The illusion experienced in addiction means that as long as dopaminergic neurons keep firing, the mu and delta opioid receptor activity related to satisfaction is not active. Thus, addicted patients only experience the expectation of a positive feeling, but not the pleasure of actually finding a satisfying object. Addiction is a frustrating and failed illusion. The more frustration the user experiences, the less dopaminergic activity their brain shows. Neurobiologically, the dopamine system is downregulated resulting in feelings of hopelessness (Watt and Panksepp, 2009). It now has neuroadaptations that compromise its capability to fire in search of a motivated exploration of its environment.

To sum up, the first stage of addiction involves the experience of intoxication, which, if repeated, will in turn lead to a decrease in the ability to feel motivation and pleasure. The neuroplastic changes imply an increased release of glutamate that impacts the NAcc, the dorsal striatum, the amygdala, the hippocampus, and the PFC. All these structures regulate dopamine firing. Because the dopamine pathway has been modified, the user's motivational feelings and behaviors will be compromised (see **Figure 2**).

The second stage for Volkow is withdrawal and negative affect. This model states that regular rewards lose their former motivational power, due to the downregulation of the dopamine mesolimbic pathway. At the same time, there is also a hyperactive impact on the extended amygdala circuitry that produces negative affects related to withdrawal. Users will try to avoid these negative feelings, constituting a new type of negative reinforcements. They now have a powerful reason to repeat drug use, which is to alleviate from withdrawal symptoms. Anxiety and stress are predominant feelings during this stage and they can in turn lead to irritability and aggression. Several alterations in the regulation of the HPA are observed (Volkow et al., 2016), enhancing the release of CRF. Volkow and Morales (2015) have called the allostatic changes that lead to the use of drugs to try and alleviate withdrawal symptoms, the "dark side of addiction." They implicate the amygdala, the BNST and the

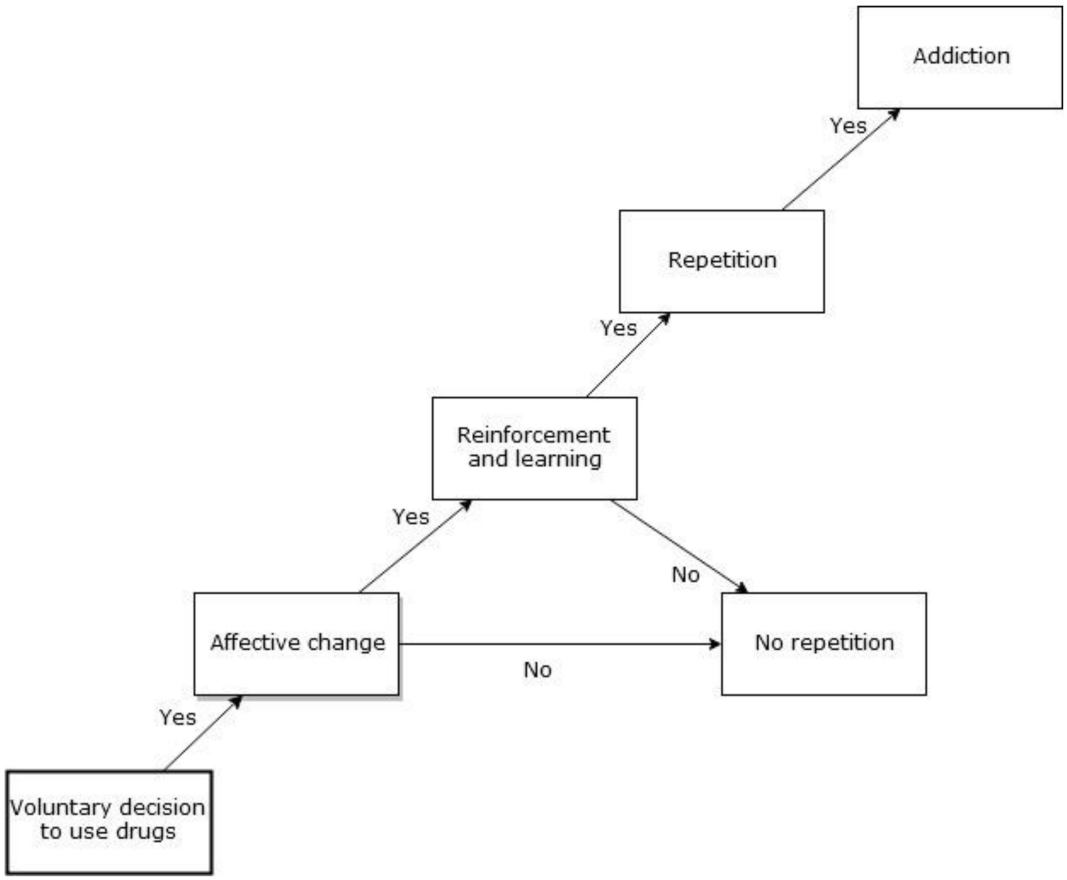

FIGURE 1 | From initial drug use to addiction. The figure describes how an initial voluntary decision to use drugs can lead to addiction, particularly when an affective change is reinforced and learned.

NAcc shell. There is also an upregulation of dynorphins linked to the dysphoric feelings that characterize this stage. Furthermore, neurochemicals related to positive emotions, such as enkephalins and endocannabinoids, are downregulated. The lateral habenula is also impacted by the use of drugs since it is another regulator of dopamine firing. It is active when positive expectations fail to happen, as well as in the presence of aversive stimuli.

To summarize, this stage recruits what has also been called the "antireward" system (Volkow and Morales, 2015). It implies an enhanced reactivity to stress which yields negative emotions when the drug is withdrawn. These dysphoric feelings result in an intense motivation to escape the discomfort, which the drug can help mitigate by a renewed increase of dopamine release. Yet, since the dopamine release gradually diminishes, the relieving feelings are also gradually less effective, leading users to increase doses and frequencies of drug consumption. They binge, which in turn deepens the dysphoria during withdrawal. Users are more prone to overdose at this stage (see **Figure 3**).

Withdrawal symptoms worsen previous stressful feelings, favoring some of the features of the third stage proposed by Volkow, preoccupation and anticipation. This stage emphasizes the compromise of the PFC, which impairs self-regulation and other executive functions. The PFC inhibits and regulates behavior (Anderson et al., 2016). In addiction the user can no longer make the decision to stop. This known progress of addictive disorders enhances the importance of detecting negative affects that can lead to the initial voluntary decision of using drugs, since this stage means that treating users will represent a complex challenge. Functions such as attribution of salience, decision making, planning, and monitoring of actions are modified. The top-down regulation of emotional circuits is compromised leading to an inability to resist the urge to use drugs (see **Figure 4**).

Addiction Feels Like Something: The Contributions of Ambivalent Separation Distress and Latent Depression

As seen before, the various stages of addiction add up and result in a compulsive cycle that is difficult to interrupt. Users face complex consequences of drug use and are somehow expected to reflect on the negative outcome and be able to stop. Giving information to prevent the use of drugs is useful and responsible, but not enough. The latter can partially be explained by acknowledging that it is not an illness related to thinking and stopping. Addiction is an illness related to emotional states. Users

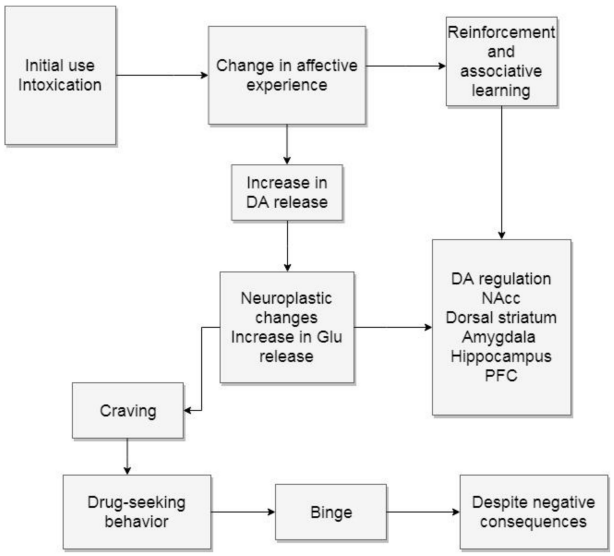

FIGURE 2 | Binge and intoxication. The diagram describes how initial drug use can cause neuroplastic changes. DA, dopamine; Glu, glutamate; NAcc, nucleus accumbens; PFC, prefrontal cortex.

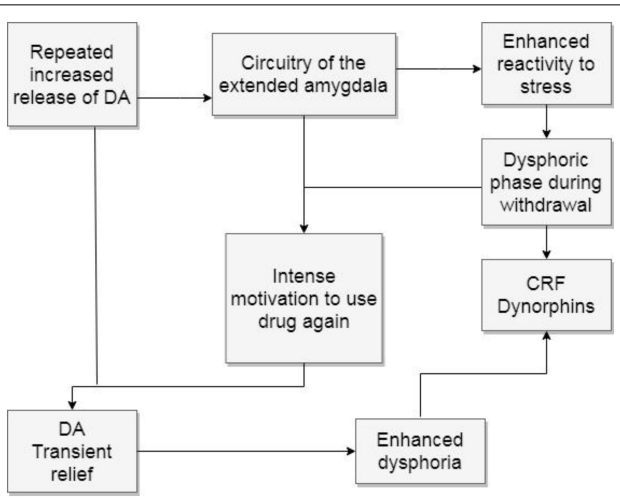

FIGURE 3 | Withdrawal and negative affect. The figure shows how the repeated increase of dopamine release causes a hyperreactivity to stress by recruiting the circuitry of the extended amygdala. The attempt to escape dysphoric feelings increases the motivation to use drugs again, deepening dysphoric feelings. DA, dopamine; CRF, corticotropic releasing factor.

try to change the way they feel through using exogenous agents that have an impact on their neurochemical emotional pathways, hence the importance of affective neuroscience. What starts and reinforces addictive behaviors is the subjective experience associated to the comparison of an initial affective state against the modified state derived from using a drug. Thus, what happens in both states should be studied which is the topic in this section.

Addiction is a multi-caused illness that cannot be prevented or solved with simple actions. Wurmser (1974) applied Freud's idea

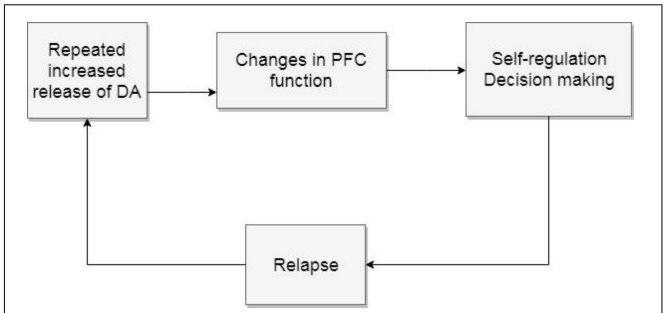

FIGURE 4 | Preoccupation and anticipation. The repeated increase of mesolimbic dopamine release changes the PFC functions, particularly self-regulation which leads to relapse to start the cycle again. DA, dopamine; PFC, prefrontal cortex.

of complementary series to highlight that addiction is caused by several factors. He suggested the existence of a precondition, i.e., a narcissistic injury, that is present before the onset of compulsive drug use, but that is not sufficient to explain it. Next, there is a specific cause, which is present in all cases but not enough to cause the disorder, unless the precondition is there too. Wurmser saw the specific cause in an emotional reason derived from a narcissistic conflict, whose related affects are anxiety, depression, disillusionment, and rage. Since they are all negative affects, there is a need to escape from experiencing them. The third set of reasons can be referred to as concurrent, which operate alongside the specific causes and preconditions, but they are not sufficient on their own to originate the syndrome and they are not present in every case. Examples of these factors may be seen in socio-cultural uses of drugs, philosophical questions and protest. The fourth type is the precipitating cause. It refers to the factor preceding the beginning of the disease, e.g., the availability of the drug.

This hierarchy of causes indicates that the vulnerability to addiction depends on a combination of components that explains why some users try drugs and do not become addicted, and why some others will. Research shows that genetic factors also play a role in the vulnerability to addiction (Kreek et al., 2005; Bierut, 2011), but cannot explain the initiation of drug use alone. An epigenetic perspective seems more appropriate and recruits other components.

To understand addiction, it is important to consider that behaviors have different sources of motivation. Subjective affective experiences guide actions. In Panksepp's view, there is a basic SEEKING system that explores the environment in search of resources to survive. But SEEKING does not have an object. Other systems inform it of what it should look for, e.g., water when thirsty, food when hungry, a caretaker when lonely and helpless. Thus, reinforcements and conditionings are mediated by an affective experience that helps organisms to learn from experience and use memory to build expectations. The SEEKING system depends on specific neurochemicals and neuroanatomy. This is why it is important to study behaviors, such as addiction; its motivational and neurobiological aspects should also be taken into account.

In terms of using drugs, I hypothesize that depressive feelings contribute to initial consumptions. If the behavior is repeated, then these initial depressive feelings are enhanced with a neurochemically induced addictive cascade. To explain this proposal, I will describe two phases. The first one characterizes a latent type of depression that would constitute a precondition of addiction, meaning that it has its origins in developmental factors that will constitute in a *pre-addictive* phase. The second phase derives from repeated drug use by causing a deep neurochemical dysregulation that takes the form of anxiety and depressive feelings in an *addictive* phase. The initial depressive feelings merge with those provoked by drug use, intensifying the negative affective experience that users describe.

As important caveats, the reader is reminded that individual drugs produce different neurochemical and subjective effects (e.g., stimulant, depressant, psychedelic, or pleasurable effects). Still, drugs of abuse share common mechanisms that explain addiction in general (Robinson and Berridge, 1993). The differences between types of drugs are beyond the scope of this manuscript. Another important reminder is that the following contents constitute only hypotheses that require further research. They derive from available data in the literature and are complemented by clinical observations that can be found in any case study previously published. The main hypothesis is that, additional to the various factors that contribute to the onset of addiction, depression plays an important, but not sole, role in the causation of addiction.

Pre-addictive Phase: Depression as a Precondition of Addiction

When individuals make the voluntary decision to try drugs, they frequently relate their decision to curiosity or recreational purposes. Some other intentions can be relevant and inaccessible to conscious awareness. Not all users become addicted, but they are all modifying affective states through the use of psychotoxic drugs. At this stage, repeated use means that the person wants to modify an emotional state again, despite the awareness that it damages the body and that it can result in both psychological and physiological dependence. To explain this paradoxical behavior, Freud (1898) suggested that addiction could be interpreted as compulsive masturbation, meaning that users were in a compelling search of pleasure. His hypothesis makes sense when users express that they want to use a drug for recreational purposes. The question is, if a person feels good, why would they need to feel better? On the other hand, there are hypotheses that state that drug users are trying to alleviate from negative emotions (Loose, 1998). As said before, behaviors cannot be understood without considering their motivations. In either case, the principle that underlies both hypotheses is that the user is aware that feelings can be modified by using drugs. An associative learning is established. Emotional states depend on neurochemical features that can be changed by introducing exogenous molecules into the body. Users become "wild" psychiatrists. The principles they are using correspond to those of psychopharmacology.

Thus, some users will find it hard to stop using drugs whenever they need to modify their emotions. As discussed before, repeated use will eventually lead to neuroplastic changes that contribute to a chronic brain disease (Volkow and Morales, 2015). Once the brain is modified, it needs the drug, becoming a slave of its own defense, i.e., while trying to feel better, it becomes ill. The latter constitutes the addictive paradox.

Users of psychotoxic drugs usually share an initial negative affective state and they try to self-medicate (Khantzian, 1985, 2003) with or without conscious awareness of it. Negative feelings indicate that action is required to solve a problem or an unmet need (Panksepp, 1998; Solms, 2018, 2019). If a solution is not available, the negative feelings persist and defenses are then used to relieve the unpleasant feelings at least partially. Yet, the unpleasant affect is there to drive the person into some sort of action that can look for a satisfying object (Damasio, 2010; Panksepp, 2010; Solms, 2019). No defense will be able to fully relieve the person from their negative feelings until a specific action (Freud, 1895/1950) is taken to meet a homeostatic need. Defenses will expire if the person does not find a way to finish with the tension that arises from unmet needs. Suffering may become a chronic, negative emotional state characterized by frustration, which may in turn cause anger, anxiety, stress and hopelessness. This affective configuration summarizes depression. Defenses, particularly manic ones, render the depressive affect into a discreet but constant feeling. This is why this type of depression is called latent.

Metapsychological analyses state that depression starts with the experience of loss (Freud, 1915/1917). The normal process of mourning becomes pathological when there is a narcissistic type of object which is characterized by ambivalent feelings toward the lost object. There is guilt related to aggressive feelings toward the object that explain self-aggressive behaviors and that isolate the person from the outside world. Freud suggested that suicide can be interpreted as a wish to kill the object.

The narcissistic aspect of depression has been studied by several psychoanalytic theories. Balint (1968) related it to the concept of a basic fault that expressed the discrepancy between what a child needs and what the environment can provide. Marty (1990) also spoke of important failures in early maternal care as the origins of essential depression. This type of experience favors the splitting mechanisms of object representation described by Klein (1946), Fairbairn (1954), and Kernberg (1975). Bergeret (1974) described an anaclitic type of object relation in which a contradictory dependence is experienced, particularly in borderline states. Anaclitism implies the need for an object that is rejected as soon as it is near. When the object is away, it is desired back only to be rejected again. Marty (1958) called this type of object relation allergic, expressing that same paradox. Bergeret (1974, 1975) suggested that the origins of this type of anaclitism come from a narcissistic disease in which parents show emphatic ambivalent feelings for their children. Parents promise to love their children only under the condition of staying close to them. In this model, the children are not loved unconditionally; parents make them feel that they have not been loved because they have not been good enough, which in turn leads to ego ideal pathology. Children feel as though they had lost their parents' love due to not being good enough. I have suggested a paradoxical mourning process for this context (Flores Mosri, 2017a,b) in

which children are trying to mourn for a lost object that they never actually had, thus, it could not be lost. An impossible mourning process guarantees a melancholic process that becomes chronically painful.

Ambivalent feelings from parents to children are also described by Kalina (1997, 2000) who states that addicted individuals are raised in environments of contradictory messages given by the parents, who tend to be narcissistic and depressive. These circumstances lead to inconsistent feelings that compromise an experience of basic trust (Erikson, 1950). The latter psychodynamic proposals come basically from clinical observations by many authors (e.g., Ferenczi, 1949). Psychoanalytic descriptions may result exhausting or too abstract to be taken into account in other clinical or research contexts. Yet, their accounts are important because they examine subjective experience in depth. A change from the exploration of unconscious fantasies to the effects of real experiences in psychoanalysis was emphasized in Bowlby's (1988) work. He highlighted the importance of an early and consistent attachment relationship upon which a child's future adapting mechanisms depend. These facts take us back to the PANIC/GRIEF system proposed by Panksepp (1998).

From an affective neuroscience perspective, the condition of helplessness of young mammalian organisms is the key to having a PANIC/GRIEF system (Panksepp and Biven, 2012), which relates to Bowlby's attachment system. Babies need to be taken care of or they die. Survival entails SEEKING for homeostasis through a primary caretaking figure. The mother is the person best suited for the role, as hormones and a CARE system are the perfect match to a baby's PANIC needs. Separation feels bad because it leaves the helpless baby exposed to various dangers that make them call for a reunion with the primary caretaker. The separation distress circuit runs from the dorsal PAG to the ACC. PANIC is felt as a subjective form of pain derived from a need for the object. The child's instinct makes them feel lonely and sad, thus they protest by using separation calls that intend to get the caretaker's attention. If the caring person is able to reunite with their child, the PANIC activation stops and with it the psychic pain that was suffered. If such an ideal context does not happen, PANIC activations will occur more often or even chronically. This can be the circumstances of ambivalent and inconsistent caretakers.

If affect is ambivalent and obscure, there is little chance of succeeding at problem resolution in the future. Instincts favor survival (Panksepp, 2011a) and children will try numerous times to meet their needs. If they receive little or faulty assistance from their primary caretaking figures, not only can they not learn, but they will also experience PANIC activations. They feel insecure, frustrated and lonely, which will eventually lead to sadness and probably to despair. All of these feelings entail KOR activation and dynorphin activity. This in turn diminishes dopamine activity in the SEEKING system, which is behaviorally seen as a lack of motivation and energy to look for a way to solve problems. This first cascade effect is enough to constitute a depressive affect (Watt and Panksepp, 2009; Panksepp, 2010; Panksepp and Watt, 2011). Separation distress may become a persistent low activation and feeling of PANIC/GRIEF. Looking for a caretaker may also become chronic and may downregulate other social instincts (Panksepp et al., 2014) such as those involved with having fun with others (PLAY), of having a love partner (LUST) and even taking care of others (CARE). Protracted unsatisfied needs also cause hyper-reactivity of the HPA axis and the amygdala, which entails an increased release of CRF and various corticosteroids (LeDoux, 1996; Watt, 2017). Anxiety and stress highly contribute to the search of psychotoxic agents (Volkow et al., 2017). Because of the massive and diverse array of negative feelings it recruits, depression constitutes a part of the vulnerability toward addiction.

Relating the findings of affective neuroscience in terms of emotional experience, it can be summarized that low activity of dopamine in the mesolimbic pathway results in a depressive feeling characterized by apathy and hopelessness; the expectation that a chronic state of separation distress will ever be solved diminishes. Yet, people who experience ambivalent attachment feel separation distress and call for a caring object that they cannot rely on. This leads to psychoanalytic descriptions of anger in depressed people (Abraham, 1911; Freud, 1915/1917; Wurmser, 1974; Dodes, 1990). As explained by Freud, in depression the object is introjected and aggression is turned against it, hence it is addressed against the self. Some addicted patients have expressed in abstinence that they needed their parents to know that they had not been good enough. It is basically anger against the narcissistic rejection that makes people feel unworthy (Freud, 1914).

Thus, two indicators of depression can be extracted from psychoanalytic contributions. The first one is a depressive affect experienced as hopelessness, sadness, and guilt. The second one is related to self-aggressive behaviors. These indicators should be searched for in future predictive studies of the vulnerability to addiction. The negative effects can hide behind the use of multiple defense mechanisms, particularly manic defenses. Thus, a proper psychodynamic exploration may be needed to distinguish them. In terms of self-aggressive behaviors, they manifest and are reliable indicators: people are willing to engage in self-damaging conducts. A higher risk of using drugs can be predicted in these people.

In sum, when depression is acknowledged, it is possible to understand why these patients feel curious to try drugs. Addicted patients frequently find themselves with a lack of resources to solve their problems. They developed inefficient templates to attempt to meet their needs and these patterns do not seem to learn from experience. These templates represent major prediction errors (Friston, 2010; Solms and Friston, 2018) since they keep failing, and cannot take into account prior and posterior evidence to modify the way to interact in the world. A negative affective subjective experience is then predominant.

Addictive Phase: The Subjective Experience of the Stages of Addiction

Drug users do not want to feel bad and the addictive process ensures that they will feel progressively worse. Some psychodynamically oriented clinicians may think of the repetition compulsion and the death drive because there is little opposition from users to engage in self-aggressive and

self-damaging behaviors, including addiction. Some of them are not aware that there are important brain modifications that explain much of what is seen in addictive disorders. The latter guarantees that wrong treatment strategies will be used.

Addictive drugs are tempting and seductive. They help the subjective sensation, but they certainly solve no need. After the intoxication stage finishes, the negative feelings are back, usually adding a new source of frustration related to the loss of a better affective state, additional to withdrawal symptoms. From a psychological perspective, the user is motivated to repeat the search of drugs in order to achieve psychotoxic relieving and/or pleasurable effects. Repetitive drug use eventually leads to brain modifications (Volkow et al., 2016) that can hypersensitize (Robinson and Berridge, 1993; Berridge et al., 2009) an incentive and motivational system ("wanting" system), also known as the "reward" system after the self-stimulation observations by Olds and Milner (1954), and renamed and enhanced in Panksepp's basic emotion systems as a SEEKING system (Panksepp, 1998; Panksepp and Biven, 2012). As explained before, dopamine is a key neuromodulator of this mesolimbic pathway (Panksepp et al., 2002; Panksepp, 2011a).

Multiple interpretations regarding the role of this circuit have been made and it is important to review them to try to understand the subjective feeling of using a drug during the morbid phase of addiction. The predominant view states that the mesolimbic dopamine pathway is "the reward pathway" and is thus involved in addictive behaviors (Volkow and Morales, 2015). From this perspective, the hypothesis that drug users look for pleasure makes sense, since they would be looking for a reward. However, recent findings suggest that this pathway is not related to rewards, but to the search for rewards (Panksepp, 1998; Schultz, 2002; Volkow and Morales, 2015). For Panksepp, it is one of the seven basic emotion systems that constitute mammalian instincts oriented toward survival. SEEKING produces emotions during its activation. It gives feelings of excitement and positive expectation (Wright and Panksepp, 2012). It can then be inferred that addicted people are looking for a positive feeling of motivation toward life. Psychostimulants, such as cocaine and amphetamines, directly activate the dopamine mesolimbic pathway. Users report that they feel excited about the plans they make during intoxication, that they feel hopeful.

Specifically addressing the separation distress feelings, the EOS also plays a part in addiction. Drugs such as stimulants, opiates, cannabis, and alcohol increase opioid activity in the NAcc and the VTA (referred in Volkow and Morales, 2015). These drugs can stimulate the "liking" system (Berridge et al., 2009), causing pleasure. However, their role in addiction may also be explained when it is understood that the subjective pain derived from separation distress involves dynorphin release (Panksepp and Biven, 2012), which in turn inhibits dopaminergic activity in the VTA and the NAcc. Withdrawal symptoms increase KOR activity, hence decreasing dopamine release, which in turn worsens the depressive symptoms previously described, along with an enhanced activity of CRF, which also plays an important role in depression (Watt and Panksepp, 2009). All of these components contribute to a depressive shutdown that users may try to decrease by using drugs that diminish the feeling of depending on others, as described in anaclitic relationships. Many drug users aim at social self-sufficiency. They would prefer not to need others because, in their experience, they are not reliable and they hurt. They would not like to risk an unpredictable outcome by relating to others. The use of drugs that have an effect on the EOS can be particularly efficient to achieve this goal; it brings a feeling of not needing anyone (Johnson and Faraone, 2013; Johnson and Flores Mosri, 2016). Opioids coincidentally have powerful antidepressant effects (Panksepp, 2015; Yovell et al., 2016).

Adding to the depressive cascade, Watt (2017) has suggested that CRF plays an important role in separation distress. Furthermore, it can be related to stressful experiences starting early in life due to diverse types of trauma, which in turn lead to permanent alterations of the HPA axis and thus, a chronic upregulation of CRF (Heim and Nemeroff, 1999). Watt and Panksepp (2009) stated that anything that restores the homeostatic regulation of the HPA axis has therapeutic effects on depressive symptoms. This constitutes another reason to hypothesize that addictive behaviors comprise an attempt to alleviate depression and also anxiety.

Therefore, as much as addicted people may seem to be in a slow process of committing suicide, they are also fighting against depression. They use drugs to alleviate from negative feelings derived from separation distress while they also try to experience motivation. Yet, as already described, drugs overstimulate dopamine mechanisms (Volkow and Morales, 2015; Schultz, 2016) impeding the search for other satisfying objects that could eventually lead to authentic rewards that enhance opportunities to adapt and feel well. Addicted patients are trying to live while they are killing themselves. They live in a paradox and harm their own body and, thus, may die while trying to survive. They dissociate their body and their mind (Kalina, 1997, 2000). They act as though they could survive in spite of the damage and deterioration of their organism.

In sum, the neurochemical features related to depression entail a complex cascade that interacts with the effects of drugs in the basic emotion systems. The "premorbid" conditions only worsen as a result and enhance depressive feelings. Addiction is an illegitimate resource to try to solve problems. It promises to stop depressive feelings, but not only does it not deliver, it will also make the initial situation worse. Addiction is a failed attempt at surviving. Addicted people usually refuse to ask for legitimate help and they find it hard to accept it when they can have it. Addiction has hijacked the mind.

Treatment

Treating patients who suffer from addiction is a challenging endeavor. Most models are integrative and well planned but the nature of addiction itself poses all sorts of impediments. This is one of the reasons why there is an impelling need to complement existent models and to improve our understanding of addiction. As highlighted throughout this manuscript, its causes represent various dimensions that interact in complex ways, motivating clinicians and researchers to deepen our comprehension of its features.

Understanding the subjective experience of patients represents a chance to prevent and treat factors that may remain neglected. The hypothesis of a latent depression underlying addictive disorders entails the need for identifying features that may remain too "silent" to be taken into account. The need of metapsychological assessments is thus highlighted. Because of their own nature, latent or essential depressions (Marty, 1966, 1990) may seem asymptomatic syndromes and thus, tend to remain untreated. If they are better understood and diagnosed, more people may have the chance to be treated in terms of the clear vulnerability to addiction that it represents. People who experience a depressive cascade are more likely to try to regulate their neurochemical functioning because they feel bad. They will lose self-regulation and self-inhibition which will in turn make the addictive disease increasingly harder to treat.

Life implies that a perfect homeostatic state is never met, but is always searched for. Panksepp stated that affects are always conscious because they are felt (Panksepp and Biven, 2012) constituting a basic kind of subcortical affective consciousness (Panksepp, 2011b; Solms and Panksepp, 2012; Solms, 2013, 2019) that guides behavior at all times. SEEKING of satisfying objects is mediated by dopamine and it is the same pathway that addiction recruits. Hence, addiction is a symptom that relates to survival; it shows how addicted people have trouble meeting their needs, which can be assessed by using the following questions.

1 Do they know what they need? (i.e., do their affective states lead them to know what their unmet needs are?).
2 If they know what they need, do they know how to meet their needs?
3 If they know how to meet their needs, are they able to actually meet them?
4 If they are unable to meet their needs, what impedes them to meet them?

These questions indicate that several problems can interfere with a successful satisfaction of internal needs, ranging from the simplest to the most complex ones. Any negative answer to the previous questions could indicate the presence of depression, urging clinicians to explore the patient's affective functioning. If a conflict remains unsolved for too long, there is certainty that the person is suffering. If parents themselves are unable to work on their own problems, they will show limitations to become models for their children. The use of affect as a guide to look for homeostasis is compromised, thus life itself is compromised and the longer they live in such a context, the worse their affect feels.

The clinical assessment then recruits the two indicators of latent depression suggested in this paper, namely, the depressive affect and the self-aggressive behaviors. The first one should consider the use of manic defenses as an attempt not to experience depressive feelings. When the morbid phase of addiction has begun, it also recruits the chemical manipulation of the original depressive features, which are then harder to assess. Self-aggressive behaviors on the other hand are explicit but not always linked to depressive feelings. Psychoanalytic theories of depression have contributed to emphasize the importance of understanding why people consciously agree to hurt themselves, in spite of being aware of the potential consequences. Some hypotheses have been presented to attempt to understand and treat them, including the use of psychotoxic drugs.

Treatments for addiction benefit from a multidisciplinary approach performed by professional teams that can take into account the various dimensions involved in addiction, i.e., the behavioral, the neurobiological and the subjective. An efficient treatment usually requires several stages. It is useful to acknowledge that addictions in general terms cannot be cured. The brain modifications implied tend to be long-lasting and the rebalancing of the various systems involved has shown limitations. This fact constitutes the most important factor to try to identify the precondition that characterizes the pre-addictive phase and the chronic latent depression that can easily escape clinical attention.

When the addictive phase is active, it is important to use all the available strategies to help addicted patients. Treatment usually entails detoxification, medication, individual and group therapy, abstinence management, self-help groups and behavioral interventions, amongst others. Once the patient is not using drugs, a psychoanalytic psychotherapy can contribute to the patient's treatment. It requires technical modifications that take into account the complexity implied in addictive disorders. A neuropsychoanalytic approach is highly recommended as seen in treatments reported by Johnson (2009, 2010, 2011), that take into account that addiction is an acquired brain disease (Volkow et al., 2016) and clinicians find themselves in the context of a special type of neurological patient. Not only should the stages of addiction be understood, but also their associated brain damage. Classic psychoanalytic approaches tend to interpret meanings of addiction. As much as those meanings may play a role in the premorbid phase, once the addictive disorder is diagnosed, the brain modifications will play a part that demands more precise interventions. Some modifications can be found in Knight's proposal to use psychoanalytic techniques to identify the causes of addiction to try to help the patient to find better adaptation strategies (Knight, 1937). Zinberg (1975), in contrast, clarified that the past may be confusing for the patient; he also proposed not to interpret defenses. These two examples represent the various efforts made by several clinicians to help addicted patients. We now know that isolated strategies are not recommended. Team work benefits from the diverse perspectives from which addiction can be treated.

The hypothesis of a latent depression as a precondition of addiction would entail to treat the depressive features, either as prevention against addictive behaviors or as part of the active phase of addiction. If the latent depression remains untreated, the risk of relapse is enhanced. But treating depression is not an easy task either. It feels bad (Zellner et al., 2011) as an evolutionary mechanism that tries to solve the separation distress that is felt as PANIC. This requires mourning for

needs that cannot be solved in an ideal way. It has been suggested that addicted patients want to skip the work needed to get satisfying objects and just experience gratification (Solms, 2019). This statement can apply to most cases, but it could also imply that these individuals do not know what to do to achieve what they need. This is particularly important when latent depressions imply a paradox. To accept feelings allows for recognition of the origins of a conflict or need. If a person accepts what cannot be achieved, they may be in a better position to come up with new strategies along with the help of a therapist.

As with any other disorders, the earlier a patient can be helped, the better the outcome. A psychodynamic assessment could pose an opportunity to identify latent depressions, despite the use of numerous defenses, because it is based on the analysis of subjective experience. The transference-countertransference relationship allows for a unique setting to explore the affective configuration of patients. Furthermore, a neuropsychoanalytic approach helps to understand the potential neurobiological implications of a latent depression. This aspect needs further research, but we now know that a neurobiological depressive cascade is linked to subjective feelings that explain behaviors. The consequential addictive cascade yields complex and confusing feelings for patients that go through the different stages of addiction. Depression and addiction are thus, deadly disorders.

In conclusion, the contribution of this paper to the existing treatment models is to emphasize the importance of the subjective feelings of addicted patients. They express an anaclitic conflict that does not find successful solutions. Thus, patients need to tolerate and accept their feelings in order to survive. If they cannot solve their separation distress conflicts in substitutive ways, the negative feelings will not stop. This context constitutes a type of traumatic memory that forms rigid defensive patterns in an attempt to suffer less. New templates should be built with psychotherapeutic help. Yet, they will not delete the old and confusing memories of ambivalent separation distress, but they can help to find better ways to update prediction models and to improve feelings in a legitimate way, i.e., finding alternative actual solutions. Many affective conditionings cannot be modified, still patients can learn to work for what they can have and mourn for what they cannot.

I am aware that these brief suggestions are also insufficient. Clinical observations of patients constitute a valuable opportunity to improve our understanding of the subjective complexity of addiction. This type of observation requires an integrative perspective. The contributions of all disciplines, interested in comprehending the many unsolved features of addiction, should be taken into account to enrich the existing therapeutic approaches. The solution to the depressive paradox entails complicated questions that a psychoanalytically oriented treatment may help to improve in a long-term basis. However, in the case of addicted patients whose brain has become deadly ill, the solution to the addictive paradox is a priority. New predictive patterns should be able to be updated in order to find realistic and legitimate solutions to problems. Their effectiveness should help to inhibit and substitute the original dysfunctional ones. The treatment should teach patients to use feelings as a guide to know what to SEEK. They should work for what they can achieve and mourn what did not and will not happen (Flores Mosri, 2017b). Yet, if people were able to mourn and elaborate loss, depression would present less frequently. The depressive paradox identified by psychoanalytic observations may constitute a valuable opportunity to prevent addiction. But, since it is a paradox, its solution still seems unsolved. Thus, any serious attempt at treating addiction represents hope to keep SEEKING and is most needed.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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Conflict of Interest: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychiatry

ORIGINAL RESEARCH
published: 18 October 2019
doi: 10.3389/fpsyt.2019.00728

Mothering, Substance Use Disorders and Intergenerational Trauma Transmission: An Attachment-Based Perspective

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Background: A growing body of research underlines that interpersonal trauma in childhood leads to heightened susceptibility for substance use disorders (SUDs) in later life. Little research has been conducted on parenting experiences of mothers in recovery from substance use, taking into account their own upbringing as a child and the potential aftermath of interpersonal childhood trauma.

Methods: Through in-depth qualitative interviews, 23 mothers with SUDs reflected on parenting experiences and parent-child bonding, related to both their children and parents. Interviews were transcribed verbatim and data were analyzed adopting thematic analysis.

Results: Throughout the narratives, consequences of trauma on mothers' sense of self and its subsequent impact on parenting arose as salient themes. Five latent mechanisms of intergenerational trauma transmission were identified: 1) early interpersonal childhood trauma experiences in mothers; 2) trauma as a precursor of substance use; 3) substance use as a (self-fooling) enabler of parental functioning; 4) continued substance use impacting parental functioning; and 5) dysfunctional parental functioning and its relational impact upon offspring.

Discussion: Findings suggest disruptive attachment can increase the vulnerability for SUDs on the one hand, but can be an expression of underlying trauma on the other, hence serving as a covert mechanism by which trauma can be transmitted across generations. Results indicate the need for preventive, attachment-based and trauma-sensitive interventions targeted at disruptive intergenerational patterns.

Keywords: mothers, substance use, children, attachment, trauma, intergenerational

OPEN ACCESS

Edited by:
Human Friedrich Unterrainer, University of Vienna, Austria

Reviewed by:
Jasmin Tatzer, Medical University of Graz, Austria
Domenico De Berardis, Azienda Usl Teramo, Italy

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Specialty section:
This article was submitted to Addictive Disorders, a section of the journal Frontiers in Psychiatry

Received: *14 June 2019*
Accepted: *11 September 2019*
Published: *18 October 2019*

Citation:
Meulewaeter F, De Pauw SSW and Vanderplasschen W (2019) Mothering, Substance Use Disorders and Intergenerational Trauma Transmission: An Attachment-Based Perspective. Front. Psychiatry 10:728. doi: 10.3389/fpsyt.2019.00728

INTRODUCTION

Mental health problems are a common co-occurring condition in substance using populations (1), with growing research acknowledging the prevalence of post-traumatic stress disorders (PTSD) in individuals with substance use disorders (SUDs) (2–6). This resulted in increased attention for integrated treatment to reduce both SUDs and PTSD symptoms (7–11). Some persons who have experienced a shocking or dangerous life event develop PTSD (12), characterized by the persistence of intense reactions to reminders of the traumatic event, altered mood, a sense of imminent threat, disturbed sleep, and hypervigilance (13). SUDs and its consequences can make individuals prone

to experience stressors or trauma, which may contribute to the development of PTSD, just as PTSD symptoms have been associated with substance use initiation.

Interpersonal Trauma and Attachment

Traumatic experiences that occur early in life within attachment relationships, often referred to as "interpersonal trauma", are known as a significant predictor of SUDs in later life (14–17). Childhood experiences of being physically or emotionally abused or neglected or sexually abused by a trusted caregiver increase the likelihood that an individual will develop SUDs (18, 19), and have been linked to patterns of insecure attachment in offspring *via* symptoms of depression (20). Exposure to trauma within the caregiving system is associated with higher levels of affective/physiological, attentional/behavioral, and self/relational dysregulation in addition to post-traumatic symptoms (21), affecting individuals' capacities for emotional understanding and processing significantly (17). The caregiving system may include biological parents or other relatives (e.g., foster or adoptive parents), staff in residential child care, or even therapists (22). Exposure to multiple and chronic interpersonal trauma experiences in the relationship with caregivers, also known as "developmental trauma" (23), is associated with a complex range of symptoms and impairments across several areas of development (21). Early trauma experiences with caregivers have repeatedly shown to have a profound influence on physical (24) and mental health (25), with enhanced risk for psychopathology, including dissociation and hallucinations (26). Hence, the absence of secure attachment relations is likely to result in poorer child outcomes, with trauma perpetrated by caregivers further amplifying these poor outcomes (23). Dugal and colleagues (27) indicate how dysfunctional early interpersonal encounters may shape dysfunctional interaction patterns to be repeated in subsequent relationships. They further state that, in reaction to the perception that the other is insufficiently available to answer one's own needs of love and protection, interpersonal trauma survivors generally present a hyperactivation of the attachment system. This can be represented by intense demands of affection, a sensitivity to perceived or real threats of rejection by a partner, a certain control over a partner's behavior, or an excessive dependence toward a partner (27). Individuals exposed to early interpersonal trauma also show an atypical combination of anxious and avoidant attachment styles that often result in severe affect dysregulation and psychopathology (17).

According to Bowlby's attachment theory (1982), babies have a primary need to establish an emotional bond with a caregiving adult from birth (28), characterized by the need to seek and maintain proximity to a person (29), especially when the baby or child is faced with internal or external stressors (30). As such, an "internal working model" (31) is developed by the unique patterns of infant behavioral responses to primary caregivers (32), containing complex mental representations of the self, the caregiver and the quality of the relationship (33), functioning as a mediator of attachment experiences (34). These representations tend to be extended into adulthood (17). In certain cases, parents are not able to provide a safe haven for their children, offering them frightening or unpredictable caregiving (27). As a consequence, experiences of interpersonal trauma can be detrimental to the core conceptual system (35) and can become permanently imprinted in an individual's internal working model (31), including ensuing long-lasting effects on attachment and interpersonal relationships in later life. Early attachment relationships are not always sufficiently positive to cultivate a sense of security in a child's world (17). Moreover, insecure attachment can serve as a vulnerability factor for alcohol (36) and other SUDs (37, 38) and may contribute to early drop-out in treatment, whereas secure attachment bonds provide a sense of safety, comfort and predictability for individuals with SUDs (39).

Mothering and Substance Use

A growing body of research reveals a high prevalence of interpersonal trauma (40–42) and insecure attachment (43, 44) in women with SUDs. In particular in mothers with SUDs, anxious-insecure attachment patterns (45, 46) may lead to difficulties when interacting with their children (e.g., inconsistency in the ability to perceive and respond to babies' signals) (47). Especially prenatal substance use has been demonstrated to be a major public health concern affecting children (48), since chronic in utero exposure to licit and illicit drugs is associated with adverse fetal, neonatal, and early childhood consequences (49). Also perinatal substance use tends to have a detrimental effect on mother-child bonding, as illustrated in many studies (50, 51). Maternal substance use is further associated with psychiatric comorbidity (52), maladaptive parenting practices (53, 54), emotional unavailability and uncertain reflective functioning (55, 56), a lack of mentalizing abilities (57), and poor infant development (58, 59), including disruptive attachment patterns in children. A recent brain imaging study (60) revealed that mothers with SUDs showed reduced activation in key reward regions of the brain in response to their infant's cues. Even when drug use is discontinued/controlled, psychological and relational dynamics underlying the development of parenting may be affected, limiting reflective parental functioning and challenging the quality of the parent–child relationship (57). Exposure to parental substance use eventually increases the risk of SUDs (61, 62) and other mental health problems in offspring (63, 64), which might install an intergenerational cycle of psychopathology.

Research has shown that a lack of consistent and responsive parenting is thought to interfere with the development of secure attachment in children (65). Attachment can be understood as providing a context in which we learn to make sense of ourselves and others (66). Infants are entirely dependent on their caregiving environment for safety and nurturance and their experiences within this environment are key to their developmental trajectories and longer-term outcomes (67). Emotional security, based on emotional bond between a child and caregiver, depends on the availability and responsiveness of the primary attachment figure, usually the mother (68). Attachment research suggests that the ability to regulate distress and to cope with negative feelings in relationships is

learnt through attachment. Fearfully attached persons have not acquired sufficient affect regulation strategies, and can easily become anxious in interpersonal (attachment) relationships (69). In this view, maternal insensitivity and unresponsiveness to children's emotional cues can be seen as a function of the caregiver's own unmet attachment needs, stemming from the caregiver's own experiences with early caregivers. Abundant research has focused on interventions for promoting the quality of mother–child interactions in combination with drug treatment (70, 71). The relationship between specific individual and relational factors can explain the fragile parenting capacities of parents with SUDs, apart from substance use (57). Treating drug addiction and promoting secure attachment bonds are increasingly recognized as two essential components of present-day mental health care (72).

Maternal substance use can impact child development adversely, since it not only increases the risk for disruptive attachment patterns (73), but also for SUDs in offspring. Adverse childhood experiences, including growing up in a context of maternal substance use (74), predicts an earlier age of onset for alcohol (62, 75) and other drug use (76, 77), and increased odds for attempting suicide (78). A positive relationship was found between maternal substance use and the occurrence of child maltreatment, indicating a clear link with insecure attachment in children and adults (65). A high incidence of emotional and physical neglect is documented among substance using mothers (57, 79, 80), as well as a greater tendency towards depression and more chaotic child-rearing environments (81). Consequently, parenting interventions need to be provided to women in substance abuse treatment, focusing on increasing maternal sensitivity, reducing harshness and providing children with sufficiently stimulating environments (82).

Childhood Trauma and Impact on Parenting

Caregivers who have been exposed to trauma face various challenges when providing sensitive, responsive and nurturing care to their young children (83). Trauma exposure is associated with greater parenting distress and increased risk for dysfunctional parent–child relationships (84). A systematic review by Christie and colleagues (85) provided evidence for the association between parental PTSD and impaired functioning across a number of parenting domains, including increased levels of parenting stress, parenting satisfaction, and suboptimal parent–child relationships. Childhood trauma may affect the formation of early relationships and corresponding defense mechanisms in adulthood (86). Parents with a history of childhood adversity are at risk of developing problematic parenting behavior in relation to their offspring, including child abuse and neglect (87–89). Cross and colleagues (90) found that trauma in parents may impact parental distress and the risk of child abuse, potentially increasing the risk of trauma symptoms in offspring. Women who reported childhood trauma and substance use and co-occurring disorders are at increased risk of developing an intergenerational cycle of abuse (91). Finally, addiction may lead to disruption of the chemical balance critical for self-awareness and self-control (92), which can indirectly predispose a mother to abuse or neglect her child(ren). However, suchlike discourses can contribute to a negative view regarding substance using mothers' identity as being restricted to that of a drug user, hindering the construction of new roles, such as being a mother (93).

Aims of This Study

Despite awareness on the long-term consequences of maternal substance use for child development, research on parenting experiences from the viewpoint of mothers with a history of substance use is scarce. Although interpersonal trauma was initially not the focus of this study, mothers' parenting experiences were clearly affected by childhood trauma experiences. Consequently, this study provides a deeper understanding on how a history of interpersonal childhood trauma may affect parenting beliefs, attitudes, and behaviors among mothers with SUDs and illustrates how trauma can ultimately persist across generations. In this study, mothers who misused illicit substances when upbringing a child reflect on their parenting experiences, based on retrospective accounts of their own childhood and their offspring's early upbringing. Improved understanding of intergenerational trauma transmission in substance using mothers and their children would be an important step toward supporting women at risk of developing substance use disorders arising from traumatic childhood experiences. This study will thereby try to add knowledge on the emerging literature exploring potential applications of attachment-theory informed interventions in individuals with SUDs (94), especially in mothers.

MATERIALS AND METHODS

Study Design and Procedure

A qualitative research design was applied, using in-depth interviews (one-on-one) as method for data collection. As focusing on lived experiences of individuals thought to be vulnerable or marginalized is relatively new (95), the objective was to provide an improved understanding of lived parenting experiences among women with SUDs by making new, significant distinctions resulting from getting closer to this phenomenon (96).

Inclusion criteria for participation in the study were: i) being a mother; ii) having a history of problematic illicit substance use during the upbringing of a minor child (older than 1 year); and iii) being in substance abuse treatment for at least one month. Individuals who only used alcohol or only used illicit substances before or during pregnancy were excluded. Abstinent individuals as well as individuals who were still using drugs despite being in treatment were included, given their alternative and complementary points of view. Participants recruited in inpatient treatment services were all abstinent since admission or for a longer period. Participants recruited through outpatient treatment services commonly used in a controlled way, except for two women who were abstinent. The average time in treatment for inpatient participants (n = 11) was 3.8 months (range 0.5 to 12 months), while mean treatment duration among outpatient

participants (n = 12) was 4.2 years (range 6 months to 11 years). Participants' mental state at the time of the interview (i.e., if they were emotionally able to participate) was considered with treatment providers. The accuracy of participants' answers was openly discussed during three interviews, which led to more consistent and accurate responses.

In total, 23 mothers were included in the study (cf. **Table 1**). The average age of participants was 34 years (range 25 to 49 years). Most women had only one child. Participants' children were between 1 and 21 years. Most mothers were involved with child protection services, including 15 mothers who lost custody of their child by court order (e.g., out-of-home placements in child care services or foster care) during the upbringing. While polysubstance use was commonplace among study participants, eight women used amphetamines when upbringing their children while nine mothers reported problematic alcohol use at that time. Detailed information regarding the characteristics of study participants is described in **Table 1**.

Data Collection

Interviews took place between October 2018 and March 2019. Participants were recruited from three inpatient and four outpatient substance abuse treatment services in Flanders, Belgium. Interviews were carried out at the center where participants were treated. Participation in the study was completely voluntary. Both oral and written informed consent were obtained from all participants. Prior to the interview, we explained the aim of the study and guaranteed the anonymous nature of participation. Any records that could identify the participant were made unidentifiable. Participants were free to withdraw from the study at any time, without affecting them negatively in any way. The contact details of the researcher were included in the informed consent form and participants were informed about the possibility of a follow-up conversation at the treatment center and/or with the researcher. The average duration of the interviews was 2 h and 6 min (range 00:59 h to 03:04 h). Two of the interviews were interrupted due to external circumstances (i.e., transport reasons and collecting a child from kindergarten) and were resumed a few days later. All interviews were conducted by the first author, audio-taped with participants' permission and transcribed verbatim, after which the recordings were deleted. Transcripts were de-identified to ensure confidentiality.

A semi-structured interview guide was used in order to discuss a broad variety of themes, while at the same time asking everyone the same key questions. The guide contained questions regarding experiences with i) mothering and substance use; ii) relationship to the own parents as a child; iii) treatment and support needs; and iv) child protection interventions. In this paper, we primarily focus on data regarding the first two areas. As a reflexive and collaborative practice, we adopted a timeline approach (97) throughout the interviews, which enabled participants to talk about potentially burdening experiences from a distant viewpoint. As such, the timeline served as a tangible, mediating object between the interviewees and the researcher, giving participants more agency regarding the way they wanted to talk about their own lives and potentially harmful experiences. It enabled them to talk about adverse periods (e.g., participants pointed at a certain period, elucidating "during *that period*"), or about abusive or violent relationships, without having to identify names of relatives which could potentially evoke feelings of distress (e.g., participants referred to the timeline by constructing stories they were still suffering from: "*that one* who repeatedly abused me").

TABLE 1 | Participants' characteristics (n = 23).

Characteristic	Value	n = 23
Ethnicity	Western European	22
	South Slavic	1
Relationship status	Single or divorced	14
	Cohabitating	8
	Incarcerated partner	1
Number of children	1	11
	2	6
	3	5
	5	1
Primary substance of choice at the time of upbringing	Amphetamine	8
	Cannabis	6
	Cocaine	5
	Heroin	3
	GHB	1
Current substance use status	Clean	13
	Active use	10
Treatment modality	**Inpatient treatment programs**	**11**
	Medical detoxification	2
	Short-term residential treatment[1]	3
	Long-term residential treatment[2]	6
	Outpatient treatment programs	**12**
	Substitution treatment (e.g. methadone maintenance) + individual counseling	2
	Pharmacological based treatment and/or individual counseling[3]	10
Number of mothers who lost custody of their children	Voluntarily assisted by child protection services	4
	Court-ordered measure	15

[1]*group therapy, lengths of stay between 4 and 6 weeks.*
[2]*group therapy, lengths of stay between 6 and 12 months.*
[3]*twice-weekly or on a monthly basis, often with breaks in between.*

Data Analysis

Collected data were analyzed using a thematic analysis technique in order to attempt to describe participants' lived experiences. In view of the scarcity of research about the experiences of these often stigmatized women, an inductive analysis was used to derive themes that popped up from the data. The process of data transcription was done by the first author, which contributed to jumpstarting the other steps of the data analysis process (98). The thematic analysis was subjected to an ongoing iterative process, following the six steps suggested by Braun and Clarke (99, 100). Initial codes were generated to identify similarities and differences in the data, which were then sorted into broader themes, with similar codes placed under the same theme. Several samples of the analysis were discussed and cross-analyzed by the research team.

