RUNNING HEAD: MATERNAL PROXIMITY-SEEKING DURING STRESS

The Effects of Children's Proximity-seeking to Maternal Attachment Figures During

Mild Stress Exposure on Mood and Physiological Responses: An Experimental Study

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Abstract

In this study we investigated the effects of seeking versus avoiding proximity to mother on children's emotional recovery from a stressor. Sixty children ages 9 to 12 years underwent a mood-induction procedure and were randomly assigned to seek proximity from or avoid an image of their mothers. The effect of this manipulation on children's self-reported negative emotions, skin conductance and heart rate variability (respiratory sinus arhythmia) was assessed. Higher levels of attachment anxiety were linked to more self-reported sadness when children had to avoid mother, but no evidence for such an effect was found on a physiological level. For avoidant attachment, a similar pattern of results emerged, but both for self-reported sadness and skin conductance.

Keywords: attachment, proximity-seeking, avoidance, stress, emotion regulation, middle childhood

The Effects of Children's Proximity-seeking to Maternal Attachment Figures During Mild Stress Exposure on Mood and Physiological Responses: An Experimental Study

Adequate regulation of stress-related emotions in middle childhood is crucial for mitigating the negative impact of stressors on current and future adjustment (Compas, Connor-Smith, Saltzman, Thomsen, & Wadsworth, 2001). The quality of the parent-child attachment relationship is one factor explaining children's emotion and its regulation (e.g., Bowlby, 1969). Children vary in their likelihood of seeking attachment figures' proximity during distress, which in turn affects successful regulation of negative emotions (e.g., Bowlby, 1969). During middle childhood, the greater demand for autonomous exploration requires more sophisticated abilities for intentional proximity-seeking toward attachment figures (Kerns, 2008), but surprisingly little is known about the regulatory effects of such behavior. Here we explore the effects of proximity-seeking versus avoidance of caregivers on school-age children's emotion regulation (ER) in terms of their emotional recovery from distress. Specifically, we test the hypothesis that the extent to which approaching or avoiding mother regulates distress is a function of their attachment with respect to the mother.

Emotion Regulation

Emotions are experienced and expressed through changes in both experiential and physiological response systems, and ER can influence one or more of these components (Dewitte, De Houwer, Goubert, & Buysse, 2010). Due to a frequent lack of correspondence between these different levels (e.g., Dewitte et al., 2010), it is important to study ER using multiple methods. On an experiential level, responses to stressors can be captured via changes in the subjective experience of negative, so-called stress–emotions (Lazarus, 1999), such as anxiety and sadness (hereafter referred to as 'negative emotions'). Negative emotions increase in response to distress, and subsequently decline thanks to different emotion regulation strategies children acquire throughout development (e.g., Compas et al., 2001).

On a physiological level, markers of autonomic nervous system (ANS) activation index the extent to which a stressor results in the mobilization of a physiological response to stress. Both the sympathetic branch (SNS) and the parasympathetic branch (PSNS) of the ANS participate in the stress-response (Porges, 2001). Consequently, both SNS- and PSNS-activity need to be measured when studying emotion in autonomic space (Berntson, Cacioppo, & Quigley, 1991). In the current study, participants' skin conductance (SC), and respiratory sinus arrhythmia (RSA), a heart rate variability (HRV) index, were assessed.

Increases in SC occur due to an increase in SNS activation during distress (see Zisner & Beauchaine, 2016). SC refers to the electrodermal activity of the skin resulting from sweat gland activation. These sweat glands are controlled by the SNS, so emotional arousal activates sweating that consists of water and electrolytes. Water and electrolytes increase electrical conductivity and lower the electrical resistance of the skin. This can be measured as increases in SC. Consequently, SC levels increase when individuals are exposed to emotionally arousing stimuli. Once the arousal or the distress is regulated, SC decreases to a baseline state.

RSA reflects PSNS influences on the heart (i.e. control over sympathetic nervous system). Polyvagal theory (Porges, 2007) provides a neurovisceral model that has been used to link RSA and attachment (Porges, 2011). Although high vagal activity (RSA), which reflects the action of the parasympathetic nervous system, is considered a marker of successful emotion regulation and stress adaptability (e.g., Thayer, Åhs, Fredrikson, Sollers, & Wager, 2012), Porges (2007) has proposed that vagal withdrawal during stress (i.e., decrease in RSA) may also be an adaptive response to prepare adequately for a challenging or stressful task (i.e., increased arousal). A decrease in RSA (withdrawal) reflects attention to threat (Porges, 2007), whereas an increase in RSA would be related with emotion regulation, specifically in social contexts (Butler, Wilhelm, & Gross, 2006). The results of some studies suggest that parasympathetic withdrawal during laboratory tasks reflects an adaptive response

to challenge, whereas others suggest that excessive parasympathetic withdrawal is indicative of dysregulation (Beauchaine, 2015). As proposed by Clark and colleagues (2016), polyvagal theory suggests that in safe interpersonal environments, high parasympathetic activity is related to increased social engagement, whereas excessive parasympathetic withdrawal may reflect greater physiological arousal and an anxious or defensive stance. Studies examining associations between attachment and RSA have found that greater use of behavioral coping strategies in securely attached children (i.e. positive social engagement that uses the mother as a secure base) was related to higher RSA (Bazhenova, Plonskaia, & Porges 2001; Skowron et al., 2011). However, the literature linking attachment style to parasympathetic reactions to stressors is mixed (e.g., Smith, Woudhouse, Clark & Skowron, 2016), potentially because this association may be dependent on developmental stage and/or the presence or absence of incentives to regulate emotions.

Attachment, Proximity-seeking, and Emotion: Theoretical Background

Accumulating evidence suggests that attachment is an important factor linked with middle childhood ER (e.g., Borelli, Crowley, David, Anderson, & Mayes, 2010; Colle & Del Giudice, 2011; Contreras, Kerns, Weimer, Gentzler, & Tomich, 2000; Kerns, Abraham, Schlegelmilch, & Morgan, 2007). From birth onward, distress activates proximity-seeking behavior in the service of eliciting protection from the caregiver (Cassidy, 1994). Depending on the child's history of attachment experiences, individual differences in the use of proximity-seeking behavior arise (Bowlby, 1969; Cassidy, 1994). When proximity-seeking consistently resolves distress – typical for children with secure attachment (Sroufe & Waters, 1977a) – the child's threshold for curbing exploration in order to engage in proximity-seeking increases; as a result, his/her ability to explore the environment and cope with distress grows (see Kandel, 1999). Thus, over time, secure children's need to seek proximity during mild stress decreases as they develop confidence in the fact that their attachment figures will be

available to them should threat increase. Conversely, when children's proximity-seeking does not consistently resolve distress – typical for children with insecure attachment (Sroufe & Waters, 1977a) –, their need to seek proximity may be persistently activated, and their threshold for engaging in exploration will be higher (Cassidy, 1994; Main, Kaplan, & Cassidy, 1985). In such a case, two alternative attachment strategies, attachment avoidance and anxiety, are possible (see Cassidy, 1994). Anxious children intensify and sustain proximity-seeking as an attempt to get attention from an inconsistently-responsive attachment figure (see Cassidy, 1994). Avoidant children suppress proximity-seeking as an attempt to avoid further alienation from or banishment by an attachment figure who consistently dismisses their emotion expression and proximity-seeking. Differences in proximity-seeking strategies during stress then instantiate differcenes in ER efficacy.

