# Training Self-compassion: Exploring the Effects on Adolescents' Physiological and Self-reported Stress Responses

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## Abstract

***Objectives.*** Previous studies demonstrated that self-compassion may generate positive effects on adults' mental health through its impact on stress responses. As adolescence is characterized by elevated levels of stress, self-compassion may be particularly relevant for this age group. The aim of this study was to assess the immediate effects of a brief training in self-compassion on adolescents' stress recovery following a validated stress induction.

***Methods***. Fifty-three adolescents between 11 and 18 years old (64% girls) were randomly assigned to a self-compassion group or a control group prior to undergoing a three-phase experiment (i.e. baseline, stress induction, and instruction phase). Adolescents in the self-compassion group received a brief training in self-compassion before the start of the experiment and were asked to use the learned technique during the instruction phase. Adolescents in the control group did not receive a training and were provided with neutral instructions during the instruction phase. Physiological stress outcomes (i.e. salivary cortisol, heart rate, and heart rate variability) and self-reported stress outcomes (i.e. self-reported affect) were compared between groups.

***Results.*** The main results revealed no clear differences between both groups pertaining physiological and self-reported stress responses.

***Conclusions.*** The current findings could not provide evidence for the beneficial effects of a brief self-compassion training among adolescents, and even suggest that it may have detrimental effects on the physiological stress response. Findings are discussed within a developmental framework and important considerations for further research are noted.


**Keywords:** self-compassion, adolescents, stress responses, Cyberball, psychophysiology

The developmental phase of adolescence is accompanied by an increased focus on peer-group relationships, sense of belonging, and acceptance (Gilbert & Irons, 2009). Consequently, this critical period is also prone to an increased focus on social comparison, feelings of shame, self-criticism and self-reassuring (Gilbert & Irons, 2009). Exploring mechanisms that allow adolescents to adaptively cope with these age-related challenges is paramount to protect them from developing mental health problems. Holding a compassionate attitude towards oneself, the antithesis of being self-critical, may be an important process to scrutinize. Research in adults showed that self-compassion is negatively related to the development and maintenance of (symptoms of) psychopathology (MacBeth & Gumley, 2012; Muris & Petrocchi, 2017; Zessin et al., 2015), because it promotes adaptive stress responses and facilitates stress recovery (Arch et al., 2014; Kirschner et al., 2019; Luo et al., 2018; Petrocchi et al., 2017; Rockliff et al., 2008). Although there is convincing evidence that trait and trained self-compassion are also linked to adolescents' mental health (Bluth & Eisenlohr-Moul, 2017; Bluth et al., 2016; Marsh et al., 2018), experimental research is needed to unravel the effects of self-compassion on adolescents' stress response patterns.

While self-compassion is strongly embedded in old contemplative traditions, it is a relatively new concept in scientific research. Accordingly, different definitions have been proposed of which the ones of Neff (2003) and Gilbert (2010) are most prominent in the clinical psychology literature. Neff (2003) conceptualized self-compassion as an attitude to oneself in times of suffering, characterized by feelings of kindness, common humanity, and mindfulness. Gilbert (2010) defined self-compassion as an evolved motivational system, desire, and intention consisting of a deep wish to relieve the suffering of oneself. Taken together, self-compassion may best be understood as the combination of different cognitive, affective, and behavioral processes that address the suffering of oneself (Strauss et al., 2016).

Self-compassion has recently received increasing attention in clinical psychology research because it is assumed to positively affect mental health. Several systematic reviews and meta-analyses focusing on the role of self-compassion in adults' mental health suggest that trait self-compassion is positively related to emotional wellbeing and negatively related to (symptoms of) psychopathology (MacBeth & Gumley, 2012; Muris & Petrocchi, 2017; Zessin et al., 2015). Results of studies among adolescents (10 – 19 years) mirror those in adult samples, emphasizing the beneficial correlates of self-compassion (see the meta-analysis of Marsh et al., 2018 for an overview). Additional evidence supporting the beneficial effects of self-compassion on mental health also comes from intervention studies that aimed to train self-compassion. These "Compassion Based Interventions (CBIs)" are interventions that directly target maladaptive processes such as self-criticism and enhance adaptive processes, such as self-kindness (Germer & Neff, 2019; Gilbert, 2009). Results from a meta-analysis on the effectiveness of CBIs in adults showed positive, albeit moderate effect sizes for several outcomes (i.e., self-compassion, mindfulness, emotional wellbeing, and symptoms of depression, anxiety, and distress) (Kirby 2017). Interestingly, these effects were large for community and clinical samples, moderate for medical health samples, and not significant for university populations (Ferrari et al., 2019).

To date, intervention studies aimed at training self-compassion among samples of adolescents are limited. However, Bluth et al. (2016) performed a pilot study and found that adolescents who participated in a six-week CBI reported increases in self-compassion and life satisfaction, and decreases in depressive symptoms after the intervention as compared to adolescents on the waiting list. Results from a similar study investigating the effects of an eight-week version of the CBI program also showed significant reductions in stress symptoms, but not in anxiety and depressive symptoms (Bluth & Eisenlohr-Moul, 2017). Thus, initial evidence

suggests that self-compassion, whether it is measured as a trait or trained in an intervention, is positively related to adults' and to adolescents' mental health outcomes.

