Association of parental and adolescent emotion-related factors with adolescent chronic pain behaviors

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Abstract

Chronic pain is a prevalent condition in youth, and the pain experience is strongly influenced by emotional processes. Studying emotion variability and regulation (ER) may help better understand pain behavior. As the development of emotion-related abilities predominantly takes place in the family context, examining ER within parent–adolescent dyads is important. We set out to test the association of parent and adolescent ER and adolescent emotional variability with adolescent pain behavior (ie, pain interference, activity avoidance, and activity engagement). A sample of 56 adolescents (Mage = 14.5, 85.7% women) with chronic pain and one of their parents (92.9% mothers) participated in this study. Adolescents completed baseline measures of average pain intensity, ER, and mean positive and negative affect. Furthermore, adolescents completed an electronic diary for 14 consecutive days, reporting on emotional state, activity avoidance, activity engagement, and pain interference. Parents completed measures of ER and their own history of pain. We performed a variable selection procedure, the least absolute shrinkage and selection operator method, to determine important predictors of adolescent pain behavior. Adolescent high positive affect was associated with more activity engagement, less pain interference, and less activity avoidance, indicating that positive affect might enhance the willingness to engage in activities in the presence of pain. Adolescent ER strategy emotional reappraisal and parents’ own history of pain were predictors of less activity engagement. Parent ER was not related to adolescent ER. In conclusion, our results highlight the potential of enhancing positive affect as an intervention target for chronic pain.

Keywords: Chronic pain, Adolescents, Emotion regulation, Parental emotion regulation

1. Introduction

Chronic pain is a common and debilitating condition, affecting approximately 25% of children and adolescents. Emotions and emotional processes are an essential part of the pain experience. Given that pain is associated with a range of negative emotions, studying how people try to regulate their emotions may help to better understand the pain experience and associated behaviors. Emotion regulation (ER) describes the ability of people to influence which emotions they have, when they have them, and how they experience and express them. The process model of emotion regulation broadly categorizes different ER strategies into antecedent-focused and response-focused ER strategies. Antecedent-focused ER includes those strategies that take place before an emotion is fully developed; hence, their prospect of success is generally greater, eg, modifying a situation that elicits negative emotions or shifting one’s attention to pleasant thoughts. By contrast, response-focused ER emphasizes the regulation of the emotional response, particularly its physiological and behavioral aspects, eg, holding back one’s tears in public, which would be considered expressive suppression. Emotion regulation is considered maladaptive if it antagonizes personal...
goals, shows negative short-term or long-term outcomes, or is inappropriate to contextual or social demands. Maladaptive response-focused ER may be an important risk factor for the development and maintenance of chronic pain in adults. Past research has linked greater emotion variability, i.e., the range of emotional fluctuations around an individual’s average emotional intensity, with more mental health symptoms in adolescents and higher ER demands. Importantly, higher negative emotion variability has been associated with greater pain and activity limitations in youth with chronic pain. High negative emotion variability has been conceptualized as a consequence of diminished ER in the context of chronic pain.

The development of ER abilities in childhood predominantly takes place in the family context. An important mechanism through which children learn about ER is by observing parents’ emotional displays and the strategies chosen to manage emotional states. Children learn the appropriateness of valence, duration, and intensity of emotion expression by observing parent ER behaviors. In the context of chronic pain, research suggests that depression and anxiety are prevalent among mothers of children with chronic pain. However, the direction of the relationship between maternal emotional functioning and their child’s experience of chronic pain remains unknown and is likely bidirectional. To conclude, it is possible that maladaptive ER strategies exhibited by parents could be one mechanism that links parent emotional functioning with greater pain-related dysfunction in adolescents.