Ethics

Ethical approval for the study was obtained from the Ethics Committee of the Faculty of Psychology and Educational Sciences at Ghent University (E.C. decision: 2018/42) before commencing the project. Being aware of the vulnerable situation of participants, interviews were conducted in a trauma-sensitive way. Before and during the interview, participants' right to declare that they did not like to talk about a specific topic without affecting them negatively, was frequently emphasized. Each interview was preceded by a brief attunement with a psychotherapist at the treatment center about the current emotional capacity of participants. Taking this information into account, the main aim at the beginning of the interview was to establish a trustful relationship, characterized by equality, trustworthiness, and safety within a secure environment. The researcher then specified the objective to gain insight into women's lived experiences as a mother in the first place, alongside recognizing their courage to participate in the study. Throughout the interviews, the researcher tried not to be intrusive by letting trauma-related disclosures exist in its verbal or tacit constellation, always validating disclosures, and creating space for dormant silence and suffering. The researcher thereby tried to verify (in-) directly whether the participant was still comfortable with talking about the given subject, without encouraging them in any way to open themselves. Following participants' individual pace, moving slowly, working with humility, patience, engagement, and an active listening attitude appeared to be of great importance throughout this project. Each interview was followed by short feedback to the psychotherapist on how the participant seemed to have experienced the interview emotionally, without disclosing any interview information.

RESULTS

Although not actively questioned, the vast majority of participants (n = 16) disclosed one or more interpersonal trauma-related experience(s) during childhood. Subsequently, the analysis showed an intricate link between early interpersonal trauma, attachment and addiction in the parenting narratives of mothers with SUDs, indicating the interrelatedness of these concepts. Five key mechanisms behind intergenerational trauma transmission were identified that contribute to disruptive attachment processes: 1) early interpersonal trauma experiences, 2) trauma as a precursor of substance use, 3) substance use as a (self-fooling) enabler of parental functioning, 4) continued substance use impacting parental functioning, and 5) dysfunctional parental functioning and its relational impact upon offspring. These themes and related sub-themes are represented in **Figure 1** and outlined below. The themes are presented in a presumed chronological order, as these were prominent 'stages', building further upon each other. However, these themes should not be interpreted linearly, and therefore rather be regarded as coexisting parts of the complex lived experiences of these mothers. By reporting on the results, specification of participants' treatment settings are abbreviated as: OT (outpatient treatment service), IT (inpatient treatment service), and ITMC (inpatient mother-child treatment service). All names throughout the results section are pseudonyms in order to ensure confidentiality.

Early Interpersonal Trauma Experiences

Sources of Trauma Within the Caregiving Environment

Speaking about parenting experiences yielded troublesome emotions in almost all participants, often reflecting upon and stemming from their own dysfunctional relationships with early caregivers. Mothers commonly experienced longstanding histories of different forms of — often repeated — sexual, physical, and/or emotional abuse, mostly inside the family. Throughout participants' narratives, it appeared that their own parents had often gone through similar experiences as a child, not always knowing exactly what had occurred. Complex parent–child relationships and complicated and prolonged histories of abuse emerged, leading to self-destructive behavior in some participants.

> "I have been sexually abused by my grandfather for years … It ultimately came out when I was in secondary school. (…) When I was a minor, I also used to harm myself … but at the same time I was experimenting with drugs. (…) When it all came out, many victims have had come to light, also my own mother … and that's where the dispute had started. She had experienced it herself, why did she sent me to him? And if she now says to me: 'How could you do it, taking drugs while being a mother for your kids?', then I'm like: 'you know only too well how that comes'. I really have difficulties coping with it. If she then wants to take over [the upbringing], then I'm really angry with her." (Olivia, ITMC)

The realities of mothers' lives include high rates of interpersonal abuse and violence during childhood, which often still live through. Suicidal ideation ignited by interpersonal — often cumulative — trauma softly surfaced, both directly (suicide attempts) and indirectly (suicidal ideation and/or attempts among family members, often witnessed by participants).

> "In 2012, my first suicide attempt occurred. (…) My biological family has contributed to increased feelings of loneliness and unacceptance. They always said that I was stupid … everything you could blame a child for. I got locked in the basement, I got beaten. Every 5 minutes to be locked up is too much for a child, even if it's just a minute. The world is collapsing for that child. (…) It was mainly my aunt that abused me, physically and emotionally. It was in [foreign city], we used to live there for a while. And then you arrive in Belgium, a refugee center, and there you got raped by a stranger. Those are all memories flashing back in my mind just like a movie. (…) My aunt used to drink a lot. We were with 3 children, of which 2 were hers, and if she had drunk too much, she vented her frustrations on me. I don't know why she had to vent it on me and not on her own children." (Charlotte, OT)

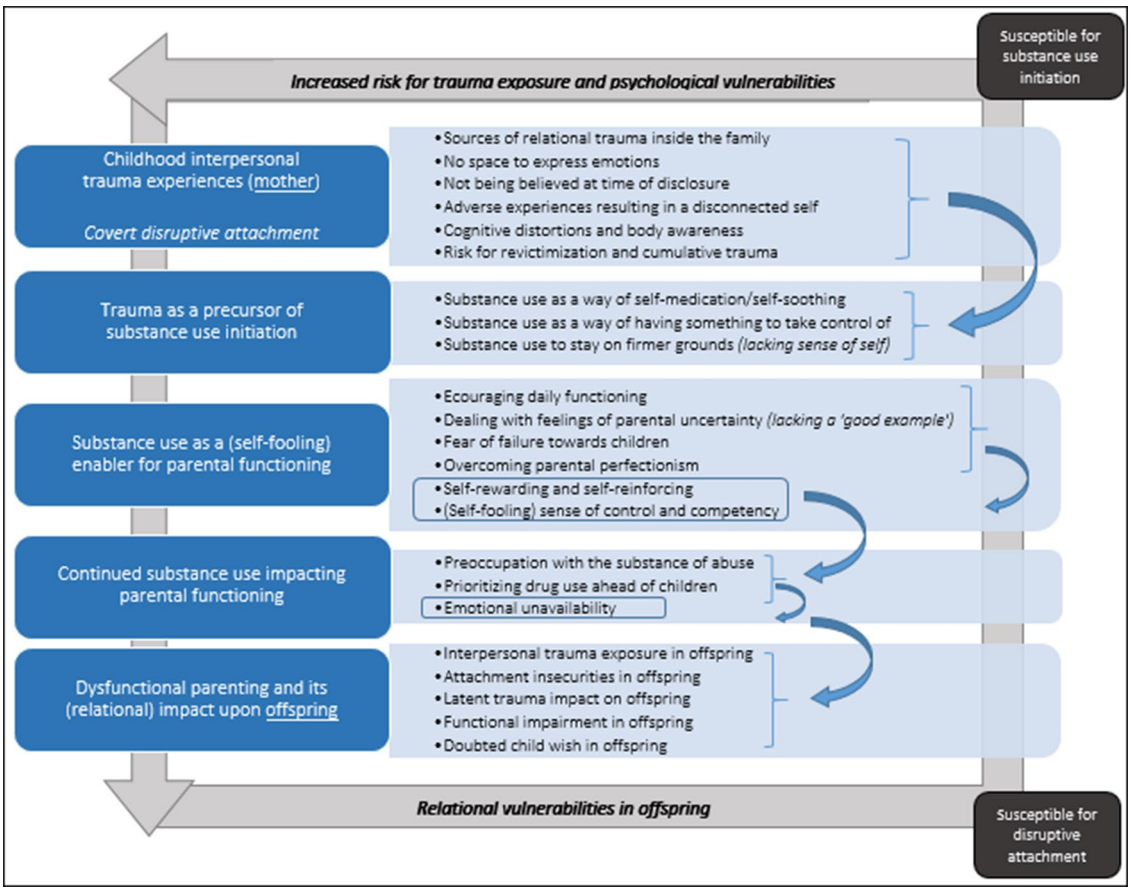

FIGURE 1 | Mechanisms underlying the cycle of intergenerational trauma transmission in mothers with SUDs through latent disruptive attachment. Prolonged substance abuse and emotional unavailability stemming from preoccupation with the substance of abuse can i) increase risk of trauma exposure in offspring; and ii) install relational vulnerabilities in next generations, making them more prone to develop attachment difficulties. As such, a heightened risk for trauma exposure can be transmitted through disruptive attachment across generations.

Some of the participants expressed early experiences of witnessing or finding a family member that had attempted suicide, leaving them behind with unresolved or guilt-feelings until today.

> "My father has tried several times to hang up himself. Once, I found him laying down at the toilet. He had been drinking too much and taken too many pills. (…) I know he also had a tough past. His mother wasn't very … she wasn't such a lovely mother, she rather was a mother of corporal punishments, even though that was common practice back then." (Evelyne, OT)

The role of participants' parents was often reflected upon, noting several deficits in their parental functioning which goes back to the way they were raised by their own parents (participants' grandparents). The way participants reflect on their children's upbringing was often prompted by these early experiences and they frequently stated they wanted "to do it completely different". One of the participants was exposed to prolonged physical abuse by her father. She had lacked a safe and nurturing environment as a kid as she grew up in a context of parental substance use herself, just like nine other participants did. From her children's birth, she experienced difficulties in mother–child attachment and is aware that the negative experiences with her parents have an impact on her own parenting behavior. The quotation below illustrates how a history of trauma can impair a mother's ability to accurately respond to her own children's cues.

> "I try to not transmit it to my children, however though … I'm already projecting my own experience of getting raised too strictly towards my daughters. (…) The experience of having received no love … Though I say every day to my children 'I love you', but it's like … I don't know. It's another kind of love, you see? Like, if children got born, a mother will be crying. I didn't with neither of the kids. I don't know why, but I just didn't. But I always cared for my children when they were young. (…) The way my parents behaved towards me, I already tend to transmit it towards my children, and I don't want that. So I already started working on it now." (Aubree, IT)

No Space to Express Emotions Within the Family Environment

Several participants stated to have developed a 'holding back' reflex and attitude concerning their affective expressions, since they have never experienced space to give vent to emotions. Some declare to have been spanked as a way of 'obeying', which hampered their affect-regulation. As participants commonly missed a warm and nurturing environment during childhood, talking about emotions or expressing feelings was perceived taboo or deemed prohibited.

> "As a child, I didn't get the support I needed from my parents. At home, they always said: 'You shouldn't cry', and 'you shouldn't be angry'. Yes, you may cry, but you shouldn't be tearing the place apart. I am re-educating my parents, in view of the moment they will look after my children … Basically, you can't control feelings. You can control your thoughts and your behavior, that's something completely different. But you should never condemn feelings, and at home they've always used to be condemned, instead of the behavior." (Evelyne, OT)

In consideration of the developmental impact of having no space to express emotions or not having received much love at home, participants try to raise their children differently.

> "I find it very important that you can show your child you can have a crisis, that things can persist, but that you can rebuild yourself and recover. At home, those things have gotten shielded always. (…) Just like with my father's suicide attempts. 'He has it again', that's just what they used to say, as opposed to me, I'm open and honest towards my children." (Chelsea, OT)

Besides the lack of emotional space, participants also declared the painful shortage of opportunities to talk about trauma-related experiences. When participants disclosed as a child, it used to be refuted as 'invalid'. One woman, who also experienced early emotional abuse and neglect, describes the significant impact of how an attempt to disclose rape was met with disbelief, ultimately supporting her to attempt suicide.

> "My parents didn't believe me. It has hugely impacted me. (…) On the journey from school, I have been dragged off my bike by three men. I have been raped, repulsed … When I came home, I said it to my parents. My father spanked me because my bike was broken. They didn't believe me … what … was very hard for me … My life was such a hell already, and then that. I also started using drugs at the age of 13, shortly after this happened. I never remembered faces, but I do remember voices and hands. And when I was clean, it came up very fiercely, but when I took drugs, it didn't. It has determined a lot of my youth." (Hazel, ITMC)

Affirmation that an account is believed and validated is seen as very important by the respondents. In addition, the fear of not being taken seriously – as a mother who genuinely loves her child despite her addiction – was ubiquitous among all participants. They felt like they continuously had to prove the love for their children because of their addiction, although 'good mothering and addiction have nothing to do with each other', according to the mothers.

> "Once, I asked my psychiatrist: 'Everything that I'm telling you, do you believe me?'. I received a very pedagogical answer: 'It is my job'. I didn't know what to say. Last week, he made me a comment, when I told him about the [adoption] ruling that it had to appear in court. He said: 'Maybe it's a good thing that your child will be adopted'. I said: 'I don't think you know what you're talking about'. He said: 'I do … I have children too'. I said: 'That's why … You didn't have to carry them … I did … I did carry him for almost 9 months … Thanks to my umbilical cord, that child was born'. He understood and he apologized." (Charlotte, OT)

Interpersonal Trauma Resulting in a Disconnected Self

Childhood trauma that was not validated or disclosures that were not believed, tend to erode participants' self-concept and ultimately yield a disconnected self over time, also resulting in altered body-awareness. Participants mentioned how they are constantly in doubt about themselves, feeling worthless and unwanted, not feeling loved and appreciated, which can ultimately push them to drug-taking behavior. These cognitive distortions might serve as a starting point for how they perceive and relate to oneself, others and the world; since these experiences instigate self-loathing and ways of disrespecting oneself, not knowing who they really are.

> "I only was able to do the things I was sure of … that I was a 'mother', that I was a 'daughter from', but who was I myself? I had no idea…" (Harber, ITMC)

> "It's more in my head, with the abuse … he totally damaged me … I do not love myself, that I am sure of. Neither do I have self-respect. These are all of the things I have to learn, but it's difficult. As long as you do not love yourself, you do not love somebody else … and for me, it doesn't seem to work yet … It [trauma] is still too deeply-rooted within myself." (Aubree, IT)

Risk of Revictimization and Cumulative Trauma

Participants' stories depicted an increased vulnerability for 'looking for love and affirmation in the wrong places', with many mothers encountering repeated interpersonal, cumulative trauma, even throughout adult life. Participants also revealed how prolonged emotional abuse tended to go unnoticed. Following quote illustrates how a cumulative interpersonal trauma history completely absorbed one mother, eventually leading to suicidal ideation.

> "Before I started treatment here, I attempted suicide. And the feeling hasn't really gone yet. I have incorporated it somewhere, but it's still torturing me. I still have the feeling my backpack is almost full. Just a little more might be needed until I would do it again. I

was astonished that I had done that. You always hear that people who really want to commit suicide will never talk about it, and I can see, now that I have wanted to do this … Indeed, you don't talk about it." (Olivia, ITMC)

Trauma as a Precursor of Substance Use

Self-Medication/Self-Soothing

All participants who experienced childhood trauma mentioned that they initiated substance use in order to self-medicate painful experiences. For example, mothers revealed how a history of broken attachment relationships and traumatic experiences played a role in substance use onset and the transition to addiction. The effects of substances enable(d) mothers – albeit temporarily – to suppress negative memories, cope with difficult emotions, and – finally – find inner peace. Without drugs, they state they would not have been able to overcome certain incidents.

"I just 'used' the pain away, the psychological pain, not the physical pain. A bruise will fade, but what it does to you, doesn't. So I heavily 'used' it away. That's why my drug usage had increased considerably in recent years. (….) My father was a professional soldier, he vented his frustrations on me. It became unbearable in the end, I had one bone fracture after the other. (…) My cousin has committed suicide with medication and alcohol, and I have found him … horrible … horrible to find someone that way. (…) Then drugs was easy, you shouldn't think, you shouldn't feel." (Hazel, ITMC)

Regaining Control and Standing on Firmer Grounds

After a history of being controlled, mothers perceived substance use as something they could control and have power over again. At the same time, *participants' own choice to use substances* instead of looking for help elicited narratives of self-blame.

"I used to do athletics on an international level. I was very good. My parents have never motivated me to continue doing what I was good at and loved to do. That made me think that it [drugs] was really something that belonged to me, that could comfort me and that I chose to do myself. I chose to use drugs myself." (Charlotte, OT)

Participants also asserted how substance use enabled them to stand up for themselves again.

"Because of the drug, you just dare to do more. 'I don't care'. You don't do it purposely, but you dare to speak up and that goes from the store, open up your mouth to a saleswoman, or to a partner." (Noelle, OT)

Substance Use as a (Self-Fooling) Enabler of Parental Functioning

Enabling Daily Functioning

Participants described various ways in which they perceived that substance use enabled them to manage their parenting roles (e.g., doing the household), which is illustrated by the quotation below about a mother using amphetamines in order to be alert enough to function during the day and to ensure that she could attend to her child's needs.

"Speed helps me a lot, but I don't abuse it. I take just as much in order to calm down and focus, so that I can do what I need in order to go through the day. (…) It's on a daily basis, but I'm working. I live in my home, my kid is nicely dressed, I'm taking him every day to school, to the speech therapist, everything … Without speed, I wasn't gonna make it. I wasn't gonna have the energy to do what I am doing. It just helps me through." (Elliana, OT)

Dealing With Feelings of Uncertainty

Mothers stated that they used substances to deal with feelings of uncertainty and fear of failure as a parent, seemingly stemming from unresolved trauma in the past, along with lack of good examples in their own environment. Some mothers were afraid that their children would get short-changed, not receiving the affective attention they need.

"I played board games with the kids, I went for a swim with the kids, we went to a theme park. I just did it all, maybe a little too much. For me, those were nice moments, but I am afraid that, if one day I will come home and there will be no speed, that these things might not happen anymore. I am afraid of becoming clean … that I will disappoint the kids: 'mom, before, you used to be like that, before, you used to do that with us'… I am afraid actually that I will be a deficient parent." (Whitney, IT)

Self-Rewarding and Self-Reinforcing Mechanisms

Some mothers mentioned that substance use was a means of self-reward (for example at the end of the day when children were asleep) and slowly became a self-reinforcing activity.

"Sometimes I also led a double life. Taking drugs at night, and in the morning you have to be there as a mother, which has taken its toll. You are tired, irritable. You are using up your reserves. So you start using again in order to get new energy from your body, which brings you in a vicious circle and you get tired even more. So you use more and more, until you become over-tired, not functioning well so you have to sleep." (Elizabeth, ITMC)

Alongside with self-reward, however, came feelings of guilt, followed by a search for affirmation from their children.

"I always made sure she had everything she needed: her food, her bed, everything in time. However, on an emotional level, you know it yourself, you're not yourself. Your child notices it, feelings of guilt arose, and from the moment she was laying in her bed, I used to consume … But from the moment I realized, I felt guilty and bad." (Noelle, OT)

Self-Fooling Sense of Control

When reflecting on the upbringing of their children, mothers in inpatient treatment agreed that they are now able to challenge

the 'false narratives' they had developed. While experiences of interpersonal trauma had resulted in feelings of inadequacy, substance use and its effects equipped them with an apparent sense of being good enough and competent as a mother, ultimately leading to a self-fooling sense of control.

> "I kept going, also for my children. I'm not saying I have done well, but … not giving up. Also taking care of his [ex-partner] children, but always in combination with substance use but trying to hide it as much as possible for the children, for the outside world. Trying to linger in family life in a good way, at least in my head. (…) In the morning, when the kids woke up, I opened the curtains, their sandwiches were spread, … Anyway, I thought I got it all, but that was a very false sense of 'I've got everything under control' and that feeling has held me back for so long." (Sofia, IT)

Respondents mentioned that motherhood is often characterized by a lack of self- and parental confidence and, consequently, fear of failure. While substance use may be perceived, particularly by amphetamine users, to help them to overcome these issues and enable parental functioning in the short-term, these benefits appeared to be transient.

> "I think that everyone who is still using drugs, is going to say: 'yes, I can raise a kid while using'. But I think it isn't. I have used for 32 years, 32 years I have been thinking: 'I can handle the whole world', but in fact, I have ruined so much, instead of dealing with things and searching for help and not taking drugs … Problems exacerbated and I only used more to push them away … Using drugs doesn't make you more human. You're a little doll, a marionette, doing what's expected, but who's not feeling and thinking." (Hazel, ITMC)

Continued Substance Use Impacting Parental Functioning

While substance use may help some mothers to avoid re-experiencing trauma, it gradually progressed to losing control over substances in many mothers. The following quote illustrates a mother's recognition of how prolonged substance use hindered her functioning as a parent:

> "I still wanted to do it all, because of the speed. I sat down in the seat to watch tv with her. So I pushed myself to still give her everything, even though she will have had the feeling: 'Mom isn't calm'. A child feels that, but in my world, I tried to do my best, but at the end, it just didn't work anymore." (Abby, OT)

Preoccupation With the Substance

Parenting was hampered through mothers' preoccupation with substances of abuse, while everything else, including their own children, was secondary. Mainly women in residential settings described how it is impossible to maintain an addiction together with child care, as they would do anything to get their drugs. This insight often went along with feelings of not having been a good enough mother.

> "In the end, we are not focused on what's happening around us. I'm going to be very rude, but if you have almost nothing left, you're constantly busy with: 'how should I get the drugs now?' In the end, it's the drugs that you live for and not your kids … Now that I'm clean, I realize." (Olivia, ITMC)

Prioritizing Drug Use Above Children

Preoccupation with the substance ultimately resulted in prioritization of drugs above the children. In addition, participants mentioned that, when being under the influence, children's needs were perceived as being 'too much', more than they could handle at the time. Some mothers unravelled profound and honest stories in light of prioritizing substance use and its impact on parenting.

> "I would have gone through a wall for it [cocaine]. When I had used, I could keep myself busy for 6h with only one pill. Nobody would have talked to me, I was very focused, living in another world, neglecting everything, neglecting my kids. Sometimes I used in presence of them. I was in my own world, ignoring everything. They had to leave me alone. I put off my bell, my phone, I locked my door, everything … so I didn't had to talk to anyone. I just wasn't able. I was just busy with that [drugs], and only that." (Aubree, IT)

Emotional Unavailability

After some months in treatment, mothers looked back and recognized that they had been unable to respond to their children's emotional needs. Although physically present, they admit that they have done considerable harm towards their children and that they were emotionally absent.

> "At a given moment, my usage was very problematic. I used almost on a daily basis, and it did impact the upbringing. If I think about it now when I am sober … At home, everything was always fine, it was clean, I used to clean a lot. The kids had fresh clothes every day, they had everything they needed, no shortcomings. They were fine with everything, but that's it. I noticed it was very hard for me to stay focused on the kids, to play with them, to talk with them … I was more introvert … But now [clean], now I have this relational thing with the kids. I am really occupied with the kids. I play with the kids." (Olivia, ITMC)

Participants frequently referred to their unavailability despite their physical presence. Participants described themselves as unable to express warmth and affection and to interact appropriately with their children. Narratives of being a good mother 'under the influence' tended to be counterbalanced by the insight that, in fact, they had forsaken their parenting role in its entirety. Consequently, drugs can be seen as an important

mediator of trauma throughout the stories, as mothers are less attentive, accompanied by a risk of transmitting trauma.

Dysfunctional Parental Functioning and Its Relational Impact Upon Offspring

Offspring Exposed to Interpersonal Trauma

As a consequence of maternal substance use, participants' stories revealed how their children had been exposed to things they should not have been exposed to, both at the hands of their caregivers and as a lack of maternal involvement and alertness due to substance use, so say the respondents.

> "I have neglected my daughter a lot. I haven't given her a lot of love. I left her behind everywhere. You don't want to know it … That child has seen too much. That child is still suffering from it." (Aubree, IT)

Respondents' children were confronted with vigorous life stressors, already from a very young age and sometimes even prior to birth. Violence committed by a former partner towards the children as well as towards the mothers was not an isolated case.

> "My ex has tried to strangle me in presence of my child … [He] locked me up underneath the stairs in presence of my child." (Evelyne, OT)

> "I was literally waiting for him to kill me … because sometimes, he grabbed my throat and squeezed it very hard. I used to see it myself a lot with my mother, we had to flee ourselves, literally with a teddy bear in our arms, we ended up there in a shelter. So, no, I don't want the kids to experience that." (Whitney, IT)

Resulting in Insecure Attachment in Offspring

The excerpt below demonstrates how mothers' childhood experiences – and subsequent substance use – are linked to insecure attachment in their children.

> "I notice it now with my son also. The things he wrestles with [separation anxiety], I am partially responsible for it. If I wouldn't have abused drugs, it might not have turned out this way." (Hazel, ITMC)

The following quote shows how a mother's past experience of sexual abuse is still alive in some form of discomfort, when being hold by her daughter. As a consequence, her daughter suffered from separation anxiety, with relational problems persisting across generations through patterns of insecure attachment.

> "When my mother saw me hugging my friend, she began to cry because I had never done that at home, and it got passed on to my daughter. I can't bear that she hugs me for more than two minutes. I'm starting to feel cramped and I'm like: 'It's ok, H.'. But I transmitted it to her, I'm trying my best. (…) To me, those arms, those hands, they burn through my body. And with that I've been … [sexually] assaulted … by my grandfather … since then it got worse, although I've always had that … but since then, it got worse. (…) She cannot live without me. She always used to cry when she didn't see me, or used to panic when she didn't find me immediately." (Lexi, OT)

Latent Trauma Impact on Offspring

Respondents mentioned that feelings of anxiety and stress originated in their childhood as a consequence of frightening, threatening situations and interpersonal trauma. They stated that their children often experienced the indirect impact of mothers' latent trauma (i.e., 'using the past away'). While one mother blames herself for not having seen and intervened when her daughter was sexually assaulted by her partner, another woman recounts the cumulative effects of multiple suicide attempts – stemming from unbearable suffering – on her child. Mothers portrayed the troubles their children face today in light of their own complex past and present, which is often accompanied with shame, regret and feelings of having failed.

> "My daughter got sexually abused by her father, and that's also why I got depressed, because of what had happened to my daughter. I've been there myself, not by my father, by other men, repeatedly, unfortunately … I have never talked about it to anyone. My parents do not know. (…) Taking drugs suppressed my emotions. (…) If I didn't take drugs, I probably might have better noticed that my man touched my daughter. Do you understand what I mean? That's something I do realize now, now I am clean. If only I had been so smart in the past, just to cope with all of that and wanting to feel." (Stella, ITMC)

> "I have done 4 attempts … I always tried to do it with medication, except for once, when I cut my wrists. My daughter was already born then, she even saw it. Because I remember that I said to her that I had cut myself wanting to throw something into the garbage … she still remembers." (Chelsea, OT)

Several mothers had children with a developmental disability, including attention deficit hyperactivity disorder (ADHD), autism spectrum disorder (ASD), learning disorders or attachment disorders, anxiety, etc. Latent trauma among one mother seemed to persist in offspring in terms of speech development.

> "My son has seen things that were absolutely unacceptable. And he still remembers. David [ex-partner] had knocked out my teeth, my son has seen it. I also have been grievously maltreated by my last partner and he has seen a lot of it, which is not ok … and that's because of my drug use, at such moments, I wasn't able to protect my child. It has hugely affected him. When he started in the childcare center, he also had completely stopped talking. He only wanted to talk to me, and not to the childcare workers, which generated a speech impediment." (Hazel, ITMC)

Ultimately, the complex lives of these mothers may have unexpected and unwanted consequences for the next generation. One mother reported about the broken dreams of her daughter, after having been exposed to intimate partner violence and missing her mother for several weeks due to a residential treatment episode.

> "It still breaks my heart. A couple of days ago, Margot [daughter, 10 years] told me: 'Basically, mom, when I bear in mind everything that you have encountered, I don't want to have children anymore.' This really touches my heart." (Noelle, OT)

DISCUSSION

Based on 23 interviews with mothers with SUDs in inpatient and outpatient treatment, this study aimed to provide a profound understanding of parenting experiences through qualitative content analysis. The struggle among mothers to self-regulate frequently shared an etiological base of attachment system dysfunction (101) due to interpersonal childhood trauma. Given the importance of understanding the mechanisms that may promote or impede connections between mothers' own experiences of interpersonal trauma and difficulties in fostering secure attachment with their (young) children, analyses were conducted taking these experiences as a starting point. The current study applies an attachment-theoretical framework to the association between traumatic childhood experiences and substance use and substance-related problems, demanding an alternative etiology of substance abuse — as a symptom of an unmet need that fuels an individual's attraction to a particular substance, rather than a stand-alone disease (102, 103). From this point of view, the self-regulation framework is introduced.

The Self-Regulation Framework: Understanding Object-Relation Re-Enactments

Findings of this study highlight that the ability to calibrate regulatory responses may be compromised among mothers with SUDs and attachment disorders, emphasizing the need to view SUDs within an attachment-based perspective (101). MacLean (104) suggested that opiate use serves as a substitute for relational attachments, which has been an impetus for a growing body of research focusing on addiction as a way of affect regulation. More specifically, addiction can be seen as a transfer by which "affectional bonds" are replaced by "addictional bonds" (105), thereby serving as an alternative means to self-regulate (101). Consequently, seeing addiction as a symptom of early relational trauma (106, 107), substance abuse can be regarded as "an attempt at self-regulation in the service of adaptation" (101), relying on something other than nurturing relationships as a way to nurture the self (108). According to Shults (108), this study reveals how negative self-perception, broken relationships with others, and a distorted world view *via* distorted perceptual filters can result from attachment difficulties. Individuals' attachment-seeking behavior, originating from early broken bonds (109), may ultimately lead to addiction, while representing a re-enactment of past trauma as a defense strategy (110). In this view, the self-medication hypothesis maintains that suffering is at the heart of addictive behaviors (111), with the latter providing the soothing and safety which are the features of an internalized secure base (109). "In the same sense that the attachment figure is sought out when the infant experiences increasing anxiety, the drug of choice may be urgently sought as a substitutive object later in life" (112, p. 61), referring to the predictability and reliability that they might have lacked as a child.

Traumatic childhood experiences can disrupt individuals' psychological stability (113), with attachment vulnerabilities as the root for emotional and adjustment problems, providing mothers with re-enactment desires to a drug of abuse in order to enhance feelings of security and create genuine self-esteem and self-regulatory functions (30). Moreover, lower self-regulation has been associated with SUDs (114). On the other hand, incomplete regulation (115) and less "controllability" (114) can make individuals also more susceptible for substance abuse. Hence, according to a growing body of research (116), childhood trauma can serve as a risk factor for developing SUDs. Fuchshuber and colleagues (86) also confirm that relationships of childhood trauma and personality organization can promote the understanding of individuals developing SUDs. Weegmann and Khantzian (117) describe how ordinary attachment needs and attachment to inanimate substances carry equal features, such as proximity maintenance and homeostasis.

Notwithstanding the persistent impact of insecure attachment throughout the lifespan, a growing body of research emphasizes that attachment representations are not permanent and can evolve across the lifespan (118). The protective role of sensitive caregiving is especially vital in the context of stress and trauma (83). Moreover, parent-child attachment also seems to be a major theme in protecting adolescents from substance use (119). Several psychotherapeutic interventions show promise in ameliorating the types of caregiver-child relationship difficulties that are common among trauma-exposed parents and their young children (83). Also among individuals with SUDs, traumatic attachments can be replaced by healthier, human attachments of various sorts (117, 118). Iyengar and colleagues (118) indicated that mothers with a history of trauma can transition towards secure attachment, based on their enhanced understanding of past and present experiences. Furthermore, children of substance using women can be attached securely, indicating the potential to break the cycle of insecure attachment transmission across generations (120). A recent empirical study in a group of prisoners undergoing therapeutic community treatment revealed an increase in secure attachment after one year of treatment (121). Bortolini and Piccinini (122) revealed consistency in mothers' experiences with their own caregivers characterized by affective, sensitive care and their children's secure attachment, indicating patterns of attachment can be securely transmitted across generations. These are encouraging findings, given the protective role of sensitive caregiving and secure attachment (83, 123, 124), and since attachment security mitigates trauma-related stress (125).

Impact of Trauma on Parenthood and Intergenerational Trauma Transmission

According to Vanderzee and colleagues (126), our study findings confirm the high prevalence of intergenerational trauma among families impacted by maternal substance use. The finding that mothers' disrupted bonds with their parent(s) led to a lack of trust

in their own parenting capabilities, concurs with recent research elucidating impaired parental functioning in adults who grew up in a context of parental substance use (127). Participants reported to have experienced emotional abuse and neglect as a child, resulting in insecure attachment and high parental stress. The long-lasting relational effects of childhood interpersonal trauma may impede parents' capacity (128), increasing the risk of abusive or neglectful behavior towards their own children and maintain the risk of intergenerational cycles of trauma.

Our findings suggest that not only experiencing early interpersonal trauma, but also witnessing such events can severely impact child development (19). A growing body of research focuses on the potential effects of witnessing violence in children (129). Pynoos and Nader (130) examined traumatic responses of children who witnessed sexual assault of their mothers. The researchers found that these children exhibited, amongst others, prominent PTSD-symptoms, alterations in their sense of security and vulnerability, challenged self-esteem, and stress in intra-family and peer relationships. In addition, exposure to child maltreatment (14) and exposure to stress early in life (131) have been associated with a heightened vulnerability for developing SUDs. Streeck-Fischer and van der Kolk (125) refer to the negative prospects of these children in the absence of prevention or early intervention, since they are likely to grow up and lead traumatized and traumatizing lives, as their problems with affect modulation are likely to lead to impulsive behaviour, SUDs and interpersonal violence.

Parental trauma history may intervene with the ability to foster child development (132). Findings of this study reveal how parental trauma can be transmitted through insecure attachment patterns when the mother has experienced early relational trauma. Padykula and Conklin (101) state that interpersonal trauma affects the capacity for emotional regulation negatively, because the emotional subsystem is predicated upon incongruent mirroring. Salberg (133) puts this very well: *"It is because of attachment's primal aspect in our psyches that trauma and its impact constitute massive disruption and disorganization of the parent–child bonding system. When trauma revisits us transgenerationally through disrupted attachment patterns, it is within the child's empathic attunement and bond that the mode of transmission can be found."* In this respect, Brothers (134) refers to the concept of "traumatic attachment," profoundly affecting parent–child interactions over generations. Experiences of early interpersonal trauma can affect parental functioning negatively (135), leading to adverse experiences in second generations. Parents who have traumatic histories themselves and consequential disruptive attachment styles tend to communicate these dysfunctions to their own children who may later develop disruptive attachment patterns (65).

Clinical Implications

Mothers with experiences of early trauma and SUDs are typically fighting against distrust, nonetheless searching for a safe caregiving environment and a genuine therapeutic relationship. Findings suggest this is particularly necessary at the start of care trajectories, allowing ways to properly express feelings related to insecurities in upbringing their children as well as previous events and contemporary emotions in an unprejudiced way. Awareness of mechanisms behind parental uncertainty and intergenerational trauma transmission is needed among practitioners, as well as the recognition of attachment difficulties in mothers with SUDs as a manifestation of underlying trauma. Hence, the impact of early trauma on mothers' parental functioning and the establishment of safe bonding in the newborn should be addressed. Coping with and healing from early trauma, validating its impact and parenting support in the critical first years of life can help mothers to stand on firmer grounds concerning their parenting capacities and to turn their pain into growth. Moreover, increased self-control, resilience, and self-esteem can enhance self-efficacy among individuals with SUDs (136).

Emphasizing the importance of different factors in the etiology, development, and maintenance of addictive behaviour (137), study findings highlight the necessity of applying attachment-enabling interventions in substance abuse treatment, to be designed and delivered in a trauma-informed manner to promote parent–child bonding and healing as a parent in the first place, as self-concept and mothering are deeply related to each other (138). Practitioners need to be aware of the enormous suffering that is at the root of SUDs (117), with a need for treatment to be based in providing what was lacking (30), mindful of the healing potential of trustful interpersonal relationships in the aftermath of trauma. In this respect, the Attachment, Self-Regulation and Competency Model (ARC-model) (22) emphasizes the importance of (re-) building safe relational systems, recognizing the core effects of trauma exposure on relational engagement, self-regulation, and developmental competencies. Furthermore, contacts with treatment providers foremost need to exhale a secure base of safety and confidentiality, where women should feel taken seriously. Consequently, results highlight the importance of a trauma-informed organizational culture in substance abuse treatment. Although there is no consensus regarding the content and modality of an integrated treatment approach focusing on trauma and SUDs (139), this study stipulates its necessity for substance abuse treatment. Our clinical recommendations are in line with Isobel and colleagues (140), who identified two contributing constructs for the prevention of intergenerational trauma transmission: "resolving parental trauma" and "actively supporting parent-infant attachment." Findings reveal the importance of promoting trauma-informed parenting interventions for facilitating secure emotional connections between mothers with SUDs and their children. In addition, supporting mothers in developing alternative pathways for dealing with their suffering requires that trauma disclosures should always be validated and processed within the therapeutic framework, in close consultation with mothers themselves and with their needs in this regard as a guiding principle. In addition, the high risk of re-traumatization and subsequent early drop-out among women needs to be considered. It is important to create a safe environment in which women can build on a safe sense of being and a validating sense of self. Given that practitioners are adequately supervised concerning the impact of trauma and how to carefully deal with it, trauma-related experiences should be systematically assessed within the treatment protocol (141), and — if desired by the individual — addressed. Hereby, it is of

utmost importance for practitioners to be trained and clinically supervised in trauma dynamics, in order to deepen their understanding of the impact of trauma on their work culture, as well as to protect practitioners from vicarious trauma (142).

Study Limitations

A first limitation of this study is the small number of participants, limiting the generalizability of our findings. Second, the effects of long-term therapeutic treatment on mothers' attitudes and reflective abilities need to be considered. Mothers taking part in this study might have been better aware of their psychodynamics, attachments, traumas, and the impact substance use had on their life and children, particularly mothers engaged in mother–child residential treatment. Third, a significant number of mothers lost custody of their children. Participants were skewed towards those with involvement in the child welfare system, indicating the severity of the cases and thus not representing substance using women in general. Lastly, while our focus here was on mothers' reports, we recognize the importance of multiple perspectives (e.g., partner, parents, children, etc.) to enrich our understanding of these transmissions' complexities from a transactional framework, as well as multiple research methods (qualitative and quantitative). Despite these limitations and although there are additional moderators of intergenerational transmission of trauma that we did not capture within the scope of this study, it is one of the first studies that tried to give an in-depth understanding of intergenerational trauma transmission from substance using mothers' perspectives. Insights derived from this study can be helpful for practitioners to decrease mothers' chances of getting involved in destructive re-enactments and diminish vulnerability across generations (110). By understanding the structure of dysregulated parenting among mothers with SUDs and a history of relational trauma, clinicians will have practical information to specifically target interventions to disrupt maladaptive parenting practices and cognitions, making this research valuable for better understanding and enhancing a mother's journey towards recovery from substance use as well as post-traumatic growth.

Recommendations for Further Research

Given that this study as well as other research have noticed a substantial prevalence of childhood interpersonal trauma exposure in women with SUDs, and given the detrimental impact of cumulative trauma on parental functioning, further research should focus on how trauma-informed, effective parenting interventions can be integrated into substance abuse treatment. Also, between group differences (abstinent vs. non-abstinent mothers) regarding trauma transmission and attachment mechanisms may be of interest for further research. A high priority for future research is to discover protective factors by which parents overcome intergenerational patterns of disruptive attachment in the aftermath of trauma. In order to develop evidence-based practices that integrate trauma work into substance abuse treatment interventions, more research is needed on the relationship between profiles of childhood trauma (143), the use of specific substances, and parenting and attachment styles. Such research may identify distinct pathways by which early interpersonal trauma is manifested in parental functioning and offspring outcomes. An enhanced understanding of how parental trauma impacts parenting — in a way that does not further traumatize parents — alongside insights in correlates of post-traumatic growth would be an important step toward recognizing individuals at risk of developing SUDs arising from traumatic attachments. Finally, recent studies have focused on alexithymia in substance using populations (144, 144–146), which recently has also been linked to attachment (147), childhood trauma (148, 149), and suicidal ideation (150–152). Research aimed at furthering knowledge on alexithymia in women with SUDs and their offspring would be of particular interest, as the results of this study may also be explained in terms of secondary alexithymia.

Conclusion

Mothers in this study expressed an etiological base of attachment system dysfunction due to early interpersonal trauma experiences. In an attempt to regulate the painful emotions of not feeling attached and safe in the world, maternal substance use may increase the risk of suboptimal caregiving, perpetuating the cycle of trauma and impacting the establishment of secure attachment in their children's lives. Problematic substance abuse and related parental dysfunction can result in mechanisms by which insecure attachment and trauma are transmitted across generations. Findings indicate the need for these concepts to be regarded in the development and implementation of therapeutic interventions for mothers with SUDs, since this study underlines the need to understand SUDs as resulting initially from broken attachment relationships. Mothers with a history of interpersonal trauma are longing for a home as — being — a place of safety instead of a place of fear, creating parental expectations for themselves which can contribute to fear of parental failure and ultimately challenge parental identification across generations.

DATA AVAILABILITY STATEMENT

Datasets for this manuscript are not publicly available because of ethical reasons and confidentiality. Requests to access the datasets should be directed to FM (Florien.Meulewaeter@UGent.be).

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Committee of the Faculty of Psychology and Educational Sciences of Ghent University (E.C. decision: 2018/42). The patients/participants provided their oral and written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

FM wrote the manuscript and was responsible for general ideas. SD and WV designed the study, provided feedback on the data-analysis process, and revised the manuscript.

ACKNOWLEDGMENTS

We would like to thank all the participants involved in this study for their efforts and trust. Also thanks to Deborah Isobell, whose intellectual support has been important while writing this article.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2019.00728/full#supplementary-material

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychiatry

ORIGINAL RESEARCH
published: 18 October 2019
doi: 10.3389/fpsyt.2019.00674

Profiles of Childhood Trauma in Women With Substance Use Disorders and Comorbid Posttraumatic Stress Disorders

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Background: It is increasingly becoming accepted that substance use disorders, including substance abuse and substance dependence, are closely related to childhood trauma and posttraumatic stress disorders. Among women with substance use disorders, the majority report sexual, physical or emotional abuse, or neglect. However, it is poorly understood which types of childhood trauma co-occur in women with substance use disorders and how combinations of different types and severities of childhood trauma are related to clinical characteristics. This information is important to inform treatment of substance use disorders.

Aim: The first aim of this research was to investigate profiles of childhood trauma in female patients with substance use disorders and posttraumatic stress disorders. The second aim was to examine relationships between these childhood trauma profiles and addiction characteristics or current clinical symptoms.

Methods: We included 343 treatment-seeking women with substance use disorders and comorbid posttraumatic stress disorders according to DSM-IV. Five types of childhood trauma (sexual abuse, physical abuse, emotional abuse) were measured using the Childhood Trauma Questionnaire. Addiction characteristics were assessed by using the Addiction Severity Index-lite. Current severity of clinical symptoms was determined by the Symptom-Checklist-27. Latent profile analysis was conducted to distinguish profiles of childhood trauma. Analysis of variance was applied to examine the relationship between childhood trauma profiles and addiction characteristics or severity of clinical symptoms.

Results: Nine out of ten women reported at least one type of childhood abuse or neglect. Four different childhood trauma profiles could be distinguished that characterized different types and severities of childhood trauma: 'Low trauma'; 'Moderate sexual abuse and emotional abuse'; 'Severe sexual abuse and emotional abuse'; and 'Severe levels of all types of trauma'. Profiles with more severe levels of childhood trauma showed an earlier age at initiation and escalation of substance use.

OPEN ACCESS

Edited by:
Human Friedrich Unterrainer, University of Vienna, Austria

Reviewed by:
Giulia Bassi, University of Padua, Italy
Klemens Ragger, Medical University of Graz, Austria

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Specialty section:
This article was submitted to Addictive Disorders, a section of the journal Frontiers in Psychiatry

Received: *03 June 2019*
Accepted: *20 August 2019*
Published: *18 October 2019*

Citation:
Lotzin A, Grundmann J, Hiller P, Pawils S and Schäfer I (2019) Profiles of Childhood Trauma in Women With Substance Use Disorders and Comorbid Posttraumatic Stress Disorders. Front. Psychiatry 10:674. doi: 10.3389/fpsyt.2019.00674

Furthermore, childhood trauma profiles were related to current severity of depressive symptoms, dysthymic symptoms, sociophobic symptoms, and distrust.

Conclusion: In women with substance use disorders and posttraumatic stress disorders, childhood trauma profiles can inform about addiction characteristics and severity of a wide range of clinical symptoms. This information is essential to understand current treatment needs and should be systematically assessed in women with substance use disorders and trauma exposure.

Keywords: addiction, alcohol, comorbidity, women, caregiving, abuse, neglect

INTRODUCTION

Childhood trauma, including sexual and physical abuse, but also emotional abuse, emotional neglect and physical neglect (1), is a risk factor of developing mental disorders. Approximately 30% of mental disorders are accounted for exposure to childhood trauma (2). Substance use disorders (SUD) are among the most frequent mental disorders following traumatic events. SUD occur when the use of a drug (e.g., alcohol, cannabis or cocaine) leads to clinically significant impairment, including health problems, social withdrawal, and failure to meet major responsibilities at work, school or home (3). SUD are more prevalent in men than in women. For example, seven out of hundred men develop an alcohol use disorder at some point in their life, but only one out of hundred women (4). As SUD are less common in women, women with SUD are generally understudied (5).

Among both men and women with SUD, childhood trauma is highly prevalent. In patients with alcohol use disorders, 22–74% report at least one type of childhood abuse or neglect (6, 7). Female patients more often report severe forms of childhood trauma, particularly sexual abuse (8).

A history of childhood trauma impacts on the development, severity and course of SUD. Patients with alcohol use disorders exposed to childhood trauma develop the disorder at an earlier age (9, 10) and show more severe alcohol abuse (9, 11) than patients without childhood trauma.

Posttraumatic stress disorder (PTSD) is another mental disorder that is closely related to childhood trauma. PTSD is characterized by intrusive memories and nightmares of the trauma, hypervigilance (indicating enhanced threat sensitivity), and avoidance of places, activities or things that could remind a person of the traumatic event (3). Individuals with both SUD and PTSD manifest more severe clinical symptoms and lower psychosocial functioning (12).

In contrast to SUD, PTSD is more common among women: Three out of hundred women develop PTSD at some point of their life, but only one out of hundred men (4). After exposure to a potentially traumatic event, women are more likely to develop PTSD than men (13, 14). This finding might be explained by biological sex differences, but also by the fact that women are more often exposed to severe forms of interpersonal trauma, particularly sexual abuse (15, 16).

Among patients with alcohol dependence, women show about twice as high rates of a current PTSD (26–27%) than men (14–24%) (17, 18). Similar relationships between gender and SUD have been found for other substances than alcohol. Women with opioid use disorder, cocaine use disorder, cannabis use disorder or sedative use disorder showed twice as high prevalence rates of a current PTSD (50–53%) compared to men (14–32%) (19, 20).

Given that childhood trauma and PTSD are closely related to SUD (21), particularly in women, trauma exposure should be systematically assessed in this patient group. Thereby, the co-occurrence of different types and severities of childhood trauma should be considered, as most patients with trauma exposure report multiple types of events (6). The systematic assessment of these profiles of childhood trauma in women with SUD may inform about current mental health problems and related treatment needs. However, no study has identified profiles of childhood trauma in women with SUD and trauma exposure, or has examined how these profiles are related to current health-related outcomes.

So far, childhood trauma profiles have been predominantly examined in male patients with SUD (22–24). Among patients with alcohol dependence, six childhood trauma profiles could be distinguished that comprised different types and severities of trauma (22). The patients' trauma profiles were differently associated with current severity of addiction-related problems in the domains of drug use, psychiatric symptoms, family relationships and social relationships. These results in male patients with alcohol dependence indicated that profiles of childhood trauma may better inform about current severity of addiction-related problems than the common distinction between trauma exposure versus no trauma exposure. Among male patients with SUD or polysubstance abuse, five childhood trauma profiles could be distinguished that were related to psychiatric problems (24). Tubman et al. (25) distinguished three profiles of childhood trauma in adolescents with SUD that were associated with severity of current psychiatric symptoms.

Although childhood trauma in SUD is closely related to PTSD, profiles of childhood trauma have rarely been examined in patients with SUD and comorbid PTSD. One study (26) assessed three different types of childhood trauma (psychological maltreatment, physical abuse, and sexual abuse) in a sample of trauma exposed clinic-referred adolescents. The authors assigned the participants to three different trauma groups, according to different combinations of the measured trauma types. Adolescents with both psychological maltreatment and physical abuse showed greater PTSD symptoms than the remaining groups.

In summary, childhood trauma profiles have been identified in different SUD patient groups that were associated with important mental health outcomes in all of the studies that have been conducted so far. These studies exclusively or predominantly included male patients, and PTSD comorbidity was not assessed. In women with SUD, childhood trauma profiles have not been examined so far. Furthermore, among patients with SUD and comorbid PTSD, childhood trauma profiles are unknown for both male and female patients.

Therefore, the first aim of this research was to investigate profiles of childhood trauma in women with SUD and PTSD. The second aim was to examine the relationships between these childhood trauma profiles and addiction characteristics or current clinical symptoms. We hypothesized that childhood trauma profiles with a greater number and/or severity of childhood trauma types would show unfavorable addiction characteristics and greater current clinical symptoms, compared to profiles with a lower number and severity of childhood trauma.

METHODS

Design

The data of this study are derived from the baseline data of a larger intervention trial among patients with SUD and PTSD (27) (DRKS00004288).

Participants

Subjects were included in the study if they were (1) female, (2) aged between 18 and 65 years, (3) diagnosed with a substance abuse or substance dependence according to DSM-IV, (4) diagnosed with PTSD or subthreshold PTSD (i.e., criterion A, B, and either C or D) according to DSM-IV (28) and if they were (5) willing to participate in the study.

Subjects were excluded from study participation if they (1) were diagnosed with a psychosis according to DSM-IV (28), (2) showed severe cognitive impairment during screening or (3) reported intravenous drug use within four weeks before the start of study.

Procedures

The participants of this trial were recruited in Germany between September 2012 and June 2015 in addiction or mental health inpatient and outpatient counseling and treatment facilities. The study was also promoted by advertisements in public venues. Written informed consent was obtained from all participants. Participants received €20 to compensate for their expenses. Data were collected from October 2012 to June 2015.

Measures

Sociodemographic characteristics were obtained by a self-constructed interview. Psychiatric diagnoses of SUD (i.e., substance abuse and substance dependence) and PTSD were assessed according to DSM-IV criteria.

DSM-IV (28) defines a diagnosis of substance abuse as a maladaptive pattern of substance use leading to clinically significant impairment or distress, as manifested by one (or more) of the following, occurring within a 12-month period: (1) Recurrent substance use resulting in a failure to fulfil major role obligations at work, school, or home; (2) Recurrent substance use in situations in which it is physically hazardous; (3) Recurrent substance-related legal problems; (4) Continued substance use despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of the substance.

In contrast, a diagnosis of substance dependence is defined as a maladaptive pattern of substance use, leading to clinically significant impairment or distress, as manifested by three or more of the following criteria, occurring any time in a 12-month period: (1) Tolerance: (a) a need for markedly increased amounts of the substance to achieve intoxication or desired effect, or (b) markedly diminished effect with continued use of the same amount of the substance; (2) Withdrawal: (a) the characteristic withdrawal syndrome for the substance, or (b) the same substance is taken to relieve or avoid withdrawal symptoms; (3) The substance is often taken in larger amounts or over a longer period than intended; (4) There is a persistent desire or unsuccessful efforts to cut down or control substance use; (5) A great deal of time is spent in activities necessary to obtain the substance, use the substance, or recover from its effects; (6) Important social, occupational, or recreational activities are given up or reduced because of substance use; (7) The substance use is continued despite knowledge of having a persistent physical or psychological problem that is likely to have been caused or exacerbated by the substance (28).