Interestingly, it is theorized that the power of self-compassion can especially be found in its underlying effects on physiological stress systems, in particular on the activity of the autonomic nervous system (Porges, 2011). When an individual is confronted with a stressful event, the sympathetic branch of the autonomic nervous system rapidly provides the body with a burst of energy by controlling several body functions (i.e., speeding up the heartbeat, increasing blood pressure, and upregulating immune systems) and triggering the threat defense systems, the so-called "fight or flight" responses. Although these defense systems are vital to survive, exaggerated or dysregulated responses are associated with an increased vulnerability to develop psychopathology (Fanselow, 1994; Goldstein, 1987; Niermann et al., 2017). The parasympathetic branch of the autonomic nervous system releases its inhibitory influences on the sympathetic system and relaxes the body (i.e., slowing down the heartbeat, decreasing blood pressure, and downregulating immune systems), which is related to the adaptive restoration of the body and long-term health (Fanselow, 1994; Thayer & Sternberg, 2006; Yaroslavsky et al., 2016). A commonly used biomarker to assess the activity of the parasympathetic nervous system, is the Heart Rate Variability (HRV) or the beat-to-beat heart rate variation (Berntson et al., 1997). In general, heightened sympathetic activity is related to low variations between subsequent heartbeats, while heightened parasympathetic activity is related to high variations between heartbeats (Dulleck et al., 2011).

A substantial body of experimental research in adults found evidence for increases in HRV - indicative of an increased activity of the parasympathetic nervous system - when self-compassion is induced or trained via a brief intervention (Arch et al., 2014; Kirschner et al., 2019; Luo et al., 2018; Petrocchi et al., 2017; Rockliff et al., 2008). These findings provide some evidence for the beneficial effects of self-compassion on physiological stress responses

in adults. However, as adolescence is a period that entails profound changes across physiological systems including the autonomic nervous system (Compas, 1987; Romeo, 2013), stress response patterns from adolescents may differ from those of adults. Moreover, cognitive abilities continue to develop during adolescence (Eccles et al., 2003; Moshman, 2020), which may facilitate engaging in self-compassion (e.g., introspection, perspective taking, and metacognition), but also poses unique risks (e.g., heightened self-consciousness, harsher self-criticism, and higher sense of isolation). As such, findings from studies in adult samples cannot be generalized to adolescence. Yet, this topic has been understudied in research with adolescents. One exception is a study by Bluth et al. (2016) who explored the impact of adolescents' trait self-compassion on several biomarkers. As compared to adolescents low in self-compassion, adolescents high in self-compassion showed lower blood pressure levels when exposed to a stress induction. However, no differences in heart rate and HRV between the low and the high self-compassion group were found. In sum, findings from this study suggest that, when adolescents are confronted with stressful events, trait self-compassion may have beneficial effects on blood pressure levels, but not heart rate and HRV levels. Studies that further examines the relationship between self-compassion and psychophysiological stress responses in adolescents are needed to underscore whether and how self-compassion may yield beneficial effects. This research may eventually inform interventions aimed at preventing heightened stress experiences during adolescence. This is important as different prevailing models of developmental psychopathology acknowledge how enduring stress responses play an important role in the etiology and maintenance of both internalizing and externalizing problems (e.g., Cicchetti & Toth, 2014; Haggerty et al., 1996).

The purpose of this experimental study is to explore the immediate effects of using a trained self-compassion technique on adolescents' stress recovery after a validated stress-induction (Fowler et al., 2017). To strengthen the findings, the use of the self-compassion

technique is evaluated on both self-reported (i.e., positive and negative affect) and physiological stress measures (i.e., heart rate and high frequency HRV) and compared with a control group. Based on the existing literature, it is hypothesized that adolescents who were trained and stimulated to use self-compassion after stress exposure would show a better stress than a control group. More specially, we expect that, adolescents in the self-compassion group would report higher levels of positive affect and lower levels of negative affect, and show a decreased heart rate and an increased high frequency HRV, as compared to the control group (Goldberger et al., 2001; Neff & Germer, 2013; Petrocchi et al., 2017) during recovery phase.

## Method

### *Participants*

A priori power analysis showed that a total sample of 42 young adolescents were needed to detect effect sizes $f \geq .20$ with a significance level of $\alpha = .05$ and a power level of $\beta = .80$. The current study is part of a large-scale research project investigating the role of emotion regulation in the prevention and intervention of psychopathology in adolescents. The first study of this project included a community sample of children and adolescents ($N = 214$) among which experienced stress was assessed using the Perceived Stress Scale (see Klosowska et al., 2020). From the larger project, participants who reported total levels of perceived stress above the sample median were invited to participate in the current study and 45% ($N = 53$) of them agreed. Among these participants, 24% ($n = 12$) had a stress score that can be considered as low, 65% ($n = 35$) had a score that can be considered as moderate, and 11% ($n = 6$) had a score that can be considered as high (See Cohen et al., 1983). Participants were between the ages of 11 and 18 ($M = 14.72$, $SD = 1.5$) and 64% of them were girls. Moreover, 96% of the participants were born in Belgium and reported Flemish as primary language. As determined with the

Hollingshead Index (Hollingshead, 1975), more than 90% of the participants belong to the middle social class. All participants attended regular education schools.