The main objective of this study was to examine the association of parent and adolescent ER and adolescent emotional variability with pain interference, activity avoidance, and activity engagement in a sample of adolescents with chronic pain. We hypothesized that (1) adolescent expressive suppression predicts more pain interference and activity avoidance and less activity engagement in adolescents, (2) greater adolescent emotion variability predicts more pain interference and activity avoidance and less activity engagement in adolescents, and (3) parental expressive suppression would indirectly be linked to adolescent pain-related outcomes through adolescent expressive suppression. In addition, we controlled for participants’ and parents’ demographics and pain-related characteristics because previous studies have found age and sex differences in pediatric pain samples.

2. Methods

2.1. Participants

We included adolescents with various types of chronic pain conditions (e.g., headache, abdominal pain, and musculoskeletal pain) and one of their primary caregivers recruited through the Pain Treatment Service at Boston Children’s Hospital (between February 2017 and December 2017, number of participants: 28 [50%]) and the Pediatric Pain Management Clinic at Stanford Children’s Health (between February 2017 and February 2018, number of participants: 28 [50%]), where they presented for initial clinical evaluation. Approval of each institutional review board was granted before the start of recruitment (Boston Children’s Hospital: #P0020889, Stanford: #39092). This study is part of the Child Pain In Context research project. Two publications are available from this project, one focused on the role of parental instructions on the relationship between parental psychological flexibility and adolescent pain-related behavior and the second one explored potential antecedents and consequences of pain-related behavior in adolescents.

Participants were considered eligible for the study if they (1) were between 11 and 17 years, (2) reported persistent or recurrent pain for 3 months or longer, (3) had internet access at home or on an accessible smartphone, (4) did not have significant cognitive impairments (e.g., intellectual disability and severe brain injury), (5) did not report severe psychiatric conditions, and (6) had a primary caregiver who was also willing to participate. Screening for psychiatric disorders was performed based on the medical chart review (i.e., physician reported) and through the parent. Including adolescents aged 11 to 17 years was chosen based on the age range of patients typically seen in the 2 pain treatment services.

Of the 84 parent–adolescent dyads who initially consented or assented to participate, 56 dyads (i.e., 67%) completed a set of baseline self-report questionnaires followed by a 14-day diary assessment period, during which parents and adolescents answered questions daily. The most common reason for non-completion was the lack of interest after initial consent (n = 19).

2.2. Procedure

After their first visit at the respective pain management center, participants and their parents were informed about the study and asked whether they wanted to participate. Informed consent was obtained on paper or online before the start of the study: Parents signed an informed consent for their own and their (minor-aged) adolescent’s participation, and adolescents additionally gave their informed assent.

Participants received an online link to access and complete the baseline self-report questionnaires. The 2-week diary assessment period was scheduled to start on the Monday after the completion of the baseline measures. Automatic messages containing the diary surveys were sent to the participants each day for 14 consecutive days. Adolescents received prompts twice a day (afternoon and evening), and parents received one prompt in the evening. Afternoon and evening assessments were chosen because the wording of the outcome variables (pain-related interference, activity avoidance, and activity engagement) always started with “since the previous diary entry.” Hence, we assessed opportunities to engage or avoid activities by assessing midday and at the end of the day. If an adolescent or a parent did not complete any of the required diary entries on 3 consecutive days despite reminder calls, the family was given the option to withdraw from the study. All study data were collected and managed using research electronic data capture, hosted at Boston Children’s Hospital and Stanford University. Research electronic data capture is a secure, web-based application designed to support data capture for research studies. All communication with participants regarding recruitment and consent was performed via the parent, using either text message or e-mail. In case adolescents had their own phone and assented to it, prompts for the daily diary assessment were sent to their phones.

Participants who started the 2-week diary period received one 10-dollar gift voucher (1 per family) at the end of the first week irrespective of the number of completed diary entries. In addition, participating dyads received a 20-dollar gift voucher at the end of the second week unless they withdrew from the study during the first week.

2.3. Measures

2.3.1. Baseline assessment

At baseline, both the adolescent and one of their parents completed a series of questionnaires (note: additional questionnaires not used in this analysis but collected for the Child Pain In Context study are reported elsewhere).