A diagnosis of PTSD according to DSM-IV (28) is defined as fulfilling the following criteria: Criterion A: The person has been exposed to a traumatic event in which both of the following have been present: (1) the person experienced, witnessed, or was confronted with an event or events that involved actual or threatened death or serious injury, or a threat to the physical integrity of self or others; (2) the person's response involved intense fear, helplessness, or horror. Criterion B: The traumatic event is persistently re-experienced in one or more of the following ways: (1) recurrent and intrusive distressing recollections of the event, including images, thoughts, or perceptions; (2) recurrent distressing dreams of the event; (3) acting or feeling as if the traumatic event were recurring; (4) intense psychological distress at exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event; (5) physiological reactivity on exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event. Criterion C: Persistent avoidance of stimuli associated with the trauma and numbing of general responsiveness as indicated by three (or more) of the following: (1) efforts to avoid thoughts, feelings, or conversations associated with the trauma; (2) efforts to avoid activities, places, or people that arouse recollections of the trauma; (3) inability to recall an important aspect of the trauma; (4) markedly diminished interest or participation in significant activities; (5) feeling of detachment or estrangement from others; (6) restricted range of affect (e.g., unable to have loving feelings); (7) sense of a foreshortened future (e.g., does not expect to have a career, marriage, children, or a normal life span). Criterion D: Persistent symptoms of increased arousal,

as indicated by two (or more) of the following: (1) difficulty falling or staying asleep; (2) irritability or outbursts of anger; (3) difficulty concentrating; (4) hypervigilance; (5) exaggerated startle response. The described symptoms must be present for at least one month and must cause clinically significant distress or impairment in social, occupational, or other important areas of functioning.

The Structured Clinical Interview for DSM-IV (SCID) (29) was used to assess diagnoses of SUD and PTSD. The SCID is an established interview to measure psychiatric disorders according to DSM-IV criteria. It has proven sufficient reliability and validity for establishing clinical diagnoses (30).

The severities of the different types of childhood trauma were assessed using the Childhood Trauma Questionnaire (CTQ) (31, 32). The CTQ is a widely used self-report measure that assesses five types of childhood trauma (emotional abuse, physical abuse, sexual abuse, emotional neglect and physical neglect) using 25 items. The frequency of each type of trauma is rated on a five 5-point Likert scale ranging from 1 = "never" to 5 = "very often." A total severity score (ranging from 25 to 125) and scores for each of the five subscales (ranging from 5 to 25) can be calculated. Severity classifications can be derived for each of the five trauma types by cut-off scores (31): "none or minimal" (emotional abuse 5–8, physical abuse 5–7, sexual abuse 5, emotional neglect 5–9, physical neglect 5–7), "low to moderate" (emotional abuse 9–12, physical abuse 8–9, sexual abuse 6–7, emotional neglect 10–14, physical neglect 8–9), "moderate to severe" (emotional abuse 13–15, physical abuse 10–12, sexual abuse 8–12, emotional neglect 15–17, physical neglect 10–12), and "severe to extreme" (emotional abuse ≥16, physical abuse ≥13, sexual abuse ≥ 13, emotional neglect ≥18, physical neglect ≥13). In patients with SUD, the CTQ demonstrated good internal consistencies, factorial, convergent and discriminant validity (32, 33).

Addiction characteristics were assessed by using the Addiction Severity Index-lite (ASI-lite) (34), the short form of the ASI (35). The ASI-lite is a structured interview yielding composite scores for severity of alcohol use and drug use (i.e., substances other than alcohol), among other addiction-related problems, in the last 30 days. ASI-lite composite scores range between 0 = "no problem" to 1 = "extreme problem," with higher values indicating greater severity. For the present study, the alcohol and drug severity scores were combined to one score by using the highest severity score out of both scores as an indicator of substance use severity. Age at initiation of substance use and age at escalation of substance use were used for this study as additional outcomes, which are also assessed by the ASI-lite. The ASI has shown evidence for its internal construct validity, reliability, concurrent validity and utility for a wide range of research applications (36). Studies on the convergent validity of the ASI-lite with the ASI suggested that the ASI-lite alcohol and drug composite scores showed sufficient agreement with the ASI alcohol and drug composite scores (37).

Clinical symptoms within the last seven days were assessed by the Symptom-Checklist-27 (SCL-27) (38). The SCL-27 is a 27-item questionnaire that measures six dimensions of psychopathological symptoms on six subscales ('Depressive symptoms', 'Dysthymic symptoms', 'Vegetative symptoms', 'Agoraphobic symptoms', 'Sociophobic symptoms', and 'Distrust'). Each of these subscales are measured by four to six items. Subscale scores are derived by calculating the mean of the respective items. The items of the subscale 'Depressive symptoms' measure depressive symptoms, e.g., "feeling blue" or "thoughts of death or dying." The items of the subscale 'Dysthymic symptoms' measure less severe cognitive aspects of depressive symptoms, e.g., "trouble concentrating." The subscale 'Vegetative symptoms' assesses somatoform symptoms, e.g., "heart pounding or racing" or "a lump in throat." 'Agoraphobic symptoms' captures criteria of agoraphobia, e.g., "feeling afraid in open spaces or on streets." The items of the subscale 'Social phobia' focus on aspects of self-confidence, e.g., "feeling very self-conscious with others." The subscale 'Symptoms of mistrust' covers symptoms of suspicion and distrustfulness towards others, e.g., "feeling that most people cannot be trusted." The SCL-27 proved satisfying reliability and very good factorial validity (38, 39).

As a potential confounding variable, PTSD symptom severity was assessed using the Posttraumatic Diagnostic Scale (PDS) (40). The PDS is a 49-item questionnaire that allows to assess severity of PTSD symptoms according to DSM-IV. The scale yields a total severity score. The PDS has demonstrated good reliability and validity in patients with alcohol dependence and comorbid PTSD (41).

Statistical Analyses

Latent profile analysis (LPA) (42) was conducted in MPlus version 7.3 to identify profiles of childhood trauma, based on the severities of the five CTQ subscale scores. Latent profile analysis (LPA; also referred to as continuous latent class analysis) is a person-centered statistical technique that allows to classify individuals to homogeneous latent classes (i.e., profiles), based on their responses to observed variables, e.g., severities of different types of childhood trauma. Model parameters were estimated using maximum likelihood estimates. The robust maximum likelihood estimator was used to include participants with missing data. Complete data were available for 94.5% of the participants. To avoid local maxima, 800 random sets of starting values were used in the first step, 40 random sets were set in the second step of optimization and 20 initial stage iterations were used.

The Bayesian Information Criterion (BIC) (43), the sample size adjusted Bayesian information criterion (ssBIC) (44), the Lo-Mendell-Rubin adjusted likelihood ratio test (LMR test) (45) and the Bootstrapped Likelihood Ratio test (BLR test) (46) were used as model fit criteria to compare models with different class solutions. The information statistics BIC and ssBIC were used to compare the goodness-of-fit of competing models; the model with the lowest BIC is preferred. The BIC is based on the likelihood function and includes a penalty term for the number of parameters in the model to avoid over-fitting. The LMR and BLR test were used to compare models with increasing numbers of latent classes. In the LMR and BLR test, the estimated model fit is compared to a model with one class less. A p-value smaller than 0.05 suggests that the estimated model provides a better fit than the model with one class less (47). Entropy (48)

was considered in the selection process as a measure of the accuracy of class assignment. Values greater than 0.80 indicate an acceptable probability of correct class assignment (49). The optimal number of classes was selected using model fit indicators, the interpretability of each class and parsimony. Other considerations included successful convergence, high entropy (greater than 0.80), no less than 1% of total count in a class, high posterior probabilities (near 1.0) and high proportions for the latent classes (all above 1%).

Effects of the childhood trauma classes on addiction-related characteristics, including age at initiation of substance use, age at escalation of substance use and current addiction severity, were analyzed by linear models. Age at initiation of substance use and age at escalation of substance use were analyzed in one multivariate analysis of variance (MANOVA) to account for multiple correlated outcomes. Wilks' lambda was used as a multivariate F-test. Current addiction severity was analyzed in a separate ANOVA, because n = 71 participants had to be excluded from this analysis, because these participants were in inpatient addiction or psychiatric treatment at the time of assessment where substance use was prohibited, which would have biased the results. Effects of the childhood trauma classes on clinical symptoms, including depressive, dysthymic, vegetative, agoraphobic, sociophobic, and distrust symptoms, were analyzed in a second MANOVA. In all linear models, participants' age, years of education and PTSD symptom severity were included as covariates to control for potential confounding, as these variables have been shown to be related to the outcomes in previous studies.

All variance inflation factors of the used variables were smaller than four, indicating low problems with multicollinearity (50). (M)ANOVA analyses were conducted using SPSS IBM Statistics Version 24 (IBMCorp., Armonk, NY).

RESULTS

Sample Characteristics

N = 343 treatment-seeking women with SUD and (at least subsyndromal) PTSD were included in the study. Participants were 40.9 years (SD = 11.4) old, on average. Years of education ranged from 7 to 13 years, with a median of 10 years. Most women were born in Germany (n = 310, 90.4%). Eight out of ten women were unmarried (n = 287, 83.7%), eight out of ten were unemployed (n = 267, 77.8%). Five out of ten women received a monthly income of lower than €1000 (n = 186, 54.4%).

Nine out of ten women (n = 324, 94.5%) were diagnosed with a substance dependence, the remaining women (n = 19, 5.5%) were diagnosed with a substance abuse. Eight out of ten women (n = 290, 84.5%) were diagnosed with an alcohol use disorder. Five out of ten women (n = 165, 48.5%) fulfilled the diagnostic criteria for a cannabis use disorder, three out of ten women (n = 106, 31.2%) fulfilled the criteria for a sedative use disorder. Three out of ten women (n = 97, 28.5%) were diagnosed with a cocaine use disorder; three out of ten women (n = 96, 28.2%) were diagnosed with a stimulant use disorder other than cocaine; and two out of ten women (n = 73, 21.3%) were diagnosed with an opiate use disorder. Eight out of ten women (n = 270, 78.7%) consumed substances within the last 30 days. Six out of ten women (n = 226, 66.1%) previously participated in a substance abuse treatment.

Eight out of ten women (n = 248, 75.2%) fulfilled the criteria for comorbid PTSD; the remaining women fulfilled the criteria for subthreshold PTSD. Two out of ten women participated in prior trauma-related treatment (n = 80, 23.4%). Four out of ten women were diagnosed with a Major Depression (n = 153, 44.9%), six out of ten women were diagnosed with an anxiety disorder (n = 221, 64.4%). Six out of ten women attempted suicide at some point in their life (n = 197, 57.8%).

As defined by our inclusion criteria, all women were exposed to a traumatic event according to DSM-IV (28). Nine out of ten women (n = 320, 93.3%) reported at least one type of childhood abuse or neglect. Eight out of ten women reported at least moderate levels of emotional abuse (n = 267, 78.5%) or emotional neglect (n = 261, 76.5%); seven out of ten (n = 249, 72.8%) reported at least moderate sexual abuse, six out of ten (n = 209, 61.1%) reported at least moderate physical neglect; and five out of ten women (n = 179, 52.2%) reported physical abuse.

Profiles of Childhood Trauma

The LMR test revealed a significant difference between the 4-class and 3-class solution (p = 0.026), but no significant difference between the 5-class and 4-class solution (p = 0.200, **Table 1**). However, the BLR remained significant for the 5-class solution ($p < 0.001$), indicating that the 5-class solution differed from the 4-class solution. The entropy values were greater than 0.80 for all models, indicating a good separation between the classes (48). The 4-class solution yielded meaningful profiles that included different severities of the five types of childhood trauma; the 5-class solution contained the same four childhood trauma profiles as the 4-class solution, and one additional class with a similar curve shape than the 'Severe levels of all types of trauma' class, but with higher mean severities of the different types of trauma. For the 4-class solution, the total counts per class were all higher than 1%, the posterior probabilities were near 1.0 and the proportions for the latent classes were all above 1%. On the basis of the fit indices and meaningful interpretability of the classes, the 4-class model was determined to best fit the data.

Profile 1 (n = 38, 11.1%) was representative of women with SUD and PTSD with minimal emotional and physical abuse, minimal emotional and physical neglect and low sexual abuse (**Table 2**, **Figure 1**). This profile was labelled 'Low trauma'. Profile 2 (n = 114, 33.3%) characterized women with moderate sexual abuse, moderate emotional abuse and moderate emotional neglect, but low physical abuse and physical neglect, and was therefore labelled 'Moderate sexual abuse and emotional abuse'. Profile 3 (n = 93, 27.1%) described women with severe sexual and emotional abuse, combined with severe emotional and physical neglect, but low physical abuse. This profile was labelled 'Severe sexual abuse and emotional abuse'. Profile 4 (n = 97, 28.3%) clustered women with high severities of all types of childhood trauma, including severe emotional, physical and sexual abuse, as well as severe emotional and physical neglect, which was named 'Severe levels of all types of trauma'.

TABLE 1 | Model fit indices of latent profiles of the severities of childhood traumatic events in female patients with substance use disorders and comorbid posttraumatic stress disorders (N = 343).

Class	*Log likelihood*	*BIC*	*ssBIC*	*LMR*	*LMR test p-value*	*BLR*	*BLR test p-value*	*Entropy*
1		10752.4	10720.7	–	–	–	–	–
2	-5097.7	10288.9	10238.1	-5347.0	.000	-5347.0	<.001	0.83
3	-5016.0	10160.4	10090.6	-5097.7	.056	-5097.7	<.001	0.82
4	-4974.3	10112.0	10023.2	-5016.0	.026	-5016.0	<.001	0.81
5	-4936.9	10072.3	9964.4	-4974.3	.200	-4974.3	<.001	0.84

BIC, Bayesian Information Criterion. ssBIC, sample size adjusted Bayesian Information Criterion. LMR, Lo-Mendell-Rubin adjusted likelihood ratio. BLR, Bootstrapped Likelihood Ratio.

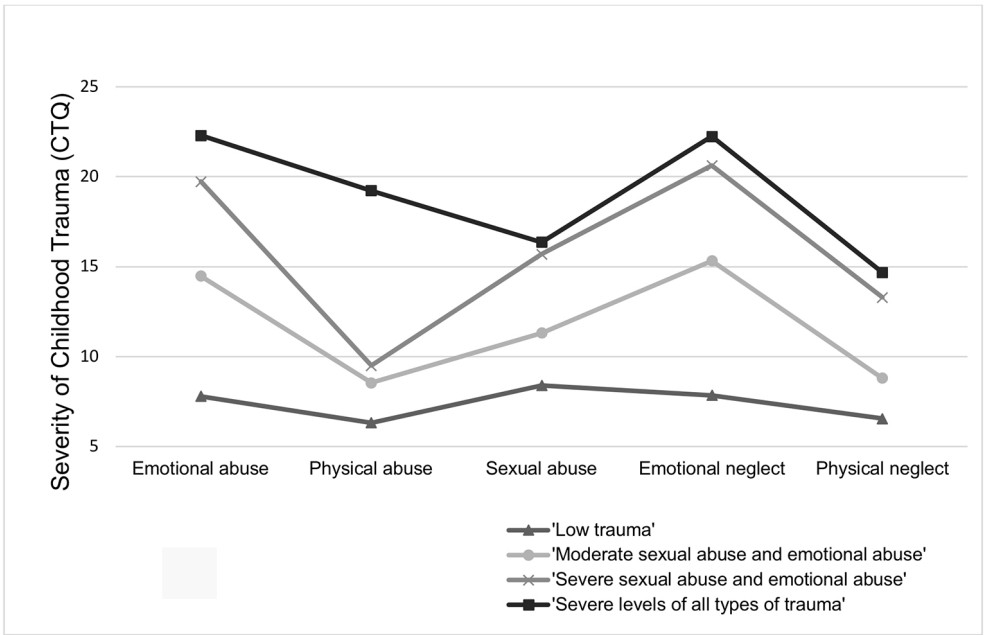

FIGURE 1 | Profiles of childhood trauma in women with substance use disorders and posttraumatic stress disorders. CTQ, Childhood Trauma Questionnaire.

Relations Between Profiles of Childhood Trauma and Addiction Characteristics

Women with a 'Severe sexual abuse and emotional abuse' profile reported an earlier initiation of substance use than women with a 'Low trauma' profile, after controlling for age, education and PTSD severity (**Table 3**). Women with a 'Moderate sexual abuse and emotional abuse' profile or a 'Severe levels of all types of trauma' profile reported an earlier initiation of substance use by trend, compared to women with the 'Low trauma' profile. Among the variables included in the model to control their effects on the outcomes (age, education, and PTSD symptom severity), age was significantly related to age at initiation of substance use, with older women showing later initiation of substance use.

Age at escalation of substance use was also significantly affected by childhood trauma profiles (**Table 3**). Women with a 'Severe sexual abuse and emotional abuse' profile or a 'Severe levels of all types of trauma' profile reported earlier escalation of substance use, compared to women with a 'Low trauma' profile. Women with a 'Moderate sexual abuse and emotional abuse' profile showed an earlier escalation of substance use by trend, compared to women with a 'Low trauma' profile. Among the potential confounder variables, age was significantly related to escalation of substance use, with older women reporting later escalation of substance use.

Current severity of SUD was unrelated to childhood trauma profiles (**Table 3**). Among the confounding variables, age was significantly related to SUD severity, with older women reporting greater SUD severity. Education was also significantly positively related to current SUD severity, with more years of education being related to greater SUD severity.

Relations Between Profiles of Childhood Trauma and Clinical Characteristics

A greater severity of depressive symptoms was shown by women with the 'Moderate sexual abuse and emotional abuse'

TABLE 2 | Clinical and sociodemographic characteristics of childhood trauma profiles (N = 343).

	Profile 1 'Low trauma' (n = 38)	**Profile 2 'Moderate sexual abuse and emotional abuse' (n = 114)**	**Profile 3 'Severe sexual abuse and emotional abuse' (n = 93)**	**Profile 4 'Severe levels of all types of trauma' (n = 97)**
	M (SD)	***M (SD)***	***M (SD)***	***M (SD)***
Age	39.66 (13.03)	39.89 (11.38)	40.62 (11.21)	42.98 (10.70)
Education (years)	10.71 (1.68)	10.90 (1.47)	10.68 (1.66)	10.38 (1.38)
Severity of childhood trauma				
Total severity	7.38 (2.98)	11.69 (3.58)	15.77 (3.73)	18.96 (3.94)
Emotional abuse	7.79 (2.86)	14.47 (3.54)	19.73 (2.78)	22.30 (2.60)
Physical abuse	6.32 (2.03)	8.55 (3.35)	9.51 (3.20)	19.23 (3.02)
Sexual abuse	8.39 (5.32)	11.31 (5.60)	15.69 (6.67)	16.36 (7.19)
Emotional neglect	7.84 (2.44)	15.32 (3.07)	20.63 (2.37)	22.24 (2.63)
Physical neglect	6.55 (2.25)	8.81 (2.34)	13.29 (3.65)	14.68 (4.24)
Age at initiation of SUD	19.53 (8.90)	17.02 (6.22)	16.79 (7.35)	17.81 (9.94)
Age at escalation of SUD	30.31 (13.19)	25.69 (10.2)	25.32 (11.53)	24.39 (11.28)
PTSD symptom severity	24.58 (10.97)	26.35 (9.75)	27.98 (9.36)	28.85 (9.27)
Severity of SUD	0.26 (0.28)	0.31 (0.29)	0.30 (0.28)	0.32 (0.28)
Severity of clinical symptoms				
Depressive symptoms	1.11 (0.90)	1.52 (0.93)	1.68 (0.86)	1.41 (0.95)
Dysthymic symptoms	1.43 (1.09)	1.70 (1.00)	1.95 (0.95)	1.62 (1.01)
Vegetative symptoms	1.19 (0.93)	1.19 (0.83)	1.36 (0.81)	1.39 (0.81)
Agoraphobic symptoms	0.89 (0.88)	1.07 (0.94)	1.19 (0.88)	1.16 (0.93)
Sociophobic symptoms	1.31 (1.04)	1.63 (1.05)	1.88 (0.99)	1.70 (1.05)
Distrust symptoms	0.96 (0.83)	1.40 (0.86)	1.53 (0.97)	1.58 (0.95)

SUD, Substance Use Disorder. PTSD, Posttraumatic Stress Disorder. Severity of childhood trauma was assessed by the Childhood Trauma Questionnaire. Addicted characteristics were measured with the Addiction Severity Index-lite. PTSD symptom severity was assessed by the Posttraumatic Diagnostic Scale. Clinical symptoms were measured using the Symptom-Checklist-27.

TABLE 3 | Effects of childhood trauma profiles on addiction characteristics (N = 343).

Variable	***b***	**95% CI Lower**	**95% CI Upper**	***p***	**Partial η^2**
Age at initiation of substance use					
Profile 2 'Moderate sexual abuse and emotional abuse'[a]	-2.83	-5.83	0.17	.065	.012
Profile 3 'Severe sexual abuse and emotional abuse'[a]	-3.40	-6.48	-0.32	**.031**	**.016**
Profile 4 'Severe levels of all types of trauma'[a]	-2.82	-5.89	0.26	.072	.011
Years of education	0.06	-0.49	0.61	.827	.000
Age	0.27	0.19	0.34	**<.001**	**.142**
PTSD symptom severity	-0.05	-0.14	0.04	.279	.004
Age at escalation of substance use					
Profile 2 'Moderate sexual abuse and emotional abuse'[a]	-3.50	-7.30	0.30	.071	.011
Profile 3 'Severe sexual abuse and emotional abuse'[a]	-4.57	-8.47	-0.67	**.022**	**.018**
Profile 4 'Severe levels of all types of trauma'[a]	-6.39	-10.28	-2.50	**.001**	**.034**
Years of education	0.31	-0.38	1.01	.376	.003
Age	0.55	0.46	0.65	**<.001**	**.306**
PTSD symptom severity	0.00	-0.12	0.11	.952	.000
Severity of substance use disorder[b]					
Profile 2 'Moderate sexual abuse and emotional abuse'[a]	0.04	-0.07	0.16	.455	.002
Profile 3 'Severe sexual abuse and emotional abuse'[a]	0.03	-0.09	0.15	.627	.001
Profile 4 'Severe levels of all types of trauma'[a]	0.04	-0.08	0.16	.536	.001
Years of education	0.03	0.01	0.05	**.013**	**.023**
Age	0.01	0.00	0.01	**<.001**	**.048**
PTSD symptom severity	0.00	0.00	0.00	.874	.000

SUD, Substance Use Disorder. PTSD, Posttraumatic Stress Disorder. [a]Reference category = Profile 1 'Low trauma'. Clinical symptoms were assessed by the Symptom-Checklist-27. [b]n = 272, because 71 participants were in stationary addiction or psychiatric treatment where substance use was prohibited.

profile and the 'Severe sexual abuse and emotional abuse' profile, compared to women with a 'Low trauma' profile, after controlling for age, education and PTSD severity (**Table 4**). Among the potential confounder variables (age, education, and PTSD symptom severity), education and PTSD symptom severity were significantly positively related to severity of depressive symptoms.

A greater severity of dysthymic symptoms were reported by women with a 'Severe sexual abuse and emotional abuse' profile, compared to women with a 'Low trauma' profile. Education and

PTSD symptom severity were also significantly positively related to severity of dysthymic symptoms.

The childhood trauma profiles were not significantly related to severity of vegetative symptoms or agoraphobic symptoms. Instead, PTSD symptom severity was significantly positively related to severity of vegetative and agoraphobic symptoms.

More severe sociophobic symptoms were reported by women with a 'Severe sexual abuse and emotional abuse' profile, compared to women with a 'Low trauma' profile. Women with a 'Severe levels of all types of trauma' profile showed more severe sociophobic symptoms than women with a 'Low trauma' profile by trend. Age and PTSD symptom severity were significantly positively related to sociophobic symptom severity.

A greater severity of distrust symptoms were reported by women with a 'Moderate sexual abuse and emotional abuse' profile, a 'Severe sexual abuse and emotional abuse' profile, or a 'Severe levels of all types of trauma' profile, compared to women with a 'Low trauma' profile. PTSD symptom severity was significantly positively related to severity of distrust symptoms.

DISCUSSION

Profiles of Childhood Trauma

In this study, we investigated profiles of childhood trauma among women with SUD and PTSD, an understudied population in SUD research. Nine out of ten women reported at least one type of childhood abuse or neglect. Remarkably, seven out of ten women reported moderate or severe childhood sexual abuse. The high prevalence of sexual abuse in women with SUD, relative to men with SUD, is consistent with earlier study results (21). Moderate or severe physical abuse was reported by five out

TABLE 4 | Effects of childhood trauma profiles on current clinical symptom severity (N = 343).

Variable	*b*	95% CI Lower	95% CI Upper	*p*	Partial η^2
Depressive symptoms					
Profile 2 'Moderate sexual abuse and emotional abuse'	0.31	0.00	0.62	**.049**	**.012**
Profile 3 'Severe sexual abuse and emotional abuse'[a]	0.44	0.12	0.76	**.007**	**.021**
Profile 4 'Severe levels of all types of trauma'[a]	0.16	-0.16	0.48	.336	.003
Years of education	0.08	0.02	0.14	**.008**	**.021**
Age	0.00	-0.01	0.01	.932	.000
PTSD symptom severity	0.04	0.03	0.05	**<.001**	**.162**
Dysthymic symptoms					
Profile 2 'Moderate sexual abuse and emotional abuse'	0.18	-0.16	0.51	.303	.003
Profile 3 'Severe sexual abuse and emotional abuse'[a]	0.37	0.03	0.72	**.034**	**.013**
Profile 4 'Severe levels of all types of trauma'[a]	0.03	-0.31	0.38	.847	.000
Years of education	0.08	0.02	0.14	**.013**	**.018**
Age	0.00	-0.01	0.01	.783	.000
PTSD symptom severity	0.05	0.04	0.06	**<.001**	**.192**
Vegetative symptoms					
Profile 2 'Moderate sexual abuse and emotional abuse'	-0.09	-0.37	0.19	.539	.001
Profile 3 'Severe sexual abuse and emotional abuse'[a]	0.02	-0.28	0.31	.913	.000
Profile 4 'Severe levels of all types of trauma'[a]	0.02	-0.27	0.32	.868	.000
Years of education	0.02	-0.04	0.07	.541	.001
Age	0.00	-0.01	0.01	.948	.000
PTSD symptom severity	0.04	0.03	0.05	**<.001**	**.188**
Agoraphobic symptoms					
Profile 2 'Moderate sexual abuse and emotional abuse'	0.08	-0.23	0.39	.594	.001
Profile 3 'Severe sexual abuse and emotional abuse'[a]	0.13	-0.19	0.45	.411	.002
Profile 4 'Severe levels of all types of trauma'[a]	0.07	-0.25	0.39	.672	.001
Years of education	0.00	-0.05	0.06	.906	.000
Age	0.00	-0.01	0.01	.915	.000
PTSD symptom severity	0.04	0.03	0.05	**<.001**	**.191**
Sociophobic symptoms					
Profile 2 'Moderate sexual abuse and emotional abuse'	0.29	-0.06	0.65	.108	.008
Profile 3 'Severe sexual abuse and emotional abuse'[a]	0.48	0.12	0.85	**.010**	**.020**
Profile 4 'Severe levels of all types of trauma'[a]	0.32	-0.04	0.69	.084	.009
Years of education	0.05	-0.02	0.11	.187	.005
Age	-0.01	-0.02	0.00	**.002**	**.027**
PTSD symptom severity	0.04	0.03	0.05	**<.001**	**.128**
Distrust symptoms					
Profile 2 'Moderate sexual abuse and emotional abuse'	0.36	0.03	0.68	**.031**	**.014**
Profile 3 'Severe sexual abuse and emotional abuse'[a]	0.45	0.12	0.78	**.008**	**.021**
Profile 4 'Severe levels of all types of trauma'[a]	0.48	0.15	0.81	**.005**	**.023**
Years of education	0.02	-0.05	0.08	.628	.001
Age	0.00	-0.01	0.01	.946	.000
PTSD symptom severity	0.03	0.02	0.04	**<.001**	**.108**

PTSD, Posttraumatic Stress Disorder. [a]Reference category = Profile 1 'Low trauma'. Clinical symptoms were assessed by the Symptom-Checklist-27.

of ten women. Compared to a predominantly male SUD sample (22), the prevalence of childhood physical abuse was lower in our female sample used in this study. This gender difference in the type of experienced trauma emphasizes the need of gender specific treatment programs. To date, these specific treatment needs among male and female patients with SUD are not appropriately addressed.

Among women with SUD and PTSD, we identified four distinct profiles of childhood trauma. Given that all participants of our study were diagnosed with at least subsyndromal PTSD, only one out of ten women belonged to a 'Low trauma' profile, characterized by low levels of interpersonal childhood trauma. The women assigned to this profile reported minimal levels of emotional and physical abuse, as well as minimal neglect, but low levels of sexual abuse. Hence, low levels of sexual abuse seem to take place in family environments that do not necessarily incorporate other types of childhood abuse or neglect.

Three out of ten women could be best described by a 'Moderate sexual abuse and emotional abuse' profile. These women had been exposed to moderate sexual abuse, combined with moderate emotional abuse and emotional neglect. In a study among predominantly male pathological gamblers (23), a comparable childhood trauma profile was identified, characterized by sexual abuse combined with emotional abuse and neglect. This profile comprised a particularly high rate of female patients. Among all female pathological gamblers that participated in this earlier study, four out of ten women belonged to this profile, which matches the proportion of women with SUD assigned to the 'Moderate sexual abuse and emotional abuse' profile in this study. Hence similar trauma profiles might exist for women with SUD across different types of addictive disorders.

Three out of ten women were grouped to a 'Severe sexual abuse and emotional abuse' profile, characterized by severe sexual and emotional abuse, combined with severe emotional and physical neglect. This profile was characterized by low physical abuse. In an earlier study among primarily male patients with SUD (22), a small subgroup of the sample was best described by a profile of severe sexual abuse, severe emotional neglect and moderate to severe emotional abuse, but no physical abuse. This profile was most often reported by women. In contrast, men that were exposed to severe levels of sexual abuse more often reported additional physical abuse. According to these results, sexual abuse seems to be more frequently combined with physical abuse in men than in women.

Thirty out of hundred women reported 'Severe levels of all types of trauma', comprising severe emotional, physical and sexual abuse, as well as severe emotional and severe physical neglect. This is a large proportion of the whole sample, compared to other research using addiction samples (22, 23). In an earlier study with primarily male patients with alcohol dependence (22), only four out of hundred patients belonged to this high-risk profile; in a study with predominantly male patients with gambling disorders (23), twenty out of hundred patients were assigned to a similar profile. The extremely high prevalence of this very severe trauma profile might be partly explained by the fact that this study only included women with SUD and at least subsyndromal PTSD. However, given that five out of ten women with SUD are affected by comorbid PTSD (19, 20), extreme levels of all types of trauma exposure seem to concern a large subgroup among the whole population of women with SUD.

Noteworthy, women of the 'Severe sexual abuse and emotional abuse' profile described more severe depressive and dysthymic symptoms compared to women of the 'Severe levels of all types of trauma' profile. The main difference between these two profiles was that the latter included additional severe physical abuse. One explanation of the lower levels of depressive and dysthymic symptoms in the 'Severe levels of all types of trauma' profile might be that women may respond to severe sexual and emotional abuse with internalizing symptoms, e.g., depression, whereas women might respond to severe physical abuse in addition to sexual abuse with externalizing symptoms, e.g., aggressive behavior (51) that may mask depressive symptoms. Consistent with this idea, women exposed to severe physical abuse in childhood had an increased risk to become a perpetrator by themselves in adulthood (52).

Comparing the profiles of childhood trauma identified in this study with the profiles found in earlier studies (22, 23), this analysis did not reveal a profile with moderate levels of emotional neglect, but no other types of childhood trauma. The absence of this profile can be explained by the fact that this study only selected women with a comorbid posttraumatic stress disorder, which is caused by extremely threatening active forms of traumatic events, such as physical and sexual abuse. A substantial amount of women with SUD but without PTSD might be characterized by an emotional neglect profile, which are underrepresented in this study. Future studies might include women with SUD but without PTSD in order to identify additional profiles of childhood trauma among women with SUD.

Relations Between Profiles of Childhood Trauma and Addiction Characteristics

Childhood trauma profiles were related to addiction characteristics, after controlling for age, education and PTSD severity. The 'Severe sexual abuse and emotional abuse' profile significantly predicted earlier initiation of substance use, compared to a 'Low trauma profile'. The 'Moderate sexual abuse and emotional abuse' and the 'Severe levels of all types of trauma' profile showed earlier initiation of substance use by trend. The women of these three trauma profiles initiated substance use three years earlier than the women of the 'Low trauma' profile, on average. These results concur with earlier research in SUD samples that showed that childhood trauma exposure was associated with earlier substance use (10). Similarly, more severe childhood trauma profiles were related to earlier onset of SUD in patients with alcohol dependence (22).

The 'Severe sexual abuse and emotional abuse' and the 'Severe levels of all types of trauma' profiles were significantly related to an earlier escalation of substance use, compared to a 'Low childhood trauma' profile. The 'Moderate sexual abuse and emotional abuse' profile was related to earlier escalation of substance use by trend. These findings are in agreement with earlier research that

reported that a higher number and severity of childhood trauma was associated with earlier onset of substance abuse (9). Trauma exposure might be related to earlier initiation and escalation of substance use, as it may help to dampen negative cognitions and emotions during and after abuse, as well as to reduce intrusions and arousal related to PTSD. Consistent with this assumption, Runtz and Schallow (53) found that women with a sexual abuse exposure more often used dysfunctional forms of coping, such as alcohol use.

Childhood trauma profiles were unrelated to current severity of SUD. Although the mean severity of SUD was lower for the 'Low trauma' profile, there was substantial variation within this profile and the difference was not statistically significant, indicating that the mean effect of childhood trauma profiles on SUD severity was minimal. Previous studies that examined relations between SUD characteristics and childhood trauma (54, 55) or childhood trauma profiles (22) also reported no relations between these variables. As addiction severity is determined by multiple factors, other factors may have masked the effect of trauma on SUD severity. Alternatively, the missing association between trauma exposure and SUD severity might be due to methodological issues. Most of the studies mentioned above (22, 55) used the ASI or ASI-Lite to assess SUD severity, which might lack power to discriminate SUD severity between subgroups of patients with SUD. Although trauma exposure might be unrelated to SUD severity at intake, there is evidence that trauma exposure is related to lower reduction in SUD severity over course of SUD treatment (15), as well as to lower reduction in SUD severity after treatment (15, 54). Further studies should clarify the relationship between childhood trauma profiles and SUD severity using different measurement approaches than the ASI.

Relations Between Profiles of Childhood Trauma and Clinical Characteristics

Childhood trauma profiles were related to severity of current clinical symptoms. The 'Moderate sexual abuse and emotional abuse' profile and the 'Severe sexual abuse and emotional abuse' profile were related to greater depressive symptoms, e.g., "feeling blue" or "thoughts of death or dying," compared to a 'Low trauma' profile (**Table 4**). The 'Severe sexual abuse and emotional abuse' profile was also related to more severe dysthymic symptoms that indicated cognitive aspects of depressive symptoms, e.g., "trouble concentrating." Relations between depressive symptoms and trauma exposure have been previously reported in SUD samples (54).

The 'Severe sexual abuse and emotional abuse' profile was related to more severe sociophobic symptoms, i.e., aspects of low self-confidence (39); the 'Severe levels of all types of trauma' profile was related to sociophobic symptoms by trend. These findings are consistent with the results of a previous study in which sexual abuse was related to greater social anxiety (56). A negative self-concept including low self-confidence is typically seen in individuals with complex PTSD (57).

All three profiles that included moderate to extreme interpersonal childhood abuse ('Moderate sexual abuse and emotional abuse', 'Severe sexual abuse and emotional abuse', 'Severe levels of all types of trauma') showed more severe symptoms of distrust. The highest levels of distrust were reported by women belonging to one of the two profiles including severe abuse ('Severe sexual abuse and emotional abuse' and 'Severe levels of all types of trauma'). Symptoms of mistrust, i.e., suspicion and distrustfulness, characterize patients with complex PTSD (58).

When compared to a representative German population (38), all trauma profiles, including the 'Low trauma profile', characterized elevated levels of clinical symptoms. Nevertheless, type and severity of trauma exposure greatly varied within women with SUD and PTSD, pointing to the need to assess profiles of childhood trauma. Women with severe trauma profiles may need treatment that considers underlying vulnerabilities related to early chronic interpersonal trauma. This may include the modification of dysfunctional cognitive schemas that affect self-concept, mistrust, and interpersonal behavior.

Secondary Results

Among the variables that were included in analysis to control their effect on dependent variables, we found that older women reported later initiation and escalation of substance use. Although most individuals with SUD initiate substance use in adolescence or adulthood, some women initiate substance use in mid or late adulthood (59). This earlier finding is reflected in our data. Older women also showed greater SUD severity than younger women. This result might be explained by the fact that age is correlated with lifetime alcohol consumption, which in turn is likely to be associated with greater SUD severity (60). As reported by a previous study (61), older women also showed less sociophobic symptoms, indicating that social anxiety might decline with age.

Women with more years of education showed greater SUD severity. This result is consistent with earlier results of a national German addiction survey (62) that found positive associations between socioeconomic status and SUD severity. More years of education were also associated with depressive symptoms and dysthymic symptoms, which might be related to greater SUD severity.

PTSD symptom severity was unrelated to addiction characteristics. This is an interesting result, given that it is generally assumed that substances are used to regulate PTSD symptoms, in terms of a self-medication hypothesis (63). In line with earlier research (64), PTSD symptom severity was associated with clinical symptoms other than SUD, including depressive, dysthymic, vegetative, agoraphobic, sociophobic, and distrust symptoms. These results indicate that women with SUD and PTSD suffer from complex comorbidities that should be addressed in treatment of women with SUD and PTSD.

Strengths and Limitations

A strength of this study is that we examined a sample of women with SUD, an often overlooked and understudied

patient group. We assessed a wide range of different childhood trauma types, including emotional abuse, emotional neglect, and physical neglect. These types of childhood trauma are often underrepresented in trauma research. However, we excluded male patients with SUD, which can be considered as a weakness of this study, as our findings cannot be generalized to men with SUD and PTSD. We were also unable to recruit a sample that was representative for the whole population of women with SUD and PTSD. However, our recruitment strategy resulted in a sample with various types and severities of SUD and childhood trauma.

We went beyond traditional approaches by investigating childhood trauma profiles including different severities and types of trauma. At the same time, we did not assess non-interpersonal types of childhood trauma. Future studies might assess these additional types of trauma and their relationship to addiction characteristics and clinical symptoms.

The cross-sectional design of this study does not allow conclusions about causal relationships between childhood trauma exposure, addiction characteristics and clinical symptoms. Due to the cross-sectional design, trauma exposure was assessed retrospectively, that might be related to recall bias. Another limitation of the study can be seen in the use of LPA that is an exploratory statistical technique to uncover latent homogeneous groups within a sample. Given its exploratory nature, no *a priori* assumptions about the number of classes were made (47). It is also worth mentioning that not all of the model fit statistics indicated that a 4-class solution best fitted the data. Further studies should examine whether a 4-class solution best describes childhood trauma profiles among women with SUD and PTSD.

DSM-IV criteria of SUD and PTSD were used to include participants in this study. The diagnostic criteria of DSM-5 significantly differ from the criteria outlined in DSM-IV. As a result, it is likely that we included participants in this study which might have not met the trauma criterion according to DSM-5 (65). Hence, the trauma profiles found in this study might diverge from profiles among women with SUD and PTSD diagnosed according to DSM-5.

Despite these limitations, the results of this study add important knowledge about childhood trauma profiles and their role for addiction characteristics and clinical symptoms in women with SUD and PTSD. Childhood sexual abuse was highly prevalent, and combinations of severe to extreme forms of childhood abuse and neglect were reported by the majority of women. Childhood trauma profiles explained early initiation and escalation of substance use, as well as a greater severity of a wide range of clinical symptoms. These findings have important implications for treatment of comorbid SUD and PTSD among women. Childhood trauma profiles should be routinely assessed to inform treatment. Given that childhood trauma profiles were related to a wide range of clinical symptoms beyond SUD and PTSD, these additional clinical symptoms should be also considered in treatment. As women with SUD are less adherent to treatment than men, treatment programs should address common reasons for lower treatment adherence by offering childcare and services specific for women's issues (66). For example, mental health consequences of sexual abuse should be preferably treated in gender-specific groups (67).

CONCLUSION

In a sample of women with SUD and PTSD, childhood trauma profiles with a greater severity and a higher number of childhood trauma were related to earlier initiation of substance use, earlier age at escalation of substance use and greater severity of a broad range of current clinical symptoms. According to these findings, childhood trauma profiles can provide a differentiated view about important addiction characteristics and current severity of a wide range of clinical symptoms. This information is essential to inform treatment needs in women with SUD and PTSD.

DATA AVAILABILITY

The datasets generated for this study are not publicly available as the participants did not provide consent to make data available for the public.

ETHICS STATEMENT

The study was approved by the local ethics committees of the medical associations of the study sites (Ethics Committee of the Medical Association Hamburg, Ethics Committee of the Hannover Medical School, Ethics Commission of the Medical Association of Westphalia-Lippe and the Medical Faculty of Westphalia Wilhelms University, Ethics Committee of the North Rhine-Westphalia Medical Association and Ethics Commission of the Medical Faculty of the University of Duisburg-Essen). The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

IS and SP designed the study. PH, JG and AL managed the conduct of the study. PH led the data assessment and data management. AL conducted the statistical analysis and wrote the first draft of the manuscript. AL, JG, PH, SP and IS contributed to and approved the final manuscript.

FUNDING

This work was supported by the German Federal Ministry of Education and Research (BMBF) under grant number 01KR1203A.

ACKNOWLEDGMENTS

We greatly thank study participants who took the time to participate in the study. We thank all study personnel and collaborators for their support in the conduct of the study, in particular R. Hiersemann, M. Bamberg, H. Dirks, A. Dotten, L. Dreetz, M. Huppertz, J. Reeder and B. Röllenbleck. We would also like to thank K. Wegscheider, M. Bullinger and C. Muhtz for their participation in the data and safety monitoring committee, M. Härter, M. Klein, M. Mülhan, U. Ravens-Sieberer and R. Thomasius as members of the CANSAS-Study Group, as well as P. Resick, M. Cloitre and E. Foa for their contribution as being part of the advisory board. Finally, we thank C. Kateifides for proofreading the manuscript.

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychiatry

ORIGINAL RESEARCH
published: 06 November 2019
doi: 10.3389/fpsyt.2019.00807

Attachment Patterns in Subjects Diagnosed With a Substance Use Disorder: A Comparison of Patients in Outpatient Treatment and Patients in Therapeutic Communities

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OPEN ACCESS

Edited by:
Andreas Schindler, University Medical Center Hamburg-Eppendorf, Germany

Reviewed by:
Michaela Hiebler-Ragger, Medical University of Graz, Austria
Peter Michael Sack, University Medical Center Hamburg-Eppendorf, Germany

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Specialty section:
This article was submitted to Addictive Disorders, a section of the journal Frontiers in Psychiatry

Received: *11 April 2019*
Accepted: *11 October 2019*
Published: *06 November 2019*

Citation:
Vismara L, Presaghi F, Bocchia M, Ricci RV and Ammaniti M (2019) Attachment Patterns in Subjects Diagnosed With a Substance Use Disorder: A Comparison of Patients in Outpatient Treatment and Patients in Therapeutic Communities. Front. Psychiatry 10:807. doi: 10.3389/fpsyt.2019.00807

The purpose of the present study is to analyze the quality of attachment in substance abuse patients in outpatient treatment vs. patients in therapeutic communities in order to identify the role of attachment insecurity in choosing a care system. The sample consisted of 127 subjects (107 males and 20 females); 97 were outpatients (83 males) and 30 therapeutic community patients (24 males). Attachment with respect to current, significant relationships was assessed using the Relationship Questionnaire. In the outpatient subgroup, the prevailing attachment style was preoccupied; for the therapeutic community patients, the prevailing attachment style was dismissive. The dimensions of care (how the caregiver is perceived as loving and caring) and overprotection (how the caregiver is perceived as intrusive and interfering)—evaluated by means of the Parent Bonding Instrument—were higher in the outpatient subgroup. Scores were higher with respect to maternal subscales regardless of treatment modality. No differences emerged with respect to self-perceived symptoms (SCL-90-R) between the subgroups; however, fearful-avoidant and dismissive-avoidant individuals reported higher self-perceived symptom regardless of treatment modality. Understanding the distribution of different attachment patterns with respect to the treatment modality may improve efficacious interventions, attuning them to the individual and his or her developmental environment.

Keywords: substance use disorder, attachment patterns, care system, diagnosis, intervention

INTRODUCTION

Substance abuse is a relevant phenomenon at a clinical and social level in Western countries: about 50.0% of youths use illicit substances by age 16 (1–3). Among the complex interaction of variables that may contribute to such a phenomenon (4) the contribution of family experiences will be the focus of the current study.

In the context of substance abuse and dependence, family relations are found to lack support and be disorganized, multi-problematic, unpredictable, and inconsistent (5–10). It stands to reason that such experiences impact the attachment system and, consequently, the development of emotional

regulation and self-representation (11–14). Indeed, a vulnerable self-regulation system is one of the most significant risk factors for substance abuse and dependence (15–17).

Despite the importance of attachment theory to the mechanisms linked to the onset of substance dependence and abuse, research on the subject is still limited. Existing empirical data have shown a link between first attachment relations and subsequent development of a dependence disorder (12, 18–22). Data have also confirmed the role of attachment in the context of substance use disorders (SUDs), not only at a behavioral and representational level but also at a neuronal level, demonstrating decreased white matter connectivity in poly-drug users (23, 24). However, data do not explain the direction of the influence of attachment and substance abuse.

Differences concerning prevailing attachment patterns may be due to the heterogeneity of the adopted methods. In fact, much of the current data are derived from studies conducted on clinical, but not select, groups. These examined subjects may present a primary diagnosis other than substance abuse, and many show a high incidence of comorbidity. In addition, attachment patterns may vary in relation to the kind of used substance (25).

Another discriminating aspect concerns the chosen instrument. Some studies applied the Adult Attachment Interview (AAI) (26). Others used self-reports that defined different models of attachment based on different, specific assumptions (27–29).

Within AAI's studies, the majority of the subjects showed either dismissive or enmeshed-preoccupied insecure attachments (19, 21, 30). Fonagy et al. (19) found the unresolved-disoriented attachment pattern to be the most frequent, showing the inability to process traumatic experiences as a crucial variable for the onset of such disorders.

Studies that applied Hazan and Shaver's self-report questionnaire (31) indicated avoidant attachment as the most common style among substance users (32, 33). Using Bartholomew's four categories of attachment (34, 35), the prevalent attachment strategy was either dismissive-avoidant or fearful-avoidant (29, 36, 37). Schindler et al. (38) carried out a cluster analysis to show the family attachment patterns of its members. The majority of members showed a "triangulated" pattern: preoccupied mothers, dismissive-avoidant fathers, and fearful adolescents.

Moreover, differences may depend on comorbidity. Several studies have shown a high association between substance abuse and personality disorders (39). Also, more negative consequences have emerged in patients with a diagnosis of SUD and a comorbid major depressive or post-traumatic stress disorder (40).

Poly-substance abuse may also explain these empirical inconsistencies. Several studies have shown a high frequency of psychopathology among poly-abusers (39). However, the type of used substance does not seem to be linked to the degree of impairment in the attachment system or the personality disorder specifically (41).

In conclusion, substance abuse is associated with insecure attachment; however, it is not associated with a specific quality of insecure attachment. The current study contributes to the study of attachment in poly-substance abusers with respect to different treatment modalities: subjects in outpatient care vs. subjects in therapeutic communities.

Outpatient treatment deals with prevention, care, and rehabilitation. The main aim is to prevent the diffusion of legal and illegal substance abuse and to intervene in favor of the health of individuals and their families. *Therapeutic communities*, in comparison, carry out personalized therapeutic interventions in a residential context.

Several studies have looked at the efficacy of interventions with substance-dependent individuals (42, 43). Meta-analytic reviews have shown that there is no substantial difference in treatment typology: hospital, therapeutic community, intensive, or ordinary outpatient treatment (44, 45). However, in the case of more serious diagnoses, hospitalization seems most effective, while outpatient treatment seems more appropriate for patients with stable psychosocial conditions and minor impairments (46, 47).

Research (although not specifically focused on substance abuse) has shown that patients in therapeutic communities often have more vulnerable backgrounds. They come from mono-parental families, have experienced abuse, and exhibit more criminal behaviors, more depressive symptoms, alcoholism, more aggressive attitudes, and cognitions. Outpatients, in comparison, have more problems concerning medical and psychiatric comorbidity (48–50).

Understanding individuals' attachment quality may help to establish a good treatment compliance that considers the specific individual and his or her family's characteristics and problems (37, 51–55). Studies on the association between attachment patterns and treatment compliance are insufficient; yet, dismissive and avoidant styles seem to be the strongest connection to poor intervention outcome and adherence (56). One study targeting attachment in inpatients with a substance use diagnosis showed that anxious-preoccupied attachment was linked to treatment retention (57). However, other variables should be considered to explain the relationship between attachment and SUD treatment, such as comorbid personality disorder, cognitive deficits, and age (58, 59).

Hypotheses

The purpose of the present study was to analyze the quality of attachment in subjects diagnosed with a SUD attending outpatient care compared to those attending therapeutic communities in order to identify the role of attachment in choosing treatment modality.

In particular, we expect:

A higher frequency of insecure attachment patterns compared to secure ones among subjects diagnosed with a SUD.

A Different Distribution of Attachment With Respect to Treatment Modality; Specifically:

- a higher frequency of dismissive-avoidant subjects—characterized by a predisposition to withdraw from family relationships—among subjects in therapeutic community treatment;

– a higher frequency of preoccupied subjects—characterized by a tendency to be over-involved in their family relations, from whom they are not able to become autonomous—among subjects in outpatient care.

A Different Family History With Respect to Treatment Modality; Specifically:

– a higher frequency of bonds—characterized by low care and low overprotection—among subjects in therapeutic community care, considering the absence or weakness of their relationship with family figures;
– a higher frequency of bonds—characterized by high or low care and high overprotection—among subjects in outpatient care, considering the controlling relationship with their family figures.
– a higher frequency of self-reported symptoms among subjects with an insecure attachment pattern, regardless of treatment modality.

MATERIALS AND METHODS

Participants

A total sample of 127 subjects with a diagnosis of SUD (107 males and 20 females) were recruited in Liguria (northern region of Italy). There were n = 97 (83 males) outpatient participants and n = 30 (24 males) participants treated in *therapeutic communities* (**Table 1**). No relationship was found between gender and type of care system [$\chi^2(1) = .535$ $p > .05$]. The average age of the participants was about 30 years (SD = 6.4, age range: 18 to 52). No significant age difference emerged between males (M = 30.28; SD = 6.29) and females (M = 29.30; SD = 6.80). Additionally, no differences emerged between subjects with a diagnosis of SUD attending outpatient care (M = 30.09; SD = 6.44) and those attending *therapeutic communities* (M = 30.23; SD = 6.17).