***Procedure***

All procedures performed in the current study were in accordance with the Ethical Standards of the Ethical Committee of Ghent University and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Both adolescents and parents were asked to give or withhold consent/assent for participation and adolescents were free to withdraw from participating at any time. Once informed consent was given, adolescents were randomly assigned to the self-compassion group or to the control group. The study consisted of four consecutive phases and took approximately 60 minutes.

*Phase I: Self-compassion workshop (40')*. Participants in the self-compassion group followed an individual self-compassion workshop delivered by clinical psychologists. At the start, adolescents were provided with an introduction to familiarize with trainers and the concept of emotions, followed by a short breathing exercise and practices on emotional awareness. Next, the workshop focused on psycho-education and different exercises on how to face emotions with a compassionate attitude. The workshop was developed based on existing CBIs (Bluth, 2017; Gilbert, 2009; Volkaert et al., 2020) (the script is provided in the Supplementary Materials). Participants in the control group did not receive a workshop, but were given more time to talk about emotions and familiarize themselves with the trainers, so that each group spent the same amount of time with the trainers (i.e., approximately 40 minutes). The content of the workshop for the control group was intended to account for any effect resulting from talking about emotions, but without applying any component of the self-compassion training. Immediately after Phase I, participants were seated in front of a computer and were prepared for the recording of electrocardiogram (ECG) activity during the experiment (see further).

*Phase II: Baseline (8')*. During eight consecutive minutes, participants were asked to stare at a black window. When finished, participants were immediately requested to score their subjective stress experience (T1).

*Phase III: Stress induction (5').* Participants played the Cyberball Game, a virtual ball tossing game, which was based on the paradigm used by Sandstrom et al. (2016). Participants were presented with standardized instructions on the computer screen, before entering their name and proceeding to play. The game was portrayed as merely a task that helped participants to exercise mental visualization skills. Moreover, participants were told they were to play the game with three other peers, represented by animated figures and labeled as Player 1, Player 2, and Player 3. These players, however, were computer generated and each of them passed the ball to the participant once at the beginning of the game, and then never again. The game consisted of 60 trials and lasted approximately 5 minutes. The Cyberball paradigm has been frequently used among adolescents as an effective stress induction task (e.g. Fowler et al., 2017), as it is known to elicit feelings of social exclusion and to induce physiological stress responses (e.g., Bass et al., 2014; Iffland et al., 2014; Mazzone et al., 2017; Ponsi et al., 2019). After the Cyberball, participants were asked to fill out the Need-Threat Scale for Children (see measures) and to report their subjective stress experiences.

*Phase IV: Instruction phase (5').* All participants were instructed to focus their attention on the feelings and thoughts they experienced after playing the Cyberball game. In the self-compassion group, participants were then instructed to use the learned self-compassion technique (i.e., being kind towards oneself and feeling the wish to relieve oneself from suffering), guided by a written step-by-step plan. Adolescents in the control group, who did not learn any technique, were stimulated to stay focused on the induced feelings and thoughts (i.e., by exaggerate negative thoughts, such as "How long will and can this feeling last?"), following a written step-by-step plan. The purpose of this instruction was to maintain the induced effect

and to prevent the participants from naturally regulating the induced stress. Scripts of these instructions can be found in the Supplementary Materials.

After the four phases, participants were detached from the heart rate recorder. To ensure that participants' stress state approached baseline levels by the end of the study, all adolescents were debriefed and finished the study with a relaxation exercise.

***Measures***

*The Need-Threat Scale for Children* (Deutz et al., 2013) was filled out to examine whether the Cyberball successfully induced exclusion and resulted in quantifiable social distress by measuring satisfaction levels on four fundamental needs. Example questions from this scale are "I felt excluded" (i.e., Belongingness), "I felt like the other players decided everything" (i.e., Control), "I felt invisible" (i.e., Meaningful existence), and "I felt good about myself" (i.e., Self-esteem). Participants rated 20 statements on a 7-point scale (1 = *not at all;* 7 = *very much*); subsequently, negatively formulated items were reverse coded. Mean needs-satisfaction scores were computed for each of the four needs, with lower scores indicating less need satisfaction. In the current study, the subscales showed an ω coefficient of .91 for belongingness, .90 for control, .78 for meaningful existence, and .90 for self-esteem.

*Self-reported stress responses* were assessed using Visual Analogue Scales (VAS) on which participants were asked to report their positive and negative affect on a scale from 'not at all' (1) to 'a lot' (100). As evidenced by Salahuddin et al. (2007) and Schlotz et al. (2008), self-reported positive and negative affect can serve as a subjective measure for assessing stress exposures. More specifically, participants reported in which degree they were experiencing feelings of tension, frustration, boredom, anxiety, sadness and angriness. Participants were requested to report their subjective stress experiences after baseline (T1), after the stress induction (T2), and after the instruction phase (T3).