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2.3.1.1. Sociodemographic information

A short baseline questionnaire was completed on adolescent age, sex, ethnic background, and grade in school. The participating parent was asked to report on adolescent pain characteristics (ie, pain location and duration), parent sex, marital status, and education level. In addition, they reported on both parents’ pain history by indicating whether they or the child’s other parent have had a history of pain problems lasting 3 months or greater in their lifetime. To assess adolescents’ average level of pain, we used the question “In the past 6 months, how intense was your average level of pain?” from the baseline questionnaire.

2.3.1.2. Adolescent pain severity

Adolescent pain severity was measured using the child version of the Graded Chronic Pain Scale26,77 that asks adolescents to rate current and average pain intensity in the past 6 months on a 11-point Numerical Rating Scale, with 0 indicating no pain and 10 indicating worst possible pain. The Graded Chronic Pain Scale consists of 7 items and grades chronic pain in pain intensity and disability. Subscale scores for pain intensity and pain-related disability are combined to calculate a chronic pain grade that enables classification into 5 hierarchical categories, ie, grades 0 (pain free) to IV (high disability regardless of pain intensity). For this study, we used the one item that asked about the average pain intensity of the past 6 months to get an impression of the participants’ average levels of pain.

2.3.1.3. Positive and negative affect

Positive and negative affect was measured using the short version of the Positive and Negative Affect Schedule for Children (PANAS-Q)21,55,80 The PANAS uses words that describe positively or negatively valenced emotions and asks the child to rate how truly they currently feel each of 5 positively (ie, proud, joyful, cheerful, happy, and lively) and 5 negatively valenced emotion descriptors (ie, blue, miserable, afraid, scared, and sad) on a 3-point rating scale ranging from “very slightly or not at all” to “extremely.” Internal consistency for the positive affect subscale was α = 0.92 and α = 0.91 for the negative affect subscale in this sample.

2.3.1.4. Adolescent emotion regulation

Adolescent ER was assessed using the ER Questionnaire for Children and Adolescents (ERQ-CA)50 that asks about the routine use of 2 ER strategies, namely, cognitive reappraisal (ie, cognitively reframing a situation’s meaning; antecedent-focused ER strategy) and expressive suppression (ie, the suppression of emotional expression; response-focused ER strategy). The ERQ-CA is based on the adult version of the ER Questionnaire and has been revised for use in children and adolescents. It consists of a total of 10 items. Cronbach α = 0.83 for the cognitive reappraisal subscale and α = 0.78 for the expressive suppression in this sample.

2.3.1.5. Parent emotion regulation

Parent ER was assessed using the ERQ37 a 10-item questionnaire that assesses routine use of cognitive reappraisal and expressive suppression. Internal consistency was α = 0.90 for the cognitive reappraisal subscale and α = 0.82 for the expressive suppression subscale in this sample.

2.3.2. Daily assessment

Both the adolescent and one of their parents completed a set of daily questions for 14 consecutive days, assessing emotional variability, pain interference, activity avoidance, and activity engagement. We used parents’ baseline values and adolescents’ baseline as well as adolescent daily reports for this analysis. Items were developed by the research team who made adjustments to items of existing questionnaires to be suitable for daily or momentary use and were subsequently validated using the discriminant content validity procedure.49

2.3.2.1. Emotional variability

Emotional variability was measured by computing an index representing adolescent emotional variability of both positive and negative emotions (based on14,72), as rated by adolescents. Adolescents completed the PANAS items twice a day for 14 consecutive days. A ratio was computed of each adolescent’s aggregate standard deviation of positive emotion scores relative to their grand mean of positive emotion scores across the 14-day period. Higher scores indicate greater variability of positive emotions. The same ratio was computed for negative emotions.

2.3.2.2. Pain interference

Pain interference was measured using one item, namely, “I experienced problems with completing activities because of the pain” and was rated on a scale ranging from 0 (“not at all true”) to 4 (“totally true”) by adolescents.