Considering the type of abused substance, about 75.8% of the sample (n = 75) reported heroin as their primary abused substance. The other abused substances included cannabinoids, cocaine, and ecstasy. No significant relationship emerged between the type of abused substance (heroin vs. other abused substances) and the type of chosen care system [$\chi^2(1) = 0.01$, $p > .05$, n = 99]. For 28 participants, it was not possible to determine the primary abused substance.

TABLE 1 | Gender distribution with respect to care system.

	M		F		Total	
	Fr	%	Fr	%	Fr	%
Outpatient care	83	65.4	14	11.0	97	76.4
Therapeutic community care	24	18.9	6	4.7	30	23.6
Total	107	84.3	20	15.7	127	100.0

Measures

The following battery of questionnaires was administered: the Symptom Checklist-90-Revised (SCL-90-R), the Relationship Questionnaire (RQ), and the Parental Bonding Instrument (PBI).

The SCL-90-R (1977/83) is a 90-item self-report that evaluates several psychological problems and symptoms. Items are scored on a scale from 0 (none) to 4 (very much), with respect to nine symptom scales: SOM (somatization), O-C (obsessive-compulsive), I-S (interpersonal sensitivity), DEP (depression), ANX (anxiety), HOS (hostility), PHOB (phobic anxiety), PAR (paranoid ideation), and PSY (psychoticism). Global indexes refer to the Global Severity Index (GSI), which measures overall psychological distress; the Positive Symptom Distress Index (PSDI), which measures the intensity of symptoms; and the Positive Symptom Total (PST), which reports a number of self-reported symptoms. The SCL-90-R has shown good convergent validity with the MMPI (60) and with the GHQ-28 (61). Test-rest reliability indexes are also satisfying, ranging from .68 (somatization) to .83 (paranoid ideation) with an interval of 2 weeks (62).

The RQ (63) consists of a single item that describes each of the four-category representations of attachment in close relationships (i.e., secure, preoccupied, fearful-avoidant, and dismissive-avoidant) in four short paragraphs. Respondents rate their degree of correspondence with each description (**Table 2**) on a 7-point scale.

The RQ allows for both a categorical and a dimensional evaluation of a subject. With respect to the latter, individuals may be described along two dimensions: a) self model/anxiety and b) other model/avoidance. Inter-rater reliability ranged from .87 and .95 (64), while convergent validity was satisfactory, considering the AAI three-category system (65). The test-rest reliability was also discrete (about 70.0% of congruent classifications) after a 4-year interval (66).

The PBI (67; 68) is a 25-item self-report that evaluates maternal and paternal care and over-protection during the first 16 years of a child's life. The 12 "care" and 13 "over-protection" items are rated on a 4-point Likert scale from 0 (not at all) to 3 (completely). The combined (high vs. low) score allows a researcher to attribute one of the four attachment categories (**Table 3**). Cut-off scores for the care dimension are 27 and 24 for the mother and father versions, respectively; cut-off scores for over-protection are 13.5 and 12.5 for the mother and father versions, respectively. The PBI showed

TABLE 2 | Bartholomew and Horowitz's model of attachment relationships (63).

		Self (*Dependence*)	
		Positive	***Negative***
Other *(avoidance)*	*Positive*	SECURE At ease with intimacy and autonomy	PREOCCUPIED Preoccupied by relationships
	Negative	DISMISSING/AVOIDANT Refusal of intimacy and dependence	FEARFUL/AVOIDANT Fear of intimacy and social avoidance

TABLE 3 | Parenting styles according to Parker et al.'s model (66).

	High overprotection	Low overprotection
High care	Affectionate constraint	Optimal bond
Low care	Affectionless control	Weak bond

a good construct and convergent validity (67) as well as good test–retest reliability, ranging from .79 to .96 (69).

Procedure

Participants were recruited within the public health service of La Spezia (Italy). Instruments were administered within the clients' evaluation/intervention program, for which patients signed written consent.

Attachment measures were added to the standard evaluation process carried out by the Local Health Service; it involved clinical interviews, the Structured Clinical Interview for the DSM-IV (SCID-IV, 1994), and the MMPI-2 (70). Regular medical drug testing was also performed. Diagnoses, therefore, were provided to the research team by the Local Health Service.

The study was approved by the Ethical Committee of the University of Cagliari (prot. N° 2019-UNCACLE-0228682).

Overview of Statistical Analysis

Chi-square statistics were used to investigate the relationship between the distribution of attachment categories and to inspect the direction of the relationship we considered standardized residuals. Analysis of variance and analysis of covariance were considered for investigating average differences among the PBI dimensions and psychopathological distress assessed with SCL-90-R with respect to the care system and attachment categories. For ANOVA we will consider estimates of partial eta squared as measure of effect sizes assuming values around .01 as "small" effect size, values around .09 as "medium" effect size, and values around .25 as "large" effect size. Finally, a logistic regression analysis was used to investigate whether attachment categories and dimensions reliably predict the care system choice.

RESULTS

Distribution of Attachment Categories as Function of the RQ and PBI

Table 4 shows the distribution of attachment categories in the sample of subjects diagnosed with a SUD based on the RQ classification system. As expected, there was no equal distribution between the four attachment categories [χ^2 (3) = 29.05, $p < .01$] and the most frequent category was preoccupied attachment (43.7%) while fearful-avoidant attachment was the least represented (10.3%). As no comparison group was available, we compared this distribution of attachment categories to a similar sample examined by Schindler et al. (54) although constituted by adolescents (**Table 4**).

The two distributions (Italian adults vs. German adolescents) diverged systematically [χ^2 (3)= 64.8, $p < .01$] with respect to the fearful-avoidant attachment category that was significantly less frequent in the Italian sample (10.3%) than in the German sample (65.0%). This difference remained even when we excluded participants who chose *therapeutic communities* from the Italian sample [χ^2 (3)= 58.7, $p < .01$; 9.0% of Italian fearful-avoidant], or when we excluded those who chose to attend outpatient services [χ^2 (3) = 24.3, $p < .01$; 13.0% of Italian with fearful-avoidant attachment]. Moreover, the two Italian distributions (outpatient-treated and *therapeutic community–treated*) were different from each other [χ^2 (3) = 9.6, $p < .05$]; dismissive-avoidant attachment was more frequently observed in the *therapeutic community*-treated group (40.0%, with respect to the 16.0% observed in the outpatient group).

Next, we considered the distribution of the attachment categories (**Table 5**) obtained from the PBI cut-off scores; first, separately for each version (mother vs. father) and then successively in combination. The distribution of attachment categories for the mother version of PBI was characterized by an over-representation of the category "affectionless control" [χ^2 (3) = 25.09, $p < .05$,

TABLE 4 | Distribution of the Relationship Questionnaire attachment categories (Secure Vs Preoccupied Vs Fearful/Avoidant Vs Dismissing/Avoidant) by nationality (Germans vs. Italians) and care system (outpatients vs. residentials).

	German Sample[a]		Italian Sample					
			Total[b]		*Outpatients*		*Residentials*	
	Fr	*%*	*Fr.*	*%*	*Fr.*	*%*	*Fr.*	*%*
Secure	5	6.0	31	24.6	25	26.0	6	20.0
Preoccupied	12	17.0	55	43.7	47	49.0	8	26.7
Fearful/avoidant	46	65.0	13	10.3	9	9.4	4	13.3
Dismissing/ avoidant	8	11.0	27	21.4	15	15.6	12	40.0
Total	71	100	126	100	96	100	30	100

[a]*Data retrieved from Schindler et al (54);* [b] *the care system was unknown for one participant*

Secure, Secure attachment category; Preoccupied, Preoccupied attachment category; Fearful/Avoidant, Fearful/Avoidant attachment category; Dismissing/Avoidant, Dismissing/Avoidant attachment category; Outpatients, Patients attending public care service; Residentials, Patients attending the therapeutic community service.

TABLE 5 | Classification of subjects diagnosed with substance use disorder with respect to Parental Bonding Instrument's (PBI) maternal and paternal cut off scores.

	Father								Tot
	Affectionate constraint		Optimal Bond		Optimal Bond		Weak or Absent Bond		
	Fr	%	Fr	%	Fr	%	Fr	%	
Mother									
Affectionate constraint	3	2.4	12	9.5	9	7.1	1	0.8	25
Affectionless control	8	6.3	24	19.0	2	1.6	22	17.5	56
Optimal Bond	2	1.6	3	2.4	12	9.5	4	3.2	21
Weak or Absent Bond	1	0.8	4	3.2	4	3.2	15	11.9	24
Total	14	11.1	43	34.1	27	21.4	42	33.3	126

approximately 44.4% of the total sample]. In comparison, the distribution of the father version was characterized by an under-representation of the category "affectionate constraint" [χ^2 (3) = 18.06, $p < .05$, respectively 11.1%]. The two distributions (the PBI category, mother version vs. the PBI category, father version) were moderately correlated [Pearson contingency correlation coefficient = .521, χ^2 (9) = 48.87, $p < .01$].

Considering the distribution of PBI attachment categories with respect to the attended care system (**Table 6**), a significant relationship for the mother version of the PBI [χ^2 (3) = 16.28, $p < .01$] emerged in which subjects with a diagnosis of SUD with a "weak or absent bond" more frequently chose to attend a therapeutic community (10.2%, standardized residual = 3.9) rather than an outpatient clinic (8.7%, standardized residual = -3.9). Such a difference did not emerge in relation to the father version [χ^2 (3) = 5.38, $p > .05$].

Nevertheless, it is important to emphasize that even if our data show that people treated in therapeutic communities are dismissive-avoidant (n = 12) in the RQ, and show a weak or absent bond to the mother (n = 13) in the PBI, RQ, and PBI subjects belonging to such groups are not necessarily the same individuals. Specifically, only four residentials are simultaneously dismissive-avoidant in the RQ and show a weak or absent bond to the mother in the PBI.

Average Differences Among PBI Dimensions With Respect to the Care System

The scores on the care and protection dimensions of the PBI (mother vs. father), reported by those who had chosen outpatient care rather than therapeutic community care, were successively compared in an ANCOVA (2 × 2) with the SCL-90-R anxiety and depression scores as covariates. The latter was performed in order to exclude the potential effect of affective symptoms contributing to the choice of the attended care system.

Results showed a significant main effect of the care system factor [F (1, 115) = 4.66, $p <$. 05, η^2_P = .04] where subjects outpatient SUD reported higher average levels of care (M = 19.98) with respect to those attending therapeutic communities (M = 16.40). A significant main effect of the PBI version factor was also found [F (1, 115) = 10.21, $p <$. 01, η^2_P = .08] where higher levels of care for the mother version (M = 20.42) compared to father version (M = 16.40) were reported. Finally, the interaction effect was not significant [F (1, 115) = 1.86, p = .17]; neither were the effects of covariate [respectively: anxiety: F (1, 115) = 0.34, p = .56; depression: F (1, 115) = 1.22, p = .27].

The same 2 × 2 ANCOVA design was repeated, considering overprotection as the dependent variable. For this analysis, the two main effects of the care system factor and the PBI parent version produced significant results [respectively: F(1, 115) = 9.12, $p < .01$, η^2_P = .07; and F(1, 115) = 4.55, $p < .05$, η^2_P = .04]. The outpatient SUD reported higher levels of overprotection (M = 18.26), in contrast to the average seen in the therapeutic community care group (M = 14.23). Furthermore, the average overprotection was higher for the mother version of the PBI (M = 17.40) than the father version (M = 15.10). The interaction effect was barely significant [F(1, 115) = 3.55, p = .06, η^2_P = .03], and, in this case, the effects of covariates were largely insignificant [respectively, anxiety: F (1, 115) = 0.06, p = .81; depression: F (1, 115) = 0.44, p = .51].

TABLE 6 | Contingency table of attachment patterns according to maternal and paternal Parental Bonding Instrument (PBI: Optimal Bond vs Weak or Absent Bond vs Affectionless control vs Affectionate constraint) and care system (outpatients. vs residentials).

	Mother				Father			
	Outpatients		Outpatients		Outpatients		Outpatients	
	Fr	%	Fr	%	Fr	%	Fr	%
Optimal Bond	16	12.6	5	4.0	23	18.2	4	3.2
Weak or Absent Bond	11	8.7	13	10.2	27	21.4	15	11.9
Affectionless control	47	37.0	9	7.1	34	27.0	9	7.1
Affectionate constraint	23	18.1	3	2.3	12	9.6	2	1.6
Total	97	76.4	30	23.6	96	76.2	30	23.8

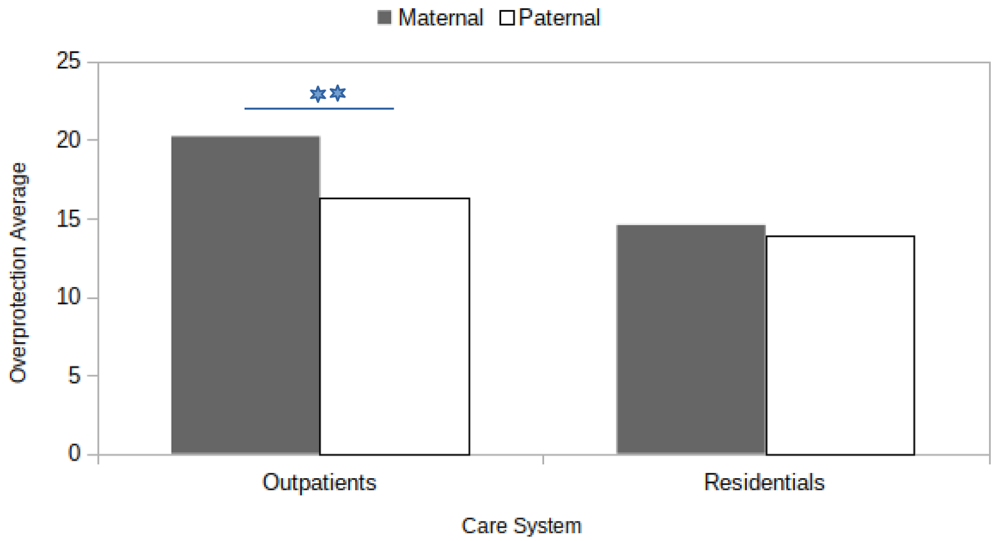

FIGURE 1 | Interaction effect between (Parental Bonding Instrument) parenting style (Maternal vs Paternal) and care system (Outpatients vs Residentials) on average overprotection scores.

As the interaction effect approached statistical significance, we proceeded, exploratively, to the inspection of simple effects (**Figure 1**). Outpatient SUD reported higher levels [$F(1, 124) = 25.373$, $p < .01$, $\eta^2_P = .17$] of overprotection with respect to the mother version condition ($M = 20.29$) compared to the father version ($M = 16.09$). This difference was no more significant [$F(1, 124) = 0.227$, $p > .05$] when we considered therapeutic community SUD [overprotection: M (mother) = 14.60; M (father) = 13.90].

Care System and Psychopathological Distress (SCL-90-R)

As the distribution of attachment categories produced qualitatively different results for the two care systems considered, we proceeded to check if the two sub-populations of subjects diagnosed with a SUD (outpatient care vs. therapeutic community care) were affected by different levels of psychopathological distress (**Table 7**). Therefore, a series of ANOVAs were performed using SCL-90-R scores on the nine psychopathology indices. The analysis of global indices is presented in the next paragraph. Not all participants completed the SCL-90-R. However, no significant relationship emerged between the chosen system of care and the missing and non-missing information of SCL-90-R [χ^2 (1) = 3.49, $p>.05$]. In general, we found no significant differences on the 9 SCL-90-R psychopathological dimensions [somatization: $F(1,125) = 0.22$, p = n.s.; depression: $F(1,118) = 0.02$, p = n.s.; anxiety: $F(1,125) = 0.26$, p = n.s.; hostility: $F(1,125) = 0.37$, p = n.s.; phobic anxiety: $F(1,125) = 0.53$, p = n.s.; paranoid ideation: $F(1,125) = 0.91$, p = n.s.; psychoticism: $F(1,125) = 0.29$, p = n.s.].

Although the two sub-populations of subjects diagnosed with a SUD did not diverge with respect to the reported psychopathological distress, we further investigated the hypothesis that there could be a difference in terms of concentration in the two care systems: people "at risk" for developing a psychopathology and those "not at risk," considering the SCL-90-R cut-off scores indicated by 62, pp. 88–91; T scores > = 70). In this case, no significant difference emerged (**Table 7**).

TABLE 7 | Distribution of psychopathological risk as function of care system (Outpatients Vs Residentials) for each SCL-90-R global index: Global Severity Index (GSI), Positive Symptom Distress Index (PSDI) and Positive Symptom Total (PST).

	Outpatients				Residentials						
	Not at risk		Not at risk		Not at risk		Not at risk				
	Fr	%	Fr	%	Fr	%	Fr	%	χ^2	df	p
GSI (N=125)[a]	67	53.6	28	22.4	21	16.8	9	7.2	.003	1	>.05
PSDI (N=93)[a]	59	63.5	6	6.5	26	27.9	2	2.1	.109	1	>.05
PST (N=120)[a]	71	59.2	21	17.5	21	17.5	7	5.8	.057	1	>.05

[a]*not all participants completed the SCL-90-R, and the sample size for each of the three SCL-90-R indices differ as function of available information.*
GSI, Global Severity Index; PSD, Positive Symptom Distress Index; PST, Positive Symptom Total; At risk, participants at risk reported a T-score > 70 at GSI, PSDI and PST; Not at risk, participants not at risk reported a T-score < 70 at GSI, PSDI and PST)

Differences in Psychopathological Distress as a Function of Care System and Attachment Categories

A series of 4 × 2 ANOVAs were performed for each of the three SCL-90-R indexes, considering the following factors: care system (outpatient care vs. therapeutic community care) and RQ attachment category system (secure vs. preoccupied vs. fearful-avoidant vs. dismissive-avoidant). A significant main effect of the RQ attachment system emerged [$F(3, 116) = 4.83$, $p < .01$, $\eta^2_P = .11$] with respect to the GSI for the preoccupied group scoring lower ($M = .58$) than both fearful-avoidant ($M = 1.33$) and dismissive-avoidant ($M = .95$) participants. The main effect of the RQ category system was also significant on the PST index [$F(3, 112) = 3.87$, $p < .05$, $\eta^2_P = .09$]; *post hoc* analysis showed lower average scores for preoccupied ($M = 33.51$) than dismissive-avoidant ($M = 48.62$) participants. None of the remaining main and interaction effects reached statistical significance.

No significant main or interaction effects were observed when the same ANOVA design was considered with PBI scores on both versions (mother vs. father) in place of the RQ attachment category system.

Predictors of Care System Choice

Logistic regression was conducted to determine whether PBI factors (care and over-protection for both the mother and father) and RQ attachment categories (secure, preoccupied, fearful, dismissive) significantly predicted the attended care system [outpatient care (0) vs. therapeutic community care (1)]. The overall fit of the full model (constant plus all predictors at once) was statistically significant [χ^2 (7) = 37.57, $p < .01$]; this means that predictors introduced in the equation were able to reliably differentiate among outpatient SUD vs. therapeutic community SUD. The model explained about 38.9% (*Nagelkerke* R^2) of the variance in group membership with a 90.5% success rate in predicting outpatient care membership and a 36.7% success rate in correctly classifying subjects diagnosed with a SUD who chose therapeutic community care. The overall success rate was 77.6%.

Interestingly, three out of five predictors (**Table 8**) reported a significant Wald coefficient; specifically, a unit increase in mother over-protection and father care significantly reduced the probability of choosing therapeutic community care [respectively *Exp(B)* = .819 and *Exp(B)* = .898]. Having a dismissive attachment style increased the probability of choosing therapeutic community care [*Exp(B)* = 4.431; meaning that dismissive people were four times more likely to choose therapeutic community care].

DISCUSSION

Paths to substance use and abuse are no doubt complex and involve many contextual, individual, and interpersonal variables (71). More and more studies have found a strong association between insecure attachment and emotional distress. Insecure attachment may be associated with an increase in substance use as a means of dealing with distress and negative affects (21, 30, 32, 33, 37, 38, 54, 72–74). However, data are inconsistent as to the impact of a specific quality of attachment on the development of substance dependence (75, 76).

Current Attachment Relationships

We hypothesize that in dismissive-avoidant attachment, characterized by strong self-control and deactivation of the attachment system, substance abuse may function as a pseudo-regulator. This type of strategy—as a defensive mechanism of pretended self-sufficiency—may reduce distress and dysphoric states (21, 30, 32, 33, 54, 72, 77). In comparison, preoccupied attachment is characterized by a hyper-activation of the attachment system, thus by the need for closeness in attachment relations expressed as an exaggerated preoccupation with caregivers, together with feelings of anger and confusion. In such a case,

TABLE 8 | Prediction of treatment modality, Outpatients (n = 96) and Residential (n = 30), as function of Parental Bonding Instrument's (PBI) dimensions and Relationship Questionnaire's attachment categories.

	Outpatients		Residential				
	M	**SD**	**M**	**SD**	**B**	**Wald statistic**	**Exp(B)**
PBI Care M	22.05	8.34	19.43	8.45	.00	.01	1.00
PBI Over-Protection M	20.19	7.03	14.60	5.88	–.20	14.11**	.82
PBI Care F	19.21	8.34	14.17	8.91	–.11	7.33**	.90
PBI Over-Protection F	16.09	7.55	13.90	9.41	.03	.80	1.03
Attachment in Close Relationship[a]	–		–			7.65 [b]	
Preoccupied	–		–		–.22	.09	.80
Fearful/avoidant	–		–		.65	.57	1.92
Dismissing/avoidant	–		–		1.47	3.87*	4.34

[a]*the reference category is that of "secure attachment"; * p<.05; ** p<.01;* [b] *p=.05*

M, Mean; SD, Standard Deviation; B, logistic regression coefficient; Exp(B), odds ratio; PBI Care M, Parental Bonding Instrument Mother Care; PBI Over-Protection M, Parental Bonding Instrument Mother Over-Protection; PBI Care F, Parental Bonding Instrument Father Care; Over-Protection F, Parental Bonding Instrument Father Over-Protection; Preoccupied, Preoccupied type of Attachment in Close Relationship; Fearful/avoidant, Fearful/Avoidant type of Attachment in Close Relationship; Dismissing/avoidant, Dismissing/Avoidant type of Attachment in Close Relationship.

substance abuse could reinforce family enmeshment: the family feels deeply involved by their family member's problem. Subjects diagnosed with a SUD, therefore, would attribute a pseudo-regulatory function of his self to the family, although an extremely fragile and poorly integrated self (78, 79). The aim of this research is to contribute to the understanding of such an association, focusing on its impact on the choice of treatment modality.

Assessing attachment means of Bartholomew's RQ, our data showed an overall higher frequency of preoccupied attachment. Considering the distribution with respect to the treatment typology, the prevailing attachment style of the outpatient subgroup was preoccupied; among therapeutic community-treated patients, the prevailing style was dismissive-avoidant. Moreover, the likelihood of choosing therapeutic community treatment increased fourfold in dismissive-avoidant subjects.

Such data are in line with the research hypothesis, according to which preoccupied subjects are more likely to be outpatients, due to their tendency to be overly involved in family relationships, from which they are not able to become autonomous. According to such a perspective, the abused substance takes the role of an external regulator (19, 80) to overcome a family's difficulties concerning their acceptance of changes and of their son/daughter separation-individuation process.

In comparison, dismissive-avoidant subjects are more likely to be therapeutic community patients. It is plausible that this is related to their greater facility to detach from their families, keeping them at a distance. On the other hand, dismissive-avoidant subjects may be in need of a support that may replace the substance as an external emotional regulator to compensate for their lack of modulation and response to their internal needs (21, 30, 32, 33, 54).

The hypothesis of a higher frequency of the fearful-avoidant category, as shown in the literature (38, 54), was not confirmed. Fearful individuals cannot deactivate their attachment system under distress; in such conditions, they perceive anxiety as linked to attachment, as preoccupied subjects do, but at the same time they are unable to look for and eventually obtain closeness to the significant figure. In our sample, instead, dismissive-avoidant subjects prevailed; through deactivation, they seemed to have an organized strategy to deal with stress (81). However, the literature highlights that fearful attachment plays a substantial role especially in the chronicization of abuse; our study has no adequate data on the issue (36, 82). In addition, our data concerned adult patients, whereas many findings refer to adolescents and college students. Certainly, an individual's developmental stage may influence his or her perception of attachment experiences and relations.

Finally, it is worth mentioning that a portion of the sample showed secure attachment patterns. It is important to acknowledge that self-reported evaluations may be insufficient to understand the role of attachment in individuals with a diagnosis of SUD. Undoubtedly, attachment is conceived as a largely unconscious process that could be better explained by means of implicit measures.

Past Attachment Relationships

For a better understanding of such outcomes, we also evaluated attachment through the PBI. The PBI allowed us to evaluate the quality of attachment with respect to each parent. Specifically, there was an over-representation of the category "affectionless control" with respect to mothers and an under-representation of the category "affectionate constraint" with respect to fathers. Certainly, inadequate parenting has been associated with difficulties in coping with stress and with more frequent negative feelings and behaviors (83, 84). Moreover, the results revealed that care and overprotection had higher mean scores in the outpatient treated subgroup compared to the therapeutic community patients. In particular, there was a significantly higher score regarding maternal overprotection among patients attending outpatient care, whereas a weak or absent bond as regards mothers emerged among individuals who attended a therapeutic community. From such findings, the attachment experiences with mothers seem to play a crucial role. Indeed, the perceived parental bonding and the representations of attachment are linked to the emotional development of the individual and to her/his ability to regulate inner affects and emotions (29, 85). Several researchers have shown that infants develop emotion regulation in the context of early mother-infant interactions (86–88) Maternal unavailability or unpredictability contribute to dysregulation because the mother does not support adequate stimulation nor arousal regulation for her child (89). Lyons-Ruth suggests that the context of the attachment relationship provides the fundamental roots of these processes, that is intersubjectivity "an essential function of mind" (90).

Self-Reported Symptoms

It is also important to consider the complexity of the psychological, mental organization of our sample. Indeed, substance abuse is characterized by high levels of comorbidity, which may affect 90.0% of subjects diagnosed with a SUD (91). The most frequent associations are with mood disorders, anxiety disorders, and personality disorders (92–95). Our study does not consider this variable. However, no difference emerged with respect to self-perceived symptomatology (SCL-90-R, 96) between the two subgroups. Indeed, psychopathology has no direct reference to the attachment motivational system (4, 97, 98); rather, the expression of symptoms is the outcome of a complex, multifactorial process, in which innate predispositions, learned behaviors, and context specificities all play an important role. Nevertheless, regardless of the treatment modality, both fearful-avoidant and dismissive-avoidant individuals, who are characterized by a more disruptive and disorganized representation of themselves, reported higher self-perceived symptomatology, in line with previous research (81, 99).

LIMITATIONS

Despite their significance, our results call for caution. The relatively small size of the sample, the effect sizes ranging from low to medium values, and the lack of a control group limit the generalizability of our findings and need to be replicated in order to verify the significant effects that we found.

As well, the use of self-reports—which rely on a subject's personal views of himself or herself and of his or her caregivers—does not allow to give a complete good definition of our clinical sample. Besides, the diagnoses were provided by the Local Health Service, with no further check on behalf of the research team.

Moreover, as mentioned above, comorbidity should be considered in future studies. Undeniably, the comorbidity of personality disorders and other severe disturbances may affect the course and prognosis of a SUD as well as its treatment outcome. In the same direction, the specific effect of the types of used substances as well as the differential impact of abuse and dependence should also be included in future studies.

Finally, the current study has not included the assessment of multiple attachments, which may play an important protective factor in the context of personality development (100). Information on the growing family type should also be included in future studies to fully understand the complex role of attachment relationships in the development of such disorders.

CONCLUSION

This study further confirmed the importance of attachment quality when planning interventions programs to support significant relationships (52, 55, 101–104).

For a deeper comprehension of the dynamics of attachment within individuals diagnosed with SUD, additional longitudinal studies are required to assess mental representations of attachment experiences at the beginning and end of the intervention. Such studies will provide more clear data concerning the stability and changes of internal working models of attachment after treatment.

It is important not to consider substance abuse as equivalent to an attachment disorder, as this is simplistic and reductive. The different distribution of attachment styles in relation to the typology of a care system may promote therapeutic compliance and consequently more adequate and efficacious interventions, corresponding to the individual and the context of his or her life and development.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The Ethical Committee of the University of Cagliari approved this research with the protocol n. 2019-UNCACLE-0228682. Written informed consent was obtained from all participants.

AUTHOR CONTRIBUTIONS

LV helped prepare the study design, coded the instruments, and wrote all sections of the manuscript. FP prepared the data set, performed statistical analyses, prepared tables and figures, and contributed to the method and results sections. MA helped prepare the study design, organized the recruitment of the sample, and supervised data collection and the research team. MB and RR contributed to the recruitment of the sample and data collection. All authors reviewed and approved the manuscript for publication.

FUNDING

This work was supported by the Open Access Publishing Fund of the University of Cagliari, with the funding of the Regione Autonoma della Sardegna - L.R. n. 7/2007.

ACKNOWLEDGMENTS

We want to thank Dr. Grazia Terrone for her precious contribution to the construction of the database.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychiatry

REVIEW
published: 08 November 2019
doi: 10.3389/fpsyt.2019.00737

Pathways Relating the Neurobiology of Attachment to Drug Addiction

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Substance use disorders constitute a significant public health problem in North America and worldwide. Specifically, substance addictions in women during pregnancy or in the postpartum period have adverse effects not only on the mother, but also on mother-infant attachment and the child's subsequent development. Additionally, there is growing evidence suggesting that parental addiction may be transmitted intergenerationally, where the child of parents with addiction problems is more likely to experience addiction as an adult. The current review takes a developmental perspective and draws from animal and human studies to examine how compromised early experience, including insecure attachment, early abuse/neglect, and unresolved trauma, may influence the development of neurobiological pathways associated with addictions, ultimately increasing one's susceptibility to addictions later in life. We approach this from three different levels: molecular, neuroendocrine and behavioral; and examine the oxytocin affiliation system, dopamine reward system, and glucocorticoid stress response system in this regard. Increased understanding of these underlying mechanisms may help identify key targets for early prevention efforts and inform needed intervention strategies related to both insecure attachment and addiction.

Keywords: attachment, addiction, oxytocin, dopamine, glucocorticoid, adverse childhood experiences

OPEN ACCESS

Edited by:
Andrew J. Lewis, Murdoch University, Australia

Reviewed by:
Mark J. Ferris, Wake Forest School of Medicine, United States
Mauro Ceccanti, Sapienza University of Rome, Italy

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Specialty section:
This article was submitted to Addictive Disorders, a section of the journal Frontiers in Psychiatry

Received: *09 June 2019*
Accepted: *16 September 2019*
Published: *08 November 2019*

Citation:
Strathearn L, Mertens CE, Mayes L, Rutherford H, Rajhans P, Xu G, Potenza MN and Kim S (2019) Pathways Relating the Neurobiology of Attachment to Drug Addiction. Front. Psychiatry 10:737. doi: 10.3389/fpsyt.2019.00737

INTRODUCTION

Within the United States and throughout the world, substance addiction is a significant problem with wide-ranging implications. Substance-use disorders in North America are a growing public health crisis with associated costs reported as reaching billions of dollars annually (1). According to the National Institute on Drug Abuse, the abuse of tobacco, alcohol, and illicit drugs in the United States tops more than $740 billion annually in costs related to crime, loss of work productivity, and health care (2). Aside from these monetary costs, the disruption to the development of secure attachment in children living in environments with substance abusing parent(s) may result in substantial risk to children, parents, and society. Of further concern is the paucity of effective treatment options, which are usually focused on the current addiction behavior rather than the underlying experiences and mechanisms that may have predisposed the individual to addiction (3).

Substance-abusing women who are either pregnant and/or have children face a significant challenge, with their addiction associated with many potential long-term adverse consequences impacting their children. Nearly 90% of women who struggle with substance-use disorders are of reproductive age (4). Although some women may abstain from substances during pregnancy, many resume substance use during the postpartum period, with adverse effects on their parenting capacities and their children's developmental trajectories. Indeed, some have suggested that the stress associated with parenting may become a risk factor for relapse in substance-using parents (5).

Addictions in mothers are associated with a range of parenting difficulties and may sometimes involve child abuse and neglect (6, 7). Ultimately, the ramifications may include having their children placed in foster care, which may further compromise the quality of the parent-child attachment. Mothers with addictions are considerably more likely than those without addictions to lose custody of their children as a result of child neglect or abuse (8). Further, an expanding body of research supports the notion that parental addiction may be transmitted intergenerationally through several possible mechanisms, with the child more likely to experience addiction as an adult (3, 9).

Twenty years ago, based on the accumulation of brain imaging research, it was argued that addiction should be defined as a brain disease, rather than solely a social or societal problem (10). While still acknowledging crucial behavioral and social-context components, this model characterized addiction as the result of repeated exposure to drugs of abuse, causing changes in brain structure and function related to reward experience and anticipation, perception and memory, and cognitive control. This model accentuated the importance of treatments that incorporated biological, as well as behavioral and societal approaches.

More recently, however, this widely accepted model has been challenged (11–13), with some authors advocating a "developmental-learning model" which characterizes addiction as a product of cognitive and emotional development, particularly during early childhood and adolescence. Lewis (12, 13) provides a specific neurobiological account of how experience and learning—particularly in an environment of chronic stress—may alter neural development and connectivity leading to addiction *via* the normal mechanisms of neuroplasticity, producing a ventral-to-dorsal shift in striatal activation with more compulsive behavior, and diminished cortical control *via* the dorsolateral prefrontal cortex.

Investigating and understanding the relationship between attachment and substance addiction is of utmost importance. Here, the neural mechanisms underlying this relationship will be considered at three different levels: molecular, neuroendocrine, and behavioral, in terms of major biological systems associated with each. These include the dopamine-related reward/reinforcement/habit formation system, the oxytocin-related affiliation system, and the glucocorticoid-related stress response system (**Figure 1**).

TYPES OF ADDICTION

For the purposes of this manuscript, addiction will be restricted to substance-use disorders as defined by criteria in the fifth edition of the Diagnostic and Statistical Manual (DSM-5). It is important to note that the DSM-5 and the recently approved eleventh edition of the International Classification of Diseases (ICD-11) include non-substance or behavioral addictions (e.g., gambling disorder), and existing data indicate negative impacts of gambling disorder on children (14). Gambling disorder has also been associated with insecure attachment styles, suggesting that early life experiences relating to attachment are important to consider in behavioral addictions (15). Substance-use disorders, especially those at the more severe end of the spectrum, are psychiatric conditions characterized by habitual and pathological patterns of drug-seeking and drug-consuming behaviors (16). Habitual patterns of drug-seeking and drug consumption absorb a large amount of time and attention in drug addictions, leading to significant functional impairment in meeting responsibilities at home, school and work (16). When abstaining from the use of a drug or chemical substance, symptoms of distress and strong urges or cravings to use the substance again may emerge and become particularly salient (9). In addition to substance addiction, behavioral addictions to activities such as gambling, gaming and potentially other behaviors (sex, specific types and patterns of internet use) share parallel features with substance addictions: 1) continuing engagement in the addictive behavior despite adverse outcomes; 2) compulsive engagement in the addictive behavior; 3) a craving or appetitive urge state prior to the engagement in the addictive behavior; and 4) diminished control over engagement in the addictive behavior (17, 18). While less research has investigated the impact of behavioral addictions (as compared to substance addictions) on parenting and attachment, features of substance addictions parallel behavioral addictions, suggesting that behavioral addictions may also interfere with parent–child attachment.

While substance use may influence the brain and behavior, it is still unclear why some individuals struggle with addiction and others do not. Once a person has used a particular substance, it may or may not lead to addiction. The developmental-learning model of addiction proposes that early experience may alter susceptibilities to different types of addiction through changes in specific neural circuits. Along this line, Alvarez-Monjaras and colleagues (2018) (9) have integrated neurobiological and psychodynamic theories through the lens of attachment: the neurobiological approach centers on identifying biological mechanisms that may influence the development of substance use and addiction while the psychodynamic approach provides a framework for understanding relational and representational aspects of addiction within a developmental perspective.

Attachment has been defined by Ainsworth (19) as a tie that endures across time and space, to a particular person to whom one turns when feeling vulnerable or in need of protection from danger. John Bowlby (20–22) introduced attachment theory as a structural, systemic model focused on the function and development of human protective behavior. Bowlby's attachment theory asserts that humans are inherently predisposed to form attachment relationships to their primary caregivers, particularly the mother. These attachment relationships serve to protect the child and occur in an organized form by the end of the first year of life (23). According to the Dynamic-Maturational Model of

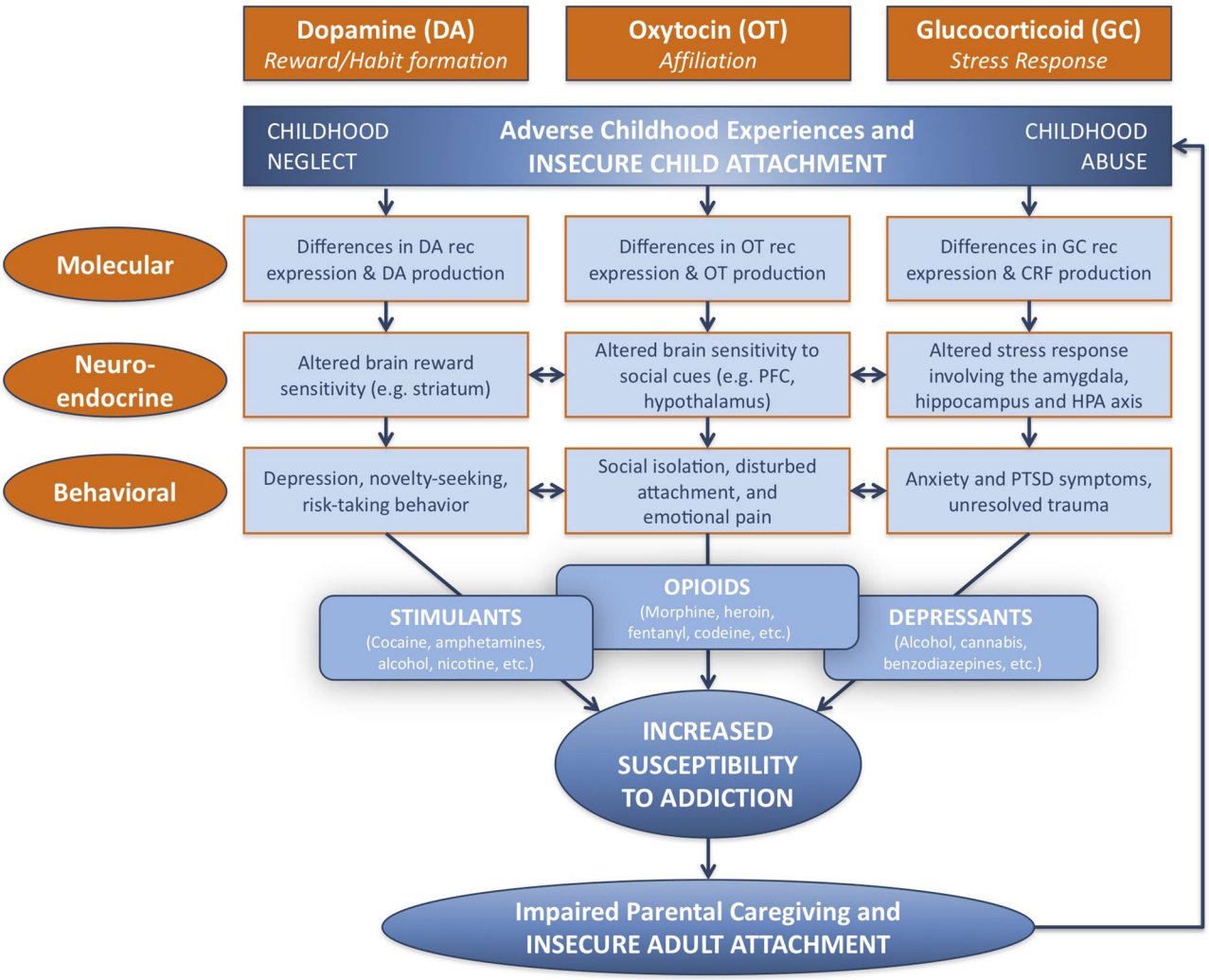

FIGURE 1 | Developmental and neurobiological pathways linking adverse childhood experience to susceptibility to addiction, *via* modifications in dopamine-related, oxytocin-related, and glucocorticoid-related systems at molecular, neuroendocrine, and behavioral levels. Childhood adversity, including abuse and neglect, may be associated with insecure attachment, and lead to behavioral patterns linked with specific patterns of substance abuse. Parental addiction may impair parental caregiving capacity as a result of insecure patterns of adult attachment, and perpetuate the cycle of childhood adversity and addiction. DA, dopamine; OT, oxytocin; GC, glucocorticoid; rec, receptor; CRF, corticotropin-releasing factor; PFC, prefrontal cortex; HPA, hypothalamic–pituitary–adrenal; PTSD, post-traumatic stress disorder. Adapted from (3) © 2016 New York Academy of Sciences. Used with permission from John Wiley and Sons.

Attachment and Adaptation (23), the organization of attachment continues across one's lifetime as a means of: 1) adapting to adverse environments and strategically protecting oneself from danger; and 2) ensuring reproductive success. Individuals who are exposed to danger, either from direct threat or absence of care, particularly during infancy, are more likely to distort or negate cognitive and affective information, and thus misinterpret crucial information from their environment. This may help to explain seemingly irrational decisions made by individuals with substance addictions as they attempt to secure a sensation of reward, gain social affiliation, or reduce stress by using substances.

More recently, with advances in neuroimaging, attachment has been systematically associated with neuroendocrine responses to salient attachment cues, such as a mother's response to seeing her baby's smiling or crying face. Such neural and endocrine responses involve activation of the dopamine-related reward system, oxytocin-related affiliation system, and glucocorticoid-related stress-response system (24), which pathways are also implicated in the neurobiology of drug addiction.

PATTERNS OF ATTACHMENT

Since Bowlby first published his seminal work (20), numerous methods have been developed to systematically classify patterns of attachment, as observed from infancy to adulthood. Ainsworth (19) initially identified and empirically linked three major patterns of attachment with their origins in maternal

responsiveness and sensitivity: Secure (Type B), Avoidant (Type A), and Ambivalent (Type C). This has led to the development of what has become one of the most accepted and empirically tested measures of attachment in adulthood: the Adult Attachment Interview (AAI) (25). The AAI is a semi-structured interview designed to identify differences in *state of mind with regard to overall attachment history* by examining participants' abilities to describe attachment-related memories while simultaneously maintaining coherent, cooperative discourses (26). The results of a recent longitudinal meta-analysis of 34 samples (total N of 56,721) confirmed a significant association between insecure attachment and substance-abuse problems (27).

The Dynamic-Maturational Model of Attachment and Adaptation (23) involves a modification of the original AAI, extending Ainsworth's childhood classifications into adulthood. This model, which has a broader focus on psychopathology and trauma, may be particularly suited for understanding high-risk populations including those of substance-using individuals (28). From an analysis of the transcribed discourse, four basic attachment patterns emerge among adults, summarized as secure (Type B1-3), "insecure/dismissing" (Type A1-6), "insecure/preoccupied" (Type C1-6), and "insecure/mixed" (Type A/C). Longitudinal studies have suggested the unique capacity of a caregiver's AAI to predict attachment patterns in the infant offspring (29, 30). Understanding the neurobiological differences between attachment patterns among adults may help us better understand the mechanisms underlying the intergenerational transmission of addictions.

Crittenden has suggested that basic attachment patterns may, in fact, represent differences in how the brain processes sensory information (31). Accordingly, she proposed that sensory stimulation is transformed into one of two basic forms of information: 1) temporally ordered "cognitive" information and 2) intensity-based arousal or "affective" information. The first is proposed to be the predominant mechanism in "dismissing" attachment organization, whereas the second is proposed to be central in "preoccupied" attachment. "Secure" organization may involve a balanced integration of both sources of information. For example, "dismissing" adults tend to dismiss their own feelings, intentions and perspectives and rely more upon rules and learned temporal relations in predicting future rewards. "Preoccupied" adults, in contrast, may organize their behavior around affective information, such as fear, anger or desire for comfort. They tend to be preoccupied by their own feelings and perspectives, while omitting or distorting cognitive or temporally ordered information. Adults with "secure" or balanced patterns of attachment may be best able to integrate temporally ordered information regarding causal effects, as well as more affect-based information, such as emotional states and imaged memory, in order to form close relationships, make accurate decisions and predict future reward. The organization of attachment may also involve the differential development of specific memory systems within the brain, such as procedural and semantic memory, imaged memory, and episodic and working memory systems, each of which is specifically coded in the AAI as considered in the Dynamic-Maturational Model, and linked to the function of specific brain regions and networks (23).

Two neuroendocrine systems that appear to be related to Crittenden's theory of cognitive and affective forms of information processing and attachment are the dopamine and oxytocin systems. These neurodevelopmental processes appear to be shaped by early-life experience, including variations in maternal behavior (32–35) (**Figure 1**). The dopamine system includes two main components: the mesocorticolimbic and nigrostriatal dopamine pathways (**Figure 2**). The former involves stimulus-reward learning and prospective decision-making based upon predicted reward (37); the latter is implicated in motoric behaviors and habit formation. The oxytocin system is important in prosocial affiliative behavior, the formation of social and spatial memories, and emotion regulation (38). Oxytocin neurons connect the hypothalamus with the mesocorticolimbic dopamine system, including the ventral tegmental area and the ventral striatum, and may facilitate reward responses and reinforcement to affective and social cues. Recent data have suggested interactive relationships between the mesocorticolimbic dopamine, oxytocin and glucocorticoid physiological stress systems (34, 39). Oxytocin receptor blockade gives rise to both an exaggerated adrenocorticotropic hormone (ACTH) as well as corticosterone stress hormone response in rats (40). Similar results are observed in oxytocin-deficient knock-out mice (41). Working alongside the oxytocin system, the mesocorticolimbic dopamine system similarly has a stress inhibitory effect on the amygdala (42) through the medial prefrontal cortex (43). Consequently, it appears that one important function of these inter-related neuroendocrine systems may be to modulate human stress responses and thereby facilitate optimal social bonding and attachment, through different but complementary mechanisms.

Our research suggests that differences in human attachment strategies are associated with significant differences in these brain activation patterns, when mothers view powerful visual stimuli that may impact the attachment system: images of their own infant's face (24) (**Figure 2**). Mothers with secure (Type B) patterns of attachment, compared with insecure/dismissing (Type A) mothers, showed greater activation of regions in the mesocorticolimbic dopamine pathway, including the ventral striatum and ventromedial prefrontal cortex, and the oxytocin-associated hypothalamic/pituitary region. Mothers with Type A attachment, in general, showed greater activation of the dorsolateral prefrontal cortex, which has been implicated in cognitive control and habit formation.

FATHERS AND ATTACHMENT

Most early investigations of parent–child attachment focused solely on the mother-child attachment relationship, overlooking the father as an essential element in the child's attachment formation process. According to Scism and Cobb (2017), the importance of creating an immediate mother-infant bond overshadowed and deferred the efforts of researchers to document factors and interventions that influence father–infant bonding. In the late 1970s and early 1980s, investigators began to recognize the importance of paternal involvement during the immediate postpartum period (44, 45), leading to additional weight gain in preterm infants, reducing cognitive delays in offspring, and increasing breastfeeding rates in mothers (46, 47).

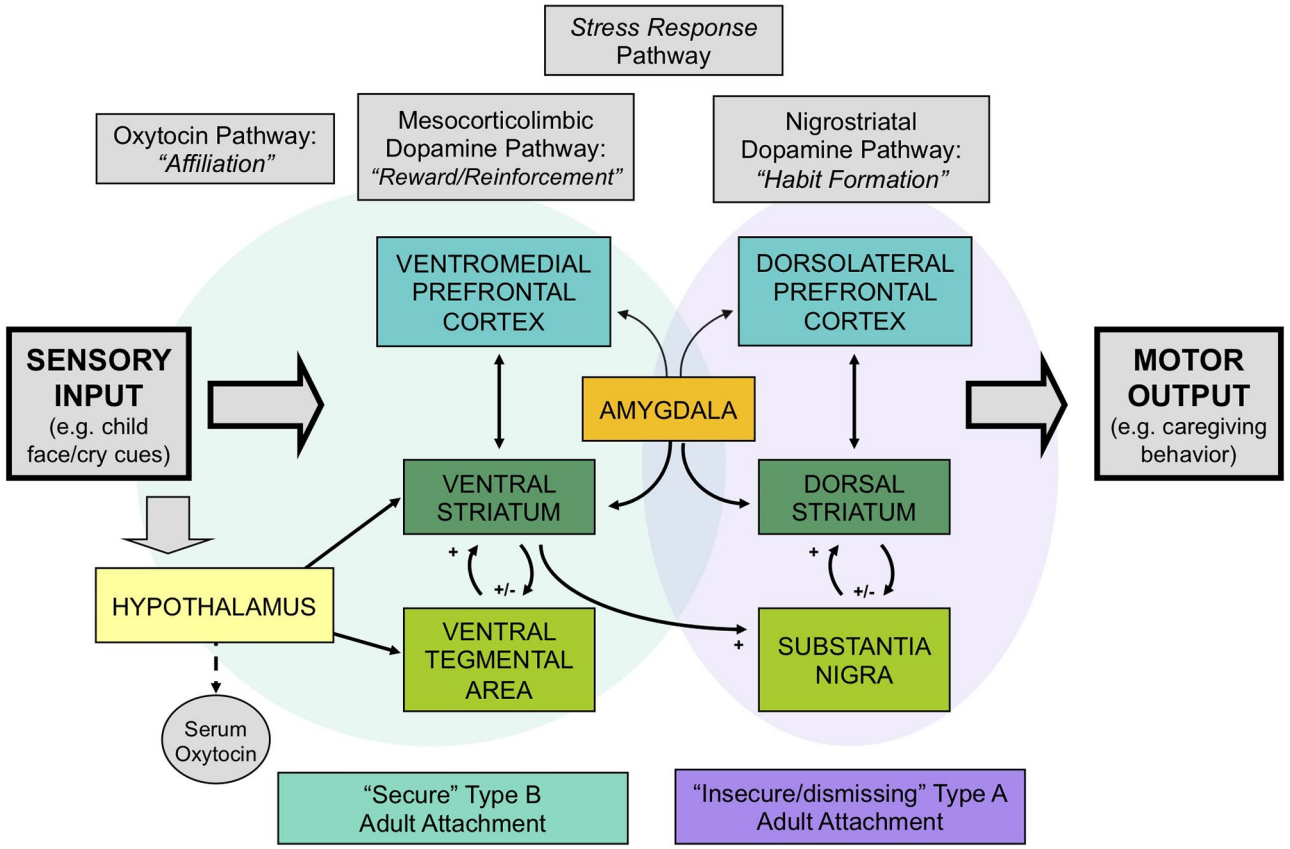

FIGURE 2 | The neurobiology of attachment, incorporating 1) dopamine-related "reward/reinforcement" and "habit" pathways, 2) oxytocin-related "affiliation" pathways, and 3) glucocorticoid-related stress-response pathways. Secure patterns of attachment are associated with greater activation of the mesocorticolimbic and oxytocin-associated circuits, whereas insecure/dismissing attachment is associated with greater activation of nigrostriatal dopamine pathways. Adapted from (36) © 2011 The Author, *Journal of Neuroendocrinology.* © 2011 Blackwell Publishing Ltd. Used with permission from John Wiley and Sons.

In recent years, the influence of father–infant interactions on attachment has become a focus of research within the field of child development, showing, for example, that fathers have a unique but complementary neuroendocrine response to infant interactions, compared with mothers (48). Much evidence has indicated that fathers are critical for the well-being of their children (49, 50) and that the absence of fathers is associated with numerous risk conditions (51). Observational investigations of the nature of parental involvement have found that father–child interaction patterns have a distinctive quality that is more dynamic and stimulating than mother-child interaction patterns, which may help promote exploration and risk-taking behaviors and ultimately facilitate cognitive development (49). Although some preliminary studies have explored the effect of parenting interventions in fathers with addiction problems (52), little is known about the direct role of fathers in preventing later addiction problems in their children (53).