Middle childhood attachment is indeed linked to different (mal)adaptive developmental outcomes through differences in the strategies used to regulate distress (Brumariu, 2015). Securely attached children more quickly seek their mothers' support during distress (Bosmans, Braet, Heylen, & De Raedt, 2015) resulting in protecting against the adverse effects of distress (Dujardin et al., 2016). Note, however, that these children need less maternal proximity in mildly distressing circumstances (Dujardin, Bosmans, De Raedt, & Braet, 2015) and over time become increasingly competent in solving problems autonomously (Koehns & Kerns, 2016). This pattern suggests that securely attached children adequately regulate mild distress autonomously, but can benefit from the ER effect of proximity-seeking when distress is more substantial (Koehns & Kerns, 2016).

Children reporting higher levels of attachment anxiety and avoidance wait longer to seek support during a significant stressor (Dujardin et al., 2016). Instead, more anxiously attached children hyperactivate their emotion, relying, for example, on rumination about negative affect (Brenning, Soenens, Braet, & Bosmans, 2012). More avoidantly attached

children react in a more emotionally deactivating way, relying, for example, more on emotional suppression (Brenning et al., 2012). These so-called secondary emotion regulation strategies are thought to be adaptive in terms of ensuring caregivers' investment but confer risk for maladjustment over the long run (Borelli, Ho, & Epps, 2017). Although documentation of the link between attachment and children's ER strategies is increasing in this middle childhood age range (Brumariu, 2015), much less is known about the direct impact on ER of proximity-seeking versus avoiding attachment figures.

Nevertheless, ER research in other stages can inform hypotheses. In infant research using the Strange Situation Procedure (SSP, Ainsworth, Blehar, Waters, & Wall, 1978), Sroufe and Waters (1977b) found that during the reunion, only securely attached infants showed physiological recovery from stress, whereas anxious and avoidant infants' physiological reactivity remained elevated. For anxious infants, this finding was congruent with the behavioral observation that they seemed unable to be comforted by contact with the mother. In contrast, for avoidant infants, this finding seemingly contradicted their behavioral appearance of recovery, as indexed by their tendency to avoid proximity and resume exploration during reunion. In addition, research revealed that for more anxiously attached adults, both presence and absence of an attachment figure are linked with equally high levels of psychophysiological arousal after exposure to distress (Dewitte et al., 2010).

These studies point to a moderating role of individual differences in (in)secure attachment on the effect of approaching versus avoiding the mother during distress. Thus, for securely attached children, proximity-seeking may be a more effective ER strategy than avoidance, except after exposure to mild distress. For insecure children, the relative advantage of approaching versus avoiding mother during distress might present differently for both insecure attachment styles depending on the experiential versus psychophysiological level of analysis. More anxiously attached children are more motivated to heighten or emphasize the

relevance of the attachment relationship (Cassidy, 1994). Therefore, anxious children may report more ER benefit at the experiential level from approaching mother. However, at the level of psychophysiology, Sroufe and Waters' (1977b) and Dewitte et al.'s (2010) research suggests that approaching versus avoiding mothers might have little impact for anxious children. Instead, avoidantly attached children minimize their negative emotions and to dismiss the importance of the attachment relationship (Cassidy, 1994). Therefore, one could predict little impact of approaching versus avoiding the mother on the experiential level. However, at the level of psychophysiology, Sroufe & Waters' (1977b) research suggests that more avoidantly attached children might benefit significantly less from avoiding their mother.

To date, only one study has examined school-age children's ER in response to proximity-seeking. Borelli and colleagues (2016) exposed children to a mild stressor and asked whether the children desired to be reunited with their mothers. The variable of interest was children's RSA reactivity following this invitation to reunite. Immediately after this invitation, more insecurely attached children displayed increased RSA levels. These authors argued that for these children, reunions might lead to emotional relief due to their uncertainty regarding their attachment figures' responsiveness to their needs in a crisis. This study was limited by only examining the association between the opportunity to engage in proximity-seeking and children's physiology, rather than exploring the physiological impact of proximity-seeking versus avoidance. In addition, because traditional attachment observation paradigms rely only on children's preferential coping strategy (e.g., Sroufe & Waters, 1977b), it is impossible to use these paradigms to investigate what the effect of the opposite strategy is on children's ER and whether these effects depend on their attachment.

Current Investigation

We exposed children to a mild stressor, after which they were randomly assigned to one of two conditions: the approach (i.e. proximity-seeking) or avoid (i.e. proximity-avoiding)

conditions, in which they approached/avoided pictures of maternal attachment figures, which we accomplished using an Approach-Avoidance Task (AAT; Rinck & Becker, 2007). In each AAT trial, participants respond to a stimulus presented on a computer screen by pulling a joystick toward them (approach) or pushing it away (avoid). These movements lead to an increase or decrease in size of the picture, respectively. Thus, both a motor action and visual impression of approach/avoidance is created. In support of the emotional relevance of this experimental manipulation, prior research has shown that asking individuals to approach faces significantly increases the implicit appreciation of these faces (Woud, Becker, & Rinck, 2008). Moreover, this paradigm has been used successfully with children in this age range to manipulate approach and avoidance behavior (e.g., Huijding et al., 2009).

In the current study, we focus on behavior toward mother, because the mother-child attachment relationship can be considered the primary learning context for the development of ER (see Field, 1994) and is the most important attachment relationship in middle childhood (Kerns et al., 2007). As our theoretical model assumes that the ER effects of avoidance versus approach depend on children's anxiety and avoidance, we test interaction effects between condition (approach versus avoidance) and children's self-reported insecure attachment styles on children's change in levels of distress both at the experiential level (self-reported negative emotions) as well as at the psychophysiological level (Skin Conductance and RSA).

Method

Participants

Sixty Caucasian children (30 boys, 30 girls) from the general population, all of whom lived with their biological mothers, participated in the study (age range = 9 to 12; M_{age} = 10.47, SD_{age} = 1.05). Most (80.0%) lived with both parents, who had a post-high school or technical degree or higher (81.6% and 68.3%, respectively).

Procedure

Participants were recruited by distributing flyers in the 4th, 5th, and 6th grades of elementary schools and in scouting troops. From responding parents (13%), 60 children and their mothers were randomly selected based on power analyses showing that 54 cases were required to achieve a power of .95 to find a medium to large effect at the level of the condition X attachment interaction. Children and their mothers were invited to the laboratory and provided informed assent/consent to participate.