2.3.2.3. Activity avoidance due to pain

Activity avoidance due to pain was assessed using 3 items based on the “avoidance of activities” subscale of the Fear of Pain Questionnaire for Children73 and adjusted for use in the daily assessment. Three items were selected to reflect different types of pain-related avoidance strategies: “I skipped my planned activities because I was afraid that I find important or fun while I was in pain” and “I persisted in carrying out my planned activities while I was in pain.” These items were based on the “activity engagement” subscale of the Chronic Pain Acceptance Questionnaire for Adolescents (CPAQ-A),59 which has been found to be a valid measure of pain acceptance (including activity engagement).59

The total score was computed as the mean of the 2 items, with possible scores ranging from 0 to 4 (“totally true”). Within-dyads α was 0.81 (afternoon assessment) and 0.82 (evening assessment), and between-dyads α was 0.95 (afternoon assessment) and 0.93 (evening assessment).

2.3.2.4. Activity engagement despite the pain

Activity engagement despite the pain was measured by means of 2 items and assessed when adolescents engaged in activities in the presence of pain (ie, a pain intensity score of one or higher). The following items were used: “I have put effort into completing activities that I find important or fun while I was in pain” and “I persisted in carrying out my planned activities while I was in pain.” These items were based on the “activity engagement” subscale of the Chronic Pain Acceptance Questionnaire for Adolescents (CPAQ-A),59 which has been found to be a valid measure of pain acceptance (including activity engagement).59

The total score was computed as the mean of the 2 items, with possible scores ranging from 0 to 4. Within-dyads α was 0.63 (afternoon assessment) and 0.73 (evening assessment), and between-dyads α was 0.92 (afternoon assessment) and 0.93 (evening assessment).

2.4. Statistical analyses

Statistical analyses were performed using R® for the least absolute shrinkage and selection operator (LASSO) analysis, using the packages caret54 and glmmnet,55 MPlus54 for the within-level and between-level reliabilities of activity engagement and activity avoidance, and SPSS® for all other analyses.
We used descriptive statistics to summarize patient characteristics. For daily assessments, a daily mean score for pain interference, activity avoidance, and activity engagement was calculated by taking the average of afternoon and evening scores. The daily mean scores were aggregated across the 14-day period to obtain an average across all days for each variable, if at least 75% of the items were completed. If less than 75% of the items were completed, the total score was not calculated and considered missing. The bivariate Pearson correlation coefficients between all variables used in this study were calculated. Reliability for activity avoidance and activity engagement was calculated using a multilevel confirmatory factor analysis framework to estimate within-level and between-level reliabilities of the scales. To investigate the relationship between predictors and pain behavior outcomes, a multiple regression model was considered to be unsuitable because of the sample size of the current study. Multiple regression models often suffer from overfitting and hence low predictive accuracy (predictive accuracy refers to the ability of a statistical model to not only fit the training data well but also fit corresponding new [test] data that has been previously unseen) when the number of predictors is high relative to the number of participants. To avoid model overfit, we performed a variable selection procedure, namely, the LASSO method, a machine learning approach. In the LASSO model, coefficients are deliberately shrunk by implying a penalty term to the likelihood function when fitting the model. As a consequence, the LASSO models are somewhat more biased than those obtained from multiple regression models but less variable, ie, they exhibit increased predictive accuracy for a deviation of the estimated coefficient from the true underlying (and unknown) parameter. Thus, when replicating the current study, the predictors whose coefficients have not been shrunk to zero by the LASSO are likely to remain predictive. Our LASSO model contained 14 predictors, namely, our predictors of interest (ie, adolescent’s baseline mean positive and negative affect, adolescent’s variability of positive and negative emotions, adolescent’s expressive suppression, adolescent’s cognitive reappraisal, parent’s expressive suppression, and parent’s cognitive reappraisal) and variables we controlled for (ie, adolescent age and sex, adolescent pain duration in months, average adolescent pain intensity over the past 6 months, parent’s own chronic pain history, and other parent’s chronic pain history). All predictors were standardized before using the LASSO. We conducted repeated (n = 10) 10-fold cross validation to assess the model’s predictive accuracy, ie, how well the LASSO model performs when applied to test rather than training data. We thereby used the root mean square error (ie, the square root of the variance of the residuals) and the R-squared ($R^2$) as measures of model accuracy. Both the multiple regression model and the LASSO model contained exactly the same set of standardized predictors. Thus, the difference in the results between the 2 models is based on how the beta coefficients were estimated. Although they were not shrunk in the multiple regression model, they were shrunk in the LASSO using the regularization parameter $\lambda$. The optimal value for $\lambda$ was determined using repeated (n = 10 complete sets) 10-fold cross validation.