PATHWAYS TO ADDICTION

Proposed pathways leading to addiction are numerous and multifaceted, involving expression of specific molecular and genetic entities, altered brain sensitivities to reward- and stress-related cues, environmental influences, and cognitive, behavioral, motivational and emotional constructs that include depression, risk-taking, social isolation, emotional pain and/or unresolved trauma (3) (**Figure 1**). Epidemiological studies have shown associations between adverse early childhood experience and addictions in adolescence and adulthood. For example, after adjusting for multiple sociodemographic and potential confounding variables, individuals who had experienced childhood abuse and/or neglect were more likely to use tobacco and alcohol in early adolescence, become dependent on cannabis, and smoke and inject drugs in early adulthood (54–57). Parental figures who abuse drugs have often experienced inadequate caregiving environments during their own childhoods (9). Furthermore, their own substance addiction increases the likelihood that they will provide neglectful or abusive care to their own children (58). This may also lead to children being placed in foster care, further impacting parent-child attachment.

Negative childhood experiences often have a profound and enduring influence upon the developing child's quality of life and well-being, frequently well into adulthood. The Adverse Childhood Experiences (ACEs) Study has examined

retrospectively recalled traumatic experiences that occurred during the first 18 years of life (59, 60). ACE categories include multiple forms of abuse (physical, emotional, and sexual), neglect (physical and emotional), parental separation or divorce, household violence, substance use, mental illness, and incarceration (59). An examination of the relationship between illicit drug use and ACEs found that each ACE experience increased the likelihood of early initiation of drug use 2- to 4-fold, while people with ≥5 ACEs were 7- to 10-fold more likely to report illicit drug use, addiction to illicit drugs, and drug use by parents (60, 61).

A substantial threat to healthy development is growing up in poverty. According to the KIDS COUNT Data Book (2018), a national average of 19% (14.1 million) of children in the United States lived in poverty in 2016, with some states reaching as high as 30%. Notably, poverty rates vary tremendously according to race, with African-American and American Indian children (both 34%) experiencing nearly three times the poverty rate for Caucasian and Asian and Pacific Islander (both 12%). Employment insecurity and high rates of job instability may disrupt daily living and relationships and compromise families' abilities to invest in their children's development. This may lead to diminished achievement in school and reduced likelihoods of future success. Secure employment is a significant pathway to financial equilibrium and well-being in families. However, Koball and Jiang (62) note that being a child in a low-income family does not happen by chance. Factors related to poverty include parental education, parental employment, race and ethnicity, family structure, region of residence, residential instability, and utility and housing insecurity. Children and parents who live in high-poverty neighborhoods face many challenges that may impact their lives on a daily basis including greater financial instability, poorer health, higher rates of violence and crime, poorer schools, and limited access to support systems and job opportunities. Each of these challenges may add to the stress level of both the child and the parent, which may interfere with attachment relationships and predispose the offspring to addiction (63).

Understanding the mechanisms by which early adverse experience may increase susceptibility to addiction is of critical importance to adequately formulating plans for prevention and treatment. Three neurobiological pathways have been identified that may link attachment and early experience with addiction at molecular, neuroendocrine and behavioral levels. These pathways include: 1) the dopamine-related reward system; 2) the oxytocin-related affiliation system; and, 3) the glucocorticoid-related stress response system (3). Each of these systems will be outlined below, summarizing what we understand about the neurobiology of attachment and how this may relate to addiction behaviors and susceptibility.

Oxytocin-Related Affiliation System Pathways

Oxytocin is a neuropeptide that functions as a neuro-regulator of social behavior within mammalian species (64). Considerable attention has been focused on oxytocin's core roles in attachment formation and stress regulation, and there has been a surge of interest in the connection between dysregulated oxytocin systems and disorders of psychosocial functions (65–67). In particular, the developing oxytocin system has been implicated in increasing vulnerability to addiction across the lifespan (68) as well as serving a protective function against the development of addiction (69). Specifically, oxytocin may enhance the salience and familiarity of social cues and lessen novelty- and reward-seeking, which have been implicated in pathways to addiction (69). Drug use may also impact the maternal oxytocin system. In postpartum human mothers, cocaine exposure during pregnancy was associated with decreased oxytocin in plasma relative to mothers not using substances during pregnancy (70). In rodent dams, chronic cocaine exposure during pregnancy also resulted in decreased oxytocin levels in the maternal brain, including in the hippocampus, ventral tegmental area, and medial preoptic area (71). Therefore, the oxytocin system may be implicated in addiction susceptibility before the transition to motherhood, and may be modulated by drug exposure during pregnancy and the postpartum period.

The oxytocin system may be of particular significance in relation to addiction and attachment because of its neuroplasticity in response to an individual's early social environment (69). Growing evidence suggests early life experiences may substantially impact long-term functioning of the oxytocin system (24, 72, 73). On the behavioral level, rat pups experiencing early-life deprivation show multiple social impairments including diminished social motivation (74), reduced affiliative behavior (75), impaired social learning (76) and increased aggressive behavior (74, 77). Rat pups who received low levels of care early in life tended to develop into adults that display similarly low levels of care with their own pups (78, 79). This intergenerational transmission appears to be at least partially mediated by oxytocin-related molecular and neuroendocrine alterations, including changes in oxytocin receptor expression and oxytocin production (80, 81) (**Figure 1**).

Empirical evidence from human research parallels findings from animal models. Extreme early deprivation in humans has been prospectively associated with severe long-term attachment disorders and social deficits (81). Numerous longitudinal and cross-sectional studies have linked early trauma and/or disrupted attachment to long-term social and attachment difficulties (82–85). Other studies have linked compromised oxytocin functioning with social deficits (65, 86, 87). In humans, social isolation and low social support may accelerate the emergence and recurrence of substance use and predict substance addiction (88).

A history of early childhood trauma or stress has been negatively correlated with levels of oxytocin as assessed in cerebrospinal fluid, urine, or plasma (89–92). A dose-dependent inverse relationship has been observed between the severity of trauma experiences and oxytocin concentration (65, 68). Among the different types of trauma, emotional abuse and neglect appear to have the strongest associations (90, 91). Since adverse experiences in childhood (rather than adolescence and adulthood) emerge as arguably the most robust predictors of long-term oxytocin functioning, the timing of the trauma and adversity appears critical to the impact that oxytocin may have upon individual functioning (92).

Infants or children who experience less synchronous, less sensitive, or less responsive caregiving show blunted salivary oxytocin levels, both at baseline and in response to social cues (72, 93), as well as disrupted patterns of attachment (94, 95). Adults with an insecure/dismissing (Type A) pattern of attachment often have a diminished peripheral oxytocin response when interacting with their infants (**Figure 3A**), which is correlated with reduced brain activation in oxytocin- and dopamine-associated brain regions, including the hypothalamus and ventral striatum (24) (**Figure 3B**). Peripheral oxytocin response (between a baseline of mother-infant separation and an interaction period) was also associated with differences in maternal behavior. A lower (or negative) oxytocin response was associated with diminished maternal gaze toward her infant, especially during heightened infant distress (86).

Studies are currently underway to test whether oxytocin may be an adjunctive treatment alongside methadone maintenance therapy for opioid-use disorders (96, 97). According to the brain opioid theory of social attachment (98), endogenous opioids are released in response to social bonding experiences, including social touch and breastfeeding. Social isolation may lead to reduced opioid activity and subsequent feelings of distress and emotional pain relating to separation and loss. Rising rates of opioid abuse and overdose deaths may be one consequence of disrupted "social capital" in society (99), mediated *via* changes in the oxytocin affiliation system.

Dopamine-Related Reward System Pathways

The dopamine-related reward system contributes to the regulation of reward, motivation, and decision-making. The majority of dopamine neurons are located in the ventral part of the midbrain (100), where the mesocorticolimbic and nigrostriatal dopamine systems originate (**Figure 2**). Dopamine-related dysfunction has been associated with the pathophysiology of many psychiatric disorders, including depression and substance addictions. While multiple studies have reported abnormal dopamine-related functioning in addiction (101, 102), including decreased striatal dopamine

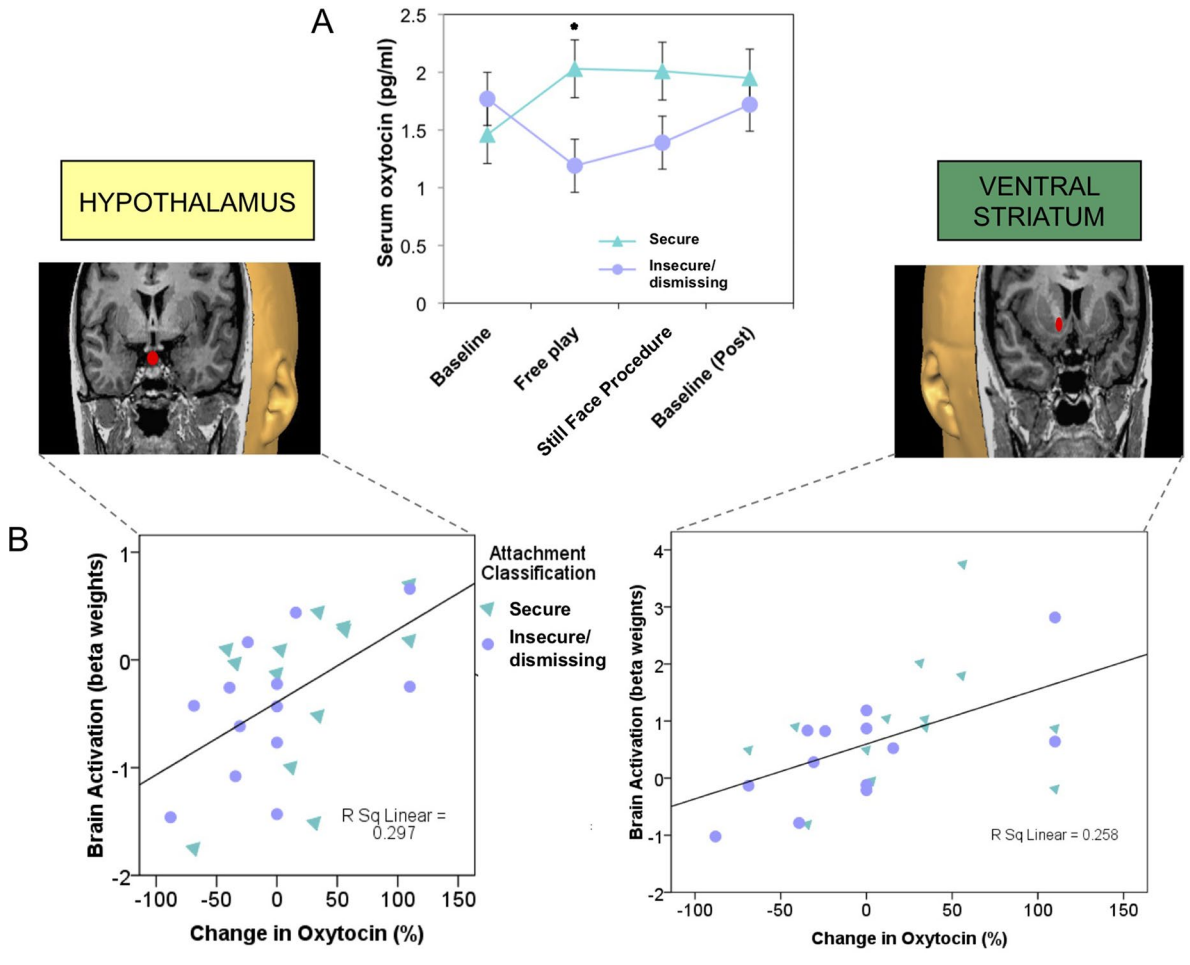

FIGURE 3 | Plasma oxytocin response to mother–infant interaction is reduced in mothers with insecure/dismissing attachment, compared with securely attached mothers **(A)**, and is correlated with activation of hypothalamus ($r_s = 0.6$, $p = 0.001$) and ventral striatum ($r_s = 0.57$, $p = 0.001$), in response to viewing own-infant faces in a functional MRI scanner **(B)**. (36) Adapted from (24) © 2011 The Author, *Journal of Neuroendocrinology.* © 2011 Blackwell Publishing Ltd. Used with permission from John Wiley and Sons.

receptor availability and dopamine release, these differences are seen primarily in stimulant and alcohol abuse, rather than abuse of opioids and cannabis (103) (**Figure 1**).

A significant and growing body of research has established the role of early-life experience in shaping the development of dopamine-related systems. Animal models have shown that early adverse experience alters dopamine-related neuronal activity and synaptic functions. For example, rat pups that are reared in isolation with prolonged maternal separation, show reduced dopamine transporter binding in the ventral striatum, increased baseline dopamine levels, and exaggerated dopamine release in response to acute stress (34, 104). Rodent studies investigating naturally occurring variations in maternal behavior (i.e., licking/grooming in rats) have demonstrated that diminished dopamine release in the ventral striatum leads to decreased licking and grooming of the rat pups in response to pup vocalization (32). High levels of postnatal maternal care provided to rat pups have been associated with an increased density of dopaminergic cell bodies within the ventral tegmental area and increased dopamine receptor mRNA levels within the ventral striatum (**Figure 2**). This association appears to persist into adulthood (105).

Notably, early adverse experience may also impact levels of stimulus-evoked dopamine release. Rodents with early adversity show dampened dopamine release in the ventral striatum in response to pups (106), enhanced dopamine release in the ventral striatum and hypothalamus in response to stress (107), and enhanced dopamine release in the ventral striatum in response to the administration of amphetamine (108). More specifically, suboptimal early caregiving in humans has been correlated with elevated dopamine release in the ventral striatum in response to stress (35) and amphetamine administration (109–111).

Behaviorally, rat-pups subjected to early maternal deprivation are more sensitive to novel stimuli in adulthood, an indicator of their enhanced spontaneous locomotor activity in novel settings (111, 112). In humans, novelty-seeking, or sensation-seeking, is defined by an amplified tendency toward novel sensations and experiences, often leading to impulsive risk-taking and/or the active pursuit of rewards (113). The link between early adversity and novelty-seeking has been observed in both community (114) and high-risk samples (115). Among different classes of substances, individuals with high novelty-seeking behavior display a preference for stimulant drugs that activate dopamine-related pathways (116). In a study of a large sample presenting with a complex set of risk factors, novelty-seeking emerged as the strongest factor contributing to the development of substance-related disorders (115). The link between childhood adversity and the presence of substance-use disorders was found to be at least partially mediated by increased novelty-seeking in individuals with histories of adverse life events (115).

Depression is likewise associated with differences in function of dopamine-related regions. Both depressed adolescents, as well as non-depressed adolescents whose mothers were currently depressed, both showed diminished activation of the ventral striatum in a reward-based functional MRI task (117) (**Figure 4**). Furthermore, activation of the ventral striatum in the adolescents was inversely correlated with the mother's—and not the adolescent's—depression scores, suggesting that maternal depression may be contributing to an abnormal reward response in the offspring. Taken together, depression, novelty-seeking, and risk-taking behavior have been associated with increased susceptibility to addiction (**Figure 1**).

Glucocorticoid-Related Stress-Response System Pathways

Glucocorticoids (cortisol in primates) are steroid hormones that contribute to the physiological stress response. A cascading set of neurotransmitters and hormones involved in this organization is collectively described as the hypothalamus–pituitary–adrenal (HPA) axis. Psychological or physical stress triggers the release of corticotrophin-releasing factor (CRF) in the hypothalamus, which binds to receptors in the pituitary to promote ACTH release. ACTH is then transported to the adrenal glands, resulting in secretion of the glucocorticoid stress hormone. Once released,

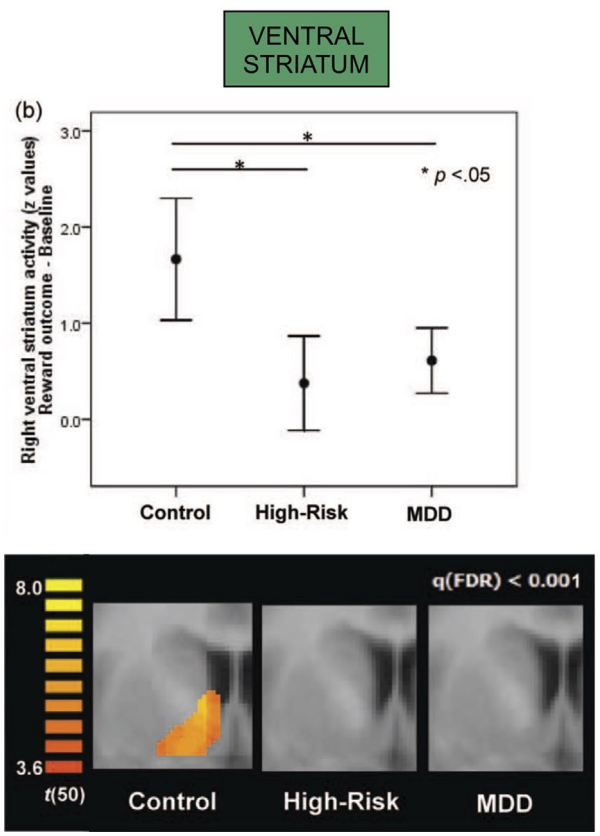

FIGURE 4 | Both major depressive disorder (MDD) and high-risk groups (with current depression in mother but not in adolescent) show attenuated right ventral striatum activation in response to a standard reward outcome during functional MRI scanning (both *p < .05; error bars depict 95% confidence interval); activation for the reward outcome versus baseline contrast within the ventral striatum region of interest, presented at false-discovery-rate-corrected q < .001; the activations are shown at y = 5. Adapted from (117). Used with permission.

glucocorticoids activate glucocorticoid receptors, which suppress further synthesis and release of CRF and ACTH, thereby providing negative feedback inhibition of the HPA system and restoring homeostasis.

In humans, decreased responsiveness, sensitivity, and synchrony in early caregiving have been correlated with prolonged or exaggerated increases in cortisol in response to stress (118, 119), whereas secure parental attachment has been associated with lower cortisol levels in response to stress (120) (**Figure 1**). However, in cases of more severe early deprivation or maltreatment, patterns of HPA responsiveness have been mixed, perhaps due to the complex nature of maltreatment and the co-occurrence with psychiatric disorders. Affected individuals may undergo a transition from early hypercortisolism to later hypocortisolism due to frequent and persistent adverse experiences (121, 122). This change may reflect adaptive down-regulation of the HPA system following chronic stress exposure, leading to flattened diurnal rhythms of cortisol secretion (with lower than normal daytime cortisol levels) (118, 123).

Rodents who experience diminished maternal care show increased DNA methylation of the glucocorticoid promoter region, which is associated with decreased glucocorticoid expression in the hippocampus and limited inhibitory feedback to stress (124). This results in elevated anxiety and fearfulness in adulthood and decreased exploratory behavior. These behavioral outcomes resemble signs and symptoms of anxiety, post-traumatic stress and addictive disorders in humans (125–127).

Early adverse experience is a potent pathway for the development of anxiety and trauma-related disorders later in life (90). Altered glucocorticoid and HPA responsiveness may contribute to the etiology of these disorders and mediate early adversity with later psychopathology and addiction (128, 129). Numerous studies connect stress dysregulation and HPA dysfunction to substance addiction (130, 131). Stress exposure may precipitate the onset of substance use, diminish the motivation to abstain, and heighten the risk for relapse, particularly in those with exaggerated HPA reactivity (131). This process may reflect the effects of a chronically activated HPA axis on enhanced striatal extracellular dopamine release, which may expose the reward system to the reinforcing properties of addictive substances (35, 132, 133). Disorders that are associated with HPA dysfunction, such as anxiety and trauma-related disorders, may serve as precursors to the development of substance addiction (128, 129, 134). These disorders may also modulate the progression of substance addiction, such that the illness course is typically more severe and persistent (135).

The amygdala, which contributes importantly to the processing and regulation of emotions, connects with the striatum and prefrontal cortex (**Figure 2**), and its development has been associated with early life stress and trauma. Enlarged amygdala volumes have been seen in children exposed to chronic maternal depression (136), and in those raised in orphanages (137). In a study of mothers with unresolved trauma, based on the AAI, amygdala activation appeared to be "turned off" when these mothers viewed their own infant's distressed face

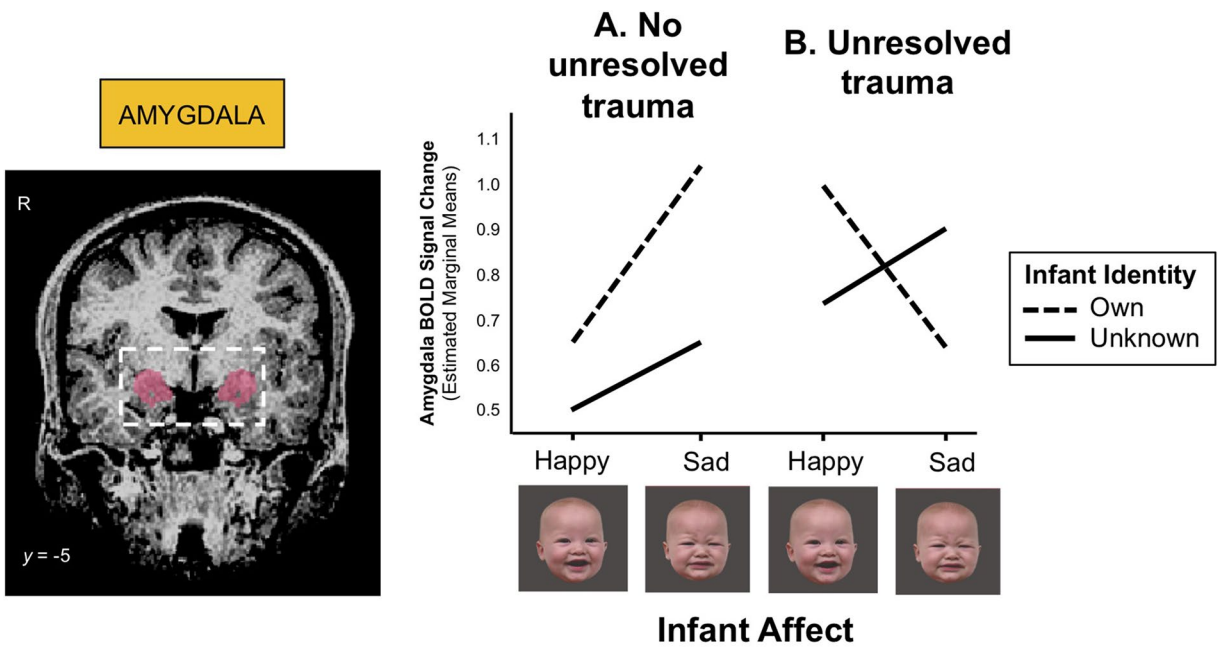

FIGURE 5 | (A) Mothers with no unresolved trauma show a greater amygdala response to sad than happy infant faces (z = 3.00, p = 0.003), whereas **(B)** mothers with unresolved trauma show a blunted amygdala response to their own infant's distress cues during functional MRI scanning (z = -2.38, p = 0.017). BOLD (blood-oxygen-level-dependent) signals were extracted from a bilateral amygdala mask (shown left) and submitted to mixed-effects linear regression analysis. Adapted from (138). Used with permission from Taylor & Francis Ltd.

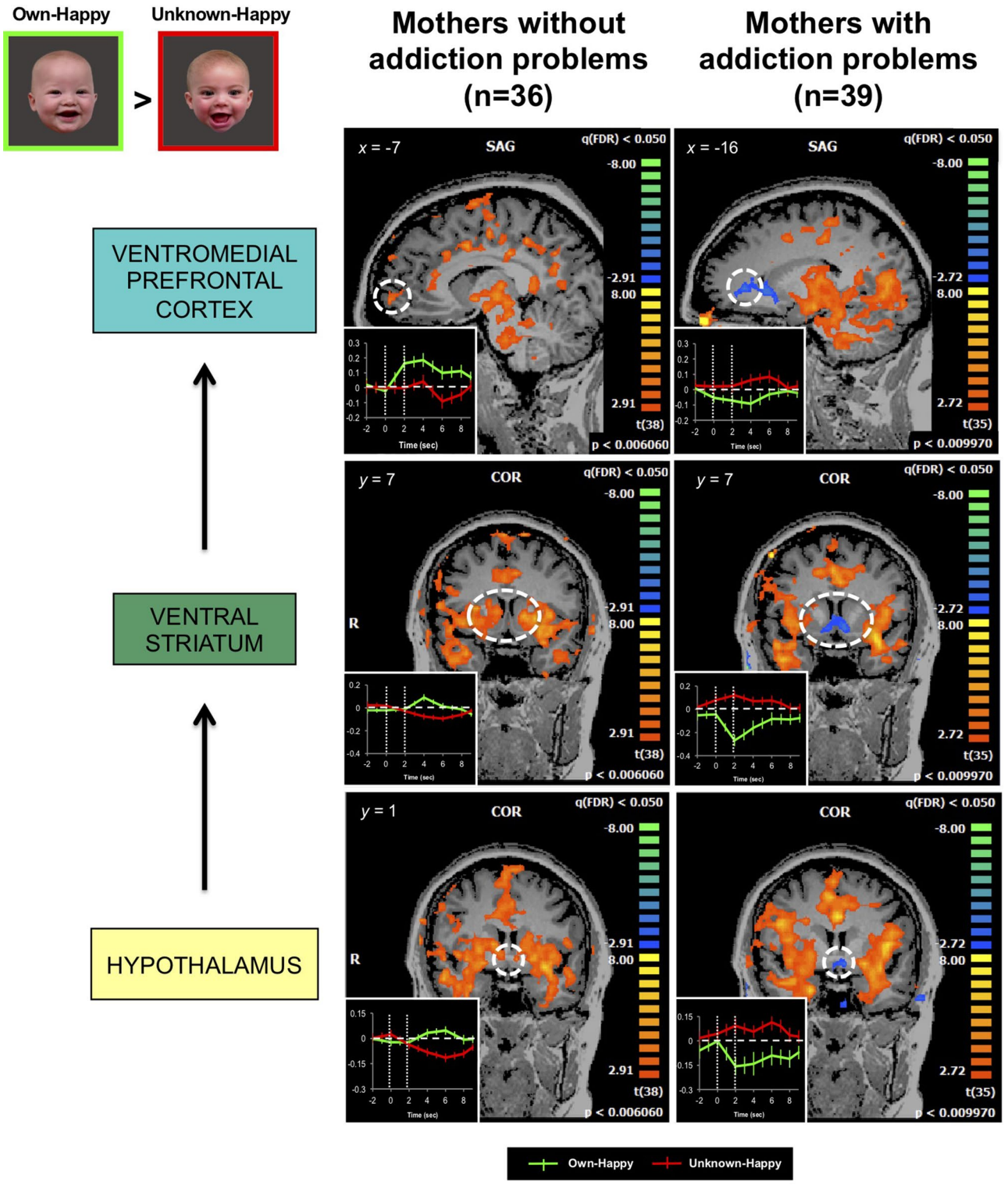

FIGURE 6 | In response to own- vs. unknown-infant happy faces (OH > UH), mothers with addiction problems show deactivation in the hypothalamus, ventral striatum, and ventromedial prefrontal cortex, regions wherein strong activation has been observed in mothers without a history of substance use (random effects analysis; FDR-corrected $p < 0.05$). Inset shows brain response time courses extracted from the peak voxels in each specified region (hashed line circle), after presentation of own-happy (green plot) and unknown-happy (red plot) infant face cues between 0 and 2 seconds. Adapted from (139). © 2017 Wiley Periodicals, Inc. Used with permission.

(138), despite responding similarly to mothers without unresolved trauma when viewing unknown infant faces (**Figure 5**). This suggests that unresolved childhood trauma may alter amygdala reactivity to salient attachment-based cues.

Substances of abuse, particularly depressants such as alcohol, benzodiazepines and cannabis, may be used to diminish the physiological and psychological effects of chronic stress as a result of childhood abuse (**Figure 1**). For example, one effect of alcohol is to dampen the neuroendocrine stress system by reducing peripheral glucocorticoid levels (140, 141). The effectiveness by which this is accomplished may itself lead to an increased susceptibility to addiction.

Interactive Pathways

Although the prior discussion has focused on individual neuroendocrine systems, each system is interconnected with the other, rather than acting in isolation (5). For example, oxytocinergic neurons connect the hypothalamus with key dopaminergic brain nuclei, including the ventral tegmental area and the ventral striatum (142), as well as the amygdala. These systems all appear to play an important role in maternal behavior, pair-bond formation and social attachment (143, 144).

In humans, intranasal oxytocin enhances brain reward activation in both the ventral tegmental area and the ventral striatum (145). The effect of individual differences in oxytocin functioning on dopamine and other neuroendocrine systems, as well as the stress axis, may underlie differences in susceptibility to addiction (68). Likewise, exposure to drugs such as amphetamines may impair bonding and attachment *via* changes in oxytocin and dopamine neurotransmission in areas such as the ventral striatum and medial prefrontal cortex (146).

Oxytocin also appears to have a stress inhibitory effect, attenuating symptoms of anxiety and activation of the hypothalamic–pituitary–adrenal axis, especially with regard to substance abuse and withdrawal (147–149). One model proposes that oxytocin may attenuate stress and addiction by shifting the preference for novelty and reward seeking toward a greater appreciation for familiarity and attachment (69). As noted previously, early life stress, such as *via* maternal separation, may also effect dopamine functioning, from neuronal development, dopamine signaling and receptor expression, to addiction behaviors (3).

Our own published work has demonstrated that mothers with drug addiction problems show a different brain response pattern in both dopamine reward and oxytocin-associated affiliation pathways, including the hypothalamus, ventral striatum and ventromedial prefrontal cortex, when viewing pictures of their own infant's smiling face (139) (**Figure 6**). Instead of showing an increased response in these brain regions, as demonstrated in non-substance using mothers (150), the response in mothers with addiction problems was diminished, compared with the responses to unknown infant faces.

Thus, all three of these neuroendocrine systems may have interactive effects on attachment and the subsequent susceptibility to addiction.

CONCLUSION

In this review paper, we have focused on three interconnected neuroendocrine pathways which, to some extent, may be programmed by early life experience and related to patterns of childhood attachment. Multiple overlapping adverse childhood experiences, ranging from traumatic abuse to absence of nurturant care and neglect, may have a profound impact on the development of secure attachment and on each of these three biological systems: the dopamine-related reward system, the oxytocin-related affiliation system, and the glucocorticoid-related stress response system. Other factors may also contribute to risk, including genetic differences, other neuroendocrine systems such as serotoninergic and glutamatergic pathways, and the effect that substance abuse itself may have on brain functioning and ongoing development.

We are currently working to determine whether differences in brain responses in mothers with addiction problems are related to drug use *per se*, as proposed in the brain disease model of addiction (10), or more fundamental underlying conditions, such as unresolved childhood trauma, insecure attachment, or other psychological or socio-demographic factors. A focus on attachment and developmental pathways may be important in delivering optimal treatment for drug-exposed mothers, as seen in some notable evidence-based recovery programs (151–153), as well as identifying key targets for early intervention and prevention efforts. By employing a lifespan developmental perspective, we may most appropriately address and target the intergenerational risk of substance use and addiction, and provide more hope for future generations.

AUTHOR CONTRIBUTIONS

All authors contributed to the formulation of the review paper topic. LS, CM, and SK drafted the original manuscript, and the other authors provided additional contributions and critical feedback.

ACKNOWLEDGMENTS

This work was supported by the Eunice Kennedy Shriver National Institute of Child Health and Human Development (R01 HD065819 and R03 HD080998); National Institute on Drug Abuse (R01 DA026437, R01 DA06025, R01 DA02446 and R03 DA045289); the National Center for Responsible Gaming; the Connecticut Council on Problem Gambling; and the Connecticut Department of Mental Health and Addiction Services. The content is solely the responsibility of the authors and does not necessarily represent the official views of these institutes or the National Institutes of Health.

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Conflict of Interest: MP has received financial support or compensation for the following: he has consulted for RiverMend Health, Game Day Data, the Addiction Policy Forum, and Opiant Pharmaceuticals; has received research support from Mohegan Sun Casino and the National Center for Responsible Gaming; and has consulted for gambling and legal entities on issues related to addictive disorders.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychiatry

ORIGINAL RESEARCH
published: 12 November 2019
doi: 10.3389/fpsyt.2019.00821

Longitudinal Associations Between the Adolescent Family Environment and Young Adult Substance Use in Australia and the United States

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Introduction: Harmful alcohol and cannabis use are social concerns associated with a range of negative outcomes. Prior research has identified links between disrupted parent-child attachment and child-adolescent substance use.

Materials and Methods: This study used cross-national data from the International Youth Development Study (IYDS; Victoria, Australia and Washington State, USA) to investigate the relationship between early adolescent family environment characteristics, mid-adolescent attachment to parents, and young adult harmful alcohol and cannabis use. The moderating role of state on these relationships was also tested. State-representative samples of students in Grade 7 (age 13, 2002) were recruited and followed longitudinally at ages 14, 15, and 25 (n = 1,945, 53% female, 50% in Victoria).

Results: Cross-state differences were evident in levels of family management, parent attitudes favorable to drug use, sibling alcohol and cannabis use, attachment to parents, and past year alcohol and cannabis use. Significantly higher rates of problematic alcohol use were reported by young adults in Victoria (25% vs. 14% in Washington State). Young adults in Washington State reported significantly higher rates of problematic cannabis use (14% vs. 10% in Victoria). Path modeling showed that characteristics of positive family environments (e.g., low conflict) in early adolescence were associated with higher attachment to parents and lower alcohol and cannabis use in mid-adolescence. Sibling substance use and more favorable parent attitudes to drug use were associated with past year alcohol and cannabis use in mid-adolescence. Results showed higher attachment to parents in mid-adolescence did not uniquely predict lower problematic alcohol or cannabis use in young adulthood. No significant cross-state differences in this pattern of associations were found.

Discussion: The implications of the current findings suggest that prevention and intervention strategies targeted at reducing problematic substance use into young adulthood may benefit from considering the influence of behavioral norms and attitudes in family relationships.

Keywords: family environment, attachment, AUDIT, cannabis, adolescence, young adulthood, longitudinal study, cross-state study

OPEN ACCESS

Edited by:
Andrew J. Lewis, Murdoch University, Australia

Reviewed by:
Giuseppe Carrà, University of Milano Bicocca, Italy
Ruben David Baler, National Institutes of Health (NIH), United States

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Specialty section:
This article was submitted to Addictive Disorders, a section of the journal Frontiers in Psychiatry

Received: *01 May 2019*
Accepted: *17 October 2019*
Published: *12 November 2019*

Citation:
Heerde JA, Bailey JA, Toumbourou JW and Catalano RF (2019) Longitudinal Associations Between the Adolescent Family Environment and Young Adult Substance Use in Australia and the United States. Front. Psychiatry 10:821. doi: 10.3389/fpsyt.2019.00821

INTRODUCTION

Preventing harms associated with substance use, including alcohol and cannabis, are international public health priorities. Population rates of heavy alcohol and cannabis use peak in early adulthood (1), meaning this period of development is a critical time for the emergence of substance use problems that represent preventable contributors to rates of morbidity and mortality among this age group (2, 3). To reduce the harmful effects of alcohol and other drug (substance) use, it is important to identify modifiable influences. One area of continued investigation is the link between disrupted parent-child attachment and later substance use (4–6). In this study, we analyze longitudinal data to identify modifiable influences that emerge from two theories of the development of substance use; *attachment* and *social development* theories.

Longitudinal studies offer the opportunity to understand those factors that influence problematic alcohol and cannabis use and provide a foundation from which to test the developmental effects of differing social contexts. Cross-national comparisons of longitudinal study findings offer additional benefits as they (1) permit testing of the role of macro-level policy and other contextual differences in alcohol and cannabis use and (2) promote understanding of the implications for feasible policy and prevention options. The observation of cross-national differences in as few as two countries, when predicted on the basis of theory, can result in highly interpretable empirical findings (7, 8).

The International Youth Development Study (IYDS) is a longitudinal research project that has conducted cross-state comparisons in the prevalence of alcohol and cannabis use, and its predictors, using data collected from state-representative samples of adolescents and young adults in Victoria, Australia and Washington State, United States (USA). At the study outset, Washington State and Victorian samples were similar in demographic and economic characteristics including population size, urbanization, educational participation, and prosperity (9). Standardized methodologies (sampling, recruitment, survey consent, and administration) were used in both states. Further, standardized measures of alcohol and cannabis use and other study variables were used in both states, and these measures were pilot tested to ensure comparability (9).

Thus, differences observed in alcohol and cannabis use or its predictors in the IYDS are likely to reflect real differences in policy and social contexts between the two states. Australia and the USA adopt different policy approaches aimed to reduce substance use among adolescents and young adults. Broadly, Australian policy focuses on minimizing the harms associated with young people's substance use, whereas policies in the US encourage young people to abstain from substance use and apply punitive consequences as a deterrent to substance use through a zero-tolerance approach. Previous studies conducted using the IYDS data have shown adolescents and young adults in Victoria report higher rates of alcohol use (10, 9, 11) but lower rates of cannabis use compared to adolescents and young adults in Washington State (10). Further, analyses using IYDS data provide evidence that cross-national differences exist in predictors for health and social problems such as substance use between Victorian and Washington State participants (10, 11), however the relationships between these predictors and problems are cross-nationally similar in multivariate analyses.

One approach to addressing the incidence of substance use and its adverse consequences on adolescent and young adult health and well-being is to understand developmental influences. Longitudinal studies can be analyzed to identify risk factors (that increase the probability of substance use) and protective factors (that decrease the probability of substance use or mediate or moderate the effect of risk factors; 12, 13). The family environment is cited as an important sphere of influence for preventing substance use (14). As such, developmental researchers have investigated risk and protective factors in the adolescent family environment, including attachment influences on substance use. Family risk factors that predict adolescent substance use include: conflict with family members (15); poor management strategies; substance use among family members, and favorable parent attitudes to substance use (15, 10, 16). Conversely, family protective factors against substance use include: attachment to parents and opportunities for prosocial behavior within the family environment (15, 17, 10).

The hypotheses to be tested in the current study are grounded in two conceptual perspectives: *attachment theory* (18, 19) and *social development* (the *Social Development Model; SDM*) (12). *Attachment theories* identify early problems in parent-child attachment as antecedents for later problems in social and emotional adjustment (18). The effects of attachment problems continue to be measured in later life (19). According to attachment theories, substance misuse arises in part due to social and emotional difficulties that originate from parent-child attachment problems.

The *SDM* is a theory of the socialization processes and the development of prosocial and antisocial behavior (12), including substance use. The SDM is distinct from attachment theories in explaining attachment to role models as the key factor in the development of adolescent substance use. It hypothesizes that individuals learn patterns of behavior (prosocial or antisocial), in multiple socializing contexts (family, peer-group, school, community). The SDM posits that individuals are socialized through perceived opportunities for involvement in activities and interactions with others, actual involvement and interaction, skills to participate in these involvements and interactions, and rewards or costs perceived from these involvements and interactions. Involvement that is rewarded encourages development of a social bond between individuals and the socializing context; this bond influences behaviors because individuals are motivated to conform to the norms and values of the socializing unit.

The current paper, informed by both *attachment theory* (18, 19) and the *Social Development Model* (12) seeks to investigate the relationship between early adolescent family environment characteristics, mid-adolescent attachment to parents and substance use, and problematic alcohol and cannabis use in young adulthood. On the basis of these two theories, we hypothesize that (1) mid-adolescent attachment to parents will decrease problematic alcohol and cannabis use young adulthood; and (2) characteristics within individual and family contexts

in adolescence will influence young adult problematic alcohol and cannabis use. The moderating role of state in associations between attachment and problematic alcohol and cannabis use will also be explored.

METHODS

Participants

Data were drawn from young adults participating in an ongoing longitudinal study, the IYDS. The IYDS explores the development of healthy and problematic behaviors among adolescents and young adults from Victoria, Australia and Washington State in the United States (USA). The study began in 2002, and used a two-stage cluster sampling approach: public and private schools with Grades 5, 7, and 9 were randomly selected for recruitment into the study using a probability proportionate to grade-level size sampling procedure (20); and (2) one class at the appropriate grade level was randomly selected within each school (9) yielding samples of approximately 1,000 students at each grade level in each state. The original sampling and recruitment methods for the IYDS have been previously described in detail (9). In summary, across Grades 5, 7, and 9, 3,856 eligible students in Washington State and 3,926 students in Victoria were approached. Of these 2,885 participants (74.8%) in Washington State and 2,884 (73.5%) in Victoria consented to and participated in the 2002 survey. Participants have been followed longitudinally from 2002, with assessments at ages 12 through 18 years, 20 years, 22 years, and 25 years (in 2014). Retention rates across the study have remained high, with 98% retention in 2003 and 2004, 85% in 2008, 84% in 2010–11, 83% in 2012–13, and 87% in 2014–15 (21).

The current study analyzes data collected from participants in the 7th grade cohort, extracted from early-mid adolescence (Grade 7, Grade 8, Grade 9) and young adulthood (Age 25 years). The 7th grade cohort was the cohort chosen for long-term follow-up in the USA, and therefore has the most complete data in both Victoria and Washington State at each of the included timepoints. The analysis sample includes 1,945 participants (n = 984 in Victoria). At Grade 7, 51% of the sample were female and ranged in age between 12 and 16 years (mean (M) = 13 years, standard deviation (SD) = .43). At the age 25 time point, the sample ranged in age between 23 and 27 years (M[SD] = 25.14[.84]) and female participants formed 53% of the sample.

Procedure

Survey Administration

The study design and measures (refer to *Instruments* section) were subjected to several processes in 2001 to ensure cross-national validity, including cognitive pretesting of the survey; pilot testing of the survey; and matching of sampling, recruitment, and survey administration procedures (9). Standardization ensured that method differences were minimized, overcoming problems with many international comparisons (22, 8). Trained survey staff used a single survey administration protocol in both states. At the study outset, written parental consent and participant assent was obtained for all participants. During formal schooling, surveys were administered to class groupings within schools. Following the completion of formal schooling, participants provided informed consent and the survey was completed online. The self-report survey took 50–60 min to complete. During adolescence, Victorian participants received a small gift (e.g., stress ball) and Washington State participants received USD$10, at the completion of each survey. Most recently, young adult participants in both states received a USD/AUD$40 gift voucher as reimbursement for their time.

Instruments

The IYDS survey was adapted from the Communities That Care Youth Survey (23, 24). In 2001, in accordance with recommendations for cross-national instrument development (8), all survey measures underwent cognitive pretesting (9). This pretesting has been previously described in detail; in sum, this process included language review and cross-national item adaptation (9). The survey measures have demonstrated longitudinal validity and reliability when administered to participants in Victoria and Washington State (10, 11). Descriptive statistics for Grade 7 demographic characteristics, Grade7–Grade 8 family environment characteristics, Grade 9 measures of attachment to parents, past year alcohol and cannabis use, and young adult problematic alcohol and cannabis use (Age 25), including Cronbach's Alpha, are provided in **Table 1**.

Demographic Characteristics

Demographic characteristics were measured in Grade 7. Participants reported their *age*, *gender*, and the *state* in which they lived (Victoria or Washington State). A measure of *family socio-economic status* was created using parent (mother and father) reported highest level of education (e.g., less than secondary school, completed secondary school, completed post-secondary school) and level of family income (ranging from less than $10,000 to $200,000+ per year). *Accommodation transitions* were measured using the item "Have you changed homes in the past year?" Response options ranged from "yes" (1) through to "no" (4) and were recoded to reflect "have not changed homes" (reference group) versus "changed homes on one or more occasion" (1) in the past year.

Early Adolescent Family Environment Characteristics

Five scales measured characteristics of the family environment in Grades 7 and 8. *Family conflict* was measured using three items. "People in my family have serious arguments" is an example item. Nine items, including "My family has clear rules about alcohol and drug use" were used to assess *family management*. For both scales, response options ranged from "definitely no" (1) to "definitely yes" (4) and were reverse coded such that higher scores indicated lower conflict and better management. Three items examined *opportunities for prosocial behavior* within the family environment. "If I had a personal problem, I could ask my mom or dad for help" is an example. Response options ranged from "definitely no" (1) to "definitely yes" (4). The scale measuring *parental attitudes favorable toward drug use* included four items,

TABLE 1 | Descriptive statistics for the study variables.

	Combined sample (CS; N = 1,945)		Washington State sample (WASH; n = 961)		Victorian sample (VIC; n = 984)		*p* value	Difference t / χ2	Cronbach's alpha (α)		
	M(SD)	95% CI	*M*(SD)	95% CI	*M*(SD)	95% CI			CS	WASH	VIC
Age 25 Problematic substance use											
AUDIT (%, referent: low risk)	19.71 4.04	– –	14.21 3.37	– –	25.00*** 4.69***	– –	<.0001	33.72	n/a	n/a	n/a
Risky use Harmful/high risk use											
Cannabis (%, referent: low risk)	12.14	–	14.20*	–	10.14	–	.011	6.52	n/a	n/a	n/a
Grade 7 Demographic characteristics											
Family socioeconomic status	1.92 (.49)	[1.91, 1.95]	1.94 (.49)	[1.91, 1.97]	1.92 (.49)	[1.89, 1.95]	.344	.947	n/a	n/a	n/a
Female (%, referent: male)	50.59	–	50.63	-	50.56	–	.975	.001	n/a	n/a	n/a
Age (years)	13.01 (.41)	[12.99, 13.02]	13.09*** (.44)	[12.06, 12.12]	12.93 (.41)	[12.90, 12.95]	<.0001	8.37	n/a	n/a	n/a
Accommodation transitions (%, referent: no transitions)	25.99	–	27.08	–	24.92	–	.279	1.17	n/a	n/a	n/a
Grade 7–8 Family environment characteristics											
Low family conflict	2.79 (.70)	[2.76, 2.82]	2.77 (.70)	[2.73, 2.82]	2.81 (.70)	[2.77, 2.85]	.186	–1.324	.68	.66	.70
Family management	3.34 (.47)	[3.31, 3.36]	3.40*** (.47)	[3.37, 3.43]	3.28 (.46)	[3.25, 3.31]	<.0001	5.44	.70	.72	.69
Opportunities for prosocial involvement	3.12 (.64)	[3.09, 3.14]	3.11 (.67)	[3.06, 3.15]	3.12 (.62)	[3.09, 3.16]	.542	–.610	.72	.74	.6 9
Parental attitudes favorable toward drug use	1.35 (.45)	[1.33, 1.37]	1.22 (.38)	[1.20, 1.24]	1.47*** (.47)	[1.44, 1.50]	<.0001	–12.67	.57	.50	.57
Sibling alcohol use (%)	57.74	–	48.94	–	66.20***	–	<.0001	55.81	n/a	n/a	n/a
Sibling cannabis use (%)	19.96	–	25.08***	–	15.02	–	<.0001	28.97	n/a	n/a	n/a
Grade 9 attachment to parents and substance use											
Attachment to parents	2.84 (.72)	[2.81, 2.87]	2.82 (.73)	[2.77, 2.87]	2.85 (.71)	[2.81, 2.90]	.350	–.0935	.75	.74	.76
Past year alcohol use (%)	58.23	–	45.16	–	71.35***	–	<.0001	133.72	n/a	n/a	n/a
Past year cannabis use (%)	16.73	–	21.68***	–	11.75	–	<.0001	33.59	n/a	n/a	n/a

α, Cronbach's alpha. n/a, scales with one item and therefore a Cronbach's alpha could not be calculated. %, percent. χ^2, chi-square. t, t-statistic. M, mean. SD, standard deviation. Female (coded 0 = male, 1 = female); Victoria (coded 0 = Washington State, 1 = Victoria); Accommodation transitions (coded 0 = no transitions, 1 = transitions); Sibling alcohol use (coded 0 = no use, 1 = recent use); Past year alcohol use (coded 0 = no use, 1 = recent use). Statistically significant state differences for continuous variables calculated using independent t-tests. Statistically significant state differences for dichotomous variables calculated using chi-square tests.

such as "How wrong do your parents feel it would be for you to use cannabis (pot, weed, grass)?" Response options ranged from "very wrong" (1) to "not wrong at all" (4). The influence of *sibling alcohol and cannabis use* was assessed using two items: "Have any of your brothers or sisters ever drunk alcohol (like beer, wine or liquor/spirits)?" and "Have any of your brothers or sisters ever used marijuana (pot, weed, grass)?". Response options were dichotomous, "no" (reference group) and "yes" (1). Participant responses for early adolescent family environment characteristics were averaged to obtain a single scale score across the two waves (Grades 7 and 8).

Mid-Adolescent Attachment to Parents and Past Year Alcohol and Cannabis Use

Attachment to parents comprised four items administered in Grade 9, including "Do you feel very close to your mother?" and "Do you share your thoughts and feelings with your father?". Response options ranged from "definitely no" (1) to "definitely yes" (4). *Alcohol use* in the past year at Grade 9 was examined using the item "In the past year (12 months), on how many occasions (if any) have you had alcoholic beverages (like beer, wine or liquor/spirits) to drink—more than just a few sips?". The item "In the past year (12 months), on how many occasions (if any) have you used cannabis (pot, weed, grass)?" was used to measure *cannabis use* in the past year. Both items were rated on eight-point scales ranging from "never" (1) through to "40+ times" (8) and recoded to reflect "not at all" (reference group) versus "one or more occasions" (1) in the past year.

Young Adulthood Problematic Alcohol and Cannabis Use

Problematic alcohol use was measured at age 25 using the 10-items comprising the Alcohol Use Disorders Identification Test (AUDIT; 25). "How often during the last year have you found that you are unable to stop drinking once you had started?" and "How often during the last year has a relative, a friend, or a doctor or other health worker been concerned about your drinking or suggested that you cut down on your drinking?" are example items. Items were answered on a five-point scale of "never" (1), "monthly or less" (2), "2–4 times a month" (3), "2–3 times a week" (4), or "4 or more times a week" (5). Participants reporting no lifetime and no past year alcohol use were included as "never" for problematic alcohol use. Scores across all scale items were summed to form a total AUDIT score (0–35), where higher scores indicated more problematic alcohol use. Total scores were then recoded as per established guidelines into "low risk," "risky," "harmful," and "high risk" alcohol use. Given the low prevalence of high-risk use in the current sample, harmful, and high-risk categories were combined. This is not uncommon with non-clinical samples. The final recoded AUDIT variable

reflected levels of problematic use as being "low risk" (0), "risky use" (1), and "harmful/high risk" (2).

Nine items were used to measure *problematic cannabis use*. "Over the past year (12 months) how often has your use of marijuana caused you to feel anxious or depressed?" and "Over the past year (12 months) how often has your use of marijuana caused you to feel you couldn't get through the week without it?" are example items. Each item was rated on an eight-point scale ranging from "never" (1) through to "40+ times" (8). Participants reporting no lifetime or past year cannabis use were included as "never" for problematic cannabis use. Scores across all scale items were summed to form a total problematic cannabis use score (0–27), where higher scores indicated more problematic cannabis use. Total scores were then categorized as per established guidelines (26) into "low risk," "risky," "harmful," and "high risk" cannabis use. Given the low prevalence of participants in high and harmful risk categories, the item was recoded to reflect "no risk" (reference group) versus "risky use" (1).

Statistical Analysis

The initial set of analyses were performed using Stata IC software for Windows (27), version 15.1. Cross-national differences in means and frequencies for all measures were examined using *t*-tests and chi-square analyses. Pooled standard deviations (28) were used to calculate effect sizes. Correlation analyses were performed to show highly correlated pairs or sets of variables that might result in collinearity in the multivariate analyses.