First, physiological measurement equipment was applied to the child. Next, mothers left the room while children completed a series of questionnaires. Children completed a resting baseline task – they were asked to stay seated and relax while watching a nature video. The experimenter explained the AAT and children completed a practice round. Next, to induce mild stress and negative emotions, children watched a (80 sec) 7 p.m. news item on the floods in Pakistan in 2010 which discussed children's distress due to this disaster. Children were randomly assigned to one of two AAT conditions . To assess changes in children's experienced negative emotions during the stress-induction and the AAT, at three time points during this procedure, children's self-reported sadness and anxiety were measured: (1) after the baseline/before the mood-induction (Emotion 1), (2) after the mood-induction/before the AAT (Emotion 2), and (3) after the AAT (Emotion 3). Similarly, to assess changes in physiology during the stress induction and the AAT, average scores for SC and HRV were calculated (details see below) for, (1) the final minute of the baseline (Physio 1), (2) the final minute of the mood induction video (Physio 2), (3) the first minute of the AAT (Physio 3), and (4) the final minute of the AAT (Physio 4).

We analyzed the first and last minutes of the AAT because we were concerned that the delay between the end of the mood-induction video and the start of the AAT would create noise in the data due to variation in duration. By measuring data from the start of the AAT,

we ensured greater standardization across participants. However, we also conducted analyses comparing physiological parameters at the end of the mood induction and the end of the AAT and the conclusions were identical. The AAT duration ranged between 3 and 9 minutes. After the AAT, children watched a joyful fragment on the first birthday of a baby elephant in a local zoo as a mood repair. Our records suggest that for the sample as a whole, the separation lasted approximately 90 minutes. Following the separation, researchers debriefed dyads and compensated them. The procedure (Figure 1) was approved by the university's Ethical Board.

Measures

Approaching versus avoiding mother. During the Approach-Avoidance Task (AAT, Rinck & Becker, 2007) single stimuli are presented on a computer screen. The participants' task is to respond as quickly as possible to each stimulus by either pulling or pushing a joystick, resembling an approach and avoidance motor action, respectively. When the joystick is pushed away, the picture shrinks, and when pulled, the picture grows until it fits the screen. This 'zooming' effect creates the visual impression that pictures come closer upon pulling and move away upon pushing the joystick, reinforcing the impression of approach and avoidance of the stimulus, respectively. In an unpublished study ($n = 60$, $M_{age} = 11$ years, 33 boys), Bosmans, Rinck, Braet, and De Raedt (2009) found children more quickly pull mothers closer compared to unfamiliar women and more quickly push unfamiliar women away compared to mothers. This suggests that, on average, children are more likely to pull mother closer and less likely to avoid her; we suspect that the pulling behavior can be seen as an attachment-relevant indicator of approach and the pushing behavior can be seen as an indicator of avoidance.

In the current study, pictures of mother and unfamiliar women were presented at the center of a CRT computer screen (1024x768 pixels). Pictures were either black-and-white or sepia colored. Children were instructed to push the joystick away when the picture was black-

and-white and to pull it toward them when the picture was sepia colored. When they moved the joystick in the correct direction, the picture disappeared from the screen. Thus participants were forced to make the correct response before proceeding to the next trial. This information was also included in the instructions. To go to the next trial, participants had to return the joystick to the middle position and press the trigger button with their index finger. Participants used their dominant hand during the entire task.

Children were randomly assigned to one of two conditions. By manipulating the color of the presented pictures (sepia versus black-and-white), the AAT was designed so that in the approach condition, children had to approach 90% and avoid 10% of mother pictures, and vice versa for unfamiliar women. In the avoidance condition, children had to avoid 90% and approach 10% of mother pictures, and vice versa for unfamiliar women. The pictures of unfamiliar women were added so that children had to make an equal amount of approach (50%) and avoidance (50%) movements in each condition. Therefore, in each condition, children were equally often presented with pictures of an unfamiliar women and with their own mother.

For the AAT, the experimenter took a picture of mother. Pictures of 10 different unfamiliar mothers were used to control for possible effects of attractiveness or resemblance to mother or others. All pictures were taken in front of a neutral background and all women were asked to display a neutral facial expression with closed lips, as has been done in prior research (e.g., Bosmans, De Raedt, & Braet, 2007; Bosmans, Rinck, et al.,, 2009; Bosmans et al., 2017), to reduce variability across photographs. To accommodate the zoom-function, seven sizes of each picture were created, with pixel sizes of 37x57, 58x88, 90x136, 140x210, 216x324, 333x499, and 513x768. Each picture was presented in size 140x210 pixels and decreased or increased in size in three steps.

During the practice phase of the AAT, the experimenter first explained the task to the child, the child was asked to repeat the instructions, and completed 11 practice trials with pictures of unfamiliar women. Next, children completed two blocks of 80 trials. In between both blocks, children were given the opportunity to have a short break.

Self-reported negative emotions. At each time point, children rated their current level of each emotion using two Visual Analogue Scales (VAS). Each VAS consisted of a 10-cm line with the labels 'not at all' and 'very much' at the extremes. Children were asked to mark the position on the line that best reflected their current answer on the questions 'I feel fearful' and 'I feel sad'. Their score on each question was calculated as the distance, in mm, from the beginning of the line to the marked position (range: 0-100 mm).

Physiological measures. SC and RSA were continuously registered using Dream® technology (Medatec Dream conductance amplifying and measuring module, Medical Data Technology, Brussels, Belgium), at a sampling rate of 200 Hz.

Skin conductance. SC was registered with an exosomatic alternating current (AC) method with constant current (1, 5, or 25 µA, periodically adapted depending on the individual's measured base impedance to optimize resolution), using two reusable 8 mm circular snap style Ag-AgCl electrodes (SE-35, J&J Engineering) embedded into a hook and loop fastener. The electrodes were applied to the volar (palmar) side of the medial phalanges of the middle- and index finger of the non-dominant hand using a salt- and chloride-free, hypoallergenic electrolyte paste (Spectra® 360 electrolyte gel, Parker Laboratories, Inc.). Based on the continuous SC signal, an average SC score was calculated for the four required one-minute epochs (Physio 1, 2, 3, and 4), representing the participant's average level of SNS-activity during these epochs (Zisner & Beauchaine, 2016).

Heart rate variability. Participants' heartbeat signals were registered using three disposable auto-adhesive surface Ag/AgCl electrodes with a circular uptake area of 16 mm

(H93SG, Kendall™, Arbo™). Two electrodes were applied beneath the left and right clavicle, and one reference electrode under the cranial bones behind the ear. Before applying the electrodes, these areas were pre-treated with Nuprep™ abrasive ECG/EEG skin prepping gel. A heart period (HP) series was derived for the whole test procedure, using PSPHA software (De Clercq, 2008) for automatic detection of R-wave timing, and for artifact detection and -correction. For artifact detection, the PSPHA algorithm automatically detects each inter-beat-interval (IBI) which deviates more than 30% from the preceding and consecutive IBIs. Artifacts were manually corrected in PSPHA. In some areas, however, R-peaks could not be correctly detected and manually corrected due to disturbance in the signal. IBIs in these areas were estimated using the very low correction level in Kubios HRV 2.1 software (Tarvainen & Niskanen, 2012). This level detects all IBIs that deviate more than 0.45 sec from the mean, allowing the estimate of the IBIs in these 'disturbed areas' without making changes to the manually defined intervals. Based on these cleaned HP-series, as a measure of RSA, the high frequency (HF) HRV-component was calculated in Kubios for the same one-minute epochs as for SC, by means of spectral analysis of the frequency components of HRV using fast Fourier transformation (FFT), and -following the recommendations of the Task Force of the European Society of Cardiology and The North American Society of Pacing and Electrophysiology (1996)- measured in absolute power (ms^2). The RSA-band was defined at all spectral power $\geq$ 0.23 (with the upper boundary set at 1.0 Hz), in order to capture both common respiratory rates within the current study's age group (Wallis, Healy, Undy, & Maconochie, 2005) and potentially high respiratory rates in response to stress (Zisner & Beauchaine, 2016).