To examine indirect links between parental ER (ie, expressive suppression or cognitive reappraisal) and adolescent pain-related outcomes (pain interference, activity avoidance, and activity engagement) through adolescent ER (expressive suppression or cognitive reappraisal); see Fig. 1, 6 indirect models were tested using a bootstrapping resampling method described by Hayes and by means of the PROCESS plug-in in SPSS (version 3.4). Instead of inspecting $P$ values to conclude for significance of the effects, bootstrapping methods focus on confidence intervals (CIs) and effect sizes. According to this analytic method, a significant indirect effect (ab) is observed if the 95% bootstrap CI does not include 0. We examined bias-corrected bootstrap confidence intervals (BC CIs) because they are the most accurate with a high level of statistical power, especially with smaller samples sizes (N < 80) (see Ref. 58 for more information).

3. Results

3.1. Sample characteristics

The final sample consisted of 56 adolescents (Mage 14.5 years, SD = 1.9) and their parents (93% mothers) of 84 adolescent–parent dyads who initially consented or assented to participate (ie, 64%). The most common reason for noncompletion was lack of interest after initial consent (N = 19). Most of the adolescents were women (85.7%) and Anglo-American (66.1%). Their mean pain duration was 26.6 months with a SD of 23.1, and their current level of pain was rated as M = 5.1 with a SD = 2.6 on a Likert scale from 0 to 10. Detailed information on the sample is listed in Table 1. Of those dyads who consented, 49 provided data for all variables of interest in this study and were used for the LASSO analyses and the indirect models.

3.2. Predictors and outcome measures

Of a total of 784 possible daily diary observations for adolescent variables (ie, one observation per day or per participant for 14 consecutive days), 625 data points were available for daily adolescent activity avoidance (ie, 20% missing), 528 for daily adolescent activity engagement (ie, 32% missing), 642 for daily pain interference (ie, 18% missing), and 710 for daily positive affect and negative affect (ie, 9% missing; used to calculate positive and negative emotion variability). The bivariate Pearson correlation coefficients between all variables used in this study are listed in Table 2. We interpreted effects >0.1 as small, those >0.3 as medium, and those >0.5 as large. In this sample, positive emotional variability scores ranged from 0 to 0.68 and negative emotional variability scores ranged from 0 to 0.88. This is similar to previous samples, with a slightly higher anchor for the negative emotional variability in our study.

3.2.1. Pain-related interference

Pain-related interference was positively correlated with pain intensity ($r = 0.291, P < 0.01$) and variability of negative affect ($r = -0.274, P < 0.01$) as well as with baseline mean positive affect ($r = -0.296, P < 0.01$) and baseline mean negative affect ($r = 0.291, P < 0.01$; see Table 2).

Four predictors were found to be important (ie, nonzero) in the LASSO regression model (in descending order): adolescent baseline mean positive affect, adolescent variability of negative affect, parental expressive suppression, and adolescent variability of positive affect (Table 3). Thus, lower mean adolescent positive affect at baseline, lower variability of adolescent negative emotions, less parent expressive suppression, and higher variability in adolescent positive emotions were all associated with more pain-related interference. The magnitude of individual effects was small, particularly for adolescent variability of positive emotions and parent expressive suppression (Table 3). Root mean square error and $R^2$ for this model were 0.93 and 0.37, respectively, after cross validation and were enhanced relative to the respective values of a corresponding multiple regression model (Table 4).
3.2.2. Activity engagement

Bivariate correlations revealed significant correlations between activity engagement and baseline mean positive affect \( r = 0.341, P < 0.01 \) and activity engagement and parent expressive suppression \( r = -0.310, P < 0.01 \); see Table 2.