A series of longitudinal path models were estimated using Mplus, version 8.2 (29). Models 1 and 2 tested the hypothesized relationship between early adolescent family environment characteristics (Grades 7–8), mid-adolescent attachment to parents and past year substance use (Grade 9), and young adult AUDIT score (Age 25; Model 1) and problematic cannabis use (Model 2) use. Correlations between exogenous early adolescent family environment characteristics were not estimated in the model, however the observed correlations between these variables are taken into account by Mplus. Full information maximum likelihood estimation was used in all analyses to minimize potential bias due to missing data (29, 30). Demographic factors were included in the analysis. Model fit indices were examined in accordance with current recommendations (31, 32). The analyses presented here are fully standardized.

The results of Models 1 and 2 in the combined Victorian-Washington State sample were compared using multiple-group modeling to test the equivalence of the models across both states. Chi-square difference testing examined moderation by state. Differences in the constrained and unconstrained models were tested using the *difftest* function.

RESULTS

State Comparisons of the Study Variables

Table 1 presents the state comparisons of means and frequencies for demographic variables, Grade 7–8 family environment characteristics, Grade 9 attachment to parents and substance use, and AUDIT scores and problematic cannabis use in young adulthood (Age 25). Across the demographic variables, adolescents in Washington State were slightly older than those in Victoria at Grade 7. State level differences were clear for several Grade 7–8 family environment characteristics. Results showed more positive family management practices and higher rates of sibling cannabis use among Washington State compared to Victorian participants. More favorable parent attitudes to drug use and higher rates of sibling alcohol use were found for participants in Victoria. Regarding Grade 9 attachment and substance use, Washington State compared to Victorian adolescents showed higher levels of attachment to parents and past year cannabis use. Rates of past year alcohol use were greater for Victoria compared to Washington State adolescents. Results showed that at Age 25, Victorian young adults reported higher AUDIT scores (problematic alcohol use) compared to Washington State young adults. Conversely, young adults in Washington State reported higher rates of problematic cannabis use compared to those in Victoria.

Correlations Between the Study Variables

Table 2 presents the correlation matrix for all study variables. Intercorrelations between all study variables were low-moderate and in the expected direction. More favorable family management practices in early adolescence (Grade 7–8) were correlated with lower AUDIT scores and problematic cannabis use. With the exception of the association between sibling alcohol and cannabis use, intercorrelations between the analyzed early and mid-adolescent variables did not show multicollinearity, with no correlations >.80. Young adult AUDIT scores were most strongly correlated with gender, living in Victoria and Grade 9 past year alcohol use. Problem cannabis use in young adulthood was most strongly correlated with gender. The correlation between young adult AUDIT scores and problematic cannabis use was low (r = .21). As sibling alcohol and cannabis use variables were used in separate path models, both variables were retained for analysis.

Path Model Findings

Two path models were estimated to examine the hypothesized relationship between early adolescent family environment characteristics, mid-adolescent attachment to parents and past year substance use, and young adult AUDIT scores (Model 1, **Table 3**), and problematic cannabis use (Model 2, **Table 4**).

Young Adult Audit Scores

The first model, testing the relationship between family environment characteristics, attachment to parents and AUDIT scores, showed good fit [$\chi^2(5, N = 1{,}698) = 16.44$, $p = .0057$, comparative fit index (CFI) = .978, Tucker-Lewis index (TLI) = .856, root-mean-square error of approximation (RMSEA estimate) = .037]. Lower levels of family conflict and greater opportunities for prosocial behavior within the family environment in early adolescence (Grade 7–8) significantly predicted greater attachment to parents in Grade 9. Being female was uniquely associated with lower Grade 9 attachment to parents. Lower

TABLE 2 | Zero-order correlations among study variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Age 25 AUDIT	–	**.21**	.02	**–.17**	–.01	.001	**.13**	**–.06**	–.13	**–.06**	.04	**.07**	**.11**	–.03	**.13**	**.10**
2. Age 25 Problem cannabis use		–	**–**.01	**–.22**	.02	.04	**–.13**	**–.11**	**–.17**	**–.13**	**.08**	**.12**	.34	**–.06**	**.13**	**.41**
3. G7 Family SES			–	**–**.02	.05	–.02	–.02	.01	–.01	.003	–.04	–.01	–.01	–.02	–.01	.04
4. G7 Female				–	**–.13**	–.05	–.001	**–.09**	**.10**	–.03	–.01	**.06**	.04	**–.14**	.05	–.05
5. G7 Age					–	–.01	**–.19**	–.001	**–.06**	–.03	.02	**.06**	**.08**	–.02	.003	.04
6. G7 Accommodation transitions						–	–.04	–.04	–.04	–.01	.03	–.01	.05	–.01	.04	**.13**
7. G7 Victoria							–	.03	**–.12**	.01	**.28**	**.27**	**–.22**	.02	**.41**	**–.25**
8. G7–G8 Low family conflict								–	**.31**	**.46**	**–.21**	**–.24**	**–.23**	**.32**	**–.17**	**–.17**
9. G7–G8 Family Management									–	**.59**	**–.49**	**–.24**	**–.25**	**.28**	**–.29**	**–.26**
10. G7–G8 Family opportunities for prosocial behavior										–	**–.22**	**–.20**	**–.20**	**.48**	**–.17**	**–.21**
11. G7–G8 Parental attitudes favorable to drug use											–	**.26**	**.18**	**–.15**	**.34**	**.21**
12. G7–G8 Sibling alcohol use												–	**.80**	**–.13**	**.48**	**.30**
13. G7–G8 Sibling cannabis use													–	**–.11**	**.37**	**.59**
14. G9 Attachment to parents														–	**–.15**	**–15**
15. G9 Past year alcohol use															–	**.63**
16. G9 Past year cannabis use																–

Statistically significant associations in bold (at least p < .05). G7 = Grade 7, G8 = Grade 8, G9 = Grade 9. Female (coded 0 = male, 1 = female); Victoria (coded 0 = Washington State, 1 = Victoria); Accommodation transitions (coded 0 = no transitions, 1 = transitions); Sibling alcohol use (coded 0 = no use, 1 = recent use); Past year alcohol use (coded 0 = no use, 1 = recent use). Point biserial correlations were performed between a dichotomous variable and a continuous variable. Tetrachoric correlations were performed between two dichotomous variables. Pearson correlations were performed between two continuous variables.

past year alcohol use at Grade 9 was predicted by less family conflict and more positive family management practices in early adolescence (Grade 7–8). Both sibling alcohol use and adolescents' perceptions of parents more favorable attitudes toward drug use, showed significant associations with past year alcohol use. Living in Victoria emerged as a unique predictor of Grade 9 past year alcohol use. Living in Victoria and higher Grade 9 past year alcohol uniquely predicted age 25 AUDIT scores. Being female predicted lower AUDIT scores in young adulthood. Adolescent family attachment was not significantly related to age 25 AUDIT scores.

Young Adult Problematic Cannabis Use

Table 4 shows results from the model testing relationships between family environment characteristics, attachment to parents and problematic cannabis use. The data fit the model well [$\chi^2(5, N = 1{,}698) = 5.270$, $p = .3838$, CFI = .999, TLI = .996, RMSEA = .006]. Lower levels of family conflict and greater opportunities for prosocial behavior in the family environment in early adolescence predicted attachment to parents in Grade 9. Attachment was negatively related to female gender. More past year cannabis use at Grade 9 was predicted by parent attitudes favorable toward drug use, sibling cannabis use, and lower family socioeconomic status, whereas living in Victoria and early adolescent positive family management practices predicted lower past year cannabis use in Grade 9. Grade 9 past year cannabis use uniquely predicted age 25 problematic cannabis use. Being female predicted lower problematic cannabis use in young adulthood. Adolescent attachment to parents was not related to later cannabis problems.

Tests of Cross-State Equivalence

Multiple-group modeling revealed no significant cross-country differences in the pattern of associations specified in Model 1 or Model 2.

DISCUSSION

Harmful alcohol and cannabis use are social concerns associated with a range of negative outcomes. The current longitudinal study, using data from the International Youth Development Study, has tested attachment theory and the SDM to investigate the relationship between early adolescent family environment characteristics, mid-adolescent attachment to parents and substance use, and problematic alcohol and cannabis use in young adulthood. We found cross-state differences in levels of problem alcohol and cannabis use in young adulthood. The rate of problem alcohol use (AUDIT scores) among young adults in Victoria was higher than in Washington State. Conversely, rates of problem cannabis use among young adults in Washington State were greater than in Victoria. Some cross-state differences in levels of early adolescent family characteristics and mid-adolescent attachment to parents were found. Consistent with prior literature suggesting developmental differences in trajectories of substance use where males compared to females show higher rates of substance use into early adulthood (33, 34, 11), we found being female predicted lower AUDIT scores and problem cannabis use in young adulthood. Despite the observed level differences across countries, the current results showed no statistically significant cross-state difference in longitudinal associations between family environment measures and either problematic alcohol or cannabis use. These findings suggest that family risk and protective factors may exert a cross-nationally similar effect on the development of young adult substance use. Further cross-national research examining the longitudinal effects of family environment characteristics should seek to confirm the current findings and investigate characteristics in other potential spheres of influence (e.g., peer-group, community).

TABLE 3 | Path models predicting mid-adolescent attachment to parents and past year alcohol use and young adult AUDIT scores.

Association estimated	Standardized estimate	Unstandardized estimate (SE)	*p*-value
G9 Attachment predicted by G7-G8:			
Low family conflict	.097***	.023	.032
Family management	– .032	.028	.264
Family opportunities for prosocial behavior	.440***	.025	<.0001
Parent attitudes favorable toward drug use		.024	.076
Sibling alcohol use (referent: no use)	– 0.15	.023	.513
Family socioeconomic status^	– .027	.022	.234
Female (referent: male)^	– .119***	.022	<.0001
Age (years)^	– .027	.021	.182
Accommodation transitions (referent: no transitions)^	– .006	.020	.779
Victoria (referent: Washington State)^	.017	023	.462
G9 Past year alcohol use predicted by G7-G8:			
Low family conflict	– .067*	.031	.031
Family management	– .176***	.039	<.0001
Family opportunities for prosocial behavior	– .008	.038	.822
Parent attitudes favorable toward drug use	.238***	.033	<.0001
Sibling alcohol use (referent: no use)	.205***	.027	<.0001
Family socioeconomic status^	– .006	.028	.845
Female (referent: male)^	.038	.028	.171
Age (years)^	.003	.026	.919
Accommodation transitions (referent: no transitions)^	.032	.027	.247
Victoria (referent: Washington State)^	.198***	.029	<.0001
Age 25 AUDIT predicted by G9:			
Attachment	– .028	.036	.436
Past year alcohol use	.177***	.051	<.0001
Family socioeconomic status^	.037	.033	.266
Female (referent: male)^	– .238***	.034	<.0001
Age (years)^	.014	.037	.697
Accommodation transitions (referent: no transitions)^	– .007	.034	.835
Victoria (referent: Washington State)^	.141***	.040	<.0001
Correlations specified in the model:			
G9 Attachment with G9 Past year alcohol use	– .104**	.032	.001

*G7 = Grade 7, G8 = Grade 8, G9 = Grade 9. Correlations among exogenous G7-G8 early adolescent family environment characteristics and demographic variables are not estimated in the model; the observed correlations between these variables are taken into account by Mplus. SE = standard error. ^Demographic factors measured at G7. Female (coded 0 = male, 1 = female); Victoria (coded 0 = Washington State, 1 = Victoria); Accommodation transitions (coded 0 = no transitions, 1 = transitions); Sibling alcohol use (coded 0 = no use, 1 = recent use); Past year alcohol use (coded 0 = no use, 1 = recent use). Statistically significant results indicated with asterisks: *p < .05, **p < .01, ***p < .001.*

Our findings supported the hypotheses that characteristics of the family environment and adolescent substance use would be associated with problematic alcohol and cannabis use in young adulthood. The findings of this study are similar to those reported in previous studies, such that less positive family environment characteristics (e.g., family conflict) were associated with later substance use (e.g., 15, 10, 16). Importantly, the current findings extend over a longitudinal period of over 12 years and thus are intrinsically valuable in contributing to understanding of the long-term developmental influence of the family environment on trajectories of substance use. The current findings suggest a developmental process in both states whereby early adolescent family factors predict Grade 9 alcohol and cannabis use, which is then maintained into young adulthood.

Although prior longitudinal studies have reported higher levels of attachment to parents are associated with lower rates of substance use, our results did not support the hypotheses that adolescent attachment to parents would be associated with less problematic alcohol and cannabis use in young adulthood. Attachment theory has long suggested that early problems in parent-child attachment are antecedents for later social and emotional adjustment problems (18), including substance use. Measures of early childhood family attachment were not available in the current study; hence, we were unable to test the potential prospective association between early life family-based attachment and young adult substance use. However, in line with SDM theory (12) and suggestions that the family environment is pivotal in substance use prevention (14), we found that early adolescent family conflict, parental norms, and sibling substance use were key predictors of later adolescent substance use and, by extension, problem use of alcohol and cannabis in young adulthood in both Victoria and Washington. We also found a small effect of family socioeconomic status on young adult cannabis use. Similar findings have been reported

TABLE 4 | Path models predicting mid-adolescent attachment to parents and past year cannabis use and young adult problematic cannabis use.

Association estimated	Standardized estimate	Unstandardized estimate (SE)	*p*-value
G9 Attachment predicted by G7-G8:			
Low family conflict	.100***	0.23	<.0001
Family management	-.030	.029	.301
Family opportunities for prosocial behavior	.441***	.025	<.0001
Parent attitudes favorable toward drug use	-.047	.024	.056
Sibling alcohol use (referent: no use)	.006	.023	.796
Family socioeconomic status^	-.026	.023	.255
Female (referent: male)^	-.120***	.022	<.0001
Age (years)^	-.029	.021	.164
Accommodation transitions (referent: no transitions)^	-.007	.020	.740
Victoria (referent: Washington State)^	015	.023	.512
G9 Past year alcohol use predicted by G7-G8:			
Low family conflict	-.047	.037	.203
Family management	-.165***	.045	<.0001
Family opportunities for prosocial behavior	-.061	.044	.160
Parent attitudes favorable toward drug use	.171***	.036	<.0001
Sibling alcohol use (referent: no use)	.299***	.029	<.0001
Family socioeconomic status^	.072*	.031	.019
Female (referent: male)^	-.048	.035	.169
Age (years)^	-.024	.036	.503
Accommodation transitions (referent: no transitions)^	.061	.033	.064
Victoria (referent: Washington State)^	-.220***	.036	<.0001
Age 25 AUDIT predicted by G9:			
Attachment	-.009	.045	.842
Past year alcohol use	.394***	.055	<.0001
Family socioeconomic status^	-.026	.042	.534
Female (referent: male)^	-.199***	.044	<.0001
Age (years)^	-.028	.049	.574
Accommodation transitions (referent: no transitions)^	-.028	.042	.496
Victoria (referent: Washington State)^	-.042	.050	.406
Correlations specified in the model:			
G9 Attachment with G9 Past year alcohol use	-.080*	.039	.041

G7 = Grade 7, G8 = Grade 8, G9 = Grade 9. Correlations among exogenous G7-G8 early adolescent family environment characteristics and demographic variables are not estimated in the model; the observed correlations between these variables are taken into account by Mplus. SE = standard error. ^Demographic factors measured at G7. Female (coded 0 = male, 1 = female); Victoria (coded 0 = Washington State, 1 = Victoria); Accommodation transitions (coded 0 = no transitions, 1 = transitions); Sibling cannabis use (coded 0 = no use, 1 = recent use); Past year cannabis use (coded 0 = no use, 1 = recent use).

elsewhere (35– 37). Further investigations on the effect of early economic deprivation and poverty, and broader environmental influences, on later substance use are warranted. In this context, our study findings are important for guiding the development of interventions targeting the adolescent family milieu and social norms within broader social contexts (e.g., peer-group, community).

Results supported the Social Development Model (SDM). Parent's attitudes to substance use and the substance use behavior of siblings were found to predict adolescent and young adult alcohol and cannabis use. These findings align with the SDM proposition that the behavioral norms and attitudes of people that children and young people form social attachments to are the critical drivers in the development of health and social behavior (12). Our findings also suggest that higher rates of alcohol and cannabis use identified in the IYDS cohorts during adolescence (10, 38) are continued into early adulthood (11).

The current findings suggest that prevention and intervention strategies targeted at reducing substance use into young adulthood, including problematic alcohol and cannabis use, need to consider the influence of behavioral norms and attitudes in social relationships between family members from early on in adolescence. The lack of cross-state differences also suggests that common interventions targeting similar family environment characteristics (risk and protective factors) might be selected to reduce young adult substance use (alcohol and cannabis) in both states. It is also critically important to understand predictors and mechanisms of persistence and desistence of both alcohol and cannabis use across a range of spheres of influence (e.g., peer group, community) into and during adulthood.

Strengths and Limitations of This Study

Study Strengths

Several strengths to the current study are noted. At the time of study commencement in 2002, the recruited sample was state representative, demonstrated high responses rates, and comprised approximately equal numbers of male and female participants. The study is unique in analyzing two cross-state samples, recruited, surveyed, and longitudinally followed using identical methods with high response rates (9). To young adulthood, the study has achieved strong participant retention. This study has detailed data on a wide range of risk and protective factors from early in adolescence and into young adulthood known to influence the development of healthy and problematic behaviors in adolescents, including those related to the family environment and participants' use of substances. Therefore, the current study presents a unique opportunity to examine predictors of attachment and prospective associations between attachment and substance use, over multiple periods of development relative to prior studies. Thus, a noteworthy strength of this study is its ability to maximize the available data to investigate the current research questions and contribute vital knowledge to theories of development and attachment.

Study Limitations

Despite these notable strengths, several limitations to the study are acknowledged. The study results are generalizable only to states with similar school contexts and grade levels to those examined here. Measures of family environment characteristics, attachment, and substance use were based on self-report data. The use of self-report data in studies of adolescents and for the measures examined in this study is considered reliable (39). The factor structure of these measures has been validated (24) and these measures have shown adequate reliability and longitudinal validity in Victorian (10, 11) and Washington State (24) samples.

CONCLUSIONS

Problematic alcohol and cannabis use are associated with negative health and social outcomes. Our study, using data from the International Youth Development Study, sought to identify modifiable influences that emerge from two theories of the development of substance use; *attachment* and *social development* theories. Our findings suggested that characteristics of the family environment, including family behavioral norms and attitudes, are important influences on substance use in adolescence and into young adulthood. These influences, as well as broader influences within social settings in which adolescents and young adults interact, are important in the development of substance use prevention and intervention strategies.

DATA AVAILABILITY STATEMENT

Please contact study directors regarding data availability. Requests to access the datasets should be directed to john.toumbourou@deakin.edu.au.

ETHICS STATEMENT

The University of Melbourne Human Ethics in Research Committee and the Royal Children's Hospital Ethics in Human Research Committee provided approval for this study in Australia. The University of Washington Human Subjects Institutional Review Board provided approval for the study in the USA.

AUTHOR CONTRIBUTIONS

JH, JB, and JT contributed to the conception and design of the study. JH performed the statistical analysis and wrote the first draft of the manuscript. JB assisted with the statistical analysis. JB and JT wrote sections of the manuscript. All authors (JH, JB, JT, RC) contributed to manuscript revision, read and approved the submitted version.

FUNDING

JH is supported by a Research Fellowship provided through the Westpac Scholars Trust. The authors are grateful for the financial support of the National Institute on Drug Abuse (R01DA012140), the National Institute on Alcoholism and Alcohol Abuse (R01AA017188), the National Health and Medical Research Council (NHMRC; 491241) and the Australian Research Council (DP109574, DPO663371 and DPO877359) for supporting the IYDS. The content is solely the responsibility of the authors and does not necessarily represent the official views of the funders. The funding agencies did not have any involvement in the analysis and interpretation of data, the writing of the article or the submission of the article for publication.

ACKNOWLEDGMENTS

The authors wish to express their appreciation and thanks to project staff and participants for their valuable contribution to the project.

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Conflict of Interest: JT is a director of the not-for-profit company Communities That Care Ltd that distributes the Communities That Care Youth Survey in Australia.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychiatry

HYPOTHESIS AND THEORY
published: 12 December 2019
doi: 10.3389/fpsyt.2019.00914

Psychobiology of Attachment and Trauma—Some General Remarks From a Clinical Perspective

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Attachment refers to a psychobiological principle that is deeply rooted in evolutionary development; it is thought to contribute a major advantage in the survival of the social group. Within individual development it indicates a primary motivational system that guides the initial transactions between mother and baby and furthermore mediates affective attunement and regulation. Psychosocial learning, in close interaction with genetics and epigenetics, also develops a decisive foundation for further brain development of the infant. Finally, the attachment pattern established forms an enduring, relational context for later affective, cognitive, and social development of the child. As an unconsciously active matrix for future personal relationships it has a particular impact on the comprehensive psychological functions of empathy and mentalization. Early adverse and traumatic experiences or major emotional neglect may lead to different levels of security versus insecurity or disorientation-disorganization of the attachment pattern that corresponds to characteristic features of neurobiological regulation.

Keywords: attachment, secure-insecure, disoriented-disorganized, oxytocin, empathy, mentalization, trauma, neurobiology

OPEN ACCESS

Edited by:
Andrew J. Lewis, Murdoch University, Australia

Reviewed by:
Alessio Simonetti, Baylor College of Medicine, United States
Renita A. Almeida, Murdoch University, Australia

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Specialty section:
This article was submitted to Addictive Disorders, a section of the journal Frontiers in Psychiatry

Received: *02 June 2019*
Accepted: *18 November 2019*
Published: *12 December 2019*

Citation:
Lahousen T, Unterrainer HF and Kapfhammer H-P (2019) Psychobiology of Attachment and Trauma—Some General Remarks From a Clinical Perspective. Front. Psychiatry 10:914. doi: 10.3389/fpsyt.2019.00914

INTRODUCTION

Early representatives of psychoanalysis argued that the roots of human social motivation are primarily physical and sensory (hunger, sexuality) and that satisfaction and/or frustration of these needs lead to the infant's initial approach to the mother. In this theoretical view, attachment refers to a "secondary motivational system." The British pediatrician, child psychiatrist, and psychoanalyst John Bowlby (1907–1990) strongly opposed this theoretical approach. Based on numerous empirical observations he developed a different theory: the infant's hunger for its mother's love and presence is as great as its hunger for food. Attachment is therefore a "primary motivational system" with its own workings. In a remarkable study conducted for the World Health Organization (WHO), Bowlby (1)provided substantial arguments supporting his view. He emphasized the importance of the link between the quality of maternal care and the child's future mental health. Leading psychoanalytic representatives initially fiercely dismissed Bowlby's position, in spite of the fact that Rene Spitz (2)had already made similar empirical observations with orphaned children some years earlier. Although carers in orphanages adequately met children's basic nutritional and hygienic needs, they failed to deliver reliable emotional support. The development of these children demonstrated that the care they received belied a disconcerting, psychosomatic failure to thrive, in addition to a high mortality rate. Early ethological research

supported Bowlby's theory. Konrad Lorenz (1903–1989) had discovered that ducklings develop a strong bond towards their mother, even if she did not feed them (3). Harry Harlow's (1905–1981) thrilling experiments on rhesus monkeys proved that the need to satisfy hunger is important, but the need for social contact is greater. Any prolonged separation from the mother, as well as an isolated upbringing, led to massive impairments of social behavior. Harlow also suggested that not only maternal bonds but also other social interactions e.g. playing with peers of the same age, were apparently crucial as regards further socioemotional development (4).

Bowlby (5) verified his attachment theory with some pioneering publications: the bond between infant and primary caregiver, usually the mother, refers to a deeply rooted evolutionary system of interaction, which increases the infant's chances of survival. Along with the infant's emotional and cognitive development and the care of its mother, a strong emotional connection is gradually developed under favorable conditions. He distinguished four stages of early development of attachment: 1) *Preattachment* (birth to 6 weeks): the infant is in close contact to its mother as well as other family members. It indicates a strong need for closeness. 2) *Early arising attachment* (6 weeks to 6–8 months): the infant reacts differently towards people it knows than those it does not; basic trust is developing. 3) *Clear-cut attachment* (6–8 months to 18–24 months): the infant shows separation anxiety and a clear attachment to its caregiver. 4) *Differentiation and integration of attachment* (18 months to >2 years): the toddler creates a reciprocal relationship with its caregiver. It actively participates in interactions, asks questions, and negotiates. Furthermore, Bowlby (5) suggested that early attachment experience creates internal working models as "life-long templates." These templates create an affective as well as cognitive matrix for future relationship patterns. Based on his theoretically sound and clinically tested results Bowlby succeeded in establishing his own tradition of attachment theory.

Mary Ainsworth (1913–1999), a co-worker of Bowlby, initiated an early empirical approach. To evaluate the quality of attachment formed by children between the ages of 1–2 years, Ainsworth created a valuable psychological system of assessment. Based on her method there are three key criteria for creating attachment bonds: 1) proximity seeking to caregiver, 2) effect of a "secure base," and 3) protest when separated from the caregiver. Her paradigm of "*separation and reunion*" refers to a characteristic research situation: a mother and her child enter a room, which offers a large number of toys. In the next scene a stranger, usually a research assistant, joins the pair. The child starts exploring its environment; it picks up toys and engages in play. Next, the child initiates contact to the stranger. The mother, still present, is sitting close by while reading the paper but is still open to contact if initiated by the child. After a while, the mother leaves the room. The behavioral and emotional reactions of the child to the separation of its mother as well as the reunion are the focus of the experiment. According to attachment theory, children between the ages of 12–20 months should have developed a secure and unique attachment to their mothers as a normative developmental milestone. Thus, even a brief separation in this crucial developmental stage can cause tremendous emotional suffering. Ainsworth's, (6) research has shown that:

- Children with a "*secure attachment*" protest when left alone. They show major distress, often cry, disrupt their play, and feel discomfort in the presence of a stranger. When the mother returns the child seems joyful, seeks proximity, calms quickly, and returns to play.
- Children with an "*anxious-avoidant* attachment" do not protest when the mother leaves the room. They continue to engage in play and initiate familiar contact with the stranger. At first glance, these children do not seem to feel uncomfortable or anxious. They do not react or notice the return of the mother and turn away if the mother tries to approach the child. This seemingly mature behavior, however, is in fact accompanied by significant internal stress. This behavioral strategy is supposed to turn the child's attention away from the situation of separation to avoid any correlating emotional pain.
- Children with an "*anxious-ambivalent attachment*" react with tremendous emotional distress when being left alone, similarly to securely attached children; they seek strong physical contact when the mother returns. Their behavior toward the mother, however, is ambivalent and alternates between clingy and avoidant. Their disproportionate attachment behavior appears to follow a strong urge to control the uncertain attachment with the mother.
- Children with a "*disoriented-disorganized attachment*" lack any consistent pattern in response to the separation and return of the mother. Children displaying this type of attachment are confused by separation, throw tantrums, and are inconsolable. When the mother returns, the child seems to, simultaneously, seek proximity and avoid the parent. Numerous idiosyncratic behavioral mechanisms such as freezing, stilling, and other psychomotor stereotypes are apparent.

These various attachment styles reflect the history between a mother and her child during early childhood. They are highly predictive of future relationships. Research suggests that the majority of children, who grow up under overall positive interpersonal and social circumstances, form a stable attachment security that endures throughout their life (7). In general, probability for attachment security increases if parents consistently meet their children's needs in a sensitive manner. Attachment security is a crucial factor for the development of children's emotional, cognitive, and interpersonal competence. On the other hand, exposure to trauma in early childhood significantly interferes with the ability to form secure attachments. Despite experiencing trauma such as neglect and abusive behavior, however, all children continue seeking proximity and develop distinct attachment patterns (7).

The present work deals with psychobiological aspects of early interactions between toddler and the primary parental figure, usually the mother, which, in a processual manner, lead to the establishment of a distinct attachment pattern with fundamental implications also on the further affective, cognitive, and social development of the child in later stages of life. It first places "bonding" in a more general evolutionary

context. Thus, the developmental principle "attachment" can already be discovered in primitive forms of a cellular differentiating organic life. Central to this is the oxytocin system, which undergoes numerous transformations in the course of phylogenesis. It achieves crucial adaptive progress when it is eventually linked to a reward system as the brain structures become phylogenetic. The importance of oxytocin is specifically linked to the emergence of important social contacts and attachments in general, for the attachment system unfolding in early baby-mother interactions. Empirical studies emphasize highly complex interactions on a psychological as well as a neurobiological level. Genetic programs of the child, ongoing experiences in the mother-child dyad and the familial and social environment, as well as epigenetic processes triggered thereby must be coordinated with each other in fine orchestration, so that ultimately a secure attachment pattern can emerge. The closely related concepts of cognitive and affective empathy on the one hand and of mentalization on the other are outlined in the context of the fundamental bonding patterns in a subsequent section. This is followed by a summary of empirically established insights into neuronal, structural, and functional relationships, which are currently being discussed as typical of safe versus unsafe attachment patterns.

Furthermore, this work primarily aims to provide a prototypical description of interactive and intrapsychic processes underlying distinct attachment patterns. It takes up findings from different developmental psychological and psychopathological examination contexts. From a clinical perspective, they are considered to be of exemplary use for understanding frequent deficits in empathy and mentalization in adult patients with different impaired attachment patterns. This form of presentation also involves a number of theoretical and methodological problems that need to be discussed. The authors are self-consciously aware that a clinical focus on prototypical principles in the psychobiology of attachment represents a strong shortening and simplification of those highly complex relationships governed by numerous mediator and moderator variables, as theoretically conceptualized in the transactional models of modern developmental psychological methodology (see 8).

Attachment From an Evolutionary Perspective

The great Russian-American geneticist, zoologist, and evolutionary biologist Theodosius Dobzhansky (1900–1975) once said, "nothing in biology makes sense except in the light of evolution" (9, p.125). Therefore, the quest for the evolutionary root of attachment and its connection in well-established adaptive patterns and mechanisms of its implementation arises. In an overall evolutionary sense, four principles of behavior can be distinguished: 1. maintenance of homeostasis, 2. consumption and acquisition of energy, 3. prevention of harm, and 4. reproduction.

This evolutionary program implies underlying primary motivational systems, which connect emotional responses with distinctive tendencies of action that are correlated with distinct affective qualities of experience. These primary motivational systems are rooted in the phylogenetic organization of the brain. This form of organization considers exclusive internal appetencies as well as environmental cues signaling either danger or reward (10). A genetically rooted preparedness to rapid action, however based on low information processing, is gradually replaced by more complex decision making, planning and behavioral execution. These developmental stages advance not only in accordance with endogenic growth, but continuously refer to manifold social learning processes within a primary relational context. Above all, they orchestrate the care of the parents for their children and provide the base for a life-long attachment, thus guaranteeing affective communication as well as social relationships (11).

Tomkins (12, 13) psychophysiological affect theory suggests a fundamental view of the development of basic emotions in early childhood. According to Tomkins, infants possess a highly differentiated set of basic emotions by the time they are born. Distinctive motor and visceral reactive patterns are connected to specific primary affects. Through subtle facial expressions, a set of eight primary affects may be distinguished. Low and high intensity labels characterize these affects [positive: interest/excitement, enjoyment/joy, surprise/startle; negative: distress/anguish, fear/terror, shame/humiliation, disgust/dissmell, and anger/rage]. Affective neuroscience suggests that primary affects can be associated with distinctive neuronal regulatory circuits. They may be identified as phylogenetically acquired adaptive structures that are widely shared among primates; in preliminary stages they reach back even further (14).

The main affective structures are directed to specific adaptive goals. Ontogenetic value is underlined through focusing attention onto significant stimuli, avoiding automatic reactions to harmful stimuli, allowing the recognition of disappointing objects, preventing overwhelming discrepancy in information processing and, most importantly, promoting parent-child proximity to ensure survival. The main affective structures form primary motivational systems when typical perceptions cause characteristic neuronal action potentials according to the gradient of the stimulus change, its absolute intensity and duration. Their biological function aims to frame stimulation in a general and abstract manner and furthermore provides it with a distinct affective, analogue quality of experience. Thus, emotions translate and amplify stimuli from various sources such as biological drives, pain signals and external perceptions along with thoughts, ideas and other affects. Defined affects show differences in facial expressions, biosocial information transmitted, as well as differences in tolerance and coping. During individual development, these affective components may undergo independent developmental trajectories (15). The system of attachment assumes a superior role during early affective development. According to the phylogenetic structural program, individual regulatory principles such as affective arousal, emotional understanding, and emotional behavior are acquired which, subsequently, are transformed into a subjective competence through continuous interactions with the primary caregivers (i.e. the parents), mainly the mother (16, 17).

Hypothetical Advantages of Attachment Respectively of Eusociality

A hypothesis of anthropological evolution implies (18): During evolutionary progression of the hominid to the homo sapiens, larger social groups have acquired vital developmental advantages. To facilitate and process complex social information, a larger brain volume was necessary. More complex brains required longer periods for an individual to develop, most notably in the postnatal period. Hence, a prolonged period of infant dependency resulted. Longer periods of dependency required additional parental attention as well as greater supervision, specialized childcare and supportive social structures. Growth of social groups facilitated the development of language; basic vocalization and gestures were insufficient for social communication. Thus, development of language subsequently set in. In turn, complex social structures initiated the development of more complex structures of communication. Ultimately, spoken and written language developed.

Evolutionary Development According to "Attachment Theory" and "Eusociality"

Numerous molecular studies allow a more precise understanding of the evolutionary development of attachment; for example, it is accepted that the oxytocin system plays a major role in a pro-social system. In its precursor stages, this system is traceable down to metazoa, which in contrast to protozoa already feature signs of differentiated and specialized cells, being an early multicellular organism. Over the course of millions of years, the oxytocin system has undergone numerous evolutionary transformations through the various stages of vertebrates to mammals and hominids and finally to homo sapiens. Various successive developmental steps of precursor cells, precursor peptides, as well as precursor receptors of oxytocin characterize this evolutionary progression (19).

During the course of evolution, oxytocin achieved a crucial developmental milestone by linking the attachment system to the reward system. Thus, attachment and love as well as care and its underlying parental bonding process towards the infant started to become rewarding. Interestingly, differential sensory information in various species has regulated both the attachment and reward systems during this evolutionary process. Thus, acoustic signals distinctively activate the attachment system in birds while olfactory stimuli that of rodents. Humans', as well as other mammals', attachment system is primarily activated through visual stimuli (19).

Neuroanatomical Pathways Underlying the Complex Effects of Oxytocin

While gazing at an infant's face, hypothalamic parvocellular and magnocellular neurons as well as nuclei supraoptici release oxytocin and vasopressin in the mother's brain. Oxytocin and vasopressin enter different brain areas, such as the anterior pituitary lobe, amygdala and brainstem (20). Simultaneously, through a complex interaction between various neurotransmitter systems such as opidoid and dopaminergic, the reward system is activated (ncl. accumbens; ventral tegmental area; ventral striatum) (21, 22).

Oxytocin and vasopressin's genetic information are located on adjoining gene-sequences and differ from each other by only two amino acids. Overall effects of oxytocin and vasopressin are manifold. They facilitate both affiliative-nurturing behavior and aggressive-defensive behavior towards external threats against attachment. Oxytocin may also lead to anxiety related reactions, in addition to regulating homoestatic energy levels and modulate perception of pain. A coordinated orchestration of HPA axis, opioids, dopamine, serotonin, norepinephrine and glucocorticoids mediate these complex functions (23).

Overall Effect of Oxytocin for the Development of Close Social Bonding

Oxytocin directs overall social interaction behavior on a neurobiological level. Dopamine initially released during a social interaction in the ventral tegmental area determines the degree of attractiveness of this contact ("*wanting*"). Activation of DA_2 receptors in the nucleus accumbens leads to the release of opioids, which in the ventral striatum and prefrontal cortex (PFC) cause this contact to be positive and rewarding ("*liking*"). On the other hand, up-regulation of DA_1 receptors seems to be crucial for the maintenance of such a contact (social bonding). Oxytocin, in combination with vasopressin, determines selective bonding, which may also include increased aggression towards rival sexual partners. Through attachment to a partner, an overall social stress buffer and unique partner protection will result. At the same time, strong negative emotional stress occurs when the partners temporarily or completely separate. Separation pain, longing, and sadness may occur. At the neurobiological level, a unique organization of oxytocin receptor, arginine-vasopressin-$receptor_{1a}$, and DA_1- and DA_2- receptors has been evolutionarily established in a coherent manner to this complex social behavioral regulation (22).

Psychobiology of Early Attachment

From the 2nd/3rd trimester onwards, mother and embryo are increasingly attuning to each other under the dominant influence of oxytocin. A major fall of progesterone right before birth continuously releases oxytocin and thereby triggers labor activity. Simultaneously, oxytocin relieves pain during labor. Following delivery, the new-born's suckling on the maternal breast promotes secretion of both prolactin and oxytocin. Breastfeeding provides a harmonious, highly satisfying and stress-reducing communication between baby and mother. Oxytocin significantly contributes to the development of a sense of security and social connectivity; it promotes the selective attention of the mother; causes contact, closeness, warmth, and love between mother and child. Oxytocin is associated with a passive, vasopressin with an active coping pattern. Oxytocin also shows significant anti-inflammatory and antioxidant effects. Furthermore, oxytocin has been shown to have an impact on additional steps of the baby's further brain development: Triggered GABAergic neurotransmission promotes synchronization in the cortex and

hippocampus and thus co-organizes social learning. Empirical evidence underlines the fact that the development of the infantile brain unfolds under the critical influence of social experiences. There is close interaction with genetic programs and epigenetic processes initiated by ongoing relational and social experiences (24–26)

Meaney, (27) numerous animal studies have given a fascinating insight into the high complexity of this early mother-to-child dyad and its consequences for the development of the brain: genes organize the brain and trigger sensitive phases. Current social experiences orchestrate genetic transcription in a continuous adaptive organization of neural systems. However, it is the specific quality of these early social relationship experiences that activate key epigenetic mechanisms and thereby very specifically modify genetic expression, particularly through DNA methylation or changes in the chromatin structure. Growth and plasticity of the neural organization of the child's brain is not the only developmental step controlled by this process. It additionally programs long-term future stress responsiveness, particularly *via* modulation of HPA activity. It should be noted that through a direct transmission from the mother even the daughter's future maternal behavior is being already pre-primed by impact on growth and activation of her medial optic area and the regulation of oxytocin and estrogen receptors.

These and several other neuroscientific research findings demonstrate that early mother-baby attachment is the key interpersonal and social matrix for the child's brain development. It thus establishes the child's future potential for mental development and physical health on the one hand and mediates a variety of mental and somatic disease risks on the other. Winnicott (28, 29) so inspiringly introduced the psychodynamic concepts of "primary maternal care," "good enough mothering," "mirroring," "holding environment," and "ability to be alone in the presence of the other" decades ago, into psychoanalytic developmental psychology. His terms today may find their immediate neurobiological correlation in the development of relational and social cerebral maturation (30–32).

Prerequisites for a Successful Attunement and Affect Regulation in the Attachment System

From an evolutionary perspective, it is imperative to understand what other members of the same social group think and feel, to be able to communicate and share affective states with them, make predictions about other people's intentions and understand possible motives for their actions, and in general to show prosocial behavior. The global term of "empathy" refers to several abilities that map overlapping but differently structured functions. These closely relate to the various forms of affective perception, experiencing, understanding and communicating. They provide the basis for socio-affective action in a hierarchical organization:

- Thus, *affective contagion* describes a tendency to absorb the emotional state of another person without having to understand the reason for the emotional experience itself.
- *Mimicry* means to synchronize one's own facial expressions, vocalizations, gestures, postures and movements with those of another person, but without feeling the same emotion of the other. Affective contagion and mimicry do not require a clear separation between self and object.
- *Imitation* refers to a purposeful act observed on another person. However, it does not necessarily correspond to the actual affective state of this imitated person.
- *Emotional empathy* requires a clear differentiation between self and object, and imbeds to feel how the other feels.
- *Cognitive empathy* involves knowing what the other person thinks, feels, intends and why. Emotional and cognitive empathy critically imply a reflective self-awareness.
- *Sympathy* means positive feelings for another and strives for the other to get better. It is a prosocial motivation based on empathy. It involves a more cognitively determined mental process, which succeeds through taking over the other person's perspective and leads to interpersonally shared feelings and goals.
- *Compassion* involves empathic concern for the other and motivates one to care and console. It does not necessarily presuppose a common, identical feeling with the other.
- *Empathic concern* is an emotional and motivational condition that seeks to help and to contribute to the well-being of others.

Furthermore, all of these aspects of perception, understanding, communication and the regulation of affective life in relationships are anchored in different neural systems of the brain (33).

Affective empathy concerns phylogenetically older parts of the brain and is initially based on an affective transference, which essentially comes about through the activation of mirror neurons. Mirror neurons were first detected in monkeys in the supplementary motor area. They specifically fired when monkeys observed motor actions of conspecifics in the environment. This neural mechanism suggests an evolutionary heritage representing an interactive understanding of action, at least in the primate range (34). In humans, this system is much more complex (35). It allows the representation of another person's emotional state that may be shared by an in-body simulation (36). In a neural network the inferior part of the parietal lobule, posterior superior temporal sulcus, premotor cortex, and especially the anterior part of the insula and anterior and middle sections of the cingulate cortex (ACC, MCC) functionally interconnect for this performance. The latter two structures occupy a special position. Insular cortex is responsible for the representation and integration of internal visceral and emotional states (37). Insula maps global emotional states, includes uncertainty information and risk preferences and conveys self-awareness. It has important connections to the prefrontal and cingulate cortex as well as to the temporal lobe, limbic system, thalamus, basal ganglia and the brainstem. ACC represents insular information on a higher cognitive level and coordinates reality-oriented decisions and actions. In particular, posterior parts of the ACC and anterior parts of the middle cingulate cortex seem to be crucial for the apprehension of another person's pain experience (17).

Another distinct neuronal network, in turn, mediates *cognitive empathy*. It functionally joins the ventromedial prefrontal

cortex, temporal pole, posterior cingulate cortex, precuneus and temporoparietal junction. This system allows for complex cognitive operations such as assessing what another person thinks, feels and intends in a defined situation, and what the reasons might be (38).

Closely related to these different, basal and also higher structured levels of the empathy-concept is the concept of *mentalization*. In recent decades mentalization has been fruitfully implemented in psychoanalytical and socio-cognitive developmental psychology, in research involving trauma and posttraumatic disorders and furthermore has led to highly promising clinical-therapeutic approaches for various psychopathologies by the research group around Peter Fonagy. Again, the mentalization concept also includes various dimensions. These dimensions may be characterized by several polarities: by an automatic experience mode, very likely evolutionarily anchored versus a controlled one, strongly based in social and interactive learning, by a predominantly external versus predominantly internal orientation, by a focus on the self versus one on significant others, by a primarily affective versus a primarily cognitive mentalization. These dimensions are not intended to be understood separately. They are hierarchically coordinated against the background of relatively undisturbed developmental conditions and are used flexibly depending on the requirements in normal, everyday situations. However, these dimensions may functionally dissociate under special conditions. These dimensions can also be assigned to differential neuronal functional systems (39). Not surprisingly, the neural systems of mentalization essentially overlap with those underpinning the concept of empathy. Even if current knowledge is based on aggregated data from numerous empirical studies, their provisional, hypothetical character should be considered.

With these conceptual prerequisites outlined, some fundamental processes of the attachment system can be considered in greater detail, which is established between baby and mother in a different distribution of tasks. It refers to a complex system of interactive affect attunement and regulation, which in its earliest stage may rely on evolutionary mechanisms:

- Primary affects are promptly and automatically available to the infant to deal with "*common situations*" (see above). However, this adaptive function of the primary affects creates the problem of an "individual reality" that does not necessarily always coincide with the circumstances of a particular situation, i.e., the system of primary affects must be relativized by a corrective system of coherent perceptions and cognitions in further development.
- Primary affects are always discrete messages to the mother. The infant's differentiated affective expressions also have a differentiated quality of subjective experience at the level of physical sensation. Despite the attribution of a differentiated experience of meaning, this does not yet imply a self-reflexive awareness. Subjective experience of meaning in the sense of meaningful feelings always requires the prior acquisition of a self-concept that arises in the course of the second year of life at the earliest. Self-reflexive experience of feelings is only possible at the level of a symbolically represented self. The development of the child's affect system initially receives its full meaning only in a systematic relation to the transactional system of the mother-child dyad.

Fonagy and co-workers, (40) consider "*mentalized affectivity*" to be the most mature form of affect regulation, favorably acquired through several years of development into adolescence and beyond. It describes the highly differentiated ability to attribute one's own feelings to subjective meanings and to be able to use them constructively in interpersonal relationships. However, their developmental origins lie in the mother's early reflection of the child's affective state. It is therefore rooted in the attachment process itself. The infant's automatic affect expressions and the maternal affective responses *via* her facial expression and voice are linked by a constitutionally anchored contingency detection mechanism. On the one hand the infant succeeds in exerting control over the maternal mirroring behavior and, on the other hand, in experiencing feelings of well-being in its own emotional state. At the same time, affect mirroring also serves as the basis for the development of a representational framework in which the infant's affects can be recognized as subjective manifestations of self-organization. In order to allow the infant to maintain a regulated state in the first few months of life, the most exact recognition of affection with the highest degree of contingency by the mother is necessary. This pattern of affective mirroring changes after the third month. Although the mother's reaction must be congruent with the infant's affect expressions and should capture it empathetically, her facial expressions and vocalizations should mark the baby's expression of affect by a certain exaggeration thereby reflecting it back. The baby internalizes the empathetic behavior of the mother towards his/her state of affect, thereby gaining a representation of a second order of his/her own affectivity. Here, the empathetic maternal face is the bearer of meaning, but the emotional arousal of the child becomes significant. The maternal affective response alters the infantile emotion insofar as it modifies the primary experience and modulates it in its potentially disorganizing intensity, thus organizing the child's self-state.

Characteristics of Secure Attachment

In these early reciprocal affective processes of the "*self with the other*," the interaction of affects is directed at three essential goals (41): 1. a reliable state transformation of the baby from an aversive state (e.g., hunger) to a comforting, satisfied state (e.g., satiety, consolation), 2. a playful interactive behavioral sequence of baby and mother in mutual relaxation, 3. a deep affective attunement, a shared, positively experienced emotional state.

Trust, reciprocity, intimacy, and love are higher structured psychological qualities of affective experience in such a primary relational context. In a neurobiological perspective, these successful affective exchanges are not only the basis of attachment; they are also motivationally coupled with the reward system (42). The main trajectory of this neural network extends from the limbic structure of the ventral tegmental area to the nucleus accumbens in the ventral striatum and is closely related to the amygdala on the one hand and the prefrontal cortex on the

other. Thus, the evolutionarily highest system of stress regulation has been interactively practiced (31):

- In the case of imminent danger, the most recent part in evolutionary terms in a hierarchical sequence is activated, e.g. the ventral vagus complex, the nucleus ambiguus and the motor cranial nerves; this initiates a social orientation reaction, a turn towards a familiar face, a contact search with vocalization that allows for verbal communication.
- When this response of the social contact system does not lead to a signal of security, sympathetic reaction patterns of fight and flight are mobilized.
- In traumatic situations, which emphasize hopelessness in addition to states of helplessness, the oldest phylogenetical neural response system is activated, namely the dorsal vagus complex, which blocks essential motor-aggressive defensive movements, and leads to immobilization, passive avoidance, and freezing in a dissociative state.

In further behavioral organizations, therefore, the attachment system is associated with both the reward system and the fear-anxiety system, as well as higher instances of behavioral selection and modulation of response intensity. The experiences accumulated during the early affective exchange processes between baby and mother serve as enduring affective-cognitive models of attachment especially regulated by the right-hemisphere orbitofrontal cortex. As an unconscious neuronal relational blueprint, they will essentially frame future interpersonal contacts and partnerships. In acute states of affective union between mother and baby, but also of intimacy and falling in love with partners, the close connection of the attachment system to the reward system becomes apparent. As already described, these intimate affective exchange processes are promoted on the one hand by the central hormones oxytocin and vasopressin, and on the other hand mediated by the neurotransmitters dopamine, serotonin, and opioids. However, as a downside of these highly rewarding affective interactions, higher cortical areas are temporarily deactivated ("*love makes blind*") (43, 44). Affective empathy is pioneered above all in these acute states of "*being one*," cognitive empathy requires "*calmer moments*." These particular emotional moments also facilitate the later development of basic self-reflective skills that are predominantly mediated by prefrontal cortical structures (39).

The child gradually acquires these higher-structured cognitive empathy and mentalization skills during prolonged sociocognitive and affective development in the context of a secure attachment (40):

- Before the child learns that its inner states actually represent the external reality symbolically, it experiences the inner and the outside world as psychologically equivalent. What it experiences in its fantasy, it equally expects in its outward orientation and vice versa (*mode of psychic equivalence*). This can be intimidating, even frightening for a while, when feelings and ideas are considered as external objects. The repeated experience of a contingent, congruent, and well-marked mirroring of the child's emotions by the parents contributes to the gradual realization that one's own affects do not necessarily pass on to the outside world, but can be disconnected from physical reality and have a subjective dimension.
- This experience situation especially manifests in free play. As the child plays, it can manipulate and transform objects of reality according to its inner needs, without any concrete impact on external reality in this transitional space (*as-if mode*). When parents accompany the child in play, non-intrusively directing its attention and encouraging constructive solutions in a commonly shared focus, they securely anchor the child's perceptions and feelings with the outside world.
- The child gradually learns to perceive himself as an *intentional*agent. His concept of self initially confines itself to the physical-somatic sphere and then gradually expands to the social sphere of interaction. In the distinction between means and ends, action and result, it acquires a teleological standpoint. This allows effectively controlling instrumental behavior in many everyday situations. In complex interpersonal relationships, conflicts and emotional tensions, however, the narrow limits of this position become apparent.
- The high-structured ability to conceive of oneself as an actor in motivic concepts of inner states may only be acquired in a socio-cognitive development that continues for several years. A mature stage of *affective and cognitive mentalization* is based on the firm realization that other significant partners of interaction are determined by independent subjective motivations in their own actions, and that they can also be influenced by subjectively motivated, intentional actions by oneself.

Characteristics of Insecure Attachment

Not all early interactions between a mother and her infant are inherently, consistently ideal, just as later relationship experiences are not always conflict-free. A hallmark of a secure attachment is that the mother-child dyad succeeds in regaining much of the above-described satisfactory affective transformation as well as efficiently overcoming painful disruptions in the relationship. An insecure attachment, on the other hand, is the result of mostly unsuccessful early affective coordination processes. This may be the result of an emotionally unstable and probably insecurely attached mother, or related to an inherently difficult temperament of the child.

A secure attachment system unfolds differently compared to an insecure attachment system. A striking clue may be observed by comparing securely versus insecurely attached mothers with each other in a behavioral observation environment as they look at images of their own baby versus those of an unknown infant in different states of affect (happy versus distress). The most striking difference is underlined: Insecurely attached mothers seeing their baby in a well-balanced state results in significantly lower activation of their reward system and associated neural relationship representations (fMRI: activation of the right ventral striatum, activation of the ventromedial PFC). For securely attached mothers, the reward system is activated significantly (fMRI: activation of the right ventral striatum) even when

they look at a picture of their baby in a crying, unhappy state. Insecurely attached mothers, on the other hand, are largely detached from the reward system; instead, there is a prominent activation of the right dorsolateral PFC in this condition, which may be interpreted as an intensified effort to deal with this irritating situation. Securely attached mothers manage this challenging task of comforting their unhappy baby intuitively, with the certainty of being able to create a harmonious condition for it. Obviously, the difference in maternal performance depends on the level of oxytocin measured (45).