Attachment. The participants completed a child version of the Experiences in Close Relationships Scale-Revised (Brenning, Soenens, Braet, & Bosmans, 2011), in which they reported on their relationships with their mothers. The measure assesses attachment anxiety (18 items; e.g., I worry about being abandoned), and avoidance (18 items; e.g., I prefer not to

show how I feel deep down). Items are rated on a 7-point scale ranging from 1 ('not at all') to 7 ('very much'). Both subscales have strong internal consistency and validity (Brenning et al., 2011). Cronbach's alpha was high, $\alpha_{anxiety}$= .75 and $\alpha_{avoidance}$= .79.

Pubertal status. Participants completed a Dutch translation of the Pubertal Development Scale (PDS, Petersen, Crockett, Richards, & Boxer, 1988) to assess pubertal status. Participants respond to five questions –for boys and girls separately– about their physical development (e.g., growth spurt, beard growth, breast development), by rating whether a physical change has occurred yet on a scale from 1 (not started/happened yet) to 4 (development completed). Total scores range from 4-20. The PDS has strong validity and reliability (Petersen et al., 1988; Shirtcliff, Dahl, & Pollak, 2009). In the current study, α = .67.

Results

Preliminary Analyses

No data were missing on the anxiety and avoidance scales. For one participant, responses were missing on the PDS. Table 1 reports on the descriptive statistics and zero-order correlations of key study variables, whereas 2 and 3 present these data by epoch of the AAT. Children's pubertal development was positively associated with children's age; anxiety and avoidance scales were positively intercorrelated. AAT condition groups did not differ significantly with regard to anxiety, avoidance, pubertal development, age, or gender.

No data were missing on the self-reported emotions. Due to technical problems during recording, SC- and HRV-data were missing for three (5.00%), and nine (15.00%) participants, respectively, during the entire procedure. In addition, for one (1.67%) and three (5.00%) participants, respectively, data were missing during the baseline only. The latter missing datapoints were only relevant for the additional control analyses in which baseline measures of ANS-parameters were included. Missing data were imputed using multiple imputation (40

iterations). Repeated measures ANOVAs with Time (Emotion 1 and 2/Physio 1 and 2) as within-subjects and Condition (approach versus avoidance) as between-subjects variables showed no main effects, $F(1, 59)$s < 1.43, ps >.237, η_p^2s < .03. Tables 4 and 5 show that these effects were probably suppressed by the interactions with avoidance and to some extent anxiety.

Mood induction manipulation check

First, to check for the effect of the mood-induction video on emotion and physiology, a series of repeated measures ANOVAs was conducted with Time (Emotion 1 and 2/Physio 1 and 2) as within-subjects variable for each ER indicator separately. To control for the potential effects of children's age, gender and pubertal status, these were added as a covariate in separate analyses.

The repeated measures ANOVAs revealed a significant increase in self-reported anxiety, $F(1, 59) = 29.00$, p <.001, $\eta_p^2 = .33$, and sadness, $F(1, 59) = 55.80$, p <.001, $\eta_p^2 = .49$, during the mood-induction video. Follow-up analyses revealed that the effect of anxiety disappeared when the increase in sadness was added as a covariate, $F(1, 58) = 2.02$, $p = .161$, $\eta_p^2 = .03$, whereas the increase in sadness remained strongly significant when the increase in anxiety was added as a covariate, $F(1, 58) = 20.29$, p <.001, $\eta_p^2 = .26$. This suggests that the video mainly induced feelings of sadness. Therefore, we only retained the sadness scale for further analysis. The increase in sadness during mood induction was not related to pubertal development, $r(59) = -.07$, $p = .615$, and marginally significantly related to age $r(60) = -.22$, $p = .098$, and gender, $F(1, 58) = 3.13$, $p = .082$, $\eta_p^2 = .05$.

The repeated measures ANOVAs revealed a significant increase in SC, $F(1, 59) = 6.45$, $p = .014$, $\eta_p^2 = .10$, and in RSA, $F(1, 59) = 6.35$, $p = .014$., $\eta_p^2 = .10$, during the mood induction video as compared to baseline. These changes were unrelated to gender, $F(1, 59) = $

.43, $p = .516$, and $F(1, 59) = 1.03$, $p = .314$; age, $r(60) = .13$, $p = .314$ and $r(60) = -.03$, $p = .840$; and pubertal development, $r(60) = .04$, $p = .771$ and $r(60) = .02$, $p = .860$.

Condition x anxiety as a predictor of change in emotion and physiological responses

To investigate the hypothesis that approaching versus avoiding mother has different effects on emotion regulation depending on children's level of anxiety, we conducted a series of repeated measures ANOVAs predicting changes in sadness, SC, and RSA, with Time (Emotion 2 and 3 / Physio 3 and 4) as within-subjects variable, Condition (approach versus avoidance) as a between subjects-factor, and anxiety added as a covariate that moderated the condition effect.

In each of the analyses, the PDS was added as a covariate to account for developmental shifts in sex hormones that may affect ER (Hankin, Badanes, Abela, & Watamura, 2010). Consequently, individual differences in pubertal development might mask the effects of other predictors of stress-reactivity and -regulation, especially when physiological markers of the stress-system are under study. In addition, we controlled for the effects of gender, age, and three other possible confounding variables: (1) the baseline measure (BL) of the emotion/physiological parameter (Emotion 1/Physio 1) because baseline values and subsequent change scores may covary negatively and lead to an underestimation of the actual psychophysiological reactivity (see e.g., Zisner & Beauchaine, 2016); (2) the duration of the AAT (Duration) procedure (including the break between the blocks) because the intensity of emotions is thought to gradually wane over time (see Harris, Guz, Lipian, & Zhu, 1985); (3) the other attachment subscale to account for the correlation between the anxiety and avoidance scales, $r(60) = .27$, $p = .038$.

The repeated measures ANOVA revealed a significant condition x anxiety interaction effect on self-reported sadness (Table 4). To interpret the interaction effect, we performed a simple slope analysis using Hayes' (2013) PROCESS tool for SPSS (Model 1) with change in

sadness (Sadness post AAT – Sadness pre AAT) as the dependent variable, anxiety as the independent variable, Condition as the moderator, and the control variables used in the repeated measures. This analysis (see Figure 2) showed that children's self-reported anxiety and the decrease in sadness during the AAT, were marginally significantly linked in the approach condition, $B = -16.01$, $SE_B = 8.17$, $p = .055$, and significantly linked in the avoid condition, $B = 18.25$, $SE_B = 8.79$, $p = .043$. Furthermore, the difference between the conditions was only significant in children scoring high, $B = 33.59$, $SE_B = 11.15$, $p = .004$, and not in children scoring low on anxiety, $B = -10.75$, $SE_B = 10.69$, $p = .319$. These results suggest that the self-reported sadness of anxious children decreased significantly less after avoiding mother in comparison to less anxious children in the same condition and in comparison to anxious children who could approach mother. The latter effect relates to the finding that anxious children tended to report a stronger decrease in sadness compared to less anxious children when approaching mother.