For the outcome activity engagement, 9 predictors were nonzero based on the LASSO model (Table 3): adolescent baseline mean positive affect, adolescent variability of positive affect, parent expressive suppression, adolescent cognitive reappraisal, average adolescent pain intensity over the past 6 months, other parent’s history of chronic pain, parent cognitive reappraisal, adolescent baseline mean negative affect, and adolescent variability of negative affect. Thus, higher adolescent average pain intensity, more negative emotions at baseline, more frequent adolescent and parent cognitive reappraisal, and the presence of pain history in one parent were all associated with less adolescent activity engagement. It has to be noted, however, that the magnitude of the effects for parent cognitive reappraisal, adolescent baseline mean negative affect, and adolescent variability of negative affect were only very slightly above 0. Root mean square error and \( R^2 \) were 0.95 and 0.32, respectively, after cross validation and improved relative to the respective values of a corresponding multiple regression model (Table 4).

3.2.3. Activity avoidance

Activity avoidance was significantly associated with baseline mean positive affect \( r = -0.506, P < 0.01 \) and with baseline mean negative affect \( r = 0.320, P < 0.01 \); see Table 2.

Only one predictor, namely, adolescent baseline mean positive affect, was nonzero based on the LASSO model (Table 3). Less baseline mean positive affect was associated with more activity avoidance. Root mean square error and \( R^2 \) were 0.85 and 0.37, respectively, after cross validation and again superior to the respective values of a corresponding multiple regression model (Table 4).

3.2.4. Association between parent emotion regulation and adolescent outcome through adolescent emotion regulation

Bootstrap analyses (with 5000 resamples) showed a significant direct contribution of parent expressive suppression on activity engagement \( c' = -0.22, P = 0.03 \) but not on pain interference \( c' = -0.12, P = 0.27 \) or activity avoidance \( c' = -0.05, P = 0.53 \); Fig. 1, Model A). Furthermore, none of the hypothesized indirect links between parent expressive suppression and these outcomes through adolescent expressive suppression were found to be significant \( ab_{\text{pain interference}} = -0.002, SE = 0.02, 95\% \text{ BC CI: } -0.05 \text{ to } 0.03; ab_{\text{activity engagement}} = -0.01, SE = 0.02, 95\% \text{ BC CI: } -0.07 \text{ to } 0.02; and ab_{\text{activity avoidance}} = -0.005, SE = 0.02, 95\% \text{ BC CI: } -0.06 \text{ to } 0.02). \)

Bootstrap analyses (with 5000 resamples) showed no significant direct contributions of parent cognitive reappraisal on adolescent outcomes \( c'_{\text{pain interference}} = 0.08, P = 0.52; c'_{\text{activity engagement}} = -0.004, P = 0.98; and c'_{\text{activity avoidance}} = 0.09, P = 0.10 \); Fig. 1, Model B). Furthermore, none of the hypothesized indirect links between parent cognitive reappraisal and these outcomes through adolescent cognitive reappraisal were found to be significant \( ab_{\text{pain interference}} = -0.04, SE = 0.06, 95\% \text{ BC CI: } -0.19 \text{ to } 0.04; ab_{\text{activity engagement}} = -0.004, SE = 0.03, 95\% \text{ BC CI: } -0.07 \text{ to } 0.07; and ab_{\text{activity avoidance}} = -0.02, SE = 0.04, 95\% \text{ BC CI: } -0.11 \text{ to } 0.05). \)
All indirect models were rerun using data from mothers alone. Those analyses did not return different results (see Supplementary Materials for detailed information, available at http://links.lww.com/PAIN/B517).