*Physiological stress responses* were measured by heart rate (HR) and High Frequency (HF) HRV. HF-HRV reflects vagally-mediated parasympathetic activity and is a commonly used measure of HRV in the stress literature (see for example Salahuddin et al., 2007). *HR* and HF-*HRV* were assessed using ECG signals that were recorded at a sample rate of 1000 Hz with a Porti 16-channel-amplifier (TMSi) and the software Polybench 1.2. One electrode was placed on the right upper sternum, the second on the lowest rib on the left side, and the ground electrode was fixed on the dorsum of the wrist. The ECG signals were recorded throughout the baseline, the stress induction and the instruction phase and were further processed with the ANSLAB software in MATLAB (Blechert et al., 2016). R waves were automatically registered by MATLAB and artifacts were visually checked and corrected if necessary. HF-HRV was computed as the natural logarithms of the summed power spectral density between 0.23 and 0.4 Hz. The cutoffs for the frequency domains varied according to the age of the participant (Shader et al., 2018). In the adult literature, HF-HRV showed to be related to self-compassion and is known to fluctuate under conditions of (induced) stress (Luo et al., 2018; Tian et al., 2020). The mean HR and HF-HRV were calculated in 120s epochs for the baseline (2 epochs; B1 and B2), the stress induction (2 epochs; S1 and S2), and the instruction phase (2 epochs; I1 and I2). The two first and the two last epochs from the baseline, as well as the data that was recorded while reading the instructions in Phase III and Phase IV (± 60s), were excluded from analyses to increase reliability.

***Data Analyses***

Three participants from the self-compassion group were excluded due to incomplete TMSi recordings. The Little's MCAR test showed that missing items on the questionnaires (< 8%) were missing completely at random (all $p_s > .05$) and were multiple imputed using the Expectation-maximization algorithm. This method imputes missing values using maximum likelihood estimation with observed data in an iterative process. The normality of the residuals

was checked by the use of the Shapiro-Wilk test. Results revealed that the distribution of the residuals of HR and HF-HRV was normal (all $p_s > .05$), but that the assumption of normality was violated for the VAS scores (all $p_s < .05$). Therefore, a square-root transformation was used to adjust skewness in the residuals of the VAS data. Baseline characteristics were analyzed using Multivariate Analysis of Variance with group (self-compassion vs control) as the independent variable and all variables of interest reported at baseline as dependent variables. In addition, the perceived stress (PSS) scores and age were included as covariates. To explore if there were significant differences between both groups in the gender distribution, a Chi-Square test was used.

Repeated Measures Analysis of Variances were conducted for each outcome with *time* (T1, T2 and T3 for VAS data, B1, B2, S1, S2, I1, and I2 for HR and HF-HRV data) as a within factor and *group* (self-compassion vs control) as a between factor. First, it was investigated if the Cyberball successfully induced stress (i.e., manipulation check) by examining changes between the baseline (T1 for VAS data, B1 and B2 for HR and HF-HRV data) and the stress induction phase (T2 for VAS data, S1 and S2 for HR and HF-HRV data) with the use of the Test of Within-Subjects. Second, the main study hypothesis (i.e., stress recovery) was tested by examining changes from the stress induction (T2 for VAS data, S1 and S2 for HR and HF-HRV data) to the instruction phase (T3 for VAS data, I1 and I2 for HR and HF-HRV data). To reduce the risk of type I statistical errors associated with multiple testing, the Benjamini-Hochberg method was used. Tests where the original p-value was less than the associated q-values were considered significant. To further explore significant effects, post-hoc pairwise comparisons were conducted. Effects sizes are provided as partial eta squared ($n^2_p$), with a $n^2_p$ of .01 indicating a small effect, $n^2_p$ of .06 indicating a medium effect, and $n^2_p$ of .14 indicating a large effect (Cohen, 1988).

## Results

### *Descriptive statistics*

There were no significant baseline differences between the control and self-compassion group on self-reported stress parameters, nor on the physiological stress parameters HR and HF-HRV (all *p*s > .05). Furthermore, no differences in the distribution of gender, $X^2(1) = .422$, $p = .566$, age, $F(1, 3) = 1.365$, $p = .249$, $n^2_p = .028$, or perceived stress, $F(1, 27) = .903$, $p = .347$, $n^2_p = .019$ between both groups were found.

### *Manipulation check*

Consistent with the findings of Sandstrom et al. (2017), participants reported low to moderate scores on belongingness ($M = 3.67$, $SD = 1.62$), control ($M = 2.11$, $SD = 1.38$), meaningful existence ($M = 3.75$, $SD = 1.33$), and self-esteem ($M = 3.54$, $SD = 3.54$, $SD = 1.59$). These results indicate that ostracism was successfully evoked by playing the Cyberball game and participants' fundamental needs were threatened.