No significant condition x anxiety interaction effect was found for change in SC, or for change in RSA during the AAT (see Table 4).

Condition x avoidance as a predictor of change in emotion and physiological responses

To investigate the hypothesis that approaching versus avoiding mother has different effects on emotion regulation depending on children's level of avoidance, the same set of repeated measures ANOVA with avoidance as moderating variable was carried out predicting changes in sadness, SC, and RSA. Results revealed a significant condition x avoidance interaction effect on self-reported sadness (Table 5). The follow-up simple slope analysis (see Figure 3) showed that avoidance and the decrease in sadness were not significantly linked among children in the approach condition, $B = -8.70$, $SE_B = 6.60$, $p = .193$, and were marginally significantly linked in the avoid condition, $B = 15.51$, $SE_B = 8.17$, $p = .063$. The difference between the two conditions was only significant in children scoring high, $B = $

29.26, SE_B = 11.25, p = .012, and not in children scoring low on avoidance, B = -7.83, SE_B = 11.11, p = .484. These results suggested that avoidant children tended to report smaller decreases in sadness compared to less avoidant children when avoiding mother. Moreover, more avoidantly attached children reported significantly more decreases in sadness when approaching versus avoiding mother.

For change in SC during the AAT, results of the repeated measures ANOVA revealed a significant condition x avoidance interaction effect (Table 5). The follow-up single slope analyses (see Figure 4) showed that avoidance and the decrease in SC during the AAT were not significantly linked among children in the approach condition, B = -58, SE_B = .39, p = .140, and were marginally significantly linked among children in the avoid condition, B = .91, SE_B = .47, p = .058. The difference between the two conditions was not significant in children scoring low, B = -.88, SE_B = .66, p = .237, and significant in children scoring high on avoidance, B = 1.40, SE_B = .67, p = .040. These results suggest that avoidant children tended to show smaller decreases in SC compared to less avoidant children when avoiding mother. Moreover, more avoidantly attached children showed significantly greater decreases in SC when approaching versus avoiding mother.

For change in RSA during the AAT, no AAT condition x avoidance interaction effect was found (Table 5).

Discussion

This study investigated the effect of proximity-seeking toward, versus avoidance of, pictures of mother, and explored whether the effect of this manipulation on ER was moderated by attachment anxiety and avoidance. Children reported increased sadness, showed increased SC, and had increased RSA while they were watching the video. In all, these results demonstrate that, at the start of the AAT manipulation, children were significantly distressed, making it plausible that the manipulation was meaningful and allowed the investigation of

children's emotional recovery. In line with our hypotheses, the main analyses revealed several AAT condition x attachment interaction effects on negative emotions and physiological responses.

When more anxiously attached children had to avoid mother, their regulation of sadness (measured via self-report) was less effective compared to more secure children. In contrast, when they approached mother –an action congruent with their predominant interpersonal ER strategy– their regulation of sadness was equally, –and seemingly even slightly more- effective as that of more secure children. However, the fact that, in the current study, no evidence was found for any effects on physiological reactivity, suggests that more anxiously attached children seem able to regulate physiological stress to the same degree as more secure children in both conditions. These data may support the hypothesis that anxiously attached individuals display heightened negative emotionality (i.e. overestimate their negative emotion expression relative to their physiological reactivity), potentially as a strategy of increasing the likelihood of the attachment figure's future responsiveness (see Borelli et al., 2017; Cassidy, 1994), and that situations in which attachment figures are unavailable are ripe for this kind of hyperactivation (see Mikulincer & Shaver, 2007).

When more avoidantly attached children had to avoid mother, their regulation of self-reported sadness was less effective compared to more secure children. Moreover, there was also evidence that this was the case for reactivity on a physiological level. More avoidantly attached individuals' predominant interpersonal strategy –i.e. proximity-avoidance- was not effective in terms of regulating negative emotions. This finding is in line with previous work of infants' responses to probes of the attachment system—despite their behavioral appearance of recovery, avoidant children's proximity-avoidance strategy is not effective for regulating stress (Sroufe & Waters, 1977b). In light of the idea that such a strategy develops as an adaptive response to a maladaptive situation (see Main, 1981; Main et al., 1985), this result

might at first seem surprising. However, this proximity-avoidance is only adaptive in the sense that it protects against rejection or banishment by the attachment figure, so that the child still maintains some access to the attachment figure in case truly threatening events occur (Main, 1981). Thus, although the current study suggested that more avoidantly attached children are better able to regulate stress and negative emotions when they approach their attachment figure, they may avoid in real life in order to prevent the negative emotional and relational consequences of possible rejection.

In addition, the current results seem to indicate that children with greater attachment security are able to successfully regulate negative emotions independently of whether they approach or avoid mother. This finding is in line with accumulating evidence that, throughout middle childhood, more securely attached children become increasingly autonomous and can cope with mild levels of stress independently (Borelli et al., 2016; Bosmans et al., 2017; Dujardin et al., 2015). Throughout development, children gradually shift from dyadic, caregiver-supported regulation to relatively independent self-regulation (Maunder & Hunter, 2001). In middle childhood a normative shift occurs toward a more dismissive attitude toward parents in which children still want their attachment figures to be available, but –probably because of increased self-reliance- rely on them less frequently for support (Colle & Del Giudice, 2011; Kerns, 2008). Securely attached children may be advantaged in this development of adaptive self-regulatory skills through internalization of experiences with effective co-regulation in attachment relationships (e.g., Contreras & Kerns, 2000). Indeed, research in middle childhood reveals that securely attached children display more constructive and more sophisticated ER-techniques and outcomes (Borelli, et al., 2010; Colle & Del Giudice, 2011; Contreras et al., 2000; Kerns et al., 2007).

Note that this by no means implies that secure school-age children do not benefit from maternal proximity. Importantly, this study investigated the regulation of negative emotions in

the context of a mild, everyday stressor. When confronted with more intense levels of stress, a different pattern may emerge. For instance, perhaps when confronted with stress with which they cannot cope autonomously, secure children would also suffer if they must avoid mother and benefit if they can approach her. However, the specificity of these results does not limit their relevance. Although it is important to understand the functioning of the attachment system as a regulating device in situations of extreme stress, it is also crucial to understand its functioning in everyday ordinary (Posada, Waters, Crowell, & Lay, 1995). Indeed, daily hassles, and the inability to cope with them, constitute an important risk factor for the development of psychopathology (e.g., Bockting, Spinhoven, Koeter, Wouters, & Schene, 2006). Nevertheless, it would be interesting to investigate this research question in the context of more severe stressors.

Limitations

This was the first study to investigate the role of seeking- and avoiding proximity toward mother in regulating stress-related emotions in middle childhood. Moreover, it was the first study that investigated the regulatory effect of children's proximity-seeking and avoidance per se, independently from actual interactions with the attachment figure. Nevertheless, interpretation of the results warrants taking into account some limitations.