Oxytocin regulates the general gaze behavior of the mother towards her child, intentionally looking at the baby's face as well as avoiding it. Securely-attached mothers have a high situational oxytocin level and maintain intensive eye contact with their baby for a longer duration than insecurely-attached mothers with lower oxytocin concentrations, who additionally have a significantly higher rate of eye contact avoidance and vision loss (46). The amygdala is significantly involved in the recognition and affective evaluation of emotional facial expressions. Both the negative and the positive emotional facial expressions activate it. In a group of first mothers, the sight of one's own baby generally activated the amygdala more than that of an unknown baby. The activation is also generally more intense at the sight of the baby in a happy state than in an unhappy state (47). It seems relevant that insecure mothers show markedly reduced amgydala activation (blunted response) when their baby is in a state of subjective distress, which may be interpreted as evidence of emotional detachment (48).

The neurobiological starting point of insecure attachment processes in the early mother-child dyad thus differs significantly from that in a secure attachment situation. Several aspects may be highlighted schematically (49): Numerous interactions in insecure attachment systems are mentalized to a lesser extent. Overall, both partners consider the interactions as less rewarding. Oxytocin-mediated coupling of the attachment and reward system is significantly impaired while also providing less protection against stressful situations. A sensitization of the HPA axis through epigenetic mechanisms lays the foundation for a long-term increased susceptibility to stress. A reduced production of BDNF in turn means less favorable conditions for the neuroplasticity needed for a higher structuring of affective and cognitive functions in further development.

The intrapsychic inheritance of such insecure attachments is manifold (40):

- Non-contingent affect reflections by the mother may cause wide areas of the child's affectivity to remain undifferentiated and not clearly represented in subjective self-experience. The mother often perceives even calm, positive experiences with less joy and attunement. To a lesser extent, recurrent interactions lead to that characteristic happy framing of the formative scenes of "*togetherness*," which usually build the foundation for trust, self-esteem, and intimacy. The temporary loss of a balanced psychophysical state of the child, in which it begins to cry or be sad, often presents the mother with conflicting challenges that endanger a secure transformation of the child's stressful state. Above all, non-containing and incongruously marking reactions of the mother, leading for example to inappropriately excitatory, anxious-worried or dismissive affect reflections on the mother's side, prevent the development of stable affect representations of the second order on the child's side. They undermine the secure creation of a boundary between self and object representations in the child's inner world. Such affective communication, which essentially involves the mother's actual, unconcerned affective experience, may act like an "*alien self part*" in the maturing self-organization of the child. It can form an affective behavioral disposition, which, especially under stress, presses for externalization in a concrete relationship situation in order to re-establish a precarious self-coherence for oneself. More cognitively overshadowed schemata of unsecure, worthless, ashamed, guilty self versus schemata of unreliable, dangerous, confusing, rejecting objects may also be a consequence.
- An integration of the early modes of the perception of reality of "*psychic equivalence*" and "*as if*" usually fails in this context of insecure attachment. Play and fantasy activity in the transitional space may unfold only poorly. If the outside world is experienced as analogous to the inner world and vice versa, then there is a high degree of vulnerability to suddenly intense and, in principle, traumatogenic affects. By contrast, an increasingly defensive retreat to an "*as if*" mode means a predominantly dissociative attitude of protection that may severely inhibit a constructive engagement with social reality.
- An *intentional* stage of self-development in the sense of a mature affective and cognitive mentalization is usually missed as well. Instead, there prevails a *teleological* point of view, especially in close relationships. Reaching a dominant goal often seems to justify any means. If the subjective goal is, for example, to deal with an overwhelming fear or a basic shame, above all aggressive, self-directed and object-directed affects and actions produce some form of self-coherence. However, this implicitly destructive dimension of one's own actions cannot be critically reflected on the self and negative effects on the partner involved cannot be adequately assessed.
- In an insecure attachment, primary caregivers have proven to be unreliable, poorly predictable, and hardly positive for the child. This child subsequently shows a strong sensitivity and hypervigilance towards potential threats in the social environment. Situations of inner tension and interpersonal uncertainty always activate the established attachment system and the associated system of mentalization functions. However, not all functions of mentalization are available in every social situation and do not always allow effective strategies for affective regulation and cognitive orientation.

A controlled affective and cognitive mentalization is no longer possible especially with increasing stress levels. From a neurobiological perspective, mature mentalization achievements can only succeed up to states of a moderately elevated arousal. D_1-dopaminergic, α_2-adrenergic, and serotonergic neurotransmission usually provides an approach behavior. A coordinated combination of reward system and prefrontal cortical structures occurs. Controlled attention, deliberate decision, and execution of prosocial actions can come about in this way.

Controlled mentalization, however, fails in states of high or extreme arousal. Here, the predominantly subcortically mediated reaction pattern of "*fight-flight*" and danger-oriented vigilance prevails. This is essentially mediated by D_2-dopaminergic, α_1-adrenergic and serotonergic neurotransmission, whereas prefrontal-cortical systems are severely restricted in their functionality (50, 51).

In individuals with an insecure attachment pattern the threshold of a switch from a controlled to an automated mode of mentalization is usually significantly low. It is an apparent paradox of human development that precisely insecurely attached people, who habitually show possible partners a heightened distrust and great ambivalence, strongly activate their unconscious attachment system in situations of strong psychological or social stress. This is especially true for people with "*anxious-ambivalent*" attachment. On a neurobiological level, a strongly activated attachment system goes along at the same time with a deactivation of two other neural systems, which would be of great service to mature mentalization. On the one hand, it is a network consisting of the medial parts of prefrontal cortex, inferior parietal cortex, medial temporal cortex and posterior cingulate cortex. Under normal circumstances, this neural system organizes focused attention, episodic, especially autobiographical long-term memory and, in the case of positive and negative affect states, a special, emotion and cognition-integrating function. On the other hand, it involves a network that functionally connects the poles of the temporal lobe, temporoparietal connection, amygdala and medial prefrontal cortex, conveying judgments about social trustworthiness, moral judgments, a theory of mind and attentiveness to one's own feelings (39).

The attachment system activated in insecurely attached individuals therefore functions somewhat automatically. Although this automatic mode allows for rapidly available mentalization steps, these are usually undifferentiated and global. The automatic mode aims to induce and share intense emotions in the current relationship situation. In cognitive orientation and affective evaluation, it primarily relies on external features such as the currently shown emotional facial expression of a partner, without performing a differentiated intrapsychic motivational analysis. It is therefore easy to jump to hasty conclusions about the significance of a current situation. In an automatic reaction mode a representation system shared by self and object is predominantly active. In this case, it may become increasingly difficult to correctly recognize and distinguish whether the affects belong to the self or to the other. A major emphasis of the externally perceived affect expressions of the other easily results in an uncontrolled affect transferal. It is important to notice that with the overactivated attachment system, the "*fight-flight*" system is also upregulated and abrupt changes may occur between panicked timidity and aggressive hostility (39).

Individuals with "*anxious-avoidant*" attachment patterns have learned to habitually classify social contacts as potentially dangerous and unsettling and thus prefer to avoid them. Instead, they may have developed compensatory techniques to strengthen their autonomy, independence and self-sufficiency. In states of psychological stress, they activate their implicit attachment system to a much lesser extent. They succeed in maintaining sufficient cognitive control in the respective situation for a longer period. However, their retrievable cognitive self and object schemata are usually rigid, with a strong bias and only poorly suited for constructive conflict resolutions in delicate, interpersonal relationships. It is also obvious that these strategies of deactivating the attachment system at the same time require enormous defensive energy. The associated increased intra-organism stress level may contribute to significant mental and physical health risks in the long term (39).

Attachment Trauma

According to Allen, (7), attachment trauma translates to the overwhelming experience of feeling alone in the midst of an unbearable emotional state or, worse, realizing that the attachment person itself is the cause of overwhelming distress. Exposition to a traumatizing attachment figure impairs the basic ability to achieve a secure attachment at all. It leads to the formative expectation that all relationships are dominated by mistrust. Fonagy et al. (40) refer to a complex situation: attachment trauma very often is cumulative, not infrequently persistent. It causes a shattering emotional distress and undermines the ability to effectively regulate this emotional distress. And it is usually incompatible with the development of a mature mentalization. Attachment trauma may occur in the form of a basic interpersonal neglect (*omission trauma*) or in the form of physical, mental or sexual abuse (*commission trauma*). In many cases, both trauma types are combined. Attachment trauma often leads to a "*disoriented- disorganized*" attachment. A disorganized attachment pattern in turn imparts an increased risk of further abuse and neglect. Attachment traumata, however, do not happen in an empty social context. Massive problems in parental care are empirically associated with numerous unfavorable psychosocial stressors, e.g. severe chronic marital conflict, perinatal loss of a previous baby, handicapped baby, postpartum depression/psychosis, parental psychiatric morbidity and violent environment (52, 53).

Key Theme in Attachment Trauma

Attachment trauma forces the child into a developmental dilemma with no way out, a constant "*horror without resolution*" (54): Traumatic anxiety, fear, or panic is associated with the presence of a central attachment figure. However, this situation inevitably activates the natural "attachment system" and provides a motivation to find presumed safety in the person through an intense search for closeness, which may further increase emotional distress. This indissoluble developmental paradox consists in maximum activation of an approaching tendency to the traumatizing attachment figure with simultaneous activation of the escape system without, however, being able to achieve consistent behavioral management. One could generally conclude that attachment traumata not only mediate damaging effects due to the specific traumatic impact, they cause even more profound psychological wounds by incompatibly colliding with the acquisition of the ability of a trusting relationship in itself and with the chance for unrestricted and autonomous self-development (7, 55).

These antagonistic behavioral desires that continually determine a child's disoriented-disorganized attachment may become apparent in the developmental psychological observation paradigm of "*separation and reunification*." The complete lack of a behavioral plan on the part of the child to consistently and effectively deal with the typical emotional challenges in this experimental situation may correspond to an uncontrollable alternation between hostile intrusiveness and helpless withdrawal in the specific interaction on the part of the mother, when traumatic experiences are primarily associated with her (56). Again, in other social interactions with the attachment figure, the child themselves may actively replicate the incompatible parental care behavior in a desperate bid to regain emotional control of the actual relational situation. The child struggles to resolve its dilemma of closeness and distance in dealing with the attachment person by alternating between a controlling-punishing versus controlling-caring behavioral pattern (57).

Disoriented-Disorganized Attachment Pattern and Increased Risk of Further Traumatization

Established insecure attachment patterns are empirically associated with a higher rate of traumatic events and subsequent sequelae of trauma (58, 59). For disoriented-disorganized attachment patterns, this increased vulnerability to traumatization applies above all to other attachment contexts. They aggravate the associated developmental deficits of mentalization, as outlined above, for insecure attachment patterns (40, 60):

Further trauma has a disastrous impact on affective and socio-cognitive development. Sexual or aggressive exposures of abuse by a parent, for example, are particularly devastating if they are based on a previous relational context of emotional neglect. Traumatic experiences often fatefully stabilize existing identity diffusion by structuring the emotional life *via* splitting or dissociation. They may promote "*identification with the aggressor*" and, as a result, may create intrapsychic relational representations of "*perpetrators and victims*" in rapid reversals. This does not just mean an increased risk of re-traumatization. It also encourages a reverse tendency towards outward victimization. However, this dominant behavioral pattern is based on a massive obstruction of general mentalization functions. Due to the overwhelming destructive affects in the trauma itself, it is often not possible to correctly record the event between perpetrator and victim in the sense of an identifiable object-subject relation that can be represented in this way. Rather, the trauma is encoded as the destructive affect state of an "*adualistic monad*" (61). The result may be a malignant introjection that constantly presses for externalization in concrete relationships. As a result of trauma-related dissociation, it can thus neither be self-reflexively assessed nor independently modified. Although hypervigilance towards the emotional facial expressions of potential perpetrators almost predominates, there is also a fundamental inhibition or refusal to empathize with or even to recognize the mental state of perpetrators at all. In a dissociative altered state of consciousness, the various aspects of a risky situation can often not be noticed. Thus, it often happens that object-related external perception and blocked self-reflexive inner attitude may express a distancing towards a potential offender, while on an unconscious or dissociated physical signal level, an attachment-inherent search for proximity may be effective. This contradictory behavior reinforces the already established, disoriented-disorganized attachment pattern and maintains a strong risk of further traumatization.

Disoriented-Disorganized Attachment Pattern and Trauma-Induced Dissociation

Intensive clinical and neuroscientific research has led to the following insight into some of the more debilitating consequences of attachment trauma: Posttraumatic processing not only follows the known psychological and neurobiological pathways in the transition to post-traumatic stress disorder (PTSD), mediating the typical symptom clusters of trauma-related intrusive recall, avoidance and autonomic hyperarousal as a result. It is also essentially determined by trauma-induced dissociative processes (62, 63). Dissociative symptoms result, on the one hand, from a failure to integrate trauma-related information ("*compartmentalization*"), and, on the other hand, from an increased use of the evolutionarily anchored protective mechanism of depersonalization and derealization ("*detachment*") (7, 55). On a perceptive and cognitive level, they affect key aspects of the psychological and psychosocial identity and the post-traumatic self. They also contribute to fragmentation in object perception. These trauma-induced dissociative processes also directly affect the systems of mentalization and empathy. They lead to deficits at an even greater extent, as they have been described in the context of uncertain bond patterns above.

About one third of all PTSD patients, especially those with a history of early attachment trauma, present a special dissociative type. Nevertheless, these patients do not permanently live within traumatically-dissociative altered states of consciousness, but commute depending on the intensity and frequency of traumatization and current situational pressures between the poles of a prominently dissociative experience and a normal, waking consciousness. In the four phenomenological areas of time experience, intentionality of mental processes, body awareness and emotional regulation, prominent post-traumatic dissociative psychopathologies may be described in a differentiated manner (64, 65):

1) In the *time dimension* of our consciousness, it is possible for us to voluntarily turn our eyes from the moment of the present into the past as well as into the future. Here, the autonoetic knowledge, which is bound to an intact functionality of the autobiographical memory, can clearly differentiate between a current experience, a retrospective memory, or a future-oriented presentation. In traumatically altered states of consciousness, this confident performance of the self may be completely suspended by flashbacks and fixed to an involuntarily revived traumatic timeline. Time experience can be fundamentally changed in this situation. It is stretched almost timelessly in some cases, but also often perceived as accelerating disquietingly on the other hand. Even in normal,

i.e. not dissociative, altered states of consciousness of everyday life, intrusive recollections may occur and cause great emotional distress. These traumatic recollections, however, do not necessarily alter the autonomic consciousness of the present, the past and the future, although they may influence it significantly.

2) Our consciousness is *intentionally* created in relation to the environment and is usually organized in distinct subject-object relations. This first-person perspective can be lost in traumatically dissociative altered states of consciousness, when one's own thoughts or memories can only be perceived in the form of voices. Here, the self-referential point of view of the conscious experience is qualitatively changed into a second person perspective. In the normal waking consciousness, numerous negative self- and object-referential cognitions, as well as evaluations related to trauma, may be present as well. Even if a person's basic self and object schemata are shaken to the very core of security, trust, self-worth, dependency, autonomy, control, intimacy, causality, and hope, the basic structure of personal identity, however, is usually not split in this state.
3) In the dimension of *body awareness*, states of depersonalization on the one hand and autonomous hyperarousal on the other can appear on both poles. Depersonalization in its pronounced, traumatic-dissociative form very often involves states of separation of the externally perceptible, externally perceived own body in a third person perspective and a self that is separated from bodily sensations, only mentally observing oneself ("*out-of- body experiences*"). This experience also indicates a fundamental modification of the identity structure. In conditions of autonomic hyperarousal triggered by normal waking consciousness, agonizing and disturbing body sensations in turn can completely control acute life and may be associated with the fear of loss of control. Nevertheless, there is no doubt that it is the subject's own body which is currently in turmoil. An intermediate position is occupied by those cases of dissociative disorders of the motor or the sensory system, in which the action or the sensibility in parts of the body or the body representation is withdrawn from a deliberate control of the self.
4) Finally, in the dimension of *emotional regulation*, two poles are determined in an analogous manner by a state of total emotional numbness on the one hand and by conditions of trauma-related affective states of overwhelming anxiety, horror, panic, shame, and guilt, on the other.

These four phenomenological dimensions of traumatic-dissociative psychopathologies are also closely associated with significant deficits of empathy and mentalization.

At the neurobiological level, there is currently no clear picture regarding a disoriented- disorganized pattern of attachment, as seems to be possible with secure and insecure attachment patterns. Disoriented-disorganized attachment patterns are primarily conceptualized in the context of diverse attachment traumata. Neurobiological research approaches have so far been performed mostly in adults who had severe trauma either in early developmental stages or later on in life, often in adolescence or adulthood; they exhibited a series of mental disorders that were to be conceptualized as associated clinical sequelae, such as a PTSD, complex PTSD, dissociative disorders, serious personality disorders, in particular of the borderline-type, but also variants of chronic depression, anxiety, somatization syndrome, chronic suicidal behavior or substance-related disorders. Significant psychopathological, psychodynamic and trauma-related overlaps are to be noted between these different clinical states (66). In neurobiological investigations, a similar transdiagnostic view is gradually embraced. Findings previously associated with individual diagnostic categories, e.g. in neuroimaging, are now increasingly evaluated as a more general characteristic imprint of just these early trauma exposures (67).

Controlled neuroscientific research on toddlers with serious emotional neglect or various forms of emotional, physical or sexual abuse, however, defies medically-ethical standards and is mostly difficult to realize for practical reasons. Suitable animal models, which approximately simulate traumatization of the early attachment process, may present themselves as insightful approaches to bridge some gaps in the understanding of the effects of early traumatization. Some aspects can be summarized as follows (68):

- Effects of early trauma involve fundamental changes at all levels of analysis, ranging from cellular signaling to behavioral expression. They include a variety of neurotransmitter systems, mechanisms of stress mediation (e.g., HPA axis, neuroinflammation), and numerous neural brain circuits. Various affected brain regions have their own maturation and development pathways and, in turn, are responsible for a myriad of distinct behaviors with their own independent developmental trajectories. Some brain areas encode traumatic information, which may later lead to behavioral problems. Of major importance in this context is the fact that some brain regions play a key role in the mediation of traumatic experiences in adulthood: For example, the amygdala, hippocampus, and especially the prefrontal cortex are still highly immature in early stages of development. However, early traumatization may pave the way for the further development of these structures, but their effects will only become apparent much later as atypical stress reactions. Traumata in these early stages of development primarily affect the neural attachment system.
- The neural attachment system is evolutionarily designed to inherently force a baby to maintain stable contact with an attachment figure for survival reasons, even under traumatic circumstances. Even the most adverse, painful experiences may be integrated into this primary relationship form. From birth, a rich noradrenergic neurotransmission (locus coeruleus) is available for these basic learning processes. Structural and functional immaturity of those brain regions organizing avoidance behaviors in later stages of development, such as the amygdala, forestall an efficient behavioral strategy of being able to withdraw from a traumatizing attachment figure at this early stage. On the contrary, the relationship with the dominant attachment figure may be particularly robust despite the low quality of parental care and repeated traumatic exposures.

- Nonetheless, those systems that are still largely immature in early stages of development have a major impact on later stages of maturation and development. They are prominently demasked at times when there are additional stressors or traumata. With an overactive system of threat perception and evaluation (cortico-amygdalar), a significantly reduced reward system (cortico-basal ganglia) and a severely restricted higher-cortical control and executive system (prefrontal cortex), there may be transposed not only massive vulnerabilities from the early traumatic developmental history into later stages of life, as regards further stressors and traumatas, but also drastically reduced chances of successful processing. Current empirical data of neuroimaging emphasizes the main modes of pathological processing of traumatic experiences, the mode of "*autonomous hyperarousal*" on the one hand and "*dissociative depersonalization and derealization*" on the other (see above):
  1) In provocation paradigms aimed at recalling traumatic experiences, the most consistent neural pattern in *autonomous hyperarousal mode* is a hyperactive amygdala, hyporeactive ventral prefrontal cortex, hyperactive dorsal anterior cingulate (dACC), and hyperactive insular region. In the general, clinical approach of understanding pathological forms of post-traumatic processing, these findings illustrate that in individuals with PTSD a shift in dominant central nervous regulation from prefrontal structures to amygdala-centered control occurs (69).
  2) In a prevailing view of *dissociative mode of depersonalization* during confrontation with traumatic memories, the findings can be summarized to the following neuronal activation network: Compared to a control group, a stronger activation is found in the upper and middle temporal gyri, parietal and occipital lobes, middle frontal gyrus, medial prefrontal cortex and ACC, with overall reduced activity of the amygdala. The affective, cognitive, and body-related variants of dissociative alienation mediated thereby acutely succeed in containing autonomic-nervous hyperactivity in the context of a traumatic memory. However, this creates major problems in the effective processing of traumatic experiences from a long-term perspective (64).

Some Critical Comments

Some critical remarks on the described psychobiological contexts of attachment, socio-affective and cognitive development should be made. The theoretical models of affective and cognitive empathy and mentalization, as developed especially in the working group around Peter Fonagy, have enormously enriched the clinical handling of patients with severe mental disorders with insecure attachment patterns and impaired functions of their empathy and mentalization capacity. They have also contributed significantly to the empirical clarification of psychological and interpersonal mechanisms of affect regulation and mentalization within a developmental context (70, 71). The attachment patterns acquired in the early childhood interactions of the mother-child dyad have a significant and probably also a lasting significance in the mediation, maintenance or endangerment of psychosomatic health in later stages of life. But relations are neither unilinear nor monocausal. It seems to be well established empirically that a predominantly successful interactive coordination between mother and baby encourages the establishment of a secure attachment pattern in the child and also promotes its development to more mature levels of cognitive-affective mentalization (40). It also seems to be empirically validated that a secure attachment pattern of the mother is a strong predictor for the quality of the child's attachment pattern, just not unilinear and monocausal. A well-bound mother may also fail due to the multiple challenges in her relationship with her baby, her baby's primarily difficult temperament, or other adverse family and social circumstances, traumas, existential disasters etc. the fundamental voting processes continue to disturb. In the former case, it can be seen that bidirectional influences are present in early attachment behavior, that is, the baby itself, e.g. exercises a potentially pathogenic effect on the behavior of the mother through a constitutional handicap and thereby reduces the quality of achievable attachment security. In the second case it is emphasized that an exclusive focus on the mother-child dyad greatly simplifies the multiple influencing factors of the family and social environment. Empirical studies, theoretically based on transactional development models and statistically based on complex analytical techniques, strongly demand this viewpoint (8).

The central theoretical assumption, that distinct bonding patterns from early mother-child interactions once formed are fundamental, lifelong blueprints for shaping future relationships, must be differentiated. A broader psychosocial and cultural context is indicated. Important transformations in later stages of development, especially in adolescence, cannot be explained solely by the dynamics of early mother-child interactions. Rather, numerous biopsychosocial factors influence transformations during this particular developmental period (72–74). In this context, the empirical finding should also briefly mention that some adults in the commonly used Adult Attachment Interview achieve a secure attachment status, but report significant problems from their early relationships with parents. In contrast to people who receive both the current classification of a secure bond and affectionate contacts with their parents ("continuous secure"), this attachment status is referred to here as "earned secure." It seems to indicate a developmental transition from initial "insecure" to "secure" later (75). The relations are again complex. They are definitely not to be clarified in retrospective cross-sectional studies, but at best in prospective longitudinal studies (76). Confounding variables such as current depressive or anxious symptoms with a memory bias has to be considered (75), compensating social contacts with important other persons besides the parent figures (77, 78), influences from adolescent development dynamics with a critical reflection on the early relational history with the parents (79), a favorable current relationship status in adult life with positive corrective emotional experiences (80) and important modifying effects in interim psychotherapy (81) is notable.

Psychobiological characteristics in the context of early acquired attachment status may be considered as significant protective and resilience-promoting factors in mental health and somatic health, even in adult life. Similarly, those

psychobiological characteristics acquired in an insecure or disorganized attachment context are likely to be life-long effective trait variables with significant negative consequences for increased mental and somatic disease risks (82, 83). However, the connections are again to be conceptualized as highly complex (84). This should also be considered for the neurobiological findings presented above, which have been grouped in the theoretically underlying framework of "safe" versus "insecure" and "disorganized" attachment types with respect to impaired mental functions of empathy and mentalization (39). The majority of these studies have been performed on adult patient samples with different psychopathological formations and correlated unsafe/disorganized binding types. However, the neurobiological findings, often obtained with methodologically very different examination paradigms, leave open the question of, for example, early traumatic events per se, a diagnostic status of post-traumatic sequelae acquired at an earlier or later stage of development, or the current psychopathological status with potentially multiple co-morbid mental disorders. Disorders and personality disorders have decisively determined the neuronal activation patterns found. The assignment to distinct types of binding must not take place in a unilinear or monocausal sense. Nonetheless, the findings give a significant insight into the neurobiological mediation mechanisms of impaired mental functions of empathy and mentalization of patients who are currently under massive stress and presently have different attachment patterns.

CONCLUSION

The most fundamental characteristics of the conditio humana are attachment and the ability to form stable bonds with significant others. An evolutionary principle deeply rooted in phylogeny underpins this drive. John Bowlby's research can only be regarded valid if the attachment system is regarded as a primary motivational system in the individual development of human beings. Initially, this principle unfolds in the interactions of the early mother-child dyad. In its evolutionary-biological composite parts, it usually guarantees a particularly intensive emotional exchange between the two partners, which should convey safety, security, value and trust and finally effective self-regulation. The typical psychosocial experiences here not only shape the neurobiological organization and structure of the further differentiating brain of the child, the particular quality of these early relationship experiences is also crucial for the further affective, cognitive and social development in the context of his/her brain development. An acquired attachment pattern is intimately linked to the capacity for empathy and mentalization of the growing child, both psychological skills that will determine his/her future relationships. While secure attachment provides a vital foundation for healthy development, an insecure and, above all, a disoriented and disorganized attachment is associated with increased risks for numerous mental and somatic diseases. Although traumata in the early attachment period provide a serious legacy, both on psychological and interpersonal as well as neurobiological levels, for further life and personal development opportunities, this is not an absolutely irreversible fate for one's own existence and subsequent generations, as impressively shown by special psychotherapeutic approaches (81).

AUTHOR CONTRIBUTIONS

TL, HU, and H-PK wrote the manuscript. All authors gave their consent for publication.

ACKNOWLEDGMENTS

We would like to acknowledge the work of Nikolas Bonatos for making helpful and invaluable critical comments about the manuscript.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The handling editor is currently co-organizing a Research Topic with one of the authors HU, and confirms the absence of any other collaboration.

frontiers in Psychiatry

REVIEW
published: 05 February 2020
doi: 10.3389/fpsyt.2019.00948

Attachment-Based Family Therapy for Adolescent Substance Use: A Move to the Level of Systems

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This paper provides an account of the theoretical basis of a family-based intervention called Behaviour Exchange and Systems Therapy (BEST). The model described here has also been applied to adolescents with substance abuse and other mental health problems such as depression and anxiety disorders in both children and adolescents. Evaluative studies of the model have been published including randomised clinical trials as well as qualitative analyses. The current paper discusses a theory of the family system as a discourse and represents an integration of aspects of attachment, psychoanalytic, and systems theories. Key concepts elaborated are the attachment-family system, the family as a single discourse, the use of segregation as a defense in relation to trauma and loss and its manifestation in a family narrative, and the role of the family secure base in affect regulation. The paper also briefly describes specific treatment techniques that are derived from the theoretical model. Our approach has wide application as a discourse focused treatment for children and adolescents using a family systems approach. Future work requires the comparison of this model to similar attachment-based models of intervention for children and families, further development and validation of measures able to be used for whole families in a clinical setting, and further empirical demonstration of treatment efficacy in a variety of clinical settings.

Keywords: adolescents, substance abuse, attachment, systems theory, family-based intervention

OPEN ACCESS

Edited by:
Marc N. Potenza,
Yale University,
United States

Reviewed by:
Mauricio Alvarez-Monjaras,
University College London,
United Kingdom
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Specialty section:
This article was submitted to Addictive Disorders, a section of the journal Frontiers in Psychiatry

Received: *20 July 2019*
Accepted: *29 November 2019*
Published: *05 February 2020*

Citation:
Lewis AJ (2020) Attachment-Based Family Therapy for Adolescent Substance Use: A Move to the Level of Systems. Front. Psychiatry 10:948. doi: 10.3389/fpsyt.2019.00948

John Bowlby opened his 1948 paper *The Study and Reduction of Group Tensions in the Family* by writing: "Child guidance workers all over the world have come to recognise more and more clearly that the overt problem which is brought to the clinic in the person of the child is not the real problem; the problem as a rule we need to solve is the tension between all the different members of the family" (Bowlby, 1948, p.123). The clinical approach we describe in this paper is something of a return to the systemic emphasis we find in this comment. Such a return to the systems level of the family can be distinguished from the internalized cognitive model of attachment based on a representational and therefore individuated model of attachment theory. When attachment theory is thought of as a discursive-relational model, it fits neatly with both interpersonal and systemic

clinical approaches. As we can hear in the comment above, from the outset, Bowlby clearly emphasized the *child and family* in his clinical thinking (1).

The current paper is focused on the elaboration of the key principles of such a discursive-relational approach, and a description of the treatment techniques of *Behaviour Exchange and Systems Therapy* (BEST). Our research team based in Melbourne and Perth have been developing the theory and practice of BEST in different forms for two decades. These interventions are family-based interventions and can be delivered either to individual families or with small groups of families. Initially, these interventions focused on the parents of adolescents presenting with substance abuse, but the model evolved over time into a whole of family approach and was adapted to also serve as a treatment for adolescent depression and anxiety (2, 3). Our work now is extending the approach to interventions for children under 12 years of age.

Clinical trials our team have being running in Australia have accumulated good evidence to show that the approach can effectively treat a range of adolescent mental disorders. The studies show that improvement in adolescent mental health is typically accompanied by improvements in family functioning and notably improvements in the parent's mental health (2–8). Previously our research group has also published qualitative studies of participant experiences as well as a description of the main features of the program for the treatment of adolescent depression called BEST-Mood (5, 9, 10). These make up a rich quantitative and qualitative dataset which forms the background to this theoretical paper.

DISCOURSE, NARRATIVE, AND DIALOGUE

There is an increasing use of the term "attachment-based therapy" referring to relational approaches and these are generally considered to have the broad goal of promoting attachment security between parents and children (11). An attachment-based approach minimally adopts a dyadic view of inter-subjective communication (12) rather than treating an individual. Such models of therapy have their origins in the clinical approach originally described by Bowlby (1), but the clinical application of attachment theory has been elaborated by many others, usually, but not exclusively, in relation to a broadly psychodynamic framework (13–18). Alongside the work of other groups focused on adolescent mental health, we are interested in how attachment patterns are perpetuated within a family system and how such an understanding can inform interventions (19, 20).

Our clinical interests in an integration of attachment theory and family systems has led us to propose a conceptual shift from a representational model to a discourse model. The most common way of clinically interpreting attachment is derived from the "working model" concept. This is thought to be an individuated representational-cognitive model (21) and it extends the cybernetic notions of signalling in Bowlby's evolutionary-development framework. The concept of an "internal working model" originates in the attempt to explain how early relationship experiences are carried forward as enduring styles of interpersonal relations and modes of regulating affects. Attachment theory's next major development occurred with Mary Main's work on the manifestation of attachment patterns within adult narratives and in developing this theory it is of importance to recall that she was drawing very directly on H.P. Grice's categories of conversational coherence (22, 23). Attachment classifications based on the coding of the Adult Attachment Interview (AAI) were able to reliably identify very specific discursive features of language use. For example, this includes the mode of recall of early attachment memories, narrative accounts of separation, loss or challenging interpersonal experiences, the subject's capacity to mentalise about aspects of their parent's relationship. Overall patterns of autonomous, dismissive and preoccupied conversational styles emerge across the full interview. These components are rated in terms of an overall *coherence* of discourse, reflecting the integration, and consistency of the narrative.

This shift to the level of representation has given rise to a range of discourse-based measures of attachment and generated a substantial body of evidence to validate the concept of attachment discourse. Discourse based assessments of adult attachment have been more recently developed to analyse responses to images (Adult Attachment Projective- AAP) (24), a secure-base script method (25), and similar ideas have been applied to the analysis of child play narratives in response to structured attachment stimuli (26). This discourse model in particular is fundamental to many clinical applications of attachment theory, and certainly attracted a renewed exchange with psychoanalytic theory in the 1990s (27–29). Empirically, a number of important studies have now shown relationships between attachment discourse measures and broader aspects of family discourse. For example, studies found that mother's scripts of secure narratives were related to both the child's degree of attachment security, and the mother's narrative style and emotional language when reminiscing about shared experiences (30). The researchers suggested that their findings should be understood in terms of the way mother-child dyads discuss emotion-laden content. Similar findings have been reported in high risk samples with histories of child maltreatment (31)

Now, in some clinical models, attachment theory has been applied to a family by supposing that each family member interacts with the other members on the basis of their internalised model of prior relationships. In effect, this view sees family interactions as reflecting individual attachment histories preserved as a generalised "Attachment State of Mind". However, by shifting this framework to the level of a systemic approach, a family therapy can more effectively focus on the family as a single discursive system. To elaborate this idea, we can say a single-family discourse, viewed synchronically, consists of the set of statements in a given family. However, the term "discourse" does not simply refer to an individual's speech acts, but its reception within a given social context. In this

sense, discourse requires dialogue. In our therapeutic application, the social context is considered to be the family and the dialogue includes not only speech, but also any actions which have a communicative effect. Such styles of interacting constitute the family discourse which we suggest has consequences for the formation and perpetuation of attachment relationships.

From a diachronic perspective, the family discourse has an historical legacy in the discourses of the parent's own family of origin. Such histories are subjected to a continual process of integration over time into the current family discourse. For example, once a parental couple is formed there is a major integration of two family histories. Similarly, when children are born, there is a further elaboration of the discourse in terms of the experiences of parenting each of their offspring. At any given moment, the family discourse *constructs* a position and role for each family member. Each family discourse consists of an implicit set of rules for what can and cannot be said, and what can and cannot be done (32). This is quite a different perspective to seeing a family as a conglomerate of "internal working models".

The difference between family discourse and internal working models has a number of consequences. First of all, a discourse is not an internalizes representation of a relationship, it is an external articulation or set of communicative actions. The family's discourse is derived from historical experiences and material which is intergenerational, but as a synchronic function, it is always updating itself and seeking to retrospectively make sense of the past. The discourse is also able to adjust to new circumstances in the present. The family narrative is the process whereby a family draws upon the resources available within its current discourse to construct a temporal account of its history. So, discourse and narrative are closely related, but distinct concepts. The family discourse at any given time is a major work of integration and an attempt to reach a degree of coherence through a process of dialogue, but coherence is only an ideal or a goal. The family discourse is analogous to a myth and could be described in terms of Levi-Strauss's celebrated concept of *bricolage*, since it is pieced together from various threads of narrative, a reconstructive and a retrospective process in which there are always revisions and contested attempts to renegotiate the meaning and significance of the past (33). There is no possibility of testing the correspondence of the narrative account with the actual historical events in the therapeutic setting. There is only the degree of coherence and consistency of statements within the discourse.

On this basis, we conceptualise our treatment goal as firstly to improve the degree of organization and discursive coherence of the attachment-family system. Any family discourse is on a continuum of being more or less coherent at any given time. The clinical goal is a pragmatic one: for the family's discourse to be coherent enough to provide a platform for family life. Second, the approach is based on the assumption that targeted and strategic interventions designed to promote changes in the relationship between parents and children can modulate both communicative actions and affective states for both parents and children (34). Changes in ways of speaking, modes of interacting, and different ways of experiencing affects lead to overall shifts in the functional operation of the family. This entails identifying impasses where the dialogical process has broken down or "frozen". We conceptualize therapeutic changes as shifts in the family discourse. There are two major ways in which the dialogue breaks down— both of which fall outside discourse as such. These are the experience of unresolved trauma or loss, and second the enactment of uncontained affect.

THE LIMITS OF DISCOURSE: TRAUMA, LOSS, AND ENACTMENT

A major theme in our clinical work is the predominance of experiences of loss and trauma when undertaking our clinical work with families. There are painful memories, attempts to represent raw events, traumas, loss, bereavement, illnesses— and these may constitute gaps and elisions, discursive 'black holes' in the realm of what is unspeakable. We find there is particularly rich material in attachment theory to draw on here, especially research on disorganized/unresolved attachment in both the behavior of infants, but particularly the attachment discourse of unresolved adults. Bowlby's work makes a major contribution to the psychology of loss and trauma by showing how permanent losses, prolonged separation from the primary attachment figure, experiences of abuse and neglect are experienced as major assaults on the coherence and function of the attachment system (35). Later research on adult attachment revealed that the transmission to infants of unresolved experiences of loss and trauma can be predicted even from the attachment discourse of pregnant women (36). This implies that the origins of an offspring's disorganized attachment are somehow present in the mother's attachment related discourse, prior to even interacting with their infant (37, 38). Therapeutically, the fundamental question here is how to intervene to prevent or reverse such transmission. This is one of the core questions of any attachment-based therapy.

Explanations of this transmission of experiences of trauma and loss across generations generally refer to Main and Solomon's characterization of disorganized infants. These authors employed the ethological concept of "conflict behavior" to explain the paradoxical dyadic interactions of disorganized mother-infant dyads (39). Others have pointed out the similarity between this concept and the systems theory concept of the double-bind (40). Bateson referred to the double bind as "some sort of tangle in the rules" or a confusion between the object language and the metalanguage such that several contradictory statements simultaneously direct a behaviour (41, 42). The disorganized-disoriented infant provides a good example of a double bind: the infant is motivated to respond to a threat by seeking the protection and proximity of their primary attachment figure, but in doing so, they encounter not comfort and assuagement, but threat, fear, helplessness, alarm, panic, aggression, and so on— their attachment system is frozen by an unresolvable paradox due to self-contradictory statements. The point made by attachment theories is that the impasse in the infant's behavior is both precipitated and maintained by the

contradictory interactions and communications of the attachment figure.

Mary Main's 1991 paper provides a cognitive explanation by introducing the idea that disorganized discourse results from lapses in the metacognitive monitoring of conversational rationality. She distinguished between single versus multiple models of attachment (43) referring to the cognitive underpinnings which allow multiple and contradictory models of the same aspect of reality. In effect, Main is using the same kind of explanation as Bateson: a confusion of object language and meta-language. The metacognitive monitoring of the coherence of discourse fails at the point where it needs to provide a consistent and coherent account of trauma or losses.

We generalize this idea to the family discourse and note that contradictory or segregated accounts of a given traumatic experience are often encountered in the clinical setting. Mary Main notes the vivid examples of segregated models of attachment given in Bowlby's discussion of parent's denial and distortion of traumatic events which a child has directly observed: a child may have witnessed a parent's suicide, only to be told that he had died of an illness or accident (43). Bowlby also referred to examples of a child who found her father's body hanging in a closet only to be told he had died in a car accident (35). Much of this has been articulated in similar terms within psychoanalytic theory, but our application to work with families is to add the suggestion that the split is not simply internal to the ego, and we do not conceptualise it as an "intrapsychic defense" but think of these contradictions as frozen elements in the family discourse.

The failure to integrate such experiences into a family discourse impacts the family's mode of communication and interaction. Instead of being integrated into the narrative process, sometimes these experiences repeat as triggered enactments and incongruous displays of affect. Enactment can be thought of as a pre-representational means of processing affect through a non-communicative action. Our view on the relationship between discourse, which is by definition social, and affect, which is individually embodied, is related to our concept of enactment. Enactment as a concept has its origins in the psychoanalytic tradition where it is related to repetition compulsion (44). A great deal more would need to be said about the relationships between attachment models of affect and the psychoanalytic drive theory, but that is well beyond the scope of this paper. The key point clinically is that the management of contradictory family discourses is closely related to conflicted and threat activated emotional systems. The escalation in parent-child conflict is well known in the literature as a very strong predictor of adolescent mental disorder (45). Families often present with narratives of contests for domination, patterns of threat and counter-threat, adolescents testing their power in response to threat, or using withdraw. Adolescence brings new modes of enactment such as threats to leave home, self-harm, suicide attempts, taking drugs, and so on. Such acts typically occur in the absence of family dialogue and proximity seeking. Addressing enactment, promotion of dialogue and resolving contradiction, defusing patterns of threat and counter-treat, are therefore crucial concepts in the clinical model.

REVIEW OF ATTACHMENT RELATED PREDICTORS OF ADDICTION

Before elaborating these ideas, it is valuable to very briefly review the evidence that can be used to justify a focus on the whole family in relation to adolescent substance abuse. This requires looking broadly across several areas of research in order to understand the kind of experiences and histories which should be the focus of family interventions where adolescent substance abuse is a salient feature. It is important that any psychological theory be posed in terms that are consistent with the most current neurobiological findings of the corresponding phenomena. A number of researchers have pointed out the parallel between psychological processes related to attachment figures, both parental and romantic, and similar mental dispositions in states of addiction (46, 47). Papers are now emerging integrating neurobiological and psychodynamic perspectives into a developmental model on the basis of the findings linking attachment and addiction (48). One neurobiological model of addiction suggests that deficits in a person's ability to derive rewards from sustained interpersonal or intimate relationships impels reward seeking through the repeated use of psychoactive substances which stimulate these same dopaminergic brain regions (49). There are animal studies in which exposure to early life stressors predispose to vulnerability to later substance use which point to neural mechanisms involving alteration of neural reward pathways and separation distress regulation (50). Another line of animal research has proposed gender specific pathways beginning in adolescence. Females predisposed to a heightened stress response are more liable to seek substances as a means of ameliorating high stress reactivity. Males are more likely to respond to chronic stressors with a blunted stress reactivity and their attraction is to substances which increase arousal, increase social capacity, or provide novel sensation such as cocaine and methamphetamine which block dopamine reuptake, and increase dopaminergic activity (51, 52).

The psychological and developmental literature already contains several excellent reviews that have examined the empirical findings showing the relationship between a variety of measures of attachment and different kinds of addiction (53, 54). While it is well accepted that addiction results in the deterioration of the quality of close relationships, Fairbairn's review showed that longitudinal studies have established that attachment insecurity prospectively predicts the development of later substance problems irrespective of the type of measure used. Another interesting finding to come from this review was that the relationship between insecure attachments and substance use was less pronounced in older age groups. The same pattern has been observed in other reviews on the wider relationship between attachment and psychopathology (55) pointing to the particular importance of the interaction of attachment and developmental

processes in adolescence. There have also been interesting findings suggesting that different types of insecure attachment may influence preferences for different substances of abuse (56).

Unfortunately, at his point in time, the current evidence includes only a handful of studies examining the attachment related discourse of substance using adolescents *via* their performance in the AAI or AAP. These include findings of a strong association between preoccupied-enmeshed and substance use in a sample of orphans (57). The other adolescent studies of this type have found associations between avoidant-dismissing and unresolved-disorganized representations in a variety of different substance using groups (54). Adult studies of substance abuse have found associations with Lyons Ruth's hostile-helpless pattern and also with the Main coding of unresolved/disorganized (58). The main findings of discourse-based measures in adolescence suggest associations between substance use and dismissing forms of insecurity and reasonably consistent findings of high rates of unresolved/disorganized attachments.

The place of trauma and loss in the clinical treatment of patients with substance abuse is also well documented in other studies. It is well established that both Posttraumatic Stress Disorder and bereavement predict increases in substance use and the development of substance use disorders (59, 60). Such findings are consistent with studies on relationship qualities within families showing that adolescent substance abuse is predicted by factors such as low family cohesion, family member enmeshment, and a parenting style known as affectionless control (61, 62). Such findings provide evidence to support the relevance of treatment and prevention goals designed to improve a person's capacity to form and preserve close relationships, be those within a family context or in other close relationships, as a means of either prevention or treatment of substance abuse (63). With these factors in mind we can now elaborate five therapeutic strategies that have been developed in our clinical work.

The Adolescent as Proxy: The Referral and Presenting Problem

A first area to comment on is the referral process where adopting a systems approach has substantial advantages over the individual model typically used in adolescent mental health services. There often are major challenges in engaging adolescents in any form of psychological treatment and, at the time of initial referral by parents or professionals, the adolescents themselves are sometimes not willing to present for treatment. Within our model the sessions can commence with whichever members of the family are willing to attend. An adolescent's refusal to attend sessions can become a powerful position in the system and can be thought about clinically as a form of communicative action. Refusal may be a signal of a wider refusal to be part of the family's everyday life. This is because underlying the referral of the adolescent and the presenting problems of "substance abuse" is a clinical encounter with a family who often are at a point of fragmentation. At the point of referral, the typical situation is one of breakdown in the major attachment relationships across the family. This is consistent with the empirical findings of a bidirectional relationship between attachment insecurity as both an antecedent predictor of substance use disorder, but also that substance use induces further deterioration in the quality and functioning of close relationships (54). In some cases, there is strong intergenerational transmission and one is dealing with the adolescent offspring of parents with a history of substance abuse (64). In the context of the treatment of adolescents still residing in their family of origin, clinical referral often comes at the end of this vicious cycle of deteriorating relationships generating a point of crisis in the family-attachment system. There are important conceptual and clinical questions to be considered even at the point of referral. Who is actually making the referral for treatment? Who in the family system is most willing to consider change? What impasse within the family does the adolescent represent? Referral is therefore not considered to be the referral of an individual with a "mental disorder" requiring that individual to attend and receive treatment. Instead we consider referral to be the referral of a family, as a system, at a point of crisis in that family's history.

A Letter of Invitation: From Helplessness to Action

One of the most common comments from a parent at the commencement of the treatment is "It feels like there is *nothing* I can do." (5). Our clinical work suggests that at the commencement of sessions parents have often adopted a helpless position and probably for quite a long time prior. The concept of helplessness (*Hilflosigkeit*) has deep roots in the psychoanalytic tradition and was revived as an attachment concept by Lyons-Ruth (65). In the parent's helplessness, one can also recognize a specific dynamic, common in child and family therapy, in which the more helpless the parent, the more domineering the child. It is a family situation of great isolation and disconnection. From a relational perspective, we can see that substance abuse acts as a freezing point in the family discourse and its dialogical movement. On the one hand the adolescent is focused on addictions and these are a one-sided affair, that is substances, while generally reliable, do not "relate back" or make relational demands (66). Addiction for an adolescent belies a breakdown in the trust that another is capable or willing to respond to their interpersonal and relational needs. On the other hand, the parental helplessness and withdrawal is the parental counterpart and complicit with this freezing in the family system's dialogue.

The first response to this sense of helplessness and isolation is to discuss with parents, either alone or in a small group, the many small ways that they can be effective in relation to their adolescent's problem, how change is incremental and requires persistence, and how they can take action to contribute to improvement in family life. It is critical to do this in a positive way which is very distinct from implying that parents are somehow responsible for their adolescent's disorder. One approach that has been used with some success is to ask parents to write a letter of invitation to their adolescent, telling

them that they are attending a group, the concerns they have about current family life, and expressing a desire for change and inviting the adolescent to join with them in attending sessions. The parents work on this letter over the initial sessions of treatment, consulting with the therapists and sharing drafts for comment. Often the parents will be lacking in confidence to produce the letter, feel it will be a useless gesture, or use the writing as a vehicle to vent their own anger and frustration. All this is worked through. The adolescent often receives the letter with surprise and it generates some curiosity. It is both a challenge to the state of helplessness and serves as a gesture of sending a message indicating that the parents are taking the initiative, stepping up as open to dialogue and agents of change.

The Oxygen Mask: Rebuilding the Family Secure Base

In many cases, what Bowlby referred to as the "emotional atmosphere" of the family is characterised by a vicious cycle of uncontained affect and its behavioral enactment (67). In other literature, a similar idea might be presented under the concept of expressed emotion. There are common parent-child dynamics in which adolescent withdrawal or aggression triggers parental distress and helplessness. It is clear that the situation with the adolescent is activating basic affective systems in the parent including panic, catastrophic or escalating fear, despair, and anger/aggression (68). As mentioned above, the attachment perspective understands these affective systems as threat activated affects which trigger basic survival systems. They do so by shutting down affiliative and care-giving motivational systems. We also find that systemically these vicious cycles of affect and enactment can escalate to such a degree that they precipitate a premature rupture in the family-attachment system. The adolescent seeks to achieve a kind of pseudo-independence in which they sometimes leave or sometimes remain physically within the family, but are psychologically cut off within the family, unable to access any sense of security *via* intersubjective relations within the family. This may take the form of an externalising presentation in the context of substance use which often consists of various conduct and "anti-social" problems, taking up with their peer group, in some cases spending little or no time in the family unit. Another permutation is the withdrawal of a depressed adolescent within the family— the parents describe them as moody, difficult to reach or living in a virtual world of social media (10).

An important concept derived from attachment thinking which we use to both understand and respond to such situations is John Byng-Hall's concept of the "secure family base". He uses this term to describe the family foundation from which an adolescent can safely explore their social world (11, 69). The notion of a secure family base refers to the parental function and it assumes to some degree a unified parental position. We have encountered several obstacles to the parents facilitating the family operating as a secure base.

First, we often encounter a challenge within the parental couple itself who, under enormous stress, find it difficult to present a unified front. Instead it is common that they turn on each other and split off into polarised reactions to a challenging situation. This is understandable within a context where each parent brings their own attachment history, styles of defense, and their own ways of having traversed adolescence and the position of parenthood. Therapeutic discussion of these three moments: the parent's own childhood attachment histories, their traversal of adolescence, and their assumption of parenthood— can be a source of significant therapeutic gain. The therapist needs to be looking out for when this parent has been able to make use of a reparative attachment experience with a reflective other. For example, it is not unusual that a parent may have worked-through an adolescent period of rupture with their own parents, but later made reparation when they formed a new couple relationship by making use of new capacities derived from their romantic relationship.

Second, we frequently encounter within disorganized family dynamics histories of role reversal emerging over early and middle childhood. The same dynamic has been described using various different terms in psychoanalytic, systems, and attachment theory (70, 71). Role confusion and reversal begins with the primary attachment figure not providing care to the infant, but in numerous different ways and circumstances seeking or requiring that care themselves. As noted by Lyons-Ruth, it is not unusual to also uncover in such parents histories of victim/aggressor relational patterns, patterns of withdrawal in the face of the child's attachment demands, and a critical failure to regulate the child's attachment need in those moments where assuagement of distress is most needed (72). The child's defensive positioning within this dynamic as "parentified" takes up a subjective position of control in their relation with others, an objectification of others as objects to be controlled, and perceives that there is an absence of any anyone else "taking control". There are elements of both grandiosity and narcissism at play in the child's position and in adulthood this can develop into a personality style which seems to exude a high degree of "competence". However, from a clinical point of view, the predominance of role reversals between caregiver and care-receiver bellies a major alteration in family structures by placing the child in the dominant and controlling position. The most obvious form this takes in adolescence is a control that takes an aggressive and commanding form, but equally the adolescent's withdraw in the more internalizing presentations can be seen as a mode of control.

The therapeutic response is twofold. First, to rebuild the family as a secure base and this entails numerous different techniques designed to allow parents to contain their distress, redefine their roles as supportive, see themselves as setting examples of coping with stressors and taking responsibility for problems. There are also a range of techniques to rejuvenate the dialogue by parents showing they are willing to change and adapt, communicate, compromise, and negotiate and to expect the same of their adolescents. Here amongst other approaches, we make use of a metaphor based on the use of the Oxygen mask — "In the aeroplane, safety instructions suggest that the parent secure their oxygen mask *before* assisting their children…"

The idea of this and various other components of the treatment is to promote the parent's adoption of the position

of the family secure base. This foundational position could also be likened to a sounding board, which facilitates the reconstruction of family discourse. The second aspect presupposes the first has been achieved to some degree and is based on an encouragement that in the context where the family has achieved a secure base, an adolescent will seek to explore. We reframe such "explorations" in terms of their importance in the adolescent resuming their developmental pathway towards autonomy, to re-negotiating their relationship with their parents as they enter adulthood, and are able to make use of the availability and receptivity of their parents in new ways.