Furthermore, findings revealed that several self-report and physiological stress parameters changed significantly between the baseline (T1 for VAS data, B1 and B2 for HR and HF-HRV data) and the stress induction phase (T2 for VAS data, S1 and S2 for HR and HF-HRV data). An overview of the mean scores and main effects of time can be found in Table 1. With regard to the self-reported measures, findings showed an overall significant increase in frustration (+2.113, CI = [1.296, 2.929], $p < .001$) and boredom (+2.137, CI = [1.191, 3.083, -], $p < .001$), and a significant decrease in happiness (-.868, CI = [-1.287, -.448], $p < .001$). For angriness, results also showed a significant interaction effect, $F(1,48) = 8.551$, $p = .005$, $\eta^2 p = .151$, indicating that angriness only increased in the control group (1.532, CI = [.813, 2.250], p < .001), but not in the self-compassion group (.022, CI = [-.726, .771], p = .953).

With regard to the physiological stress parameters, HR increased massively from S1 to S2 (+4.916, CI = [4.050, 5.783], $p < .001$), leading to a higher HR at S2 compared to HR at B1 (-4.553, CI = [-5.848, -3.259], $p < .001$) and B2 (-4.351, CI = [-5.459, -3.243], $p < .001$). Moreover, HF-HRV significantly decreased between S1 and S2 (-.470, CI =[-.646, -.294,], $p < .001$), resulting in significant lower HF-HRV levels at S2 compared to B1 (-.362, *CI = [*-.552, -.172], $p < .001$) and B2 (-.354, CI = [-.551, -.157], $p = .001$). To summarize, the Cyberball game successfully induced stress in both groups as indicated by low need scores, increases in frustration, boredom, and HR, and decreases in happiness and HF-HRV. No significant changes from pre- to post- Cyberball were observed in self-reported tension, anxiety, and angriness, and these variables were therefore excluded from further analysis.

*<< insert table 1 >>*

***Effects of Self-Compassion on Stress Recovery***

In general, none of the time x group interaction effects were found to be significant after Benjamini – Hochberg corrections, indicating that stress recovery (i.e., time between the stress induction, T2 for VAS data, S1 and S2 for HR and HF-HRV data, and the instruction phase, T3 for VAS data, I1 and I2 for HR and HF-HRV data) did not differ between the self-compassion and the control group. However, as effect sizes were small to moderate for happiness, frustration, boredom, and HF-HRV (I1 – I2), pairwise comparisons were further conducted for exploratory purposes. Findings revealed that participants in the self-compassion group, but not in the control group, reported a significant decrease in frustration (-1.139, CI = [-2.017, -.261], $p = .012$) and boredom (-2.341, CI = [-3.514, -1.168], $p <.001$) between T2 and T3. There were no significant changes in happiness. Furthermore, HF-HRV decreased significantly between I1 and I2 in the self-compassion group (-.460, CI = [-.676 -.243], $p < .001$), but not in the control

group (-.147, CI = [-.355, .061], $p$ = .163), resulting in significantly higher HF-HRV in the control group at I2 compared to the self-compassion group (.657, CI = [.069, 1.244], $p$ = 0.26).

Despite the fact that we took into account the normative differences in breathing rates for children and adolescents, HRV was not controlled for individual breathing rates. This may be worthy to note, as the instructions from the experimental group included a short breathing exercise, whereas the instructions from the control group did not. These breathing instructions may have partially evoked group differences reflected in the HF-HRV outcome at the start of the instruction phase (i.e., first epoch). To test this proposition however, we additionally conducted a repeated measures ANOVA with the Root Mean Square of the Successive Differences (RMSSD) as an outcome. RMSSD closely represents parasympathetic activity and is highly correlated with the HF-HRV component. Results showed that RMSSD significantly decreased between I1 and I2 in the self-compassion group ($p$ = .003), but not in the control group ($p$ = .574), resulting in a significant difference in RMSSD between the self-compassion and the control group at I2 ($M_{dif}$ = -5.224, $p$ = .015). An overview of the mean scores, main effects of time, and interaction effects can be found in Table 2.

*<< insert table 2 >>*

**Discussion**

The aim of the current study was to investigate whether the use of a learned self-compassion technique could influence adolescents' stress recovery. Based on the literature in adults, it was hypothesized that trained adolescents who were stimulated to use a self-compassion technique after being exposed to a validated laboratory stress task would show a better stress recovery, as indicated by a higher increase in self-reported positive affect and HRV, and a stronger decrease in self-reported negative affect and heart rate, as compared to adolescents in the control group (Goldberger et al., 2001; Neff & Germer, 2013; Petrocchi et al., 2017).

In contrast to our hypothesis, no significant effects of the self-compassion technique were found on adolescents' physiological and self-reported stress recovery. With regard to self-reported stress parameters, it has been stated that self-compassion techniques do not primarily aim to regulate affective states, but are rather known to reduce the emotional (i.e., shame and guild) and cognitive (i.e. self-blame, defensiveness) processes that may hinder adaptive emotion regulation (Terry & Leary, 2011). Thus, one may argue that the current measurements were not sufficient to capture strong differential effects on emotional and cognitive processes, if they exist. It is for example possible that the VAS scales did not reflect changes in the specific positive emotions triggered by the use of self-compassion techniques, such as contentment, joy, and compassion. Moreover, it is stated that a self-compassionate attitude may facilitate the experiences of positive affect through the acceptance of negative affect (Neff & Germer, 2013). As such, it is possible, although not conclusive, that adolescents in the self-compassion group successfully became aware of and accepted induced negative affect, resulting in the lack of significant between-group effects on the self-reported stress parameters. In light of this view, it also should be noted that the instructions in the self-compassion group and in the control group were somewhat alike. In both groups, attention was first drawn to the induced feelings, which is a core component of emotional awareness. Emotional awareness refers to the identification, explanation, and discrimination of emotional experiences (Lane & Schwartz, 1987) and is showed to be inversely related to maladaptive stress responses (Flynn & Rudolph, 2010). Williams et al. (2015), for example, found that emotional awareness is related to variations in HRV more than other emotion regulation skills. Thus, the fact that the same instructions were used in both groups may also be (partially) responsible for the lack of significant between-group effects.