First, this study relied solely on self-report measures of attachment. Self-report attachment-measures underestimate attachment insecurity (Ainsworth, 1985). Although recent research in middle childhood reveals associations between self-reported attachment and narrative assessments of children's attachment (Psouni & Apetroaia, 2014), replication research is needed with other attachment measures. Second, the absent effect of RSA during the AAT is difficult to interpret, due to the nature of the task. The AAT task can both have had an emotional meaning and be attention- and/or executive control demanding –especially in the condition that interferes with the participant's predominant strategy– caution is needed

when drawing conclusions regarding the absence of effects on change in RSA (see also Zisner & Beauchaine, 2016). Nevertheless, prior attachment research also found stronger links with changes in SC than in HRV (e.g., Gilissen, Bakermans-Kranenburg, van IJzendoorn, & van der Veer, 2008). Third, the AAT does not permit researchers to draw conclusions about the regulatory effect of children's actual approach and avoidance behavior. Nevertheless, previous research (e.g., Huijding et al., 2009) does suggest that the task has a certain level of ecological validity. Nevertheless, future research should also focus on ER-effects of actual approach and avoidance behavior. Finally, replication is needed in larger samples and in more insecurely attached samples like in clinical samples. With regard to the latter, it was important to note that the current distribution of the attachment questionnaire was similar to what has been found in other studies with similar samples (e.g., Brenning, Soenens, Braet, & Bosmans, 2014).

Implications

These results suggested that having to avoid mother is associated with less effective regulation of self-reported sadness in both anxiously and avoidantly attached children compared to less anxious/avoidant children, and compared to when children have to approach mother. Moreover, results showed similar effects using physiological stress as an indicator of ER, but only for avoidant attachment. Taken together this suggests that avoidantly attached children's predominant ER-strategy -i.e. proximity-avoidance– is not really effective for regulating their negative emotions. Instead, for anxiously attached children, ER effects of avoiding versus approaching mother only were found for self-reported emotions, but this did not replicate at the psychophysiological level. The self-report effect for more anxiously attached children may reflect that they are more motivated to report beneficial effects of approaching versus avoiding mothers even though such effects seem less strong at the level of psychophysiology. These findings are consistent with theorizing that more anxiously attached

children maximize the expression of their attachment needs in order to ensure the availability of an inconsistently responsive caregiver (Bowlby, 1969). Future research could explore whether this mechanism explains why these children appear motivated to seek caregiver support in spite of a negative learning history and lack of trust in the caregiver (see also Bosmans, 2016).

The current findings shed an optimistic light on avoidant children's prospects, suggesting that if parents increase their availability to their children, such that these children can seek proximity to them, this might have positive consequences for avoidant children's ER, and in so doing buffer against negative developmental outcomes associated with stress. Attachment Based Family Therapy is in line with this hypothesis (ABFT; Diamond, Diamond, & Levy, 2013), and studies find that this form of therapy reduces adolescent depression by repairing the parent-child bond through acknowledgement of and empathy for the child's need for parental support. Future research is needed to test this hypothesis directly.

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Table 1

Means, Standard Deviations, and Links with Age and Gender for the Anxious and Avoidant Attachment Scale of the ECR, and for the PDS

	Descriptives				Link with Age			Link with Gender		
	M	*SD*	*Skewness*	*Kurtosis*	*r*	*df*	*p*	*F*	*df*	*p*
Anxiety	1.88	0.65	.894	-.415	-.13	60	.325	0.74	1,58	.3
Avoidance	2.26	0.77	.446	-.214	-.03	60	.804	0.39	1,58	.5
Pubertal Development	7.46	2.58	1.640	2.761	.38	59	.003	1.68	1,57	.2

Table 2

Means, and Standard Deviations for, and Mutual Correlation between Self-reported Sadness and Anxiety for each Time Point

	Sadness		Anxiety		Correlation	
	M	*SD*	*M*	*SD*	*R (df = 60)*	*p*
Between BL & mood-induction	5.40	11.84	4.60	11.34	.45	<.001
Between mood-induction & AAT	33.25	30.55	24.98	28.74	.67	<.001
After AAT	5.15	13.46	4.67	10.55	.19	.15

Table 3

Means and Standard Deviations for Skin Conductance (SC, µS) and Respiratory Sinus Arrhythmia (RSA, ms^2) for each test epoch

	SC		RSA	
	M	*SD*	*M*	*SD*
End BL	14.39	7.75	2128.15	1882.76
End mood-induction	15.02	7.79	2398.46	3089.99
Start AAT	15.69	8.11	1444.54	1719.24
End AAT	14.61	7.66	957.06	1272.47

Note: values reflect raw scores at each epoch

Table 4

Repeated Measures ANOVA to test Condition X Attachment Anxiety Effects on Sadness, Skin Conductance and RSA during the AAT Manipulation

	Sadness			Skin Conductance			RSA		
	$F(1, 50)$	p	η_p^2	$F(1, 50)$	p	η_p^2	$F(1, 50)$	p	η_p^2
Time	.02	.891	<.01	.57	.456	.01	1.44	.235	.03
Time X Condition	5.16	.027	.09	.06	.807	<.01	1.15	.289	.02
Time X Gender	2.50	.120	.05	2.90	.095	.05	.86	.358	.02
Time X Age									
Time X Duration AAT	4.48	.039	.08	.70	.792	<.01	3.25	.077	.06
Time X Baseline	2.57	.115	.05	5.99	.018	.11	7.71	.008	.13
Time X Pubertal Development	.08	.774	<.01	1.65	.205	.03	.95	.333	.02
Time X Attachment Anxiety	.03	.854	<.01	.06	.812	<.01	.33	.566	<.01
Time X Attachment Avoidance	.20	.656	<.01	.02	.968	<.01	.50	.483	.01
Time X Condition X Attachment Anxiety	8.35	.006	.14	.01	.938	<.01	.45	.503	<.01

Note: AAT = Approach Avoidance Task; Time = post mood induction versus after the AAT for Sadness and start versus end of the AAT for Skin Conductance and RSA

Table 5

Repeated Measures ANOVA to test Condition X Attachment Avoidance Effects on Sadness, Skin Conductance and RSA during the AAT Manipulation

	Sadness			Skin Conductance			RSA		
	$F(1, 50)$	p	η_p^2	$F(1, 50)$	p	η_p^2	$F(1, 50)$	p	η_p^2
Time	.03	.873	<.01	.47	.497	<.01	1.06	.307	.02
Time X Condition	3.25	.077	.06	4.73	.034	.09	.55	.461	.01
Time X Gender	1.24	.271	.02	3.35	.073	.06	1.20	.279	.02
Time X Age									
Time X Duration AAT	3.12	.084	.06	.21	.648	<.01	3.82	.056	.07
Time X Baseline	2.20	.144	.04	7.00	.011	.12	9.29	.004	.15
Time X Pubertal Development	.11	.745	<.01	2.11	.153	.04	.92	.341	.02
Time X Attachment Anxiety	.01	.925	<.01	.01	.909	<.01	.21	.646	<.01
Time X Attachment Avoidance	.40	.529	<.01	.29	.595	<.01	1.09	.302	.02
Time X Condition X Attachment Anxiety	5.58	.022	.10	6.27	.015	.11	1.50	.227	.03