4. Discussion

Previous research has extensively studied the role of negative affect in chronic pain in adolescents, partially given by its dominant role in psychological comorbidities of chronic pain, especially depression. In this study, we examined the role of emotion-related factors, such as ER, positive and negative emotion variability in pain-related interference, specifically activity avoidance, and activity engagement. Adolescent baseline mean positive affect was a consistent predictor across all outcomes in the hypothesized directions: Higher positive affect was associated with less mean pain-related interference, less activity avoidance, and more activity engagement. This is in line with previous research indicating that higher positive affect is related to an attenuated perception of pain. In pediatric studies, more positive affect has been linked to significantly lower pain intensity, which may be explained by the broaden-and-build theory of positive emotions. This theory states that positive emotions such as joy, interest, and contentment may allow people to broaden their thought-action repertoires. Interest, for example, creates the urge to explore, expand, and take in new information. This is in sharp contrast to negative emotions which carry immediate and adaptive benefits in survival-threatening situations by narrowing the thought-action repertoire to the immediate danger. Within the broaden-and-build theory, positive affect can be conceptualized as a factor that promotes resilience. In the context of chronic pain, this might mean that positive emotions enhance the possibility to engage in activities despite the pain. A recent review has highlighted the potential of positive affect interventions to reduce pain sensitivity and foster well-being despite pain and suggested that positive affect might be useful to handle some of the challenges faced in the treatment of patients with chronic pain. Moreover, the dynamic model of affect specifies how positive and negative states function relatively independent from each other in safe and predictable environments. However, under conditions characterized by uncertainty, including pain and stress, the 2 affective states become inversely correlated, ie, it becomes progressively difficult to maintain positive affective states during periods of high pain intensity, which in turn increases vulnerability to negative affective states and future pain episodes. Stress reduction techniques, such as mindfulness training, can help to broaden emotional awareness and support patients in retaining positive emotions also during times of high pain.

In addition, we found that adolescent higher variability of positive emotions predicted less pain interference and more engagement in activities. This is in contrast to the results of a recent meta-analysis that found higher variability in positive emotions in youth with internalizing mental disorders compared with healthy peers. This might be due to greater emotional reactivity in adolescents (compared with children and adults) because adolescence is commonly described as a time of inner turmoil. Children and adolescents high in emotional reactivity are disproportionately negatively affected by adverse environments but profit enormously from supportive set-
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*P values < 0.05 are marked in bold. Variables refer to adolescent unless stated otherwise.

* P < 0.01 (2-tailed).
† P < 0.05 (2-tailed).
emotions compared with children or adults, increasing the ER that adolescents generally experience more frequent and intense interference.

Regarding the developmental stage, it might be worth noting that adolescents generally experience more frequent and intense emotions compared with children or adults, increasing the ER demands at a time of profound transformation related to ER development. Previous research has found that adults who routinely use cognitive reappraisal experience more positive emotions compared with people who used this strategy less often. One reason for this might be that cognitive reappraisal is part of the antecedent ER strategies that are typically used before the full-blown emotional response in the process model of ER. In our sample, cognitive reappraisal was found to be a predictor for less activity engagement in the LASSO model; however, bivariate associations between the variables were not significant. Although we were not able to identify why this is the case, a recent systematic literature review also pointed out that antecedent-focused ER might not be directly associated with pain. Hence, it may be that unmeasured confounding variables explain the link between more cognitive reappraisal and less activity engagement.