With regard to physiological stress responses, the current findings question the idea that (shortly trained) self-compassion techniques have beneficial effects on adolescents

physiological stress responses, as it has instead been found in the adult literature (Arch et al., 2014; Kirschner et al., 2019; Luo et al., 2018; Petrocchi et al., 2017; Rockliff et al., 2008). Several explanations within a developmental framework can be considered. First, it may be speculated that adolescents' physiological responses are different from the ones of adults when they try to (adaptively) cope with stress and other emotions. In line with this view, it is acknowledged that adolescents' biological systems are configured differently as compared to adults (see for example Ernst et al., 2006). For example, studies have indicated that stress-sensitive brain areas, such as the limbic and cortical systems, and regulatory brain areas, such as the prefrontal system, are continually maturing throughout adolescence (Giedd & Rapoport, 2010; Romeo, 2013; Romeo et al., 2006). Although there is a lack of studies comparing adolescents' and adults' responses while experimentally learning or instructing emotion regulation competencies, prior studies also suggested that the maturation of certain brain regions may explain developmental differences in emotion reactivity and regulation (e.g., De Witte et al., 2017; McRae et al., 2012; Silvers et al., 2017).

Second, it may be the case that especially adolescents need a more prolonged and extensive training in a safe environment in order to change the automatic mental habits that make a compassionate attitude possible. It has been suggested that adolescents show higher self-consciousness and are more egocentric than adults (Frankenberger, 2000; Schwartz et al., 2008). Therefore, it is possible that this age group has more difficulties to reflect objectively on and distance themselves from their own suffering, which may complicate the appliance of being fully aware without being overly reactive. Additionally, it has been widely evidenced that adolescents are highly sensitivity to negative evaluations (Gullone & King, 1997), and one can assume that participants in the self-compassion group may consider the instruction phase as an evaluative moment of the skills learned in the workshop. In line with this thought, Porges (2017) emphasized that especially self-compassion techniques must be performed in a safe (non-

evaluative) environment; if they are not, their use may be ineffective, and even promote the activation of defense systems. This statement may also explain why in the self-compassion group HRV tended to decrease during stress recovery, which may even indicate poorer stress recovery as compared to the control group.

Although it was not the scope of our study, it is worth noting that the current results also yielded a significant time-by-group interaction during the induction phase. In particular, findings showed that adolescents in the self-compassion group became less angry than adolescents in the control group while playing the Cyberball game. Although not instructed, it is possible that adolescents who learned the self-compassion technique before the experiment faced the stress-eliciting game with a compassionate attitude. As evidenced by Fresnics and Borders (2017), self-compassion may negatively be related to feelings of anger because it reduces negative thinking, perceived injustices, and images about revenge. It is also possible that adolescents in the self-compassion group experienced increased feelings of affiliation and kindness towards the other (computer-generated) players while playing the Cyberball game, which kept them from getting angry. Despite compassion towards others was not the aim of the brief self-compassion workshop in the current study, self-compassion is directly related to feelings of kindness for others and the belief that all people make mistakes and are worthy of compassion (Neff, 2003). In line with this idea, Hutcherson et al. (2008) showed for example that a few-minutes compassionate meditation was sufficient to increase adults' feelings of social connectedness and positivity towards strangers.

**Limitations and Future Research**

The results of the present study should be viewed in light of a number of limitations. First, it should be emphasized that the current study was designed to have adequate power to detect medium effects, which is consistent with prior studies among adults (e.g., Kirschner et

al., 2019). However, effect sizes were rather small and failed to reach significance, so replication in larger samples designed to also detect small effects seems desirable before strong conclusions can be made. Additionally, it should be acknowledged that small samples have a higher risk to over-estimate the magnitude of effects, or yield false negative results (Hackshaw 2008). Furthermore, it is possible that sample characteristics such as age, gender and trait self-compassion affected the results, but due to the lack of power and assessment, these possibilities were left unexplored. Despite the paucity of research on the development of self-compassion in childhood and adolescence, Bluth et al. (2017) examined age and gender differences in trait self-compassion in a large sample of adolescents between 11 and 19 years old. Their findings suggested that young females have the highest levels of self-compassion, whereas older females have the lowest levels of self-compassion, and that male adolescents have similar levels of self-compassion across age. Furthermore, research showed that related constructs such as self-reflection, self-consciousness, and perspective-taking abilities increase during adolescence (Cole et al., 2001) and that female adolescents tend to be more self-consciousness compared to their male peers (Hyde et al., 2008). Therefore, it can be expected that learning self-compassion is more complicated for boys and older adolescents. Evaluating the (different) effects of learning self-compassion techniques on adolescents' stress responses in a larger sample and using rigorous design will be an important avenue for future research.