Note: AAT = Approach Avoidance Task; Time = post mood induction versus after the AAT for Sadness and start versus end of the AAT for Skin Conductance and RSA
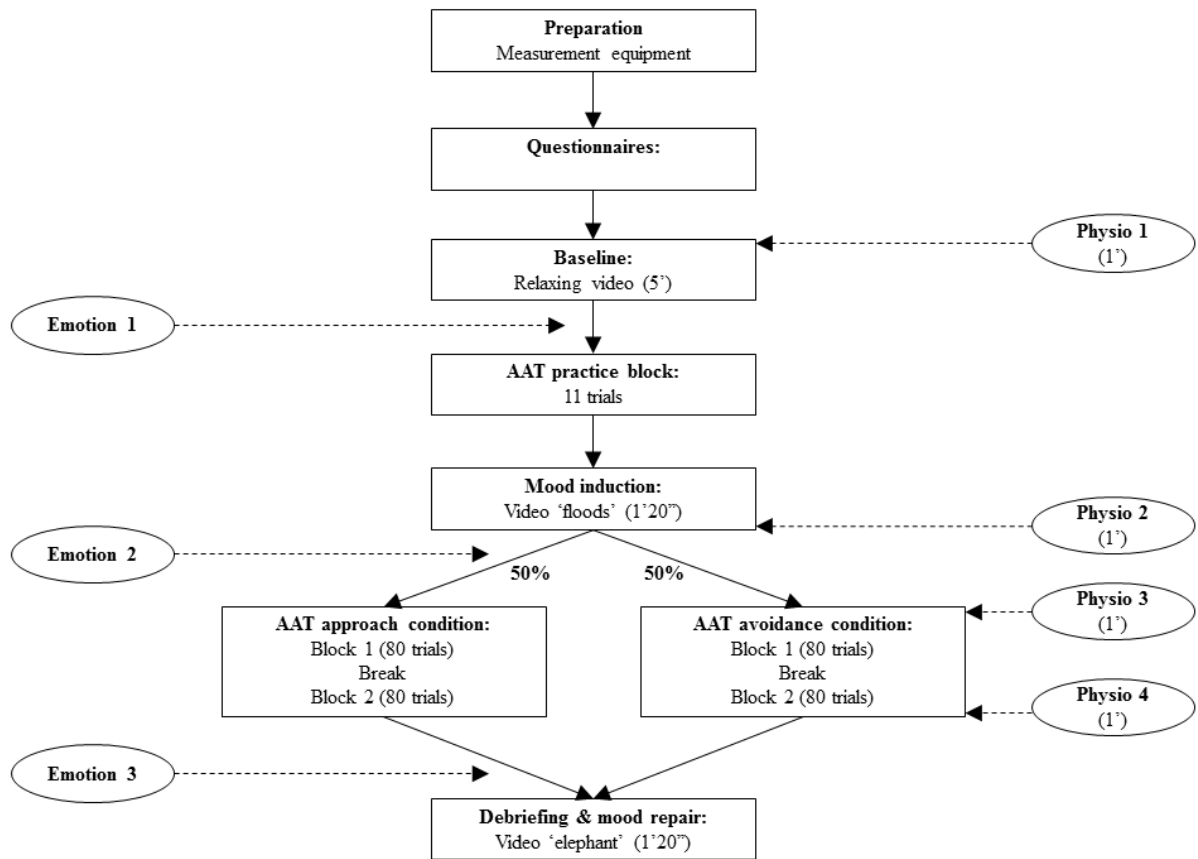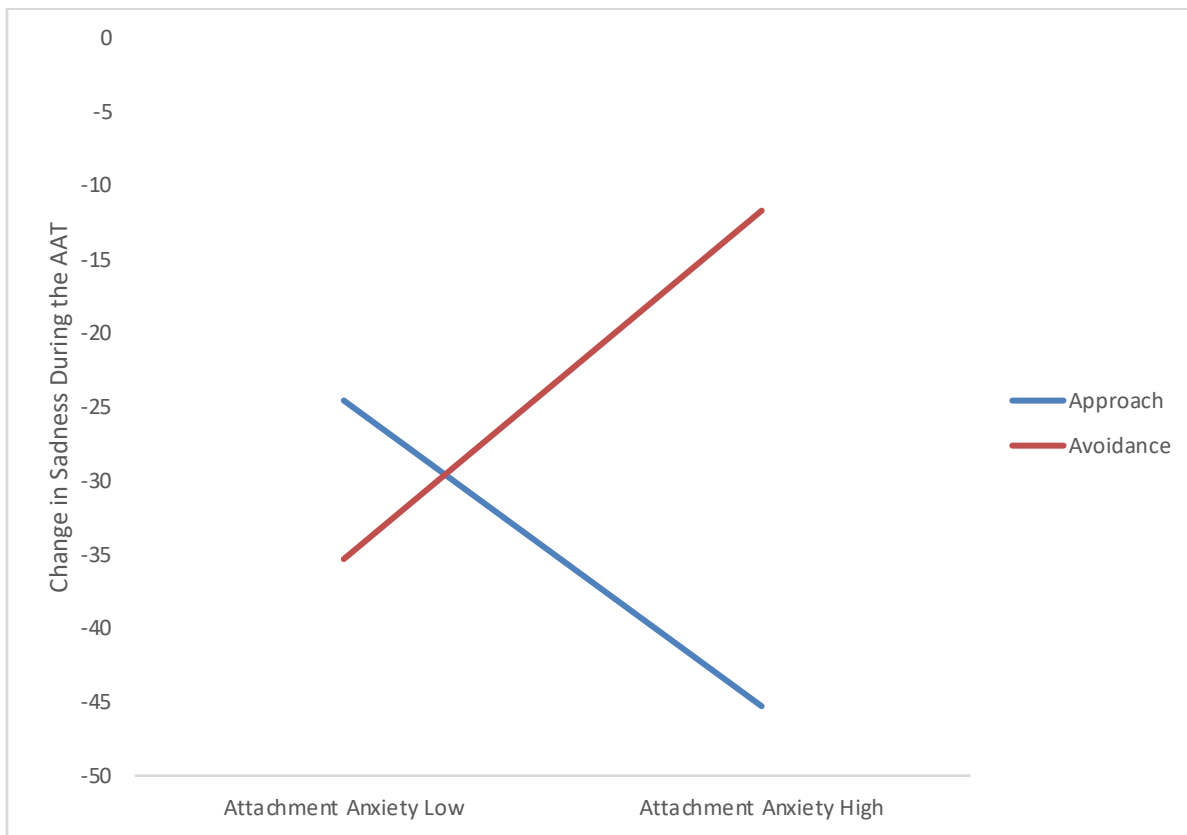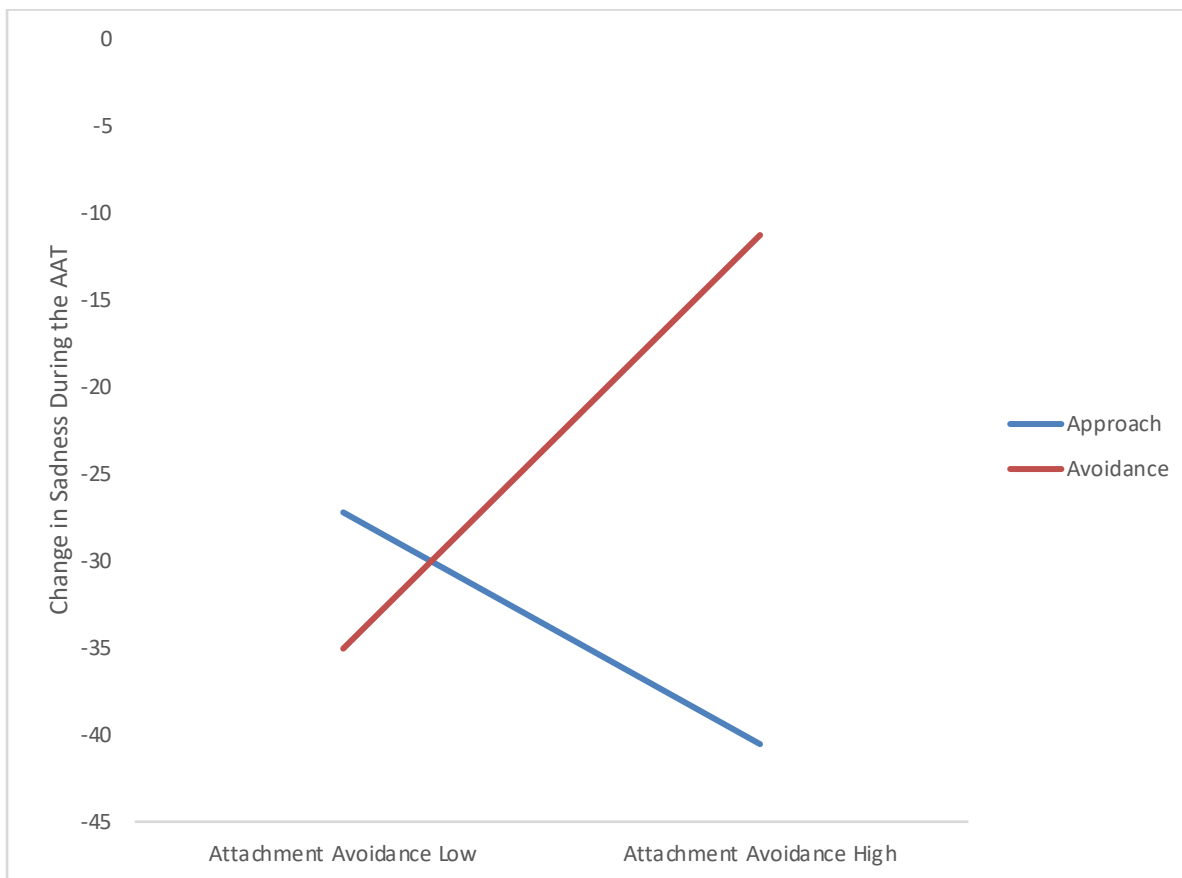
Figure 1. Overview of the procedure