Parental ER, specifically expressive suppression, was also a consistent predictor of adolescent pain-related interference and activity engagement. Our indirect models supported these findings from the LASSO model in part: We found a significant direct contribution of parental expressive suppression on less engagement in activities through adolescent expressive suppression but no significant direct contribution of parental cognitive reappraisal on any adolescent outcomes. In addition, we found no evidence for direct associations between parental and adolescent habitual use of ER strategies. Previous studies have stated that there is little research examining a potentially direct relationship between parental ER and adolescent social or emotional outcomes, although it is assumed that parental emotional factors are integral to an adolescent’s development of ER capacities. Furthermore, parents of children or adolescents with chronic pain experience high levels of stress and anxiety compared to parents of healthy children, and maladaptive ER is considered a key component of several mental disorders. In contrast to our own findings, results of previous studies lend support to our initial hypothesis that stated that parental expressive suppression would indirectly be linked to adolescent pain-related outcomes through adolescent expressive suppression. Nevertheless, a systemic approach that takes the adolescent’s and the parents’ experience, emotional state, and behavior into account is crucial when treating children and adolescents with chronic pain.

### 4.1. Strengths and limitations

This study has several strengths. Data from adolescents and one of their parents were collected, including parental ER and information on parents’ history of chronic pain. Our outcomes
not only focused on daily pain interference but also on activity engagement and activity avoidance, which might better capture the influence chronic pain has on adolescents’ daily life. One of them, activity engagement, is a positive outcome, i.e., an outcome that involves positive behaviors or emotions despite pain. The inclusion of positive outcomes is recommended to capture resilience in the context of chronic pain that might contribute to an upward spiral of sustainability despite pain. The data used for this study were collected over a period of 2 weeks; hence, it is likely to depict a representative image of the daily lives of the included sample. Regarding our analyses, we used the LASSO procedure to select predictors of our outcomes, indicating that they are likely to remain predictive in a potential replication study. This is preferable over other methods, such as stepwise regression, where the risk of excluding important predictors and finding random results is higher.

Besides these strengths, our study also suffers from limitations. First, our sample size was limited. Second, we aggregated data across the diary period and did not examine day-to-day changes to receive a reliable value for the respective values. Without these temporal associations (i.e., day-to-day), interpretations regarding causality are impossible. A larger sample size would be needed to conduct analyses suitable to examine temporal associations (e.g., multilevel modeling). In addition, we used self-report measures for parent and adolescent behavior. Although self-report is considered the gold standard when it comes to pain assessment, self-reports can be biased (e.g., because of socially desirable answers and memory bias). Finally, most of the parents included in this study were mothers; thus, we cannot generalize conclusions to fathers.

4.2. Implications and future studies

One important clinical implication of our results is to consider including positive affect in the description and research of pediatric pain problems. As positive affect seems to be related with pain-related interference, activity avoidance, and activity engagement, pain interventions could consider including positive affect. Previous literature supports the notion that positive affect might play an important role in pain and its treatment and should be studied further. Based on the broaden-and-build theory, increasing positive affect might support patients to optimize living with chronic pain by fostering their resilient qualities. Fostering adolescents’ skills and resilient qualities might support an increase in their well-being despite their pain. Future studies in the context of pediatric chronic pain could routinely assess not only negative but also positive affect, to clarify the directionality of the association between chronic pain and positive affect. Regarding ER, we suggest that future studies should assess environmental factors, such as diurnal patterns of emotions, previous experiences, parent-child psychopathology, parent ER, and frequency and intensity of potentially emotioneliciting events in daily life, by using a multimethod approach (e.g., psychophysiology, observation, and questionnaires).

Previous studies have highlighted the unique contribution of paternal behavioral to child outcomes. Hence, future studies could include fathers and mothers to disentangle the association of both parents’ ER and pain history.

5. Conclusion

This study examined emotion-related predictors of pain-related interference, avoidance of activity, and activity engagement in a sample of adolescents with chronic pain and their parents. Adolescent positive affect was found to be a constant predictor across all pain behavior outcomes. Our study is in line with recent research highlighting the importance of positive affect in the pain experience and points to its potential in pain treatment.

Conflict of interest statement

The authors report no conflicts of interest.

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Appendix A. Supplemental digital content

Supplemental digital content associated with this article can be found online at http://links.lww.com/PAIN/B517.

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