Another important limitation to consider is the absence of a manipulation check in the instruction phase. Although participants were guided by a written step-by-step plan, it is unclear whether a neutral versus self-compassionate attitude was induced successfully or whether or not some participants have used their habitual ways to regulate the induced affect. Further research needs to clarify the effects of the core self-compassion technique by considering the inclusion of a waiting group and a more active control group, in which adolescents are for example learned and instructed to use cognitive reappraisal (see for example Hessler-Kaufmann

et al., 2020). Furthermore, future research may consider to strengthen the manipulation check in the induction phase, by for example asking participants whether or not they already used the learned (self-compassion) technique.

The current findings revealed that learning and using a self-compassion technique may have different effects on physiological stress measures as opposed to effects on self-reported stress measures. In line with these findings, correlation-analysis indicated that there were no noteworthy relationships between the physiological and the self-reported stress parameters (all *p*s > .05). Previous research also suggested that there may exist rather small associations between physiological and self-reported stress measures among adolescents (e.g. Evans et al., 2013; Zijlmans et al., 2013). It will be a challenging research avenue for further research to compare the relationships between adolescents' self-reported and physiological stress measures across different stressful events.

### *Conflict of Interest*

Authors declare that they have no competing interests.

### *Ethics Statement*

All procedures performed in current study were in accordance with the ethical standards of the ethical committee of Ghent University and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

### *Informed Consent*

Both adolescents and parents were asked to give or withhold consent/assent for participation and adolescents were free to withdraw from participating at any time.

### *Authors Contributions*

BV designed and executed the study, analyzed the data, and wrote the manuscript. SV was involved in preparation of the funding proposal, design of the study, and provided advice and editing of the final manuscript. TDB contributed to the data collection and delivered self-compassion workshops to the participants. NM was involved in preparation of the funding proposal, design of the study, assisted with the data analyses, and collaborated in the writing and editing of the final manuscript. CB was involved in preparation of funding proposal, design the study, monitored the study implementation, and provided advice in writing the manuscript.

### *Data Availability*

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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**Table 1.** Mean scores for the stress outcomes by the function of time (baseline and stress induction) and condition

| | Group | B (T1) | S (T2) | *P*(T) | $\eta^2p$ |
|---|---|---|---|---|---|
| **Tension** (0-100) | Self-compassion | 14.42 (3.88) | 13.63 (3.76) | *.295* | *.023* |
| | Control | 20.00 (5.33) | 18.54 (5.60) | | |
| **Frustration** (0-100) | Self-compassion | 5.21 (2.50) | 17.54 (4.08) | <.001* | .361 |
| | Control | 3.50 (1.30) | 21.42 (5.34) | | |
| **Boredom** (0-100) | Self-compassion | 11.79 (3.52) | 31.38 (5.35) | <.001* | .301 |
| | Control | 16.62 (4.91) | 31.15 (5.62) | | |
| **Anxiety** (0-100) | Self-compassion | 3.21 (1.17) | 2.54 (1.52) | .146 | .043 |
| | Control | 1.96 (.601) | 1.46 (.484) | | |
| **Sadness** (0-100) | Self-compassion | 3.54 (1.38) | 2.08 (.98) | .803 | .001 |
| | Control | 4.58 (1.95) | 7.5 (2.85) | | |
| **Angriness** (0-100) | Self-compassion | 1.88 (.84) | 2.13 (1.05) [a] | .004* | .159 |
| | Control | 1.23 (.46) | 10.73 (4.06) [a] | | |
| **Happiness** (0-100) | Self-compassion | 65.17 (4.49) | 54.92 (4.32) | <.001* | .265 |
| | Control | 72.88 (5.21) | 59.12 (6.17) | | |

| | | B1 | B2 | S1 | S2 | *P(T)*** | $\eta^2p$ |
|---|---|---|---|---|---|---|---|
| **HR** (bpm) | Self-compassion | 78.49 (1.83) | 78.57 (2.03) | 78.82 (2.49) | 83.80 (2.32) | B1 <.001* | .510 |
| | Control | 78.37 (2.16) | 78.70 (2.07) | 77.31 (1.97) | 82.16 (2.07) | B2 < .001* | .565 |
| | | | | | | S1 < .001* | .731 |
| **HF-HRV** (ln ms²) | Self-compassion | 7.20 (.17) | 7.09 (.18) | 7.21 (.17) | 6.72[b] (.18) | B1 <.001* | .375 |
| | Control | 7.51 (.18) | 7.60 (.18) | 7.71 (.19) | 7.26[b] (.18) | B2 < .001* | .213 |
| | | | | | | S1 < .001* | .375 |