Red Buttons: Intersubjective Regulation of Affect

There are important systemic factors which perpetuate family conflict. It is also apparent that conflict based on mutual aggression can become a vicious cycle of affective dysregulation, where aggression triggers the escalation of threat which in turn triggers further aggression, described by Bateson using the concept of schismogenesis (73). This cycle can become particularly vicious when, as occurs for many parents in our intervention, the idea of the adolescent's separateness generates panic. Separateness is not greeted as a developmental achievement, but as a threat to their child and the integrity of the family. Parents then see it as their role to intervene to "prevent damage" occurring, and this can be very acute in relation to drug use, but this implicitly sends a message to their adolescent that they are considered "incompetent" or cannot "cope on their own". It also sends a message that their adolescent is in grave danger, but the adolescent is considered to lack the skills to keep themselves safe. In our experience, this can generate an emotional atmosphere which does have features of alexithymia, but with a heightened sense of panic and an aggressive battle for control. This drives the adolescent further away and undermines the adolescent's developmental process of autonomy seeking, building social confidence, and sometimes taking risks.

These are themes discussed in our intervention around a series of metaphors. These take the form of stories of separation, autonomy, risk, and adventure designed to evoke discussions of separation as a key developmental process in adolescence. The generation of the family as a secure base requires that the parents stabilise their affective responses to these sometimes-threatening themes. Such stabilization occurs through discursive coherence and the capacity to speak about and think about, rather than enact these powerful affective experiences.

Clinically addressing family conflict and aggression is a core part of our approach. Above all we emphasize that effective communications cannot occur in the context of conflict and hostility. The first step is often to help families recognise the degree of aggression and conflict inherent in many of their interactions. It is critical to have therapeutic discussions naming the kinds of emotional experiences the parents are having. We also discuss common "hot spots" which are points in family life which tend to generate conflict- getting out of bed, going to bed, getting to school on time, etc. We often appeal to the idea that parents need to model taking control not of their child, but of their own emotions, to recognise when they are feeling "out of control" and to curtail interactions based on that recognition. Parents are encouraged to regather their self-control and then return to seek dialogue. Often this is discussed, modelled and even roll played with the therapists.

Sometimes, a "circuit breaker" is needed by way of intervention. One idea arose from recounting the experience of one of the participants. One of our dads used to talk a lot in the sessions about his "Red buttons"— these were the ones his daughter knew well how to push! And the two of them were often triggering aggression in each other to the point where they were often unable to inhabit the same space. One day, anticipating an argument, the dad came into his daughter's room with an actual red button stuck on his sleeve and said to her "Do you just want to push it and get that bit over with and then we can discuss the issue" She laughed and there was a shift … This has become a story we tell within sessions since it very nicely illustrates how a parent can redirect what was typically an aggressive enactment onto a discursive level through the use of humour.

Bumps in the Road: Integrating the Narrative of Loss and Trauma

Therapeutically, there is great benefit in addressing segregated systems at a family level. There are a variety of techniques that encourage a family unit to collectively work through their narrative of traumatic experiences, or family losses or other major setbacks. The approach is to ensure that this is done in a manner in which all family members can contribute and where therapists are proactive in seeking clarity, in asking for other's versions of events, and to encourage a goal of "setting the record straight". In our model, we used a simple drawing technique called "bumps in the road" in which family units are asked to draw their family road trip along a "rocky road" with the bumps and pitfall labeled along the way. Who is driving their car, who are the passengers? When has it needed repairs? It generally takes some time before the family is ready for this task following earlier work to build the family secure base and a sense of trust in the therapeutic process. Often there are highly impactful sessions where a sense of both clarity and the theme of "how did we survive it all" emerges.

CONCLUSIONS

To conclude, this paper has tried to give a sense of how attachment research and theory can be used to inform and develop a family-based treatment approach for adolescents with mental health issues— including substance use. There is compelling evidence that there are higher rates of attachment insecurity in substance using adolescents and also strong evidence for histories of trauma, loss, and family conflict. Alongside what we now know of the neurological processes involved in addiction and their links to social affiliative systems, this justifies the need for an attachment approach to such family-based treatments.

The basic theoretical commitment of the BEST approach is based on the claim that the "move to the level of representation" in attachment theory, can be reconsidered as a properly inter-subjective and linguistic model, compatible with family systems theory. This is broadly consistent with those approaches which could be called the "linguistic turn" in psychotherapy. These approaches all emphasize language as a means to generate meaning in shared patterns of communication, and that meaning can take the forms of action and interaction. There are limits to meaning generation in terms of enactment and overwhelming experiences of affect. The concern with language, meaning, dialogue, and narrative are widely shared by systemic approaches such as narrative therapy (74) postmodern therapy (75) and dialogic family therapy (76), and by contemporary psychodynamic approaches such as Lacanian and Neo-Kleinian psychoanalysis. This paper has attempted to bring these elements of systems and psychoanalytic thinking together with discourse-oriented research within attachment theory (40, 77, 78).

Certainly, BEST is not the only family systems model to draw on attachment theory and comparison can be made to Attachment Based Family Therapy (ABFT), which is a similarly manualized and evidenced based approach, which has shown impressive results with depressed and suicidal adolescents (20). Very briefly the main theoretical differences between BEST and ABFT would appear to be the former's emphasis on discourse and narrative as the aspects it draws from attachment theory. However, both approaches have similar overall goals and what appear to be some similar techniques to reduce family conflict, promote affect regulation, build attachment relationships, and encourage adolescent autonomy on the basis of strengthened family relationships. A detailed comparison of the two approaches would be a promising avenue for future research.

Treatments for adolescent substance use will clearly benefit from strategies designed to enhance not only attachment security, but the organisation of attachment related discourse. Such changes provide the secure family-base which enables an adolescent's continuation of the developmental process into adulthood. Underlying attachment vulnerabilities are maintained not only in the representational models of the individual members, but also as interactional patterns and modes of communication within families. We propose that this discursive level of the family system can be a target of a number of specific techniques. Families as a whole can be engaged in these techniques and new approaches to patterns of communication and connectedness used as a means of engaging substance using, depressed, or suicidal adolescents.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

FUNDING

Evaluation studies of BEST have been funded by the Australian Research Council (grant number LP110200167) and also Beyondblue, Drummond St Services, Australian Drug Foundation, Turning Point and WA Department of Justice and supported by Deakin and Murdoch Universities.

ACKNOWLEDGMENTS

The current paper is derived from a presentation to the conference *Sucht und Bindung* held in Vienna, 16th–18th May 2018 and hosted by the Grüner Kreis Society. I would like to thank the conference organizing committee and in particular Dr Human-Fredrich Unterrainer for their kind invitation to present this work. Many thanks also to conference participants who offered comments and suggestions for this paper. Evaluation studies of BEST have been funded by the Australian Research Council (grant number LP110200167) and also Beyondblue, Drummond St Services, Australian Drug Foundation, Turning Point and WA Department of Justice and supported by Deakin and Murdoch Universities. Many colleagues over the years have contributed to the development of these clinical techniques and the evaluation of BEST. These include Irene Serfaty, Kim Kho, Michelle Benstead, Renita Almeida, Lucy Poole, Tess Knight, John Toumbourou, John Bamberg, Nic Cecic, Campbell Paul, Reima Prior, Dan Lubman, Melanie Bertino, Joanna Skewes, and Karen Field.

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Conflict of Interest: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychiatry

PERSPECTIVE
published: 06 August 2020
doi: 10.3389/fpsyt.2020.00786

The Therapeutic Community: A Unique Social Psychological Approach to the Treatment of Addictions and Related Disorders

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OPEN ACCESS

Edited by:
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Specialty section:
This article was submitted to Addictive Disorders, a section of the journal Frontiers in Psychiatry

Received: 28 August 2019
Accepted: 22 July 2020
Published: 06 August 2020

Citation:
De Leon G and Unterrainer HF (2020) The Therapeutic Community: A Unique Social Psychological Approach to the Treatment of Addictions and Related Disorders. Front. Psychiatry 11:786. doi: 10.3389/fpsyt.2020.00786

The evolution of the contemporary Therapeutic Community (TC) for addictions over the past 50 years may be characterized as a movement from the marginal to the mainstream of substance abuse treatment and human services. TCs currently serve a wide array of clients and their diverse problems; through advances in research in treatment outcomes, the composition of staff has been reshaped, the duration of residential treatment has been reduced, the treatment goals have been reset and, to a considerable extent, the approach of therapy itself has been modified. An overview of the TC as a distinct social-psychological method for treating addiction and related disorders is provided by this paper. Included in this is a focus on the multifaceted psychological wounds that consistently show a strong association with addiction and thereby require initiating a recovery process characterized by life-style and identity changes.

Keywords: community as method, overview, group therapy, substance use disorder, therapeutic community

INTRODUCTION

We intend here to give a brief overview of the development of the therapeutic communities (TCs) for the treatment of addictions. After a brief historical introduction (pt 1), the core dimensions of the TC treatment approach will be introduced and the characteristic peculiarities will be discussed (pt 2). Based on this, we will describe the "community as method" approach in more detail and show different approaches to empirically depict the change process that the patients go through during their stay in the TC (pts 3–5). In line with this, the state of research regarding the possible change processes taking place in the TC will be summarized (pt 6) and possible other forms of application

of TCs for special populations and settings will be discussed (pt 7). Lastly, we conclude by summarizing the TC key elements, also in comparison to other therapeutic approaches (pt 8).

THE EVOLUTION OF THE TC

According to DeLeon (1) "the idea of therapeutic community recurs throughout history, implemented in different incarnations. Communities that teach, heal, and support, appear in religious sects and utopian communes, as well as in spiritual, temperance, and mental health reform movements." (p.11). In correspondence to this, indirect influences on TC concepts, beliefs, and practices can be found in religion, philosophy, psychiatry, and the social and behavioral sciences. Thereby, early prototypes of communal healing and support can be traced back to classical antiquity. Remarkably, there are two elements in ancient medical texts that can also be applied to modern TCs for addictions: 1) the mental illness (or the disease of the soul) manifests itself as a disease of the whole person and is characterized in particular by problems with self-control on the behavioral and emotional level and 2) the healing of the disease (or the soul) happens through the involvement of a community or group. Then, as now, violations of the rules of the community were sanctioned or had negative consequences for the individual. In this sense, the group also determines the type and extent of the sanctions, which in the case of serious violations, especially against the integrity of the group, can also mean expulsion from the community (2).

Although the TC for addictions has been influenced by numerous sources, both current and historical teachings can be found herein, the actual term "therapeutic community" can be considered modern. This was first used to describe psychiatric TCs in Great Britain during the 1940s (3). However, it is unclear, how these first TCs (for general psychiatric patients) have influenced the development of the TCs focusing on addictions, which began in the United States (4). In North America, Charles Dederich, as a former alcoholic himself and member of "Alcoholics Anonymous", founded one of the first self-help groups for opiate addictions in 1958 named "Synanon". Primarily, he was inspired by the works of the writer and philosopher R. W. Emerson and a religious organization called "The Oxford Group", which saw itself as a moral antipode to international armament. This group was also influenced by "Alcoholics Anonymous" and their 12-step method of treating alcohol addiction. So-called Synanon houses and Synanon villages developed, in which former addicts renounced their old way of life, concentrating instead on the present moment and communal work, which was based on values such as truth and sincerity (5).

In Europe the first TCs shaped by American models were founded in the mid-1960s. A self-help group called "Release" was setup in England in 1967. As a result of the success of "Release" TCs were independently developed in several countries across Europe from the 1960s and 1970s (5). As illustrated, for example, by Cortini, Clerici, and Carrà (6), today we can certainly speak of a unique evolutionary strand of the TC movement in Europe. Furthermore, the authors rightly argued that a comparison of both the European and the American treatment routes could contribute to a more differentiated discussion of the TC treatment concepts in general as well as guide their further development. Although different variations of TCs have developed in the United States as well as in Europe independently from each other, they still share some key core elements which will be further characterized now.

THE TC PERSPECTIVE

Comprehensive accounts of the TC theory, model, and method are contained in De Leon (1, 7). The TC theory, "community as method" shapes its program model and its unique approach. The paradigm is comprised of four interconnected views of substance use disorder and how the individual, process of recovery, and living healthy are defined.

View of the Disorder

The abuse of drugs is considered a comprehensive disorder affecting the whole person and many, if not all, parts of functioning. It is evident that those suffering from drug abuse have problems not only with cognition and behavior, but also mood disturbances (8). The substance abusing individual's thoughts may be classed as unrealistic or even disorganized, their values are mixed up, antisocial or even nonexistent (9, 10). All too often they suffer from deficits in comprehension, writing, reading, and so-called "marketable skills" (11). Spiritual struggles, or even moral problems, are consistently apparent whether expressed in psychological or existential terms (12). Thus, it can be argued that the problem is with the individual and not the substance abused; in other words, addiction can be seen as a symptom rather than the essence of their disorder (13). This perspective may also be one of the main characteristics of the TC and one of the major differences between the TC model and standard psychiatric inpatient treatment, which is much more based on symptom-oriented diagnostic systems such as the International Classification of Diseases in 11th revision [ICD 11; (14)] or the Diagnostic and Statistical Manual of Psychiatric Disorders Version 5 [DSM 5; (15)].

Accordingly, in terms of an attachment based therapeutic approach, it can be said that the TC tries to break the bond to a substance and instead direct the patient toward forming a bond to the community. Thereby, the TC can serve as an attachment figure, acting as a safe haven in which one can enter, but also as a secure base from which one can start again into a new (drug-free) life (16). While clinical evidence suggests the important role of the community for the functioning of affect regulation (17), some additional support comes from a neuro-evolutionary perspective e.g., through the "social baseline" model, which proposes "that social species are hard-wired to assume relatively close proximity to conspecifics, because they have adopted social proximity and interaction as a strategy for reducing energy expenditure relative to energy consumption" [(18), p. 19; see also (19), for a more general discussion].

View of the Person

In TCs, rather than classifying individuals according to their patterns of drug abuse, they are instead delineated along degrees of "psychological dysfunction" and "social deficits". Additionally, many residents in TCs have manifested vocational and educational problems; society's mores are either ignored or totally avoided. These residents are often from a socially depressed sector. A better term for their TC experience is "habilitation", the development of a social, productive, and "conventional" lifestyle for the first time. However, among residents from more advantaged backgrounds, the term "rehabilitation" is judged more appropriate since it emphasizes a return to a rejected lifestyle previously lived and known. Despite apparent differences in social background, psychological problems, or drug preferences most individuals admitted to TCs share profound clinical characteristics that center around antisocial dimensions or immaturity (**Table 1**). Whether they precede or follow serious involvement with drugs, these characteristics are commonly observed to correlate with substance dependency. Crucially, in TCs, a change for the better in these characteristics is thought to be essential for long-term recovery (1).

From the TC perspective, for recovery to occur a change in lifestyle, in addition to social and personal identity, is considered vital. Thus, the main psychological goal of treatment is an attempt to change negative patterns of thinking, behavior, and feeling that predisposes an individual to drug use; meanwhile the main social goal is to develop skills, attitudes, and instill values necessary for a responsible, drug-free lifestyle. Stable recovery, however, is dependent on a successful integration of these psychological and social goals. Without insight behavioral change is unstable; however, without lived experience mere insight is insufficient. Several key assumptions underlie the recovery process in the TC (1).

Motivation

Recovery depends on pressures, both positive and negative, to change. For example, certain people might seek help due to stressful external pressures; others may be moved by more intrinsic factors. For everyone, however, sticking to a treatment program requires a continual internal motivation to change. Thus, some elements of the treatment approach are designed to either sustain motivation or enable early detection of signals that the subject might terminate treatment prematurely (1).

TABLE 1 | Typical behavioral, cognitive, and emotional characteristics of substance abusers in therapeutic communities.

Low tolerance for all forms of discomfort and delay of gratification
Problems with authority
Inability to manage feelings (particularly hostility, guilt, and anxiety)
Poor impulse control (particularly sexual or aggressive impulses)
Poor judgment and reality testing concerning consequences of actions
Unrealistic self-appraisal regarding discrepancies between personal resources and aspirations
Prominence of lying, manipulation, and deception as coping behaviors
Personal and social irresponsibility (e.g. inconsistency or failures in meeting obligations)
Marked deficits in learning and in marketable and communication skills

Self-Help and Mutual Self-Help

In practical terms treatment is not provided per se; rather, it is provided to all individuals in the TC through the daily regimen of groups, seminars, work, recreation and meetings, and its staff and peers. The efficacy of these elements, however, depends on the individual: they must engage fully in the treatment regimen for best outcomes. In self-help recovery the individual must make the main contribution to his/her change process. By contrast, in mutual self-help the primary messages of personal growth, "right living", and recovery are mediated by peers through discourse and sharing experiences in groups, providing examples as role models, and acting as encouraging, supportive friends in daily interactions (1).

Social Learning

Lifestyle changes occur in a social context. Negative behavioral attitudes, patterns, and roles, in general, are not acquired in isolation, nor can they be ameliorated in isolation. Thus, this presupposition is the basis for the view that a peer community can facilitate recovery. Social responsibility as a role is learned by acting the role within a community of one's peers (1).

VIEW OF RIGHT LIVING

TCs adhere to certain values, precepts, and a social perspective that guides and reinforces recovery. For instance, there exist community sanctions that address antisocial attitudes and behavior: emphasis is also placed on changing the negative values of irresponsible or exploitative sexual conduct, in jails, negative peers or "the streets". Positive values, by contrast, are given a positive emphasis as being essential to both social learning and personal growth. These values include such concepts as truth and honesty (both in word and deed), a strong work ethic, a feeling of responsibility for others (e.g. being one's brother's or sister's keeper), a sense of achievement and that all rewards have been earned, self-reliance, personal accountability, community involvement, and social manners. The values of "right living" are reinforced constantly in various informal and formal ways (e.g. signs, seminars, in groups, and community meetings) (1).

In order to counter the concerns of critics, attempts have been made to date to scientifically prove the effectiveness of the treatment concept (20). However, the therapeutic concept of the TC is being questioned due to the lack of randomized clinical studies with regard to the therapeutic success. Despite these criticisms, "community as method" can still be seen as the top principle of the TC, both in terms of the treatment and the research into change processes in the TC. This method will now be explained in more detail (21).

TC APPROACH: COMMUNITY AS METHOD

The approach of TC can be summarized by the phrase "community as method". The definition of community as

method offered by theoretical writings is as follows: The purposive use of the community to teach individuals to use the community to change themselves. Thus, the fundamental assumption that underlies the concept of community as method is: individuals obtain maximum educational and therapeutic impact when they engage in, and learn to use, all of the diverse elements of the community as tools for self-change. Therefore, "community as a method" means that the community is both context and mediator for individual change and social learning. Its membership establishes expectations or standards of participation in the community. It assesses how individuals are meeting these expectations and respond to them with strategies that promote continued participation (1).

COMMUNITY, THE INDIVIDUAL, AND THE PROCESS OF CHANGE

Everyone uses the expectations and context of their community to change and learn. Living up to the expectations of their community requires that an individual continually change their behaviors, attitudes, and emotional management. Conversely, avoidance of, or difficulties in living up to community expectations can also result in an individual's growth through continual self-examination, re-motivation to engage in trial and error learning, and re-committing to the process of change. Thus, the drive to cohere to what the community expects for participation compels residents to pursue personal goals of psychological growth and socialization. The whole process can be summed up in the phrase: if you participate, then you will change (1).

TC RESEARCH: DIRECT EVIDENCE FOR SOCIAL AND PSYCHOLOGICAL CHANGES

A considerable scientific knowledge base has been developed over the past four decades, with the addition of follow-up studies on thousands of individuals treated in TCs. The most extensive body of research bearing on the efficacy of TC programs involving addiction has been collected from numerous field outcome studies. All of these studies utilized similar longitudinal designs that followed admissions to TCs during treatment and 1–5 years (and in one study up to 12 years) after leaving the index treatment. These studies consistently show that TC admissions have poor profiles with regard to severity of substance use, psychological symptoms and social deviance. The striking replicability across studies has left little doubt as to the reliability of the overarching conclusion: There is a consistent correlation between treatment retention in TCs and positive post-treatment outcomes. This conclusion is additionally supported in the smaller number of controlled and comparative studies involving TC programs [for enhanced reviews of the TC outcome literature in North America, see (21); and internationally, see (20)].

INDIRECT EVIDENCE BASED SOCIAL PSYCHOLOGICAL PRINCIPLES AND PRACTICES ARE EMBEDDED WITHIN COMMUNITY AS METHOD

The TC for addictions emerged practically, outside both mainstream mental health and social science. Nevertheless, a unique theoretical social learning approach has evolved, captured in the phrase "community as method". The latter, however, contains elements and practices that are familiar and supported by abundant social–psychological and behavioral research outside of TCs (**Table 2**). Similarly, behavioral training and social learning principles are obvious, e.g. vicarious learning, the training, and acquisition of social roles and social reinforcement. As discussed elsewhere, these principles are naturally mediated by the context of community living (1).

Overall, the weight of the direct evidence from all sources (e.g., multiple sources of outcome research in North America which includes single program controlled studies, cost–benefit studies, meta-analytic statistical surveys, and multi-program field effectiveness studies) supports the conclusion that the TC is both a cost-effective and therapeutically effective treatment for certain substance abuser subgroups, particularly those with severe drug use, social and psychological problems. This conclusion is supported by considerable indirect evidence from social psychological principles and practices that are inherent within community as method. Other strategies that are informed by evidence can be incorporated to enhance rather than substitute for community as method, the primary approach (1).

TC model was developed further or adapted to different circumstances or patient groups. These changes will be briefly explained below.

TABLE 2 | Indirect evidence: examples of TC program and practice elements that are evidence-based in the behavioral and social-psychological research literature.

Peer Tutoring
TC: Mutual self-help grounded in peers as role models and mentors.
Therapeutic Alliance
TC: Affiliation and participation in the program depends upon the relationship between the individual and the community
Motivational Enhancement
TC: Group process focuses individuals on problem identification and encourage desire to change.
Behavior Modification
TC: System of verbal correctives and affirmations as well as social sanctions and privileges for facilitating behavioral change.
Goal Attainment
The program plan focuses on incremental learning, defined by specific stage and phase outcomes leading to program completion.

TC, therapeutic communities.

TC APPLICATIONS TO SPECIAL POPULATIONS AND SETTINGS

The traditional TC model described herein is in actuality the prototype of a variety of TC oriented programs. Today TC modality largely consists of a wide range of programs that serve a variety of patients who use diverse drugs and who, in addition to their chemical abuse, present with complex psychological and social problems. Clinical requirements as well as client differences, in addition to the reality of funding, have encouraged the development of modified residential TC programs that offer shorter planned durations of stay (3, 6, and 12 months) as well as TC-oriented outpatient ambulatory models and day treatments. Correctional facilities, medical and mental hospitals, and community residences and shelters, having become overwhelmed with alcohol and drug abuse problems, have implemented TC programs within these settings (11).

Most community-based traditional TCs have either incorporated new interventions or expanded their social services to address the diverse needs of their members. These changes and additions include specific primary healthcare geared toward individuals with AIDS or who are HIV-positive, family services, relapse prevention training, aftercare services specifically for special populations such as substance-abusing inmates leaving prison treatment, mental health services, components of 12-step groups, and other evidence-based practices (e.g., cognitive-behavioral therapy, motivational interviewing). These modifications and additions enhance, but are not intended as a substitute for, the fundamental TC approach: Community as method. Research literature documents the effectiveness and cost-effectiveness of modified TCs for special populations such as homeless and mentally ill chemical abusers, those in criminal justice settings and adolescents (1, 22–26).

CONCLUDING REMARKS

The fundamental, primary foundation for the TC program model, its distinctive methodology, community as method, and its longer than usual treatment duration is the recovery perspective. Fundamentally, multi-dimensional ("whole person") change necessarily requires a multi-interventionist approach that is sustained for a sufficient amount of time (1).

The TC for addictions is arguably one of the first formal treatment paradigms that is overtly recovery oriented. Although Alcoholics Anonymous and similar programs, focused on an approach of mutual self-help, facilitate recovery these programs differ from TC by representing their service as support rather than treatment. Meanwhile, pharmacological treatment paths, such as methadone, have as their putative treatment objective the outright elimination or, at the very least, reduction of the abuse of opiates. Empirically based approaches to behavior, such as motivational enhancement (MET), cognitive behavioral therapy (CBT), and contingency contracting, focus upon reducing the abuse of the targeted drug. From the TC's perspective, however, the main goal of treatment is "recovery" which is broadly defined as identity and lifestyle changes. These changes involve abstaining from the illicit use of narcotics (and other drugs), the total elimination of social deviance and the development of positive social values and appropriate behavior (1). Thus, the mission, and that which distinguishes TC from other treatment paths, is promoting recovery and encouraging living right.

AUTHOR CONTRIBUTIONS

GDL wrote the draft of the manuscript. HU read the manuscript and made some critical comments. All authors contributed to the article and approved the submitted version.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychiatry

ORIGINAL RESEARCH
published: 25 September 2020
doi: 10.3389/fpsyt.2020.460506

The Influence of an Attachment-Related Stimulus on Oxytocin Reactivity in Poly-Drug Users Undergoing Maintenance Therapy Compared to Healthy Controls

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Background: Substance use disorders (SUDs) have been described as a dysfunctional way to compensate for deficiencies in that person's underlying attachment system. Furthermore, the neuropeptide oxytocin (OT), which is a critical component of the neurobiology of the attachment system, has been shown to effectively reduce addictive behavior and therefore has been discussed as a potential medication in SUD treatment. This study investigates variation in peripheral OT plasma levels as a function of exposure to an attachment-related stimulus in SUD patients compared to healthy controls (HCs).

Methods: A total sample of 48 men, 24 inpatients in maintenance treatment who were diagnosed with poly-drug use disorder (PUD) and 24 HC, was investigated. A 15-min exposure to the Adult Attachment Projective Picture System (AAP) was used as an attachment-related stimulus and coded for attachment status. Blood samples before and after the AAP-assessment were taken and assayed for OT levels. Variation in baselines level of OT was examined in relation to the Alcohol, Smoking and Substance Involvement Screening Test (ASSIST), the Adult Attachment-Scale (AAS), and the Brief Symptom Inventory (BSI).

Results: Following the AAP stimulus controls showed no significant difference in OT levels elevation from baseline compared to the PUD group's OT levels. Furthermore, in the PUD group only OT-baseline-levels may be negatively associated with the AAS subscale "Comfort with Closeness" and "Anxiety" and lifetime substance use.

OPEN ACCESS

Edited by:
Carlos Roncero,
University of Salamanca, Spain

Reviewed by:
Gareth Leng,
University of Edinburgh,
United Kingdom
Yannis Paloyelis,
King's College London,
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Specialty section:
This article was submitted to Addictive Disorders, a section of the journal Frontiers in Psychiatry

Received: 16 March 2019
Accepted: 26 August 2020
Published: 25 September 2020

Citation:
Fuchshuber J, Tatzer J, Hiebler-Ragger M, Trinkl F, Kimmerle A, Rinner A, Buchheim A, Schrom S, Rinner B, Leber K, Pieber T, Weiss E, Lewis AJ, Kapfhammer H-P and Unterrainer HF (2020) The Influence of an Attachment-Related Stimulus on Oxytocin Reactivity in Poly-Drug Users Undergoing Maintenance Therapy Compared to Healthy Controls. Front. Psychiatry 11:460506. doi: 10.3389/fpsyt.2020.460506

Discussion: Our results suggest that peripheral OT levels in poly-drug users undergoing maintenance treatment are not significantly different in responsiveness to an attachment related stimulus compared to HC. With regard to non-significant tendencies observed in this study which hint toward decreased OT-reactivity in the PUD group, further research is needed to explore this hypothesis with increased statistical power.

Keywords: attachment, maintenance treatment, poly drug use, oxytocin, substance use disorder

INTRODUCTION

Substance use disorders (SUDs) have been characterized as a compulsive substance use without consideration of the negative consequences (1) and are increasingly framed as a neurobiological disorder (2, 3). Currently, the most common form of SUD in patients undergoing treatment in Austria is poly-drug use disorder (PUD), with opioids as the primary drug of choice (4), a pattern which is also found in the majority of SUD patients across Europe (5). In recent years, increasing number of patients are treated within maintenance treatment programmes, which have been shown to be effective treatments by reducing heroin use and risk behaviors as well as improving health, social and criminal justice outcomes (6).

From a psychodynamic perspective, SUD has been understood in relation to attachment disorder (7) and as a dysfunctional way of self-medicating (8). Specifically, insecure attachment has been linked to increased psychopathology for decades (9). Formed by early parent-infant interactions, which are gradually imprinted in neuronal pathways (10, 11), attachment can be understood as a neurobiological system designed to promote social affiliation and primary bonding experiences (12, 13). Recent studies indicate a substantial role of insecure attachment in the etiology of SUDs (14–16)—among other psychiatric disorders (17). This relationship has been linked to the influence of attachment styles on the interpersonal regulation of human emotions particularly fear, anxiety and hedonic experiences within close relationships (18, 19).

Attachment research across mammalian species has suggested that the neuropeptide oxytocin (OT) plays a central role in the neurobiological processes involved in the formation and maintenance of social bonds (20), interpersonal affect regulation (14, 21) and parent-child relationships (22–24), but also protective aggression (25). The OT-system in humans is associated with brain regions including the amygdala, paraventricular nucleus (PVN), supraoptic nucleus (SON), ventral pallidum (VP), ventromedial nucleus of the hypothalamus (VMH), area tegmentalis ventralis (VTA), substantia nigra (SN), and the neuroendocrine systems (26). Consisting of nine amino acids, this neuropeptide is produced by PVN and SON. Through axonal transport OT is centrally released to hippocampus, amygdala, striatum, hypothalamus, nucleus accumbens, and the central brain in response to social interactions and stressors (27–30). In line with the Calm and Connect Model (31), which assumes that bonding, experienced through touch and social affection, leads to OT production and thus positively reinforces social connection, several studies have linked insecure attachment patterns to impairments of the OT-system (23, 27, 29, 32).

In the context of addiction, beneficial effects of administered OT on drug tolerance, withdrawal and seeking have been proposed across various substance classes (33, 34). Individual differences in the endogenous OT-system may therefore affect the vulnerability to addiction. SUDs have been repeatedly linked to decreased levels of OT (35–37). Furthermore, OT is assumed to modulate the mesolimbic dopamine system (38), a structure which is substantially involved with the process of addiction development and bond formation (2, 39). Similarly, there is considerable evidence suggesting interactions between the OT and endogenous opioid system (40). In line with these observations, a recent review by Zanos et al. (41) concluded that the OT system is not only meaningfully influenced by opioid addiction and abstinence but also might serve as a critical target for pharmacological interventions. Such findings inform the first aim of this study to investigate cross sectional relationships between substance use and OT levels.

Previous research indicated a relationship between the administration of stimuli designed to activate the attachment system of participants and the OT-system. One such measure, the Adult Attachment Projective Picture System (AAP) was shown to significantly increase OT levels (42). This study was conducted with a sample of healthy lactating mothers who might be thought to be especially responsive to attachment cues. Moreover, these authors hypothesized that women with more secure attachment patterns should show higher OT-reactivity. However, in this study, the authors were not able to confirm the proposed association between a larger increase in OT and more securely attached mothers. This experimental paradigm using the AAP as an attachment stimulus is adopted in the current study, while our study is focused on substance users compared to healthy controls (HCs).

What is more, in recent years, several reviews have been published which critically asses methodical flaws frequently observed within the research of the human OT system [e.g., (43–45)]. These contributions specifically emphasize the importance targeted hypotheses, consideration of differences between central processing of OT and its peripheral levels, as well studies focussed on peripheral levels making use of plasma samples, and plasma to be assayed for OT levels after extraction.

With this in mind, this study aimed to enhance the understanding the relationship between attachment and the OT-system in patients with SUD. We sought to address two primary aims. First, using baseline levels of peripheral OT, we examined their associations with substance use (using the ASSIST), attachment (using the Adult Attachment-Scale), and current symptoms (using the Brief Symptom Inventory). In relation to

the first aim, we expected to find OT levels negatively associated with insecure attachment patterns and psychopathological symptom burden in the PUD group. Our second aim follows the experimental study by Krause et al. (42), which focuses on the response of the peripheral OT-system in response to an attachment-related stimulus. In the experimental study, we compared PUD patients undergoing maintenance therapy to HCs. Following Krause, we expected to see a rise in the OT levels of health controls when exposed to an attachment stimulus. We were exploring whether the SUD group would show a different OT response to the same stimulus. However, as this is the first time, this experimental paradigm is investigated in patients undergoing maintenance treatment, this hypothesis remains exploratory.

SAMPLE AND METHODS

Participants

The study sample consisted of 48 male participants between 19 to 38 years of age (M = 27.42, SD = 4.82), consisting of one clinical (PUD; n = 24) and one non-clinical group (HC; n = 24). Participants in the clinical group met diagnostic criteria for PUD (F19.2), diagnosed according to the International Classification of Diseases version 10 (ICD 10) (46) by a licensed psychiatrist. Due to the haphazard drug use, one of the main characteristics for PUD, the drugs consumed cannot be reported in detail. At the time of the study, all PUDs were currently participating in maintenance therapy as described below. PUDs with fluid psychotic symptoms were excluded. Comorbidities with other diagnoses were distributed as follows: 9.2% Affective disorders (F3.x), 5.8% Neurotic, stress and somatoform disorders (F4.x), 4.6% Personality and behavioral disorders (F6.x), 2.3% Schizophrenia, schizotypal and delusional disorders (F2.x), 1.2% Behavioral and emotional disorders (F5.x) with onset usually occurring in childhood and adolescence.

Before participating in the study PUD patients had been in maintenance therapy for a mean time of 15 weeks (SD = 13.8) and received either *Levo-Methasan* (n = 21), *Bupensan* (n = 1), *Substitol Retard* (n = 1), or *Compensan Retard* (n = 1) as a substitution agent, with daily doses ranging from 2 to 320 mg, depending on patient and medication. Furthermore, 21 PUD patients received additional psychopharmacological medication: 16 (66.67%) received antipsychotics and 19 (79.17%) received antidepressants. Participants of the non-clinical group, exclusively non-smoking men, reported either none or just a few previous experiences with illegal substances. With the exception of occasional consumption of alcohol, no use of psychoactive substances was reported by HC in the last 30 days prior to the investigation and no use of psychopharmacological medication. HCs were included if they reported no past or present psychiatric disorder or chronic disease.

Exclusion criteria for both groups were insufficient knowledge of the German language. Clinical subjects were assessed at the Johnsdorf therapeutic facility of the Grüner Kreis Society. Non-clinical subjects were recruited through advertising on social networks and *via* email distribution of the University of Graz. The study was approved by the ethics committee of the University of Graz, Austria and conducted in accordance with the Declaration of Helsinki.

Procedure and Design

In order to eliminate any effects due to circadian rhythms the timing of the experiment was standardized. Participants were asked to fast for at least 3 hours before arriving in the laboratory (between 12.00 am and 3.30 pm), avoid caffeinated drinks and to refrain from smoking on the day of participation, before and during the experiment. After written informed consent was obtained and the subjects were notified about the course of the experiment, the first venipuncture and blood collection was performed. Immediately after, the AAP (47) was applied in which participants were asked to tell a story for each of the eight shown pictures with either monadic or dyadic scenes by answering the following questions: "What is happening in the scene?", "What led up to the scene?", "What are the characters thinking or feeling?", and "What might happen next?". The abstract line drawings indicate scenarios such as illness, separation, and abuse without detailed facial expression, allow a large scope of interpretation (47). The AAP measure is designed around a common assumption in observational and discourse attachment measures that attachment behavior is best observed directly after an attachment related stimulus is delivered or represented such as a separation, loss, illness and so on (48). The interviews lasted on average 16 min (SD = 4.50). The AAP interviews were administered by a trained psychologist in a standardized manner according to the published administration requirements. Following the AAP, and 25 min after the first blood sample a second blood sample was collected, again *via* venipuncture. The psychometric assessment (described below) took place online *via* Lime-Survey® before the experiment.

Measures

Addictive Behavior

The German Version of the *Alcohol, Smoking and Substance Involvement Screening Test* [*ASSIST 3.0*; (49), German Version; (50)] is a structured short interview designed to record life-time consumption behavior and its negative effects from the following substance classes: alcohol, tobacco, cannabis, cocaine, amphetamines, inhalants, sedatives, hallucinogens, and opiates among others. For this study, the interview was adapted as a self-report questionnaire. Questions about the "Frequency of drug use", "Craving to use the drug", "Problems", and "Failed expectations" are rated on a 7-point Likert scale from 0 (never) to 6 (daily). Questions about "Expressed concerns by relatives or friends", "Failed attempts to cut down drug use", and "Drug injection" are rated on a 3-point Likert scale (0 = "no never", 3 = "yes, but not in the past 3 months", 6 = "yes, in the past 3 months"). By adding the drug specific symptom scores an overall score for every symptom class (mentioned above), as well as a total score was calculated. Subscales ranged in Cronbach's alpha from 0.79 to 0.89.

Mental Health Symptoms

The short version of the *Brief Symptom Inventory* [*BSI-18*; (51), German Version: (52)] assesses the amount of psychiatric burden of the last 7 days by means of 6 items on each of the

three subscales: (1) Somatization, (2) Depression, and (3) Anxiety. It is rated on a 5-point Likert scale from 0 "absolutely not" to 4 "very strong". A Global Severity Index (*GSI*) can be generated for a total of the 18 items. Cronbach's alpha for the subscales ranged from 0.70 to 0.87. The total Global Severity Index score showed a Cronbach's alpha of 0.87.

Attachment Styles

The German Version of the *Adult Attachment Scale* [*AAS*; (53, 54)] is a self-report method measuring attachment dimensions based on attachment theory (55). This questionnaire consists of three subscales: (1) Anxiety about being rejected or unloved, (2) Comfort with Closeness and Intimacy, and (3) Comfort in Depending on others. This questionnaire consists of 18 items rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Cronbach's alpha for the scales ranged from 0.68 for to 0.79.

Oxytocin Assessment

For measuring the plasma OT levels, blood samples were drawn from antecubital veins into 3-ml vacutainer blood vacuettes (Greiner Bio-One International GmbH, Austria) containing Aprotinin (500 KIU/ml of blood) (Sigma-Aldrich, Germany). Vacuettes were stored at −20°C before use. Vacuettes were centrifuged at 4°C at 1.600 g for 15 min. Supernatants were stored at −80°C until analysis. Extraction of samples was undertaken and OT concentrations in the extracts were determined in duplicate by *Oxytocin ELISA kit* (ADI-900-153A, Enzo Life Sciences, USA), a colorimetric competitive enzyme immunoassay kit at the Center for Medical Research at the Medical University Graz, Austria. The mean intra-assay and inter-assay coefficients of variability were 23.4% and 13.9%, respectively; sensitivity was 15.0pg/ml. All procedures were performed according to the manufacturer's instructions by authorized personnel.

Data Reduction and Statistical Analyses

For group comparisons in the experimental design, one-way analyses of variance and χ^2 tests were conducted. To evaluate the reactivity of OT, the amount of the difference value of pre- and post-OT-level was considered. To investigate the relationship between OT and behavioral measures Pearson's correlation coefficients were calculated separated for the PUD group. Alpha was set to $p < 0.05$ in ANOVAs and Pearson's correlations. However, with regard to recent critical reviews of OT-literature [e.g., (43, 44)], we additionally corrected for multiple comparisons *via* the Bonferroni correction. In order to ensure a better evaluation of the results, effect sizes were included.

RESULTS

Demographics and Clinical Characteristics

Socio-demographic variables, scores for addictive behavior as well as requirements prior to the interview of both groups are presented in **Table 1**.

Hypothesis-Testing Results

Group Differences in OT and Attachment

As depicted in **Table 2**, group comparisons showed that PUD had higher levels of OT compared to HC before at baseline ($F_{(1,\ 46)} = 7.02$; $p < 0.05$). No other significant group differences regarding OT were observed (all $p > 0.05$) [for comparative means see (56)]. Following the administration of the AAP as attachment stimuli, the HC seemed to increase in OT levels whereas the PUD group's OT remained flat. However, this difference was not significant ($F_{(1,\ 46)} = 3.25$; $p = 0.08$).

Furthermore, the between group tests for differences in the measures of mental health and attachment the PUD group showed a tendency toward less Comfort with closeness ($F_{(1,\ 46)} = 3.97$; $p = 0.05$) and Comfort with Depending on others ($F_{(1,\ 46)} = 3.61$; $p = 0.06$) and higher depressive symptom burden ($F_{(1,\ 46)} = 8.27$; $p < 0.05$). With regard to the Bonferroni corrected alpha level, no group differences remained significant (all $p > 0.003$)

Intercorrelations of Oxytocin, Attachment, and Personality Characteristics for PUD

Correlations over PUD showed that baseline OT-levels were related to less Comfort with closeness ($r = -0.41$, $p < 0.05$) and lifetime substance use over all substance classes ($r = -.48$, $p < 0.05$). Furthermore, OT-reactivity showed non-significant tendencies with Comfort with closeness ($r = .34$, $p < 0.10$) and Lifetime substance use ($r = .37$; $p = 0.07$). Moreover, as shown in **Table 3**, insecure attachment patterns were related to Depression ($r = -.51$–$.49$; all $p < 0.05$). No correlation remained significant if corrected for multiple comparisons (all $p > 0.003$).

DISCUSSION

In order to enhance the understanding of the relationship of OT to SUD, we investigated the differences in psychopathology, attachment, and the OT-system between PUD patients undergoing maintenance treatment compared to HC, as well as differences in peripheral OT response to an attachment-related stimulus. Our results suggest that PUD patients were higher OT at baseline compared to a HC group. In response to the attachment stimulus containing the AAP procedure, differences between the PUD and HC groups regarding OT-reactivity remained non-significant. Furthermore, baseline OT-levels showed a significant relationship with decreased Comfort with closeness in PUD patients.

However, these results should be interpreted with caution. In the first instance, the sample size of the study was small and there were numerous significance tests run. Following Nave et al. (44) and McCullough et al. (43), who proposed the necessity for correcting for multiple comparisons, no finding remained significant based on a Bonferroni corrected alpha level. While the Bonferroni correction has been criticized as being overly conservative (57, 58), the findings of this study are tentative and require replication in a larger study.

TABLE 1 | Group differences in demographic data and conditions prior to investigation.

	PUD (*n* = 24)		HC (*n* = 24)		*T*	*df*	*p*
	M	*SD*	*M*	*SD*			
Age	28.50	5.85	26.33	3.25	-1.59	35.99	0.119
Risk of substance use							
Lifetime substance use (incl. alcohol & tobacco)	23.63	4.79	8.63	4.18	-11.56*	45.17	0.000
Global continuum of substance risk (incl. alcohol & tobacco)	29.04	4.43	13.75	7.04	-9.01	46	0.000
Conditions day of examination							
Waking up	467.17	79.61	371.96	138.38	-2.92*	46	0.005
Caffeine consumption[a]	440.63	178.57	–	–	–	–	–
Nicotine consumption[a]	103.54	195.23	–	–	–	–	–
Last meal[a]	272.63	133.84	360.04	256.75	1.48	34.64	0.146
Sexual activity	700.43	138.25	621.25	231.45	-1.43	37.83	0.161
	PUD (*n* = 24)		**HC (*n* = 24)**		X^2	*df*	*p*
Nationality	*n*		*N*		7.54	4	0.110
Austria	16		19				
Other Country	8		5				
German language skills					4.73	2	0.094
Mother tongue	16		22				
Very well	7		2				
Less well	1		0				
Education					48.00*	5	0.000
No completed Education	1		0				
Secondary school	10		0				
Apprenticeship	12		0				
High School	1		14				
Bachelor	0		5				
Master/Doctor	0		5				
Psychiatric diagnosis					45.15*	1	0.000
Yes	24		0				
Current psychotherapy					49.00*	1	0.000
Yes	24		0				
Chronic physical health problems					3.33	1	0.068
Yes	3		0				
Regular medication					49.00*	1	0.020
Yes	24		0				

*$p < 0.05$; PUD, Poly-drug use disordered patients; HC, Healthy controls. [a]Past time in minutes since last consumption on test day.

TABLE 2 | Group differences (ANOVA) in behavioral and biological measures.

Measures	*a*	PUD (*n* = 24)		HC (*n* = 24)		$F_{(1, 46)}$	η^2	*p*
		M	*SD*	*M*	*SD*			
BSI-18								
Somatization	0.690	2.17	2.73	2.13	2.35	0.00	0.00	0.955
Depression	0.852	6.25	5.57	2.71	2.33	8.27*	0.15	0.006
Anxiety	0.816	4.54	5.01	3.46	2.41	0.91	0.02	0.344
Total Score	0.869	12.96	11.14	8.71	5.39	2.83	0.06	0.099
Oxytocin								
Pre (pg/ml)		60.64	24.87	44.74	15.68	7.02*	0.13	0.011
Post (pg/ml)		60.38	17.25	60.46	38.73	0.00	0.00	0.992
Reactivity		-0.26	17.64	15.72	39.66	3.25	0.06	0.078
AAS								
Dependence	0.731	16.13	4.89	18.42	3.31	3.61	0.07	0.064
Closeness	0.786	11.63	3.93	13.92	4.03	3.97	0.08	0.052
Anxiety	0.678	12.29	3.91	12.29	3.75	0.00	0.00	1.000

*Bonferroni corrected p = 0.005; *$p < 0.05$; PUD, Poly-drug use disordered patients; HC, Healthy controls; Pre, baseline OT-levels; Post, OT-levels after confrontation with attachment related cue.*

The finding of increased OT-baseline in the PUD group is in contrast to many other studies (41). The interpretation of this result needs to remain speculative at this point. However, it is conceivable that this finding might be traced back to the characteristics of living in the therapeutic community which is characterized by high social cohesion and an attachment focused treatment approach (59). Furthermore, in contrast to the HC group, PUD participants traveled to the OT measuring in groups, which might have

TABLE 3 | Intercorrelations for behavioral and biological measures for PUD (n = 24).

Variable	1	2	3	4	5	6	7	8	9	10	11
1. BSI-18 Somatization		.40	.79**	−.21	−.03	.27	−.11	−.15	.19	.17	.14
2. BSI-18 Depression			.48*	−.04	.01	.06	−.51*	−.46*	.49*	.21	.21
3. BSI-18 Anxiety				−.13	−.08	.10	−.02	−.12	.22	.14	.34
4. OT Pre					.70**	−.72*	.05	−.41	−.37	−.48*	.11
5. OT Post						−.02	.07	−.24	−.33	−.31	−.04
6. OT Reactivity							.00	.34	.20	.37	−.19
7. AAS Dependence								.68**	−.36	−.05	−.20
8. AAS Closeness									−.02	−.04	−.22
9. AAS Anxiety										−.18	.24
10. ASSIST Lifetime SU											−.16
11. ASSIST GC of SR											

*N = 24; Bonferroni corrected p = 0.004; **p < .01, *p < .05; Pre, baseline OT-levels; Post, OT-levels after confrontation with attachment related cue; GC, global continuum; SU, substance use; SR, substance risk.*

further contributed to inflated OT baseline levels (60). Another possibility would be an influence of the various medications used for maintenance therapy which interact with the opioid system, or indeed the use of antidepressant or antipsychotic medications in PUD participants. However, while not extensively researched, recent literature indicates no influence of antidepressant pharmacological treatments on OT (61) but there have been some animal studies suggesting a relationship between antidepressants and OT metabolism (62).

OT-reactivity in PUD patients did not significantly differ from variability of HC participants. Based on previous research it might be speculated (29, 42), that an increase in OT in response to an attachment related stimulus is associated with seeking and finding of an internalized positive attachment representation. Furthermore, animal research has shown that the administration of morphine potently inhibits the secretion of OT and depresses the OT-sensitivity of the mammary gland, due to inhibition of the firing of supraoptic OT-neurons (63–66). Considering potential ceiling effects of methadone on the endogenous OT-system, its chronic administration could cause a maximum release of OT, so that further increases in OT are diminished, regardless of whether the person is triggered with an attachment related stimulus or not. Regarding the statistical tendencies observed in our sample which hints in the direction described above, more data is needed to further evaluate this line of interpretation.

Contradicting recent literature (15, 67), no significant differences between PUD patients and HC were found regarding adult attachment attitude using the AAS measure. Nevertheless, the non-significant associations showed there may be important relationships here which the current study was underpowered to detect and are consistent with the pattern observed in previous research (14, 67–69).

In general, the main results in this study may be influenced by several effects brought about by a combination of psychopharmacology, maintenance, and long-term psychotherapeutic treatment.

In addition, our findings designate a negative relationship between baseline OT-level and Comfort with Closeness in PUD patients. Corresponding to recent findings by Torres et al. (70), which suggested a negative correlation between the dose of maintenance therapy and Closeness as well as decreased Anxiety in patients undergoing maintenance therapy. Therefore, the mechanism of maintenance therapy might operate on the surface but helps PUD patients only to a limited extent in the formation of healthy interpersonal relationships and positive attachment representations that can be relied on in times of distress (15, 21).

Moreover, we observed tentative hints toward a link between OT-reactivity and increased Comfort with closeness which, however, did not achieve statistical significance. Similarly, Krause et al. (42) did not find significant associations between attachment security and OT-reactivity in lactating mothers. Hence, while a relationship between attachment and OT-reactivity may be a reasonable premise, more research should be done to further analyse this subject matter.

Limitations and Future Perspectives

Findings of the present study are mainly limited by the sample size, the exclusion of the female gender and the use of self-report measures. Furthermore, the measurement of OT is controversially discussed in literature (43, 71).

Furthermore, nicotine abstinence was not given in PUD patients prior to the investigation in this study, which might be seen as a characteristic of PUD patients in maintenance treatment. However, in line with previous research, nicotine abuse was not related to OT (72, 73). Moreover, due to the explorative nature of this study, no control condition was administered, which limits the interpretability of the effects of the AAP on OT-levels. This shortcoming needs to be addressed in future studies. What is more, a recent study by Fuchshuber et al. (74) indicated a medium effect size regarding the difference in attachment security comparing PUD and HC groups (74). With respect to the relatively small sample size employed in this study, future research addressing this subject might take this to an account regarding the estimation of the required sample size. Along, to gain a more complete understanding of the relationship between attachment, OT and maintenance treatment, the investigation of abstinent SUD patients who are not undergoing maintenance therapy is of interest for future studies. Finally, cortisol and vasopressin, both known for their close interrelatedness with OT, should be taken into account (29, 30, 75, 76).

CONCLUSION

This study suggests that peripheral OT levels in poly-drug users undergoing maintenance treatment do not show significant

differences regarding responsive to an attachment related stimulus delivered *via* the Adult Attachment projective task compared to HCs. The meaning of this finding is complicated by a number of confound in the PUD group related to both the pharmacological and psycho-social treatments they are receiving. The current findings which indicate non-significant tendencies however are an important preliminary finding which we hope will motivate more research using an experimental paradigm to further explore this hypothesis.

DATA AVAILABILITY STATEMENT

This article contains previously unpublished data. Datasets are available on request.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of the ethics guidelines of the Karl Franzens University of Graz, Austria. The protocol was approved by the ethics committee of the Karl Franzens University of Graz, Austria. Written informed consent in accordance with the Declaration of Helsinki was given by all subjects.

AUTHOR CONTRIBUTIONS

JT, EW, and HU conceptualized the study. JT, AK, FT, AR, and collected the data. JT, AB, SS, BR, TP, and KL analyzed the data. JT and AB interpreted the AAP data. JT, MH-R, HU, and AL drafted and revised the manuscript. EW, H-PK, AB, MH-R, HU, JF, and AL critically reviewed the manuscript. All authors contributed to the article and approved the submitted version.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2020.460506/full#supplementary-material

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