Figure 2. Condition x attachment anxiety interaction predicts the decrease in sadness during the AAT.
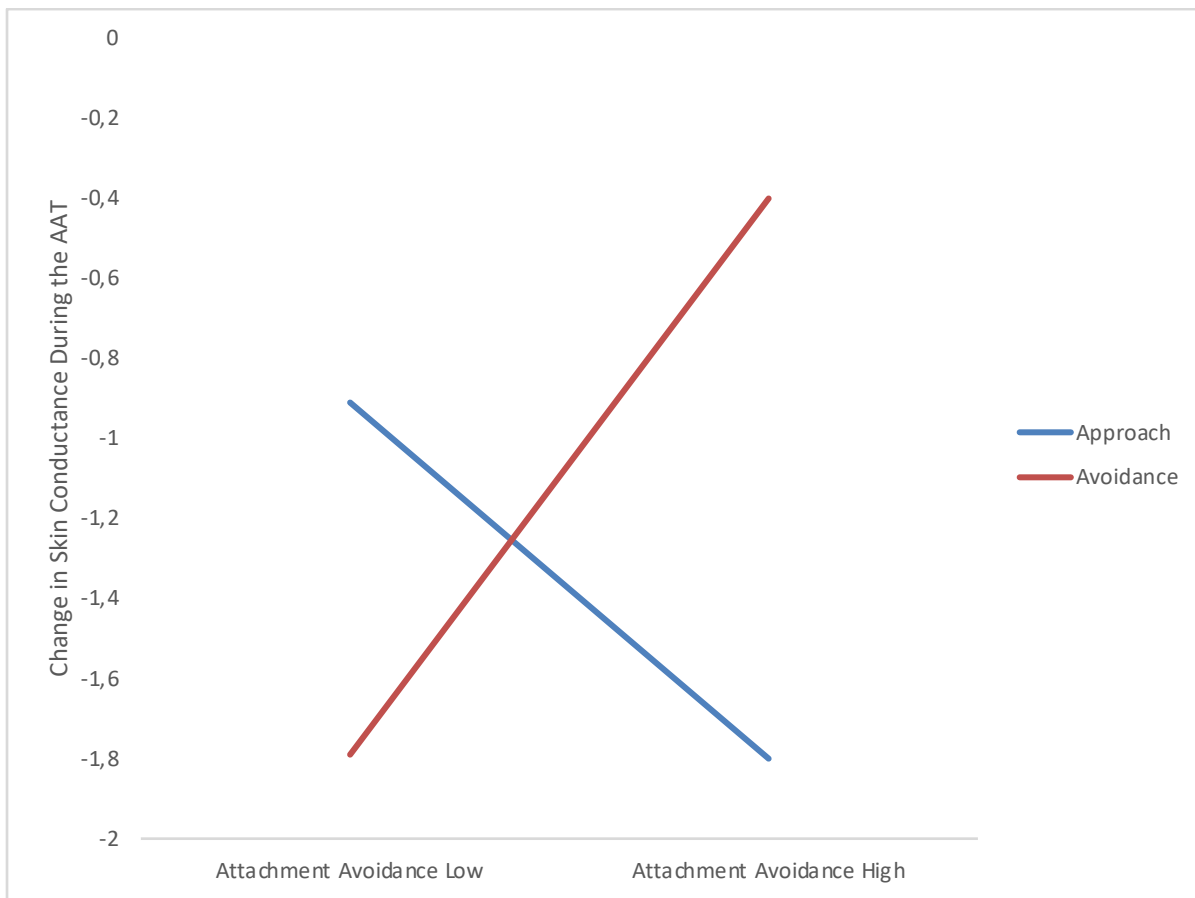

Note: Change in Sadness = Sadness after AAT – Sadness after Mood Induction

Figure 3. Condition x attachment avoidance interaction predicts the decrease in sadness during the AAT.

Note: Change in Sadness = Sadness after AAT – Sadness after Mood Induction

Figure 4. Condition x attachment avoidance interaction predicts the decrease in skin conductance during the

AAT.

Note: Change in Skin Conductance = Skin Conductance End of AAT – Skin Conductance Start of AAT