*Note:* HR = heart rate, HF-HRV = high frequency heart rate variability, B = baseline, S = stress induction, *P*(T) = p-value for the main effect of time, * significant according to B-H correction, ** significant p-values compared to S2, Groups with identical superscript letters are significantly different from each other ($p \leq .05$)

**Table 2.** Mean scores for the stress outcomes by the function of time (stress induction and instruction phase) and condition

| | **Group** | **S (T2)** | | **I (T3)** | | ***P (T)*** | $\eta^2p$ | ***P (CxT)*** | $\eta^2p$ |
|---|---|---|---|---|---|---|---|---|---|
| **Frustration** (0-100) | Self-compassion | 17.54 (4.08) | | 10.00 (3.55) | | .023 | .103 | .162 | .040 |
| | Control | 21.42 (5.34) | | 17.62 (4.73) | | | | | |
| **Boredom** (0-100) | Self-compassion | 31.38 (5.35) | | 14.08 (4.14) | | < .001* | .262 | .104 | .054 |
| | Control | 31.15 (5.62) | | 20.92 (4.20) | | | | | |
| **Happiness** (0-100) | Self-compassion | 54.92 (4.32) | | 59.71 (4.66) | | .435 | .013 | .449 | .012 |
| | Control | 59.12 (6.17) | | 59.19 (6.14) | | | | | |

| | **Group** | **S1** | **S2** | **I1** | **I2** | **P(T)**** | $\eta^2p$ | ***P (CxT)*** | $\eta^2p$ |
|---|---|---|---|---|---|---|---|---|---|
| **HR** (bpm) | Self-compassion | 78.82 (2.49) | 83.80 (2.32) | 83.88 (2.24) | 85.16 2.27) | S1 < .001* | .747 | .957 | .000 |
| | Control | 77.31 (1.67) | 82.16 (2.07) | 81.87 (2.13) | 83.60 | S2 = .002* | .179 | .936 | .000 |
| | | | | | (2.12) | I1 < .001* | .306 | .549 | .008 |
| **HF-HRV** (ln ms²) | Self-compassion | 7.21 (.17) | 6.72[b] (.18) | 6.97 (.23) | 6. 51[c] (.24) | S1 <.001* | .381 | .476 | .011 |
| | Control | 7.71 (.19) | 7.26[b] (.18) | 7.32 (.16) | 7.17[c] (.17) | S2 = .100* | .056 | .545 | .008 |
| | | | | | | I1 < .001* | .256 | .041 | .084 |

*Note:* HR = heart rate, HF-HRV = high frequency heart rate variability, , S = stress induction, I = instruction phase, *P*(T) = p-value for the main effect of time * significant according to B-H correction, ** = significant p-values compared to I2. Groups with identical superscript letters are significantly different from each other ($p \leq .05$)

**Supplementary Material: scripts of the instructions in the self-compassion condition and in the control condition.**

The self-compassion instruction was as follows: “Close your eyes and take a few deep breaths to allow yourself to relax. Let’s try to check in with how you are feeling. Try to feel clearly which emotions you have and write them down. Try to observe how strong these emotions are and indicate their intensity on the thermometer. Take some time to figure out where you feel these emotions in your body right now. You can draw what you notice on the template below. You might find you aren’t actually sure, but it is ok to feel like that. Acknowledge that you can be proud of yourself for confronting your emotions, whatever emotions you are having right now. Try to watch yourself from an outsiders’ view and imagine what you look like right now. Write this down from the perspective of an engaging viewer. Let’s now try to be kind and loving for yourself. Try to approach yourself with those special feelings of empathy and kindness, just like you would have looking to your best friend when he or she is upset. Then take some time to signalize that you are here for yourself. That you love yourself unconditionally, and that is it ok to feel like that. It may help to say loving sentences or to let yourself know that you are here to help. You can write down the sentences that may help you on the template. If it feels comfortable, you may suit yourself by putting a hand on your shoulder or give yourself a friendly smile. Take your time to do so. If you are ready, you can say goodbye to yourself in this situation and signalize the researcher.”

Based on Volkaert, B., Van Beveren, M. L., & Wrzesien, M. (2020). Op compassie gebaseerde interventies bij adolescenten. In C. Braet, & S. Bögels (Eds.), *Protocollaire behandelingen voor kinderen en adolescenten met psychische klachten* (pp. 349-385). Boom.

The control instruction was as follows: “Close your eyes and think about the game you just played. Let’s try to check in with how you are feeling. Try to feel clearly which emotions you have and write them down. Try to observe how strong these emotions are and indicate their intensity on the thermometer. Take some time to figure out where you feel these emotions in your body right now. You can draw what you notice on the template below. How long do you think these emotions will last? (write down) Why do you think that? (write down) Think about other situations where you experienced similar emotions. What happened? (write down) How long did you experienced these emotions? (write down). Which thought did you have back then? (write down). Take your time to think about the game and these questions. If you are ready, you can signalize the researcher.

Based on Volkaert, B., Wante, L., Van Beveren, M. L., Vervoort, L., & Braet, C. (2019). Training Adaptive Emotion Regulation Skills in Early Adolescents: The Effects of Distraction, Acceptance, Cognitive Reappraisal, and Problem Solving. *Cognitive Therapy and Research*, 1-19.