ATTACHMENT IN MALTREATING MOTHERS

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Attachment Representations and Autonomic Regulation in Maltreating and Non-Maltreating Mothers

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Mothers

Abstract

This study assessed attachment representation and attachment-related autonomic regulation in a sample of 38 maltreating and 35 non-maltreating mothers. Mothers' state of mind regarding attachment was measured using the Adult Attachment Interview. They further watched an attachment-based comfort paradigm, during which we measured skin conductance and vagal tone. More maltreating mothers (42%) than non-maltreating mothers (17%) had an *unresolved/disoriented* attachment classification. Attachment representation was related to physiology during the comfort paradigm: An unresolved state of mind and a non-autonomous classification were associated with a decrease in skin conductance during the comfort paradigm, specifically during the responsive caregiver scenario. However, physiology did not differ between maltreating and non-maltreating mothers. The decrease in skin conductance of unresolved mothers during the comfort paradigm might be indicative of a deactivating response, which is congruent with the dissociative nature of the unresolved state of mind. Results point to the potential utility of interventions focused on attachment representations for maltreating mothers.

Key words: child maltreatment, attachment, autonomic regulation

Introduction

Adult attachment representation has been recognized as an important predictor of parenting behavior (Main et al., 1985; Van IJzendoorn, 1995). Mothers with an unresolved state of mind toward attachment-related trauma show more anomalous behavior in interaction with their children than other mothers (Main & Hesse, 1990; Madigan et al., 2006). Findings from a limited number of studies suggest that unresolved attachment is also overrepresented in maltreating parents (e.g., Adshead & Bluglass, 2005), but additional evidence from case-control studies with a comprehensive operationalization of child maltreatment is needed. Therefore, in this study we assessed attachment representation in a sample of maltreating mothers for whom emotional and physical neglect and abuse were substantiated and a comparison group of non-maltreating mothers. Attachment-related autonomic regulation has been associated with both attachment representations (Roisman, Tsai, & Chiang, 2004) and parenting behavior (Sturge-Apple, Skibo, Rogosch, Ignjatovic, & Heinzelman, 2011). We examined whether autonomic regulation during a comfort paradigm differed according to mothers' attachment representation and according to their maltreatment status.

State of Mind toward Attachment

Child maltreatment has a wide variety of etiological risk factors, including low SES, single parenthood, parental psychopathology, low social support, and parents' negative experiences with caregivers in their own childhood (Cicchetti & Valentino, 2006; Euser et al., 2013; Stith et al., 2009). In addition to actual childhood caregiving experiences, a possibly more proximal factor to be considered in the etiology of child maltreatment is parents' mental *representations* of childhood experiences (Morton & Browne, 1998). The foremost instrument to assess adult attachment representations is the Adult Attachment Interview (AAI; George, Kaplan, & Main, 1985; Hesse, 2008), a semi-structured interview in which individuals are

asked to describe their early and ongoing relationship with their caregivers. Their narrative is coded using classifications of state of mind with respect to attachment (Main, Goldwyn, & Hesse, 2003). Typically, one out of three possible main classifications is assigned to the state of mind most prominent throughout the interview as a whole: secure-autonomous (F), insecure-dismissing (Ds), or insecure-preoccupied (E), of which F is considered the most beneficial (see the method section for further details). Furthermore, when present, discussions of experiences of loss, abuse or other potential trauma are scored for disorientation in reasoning or discourse, and when sufficiently marked may lead to a primary classification of an unresolved/disoriented state of mind (U/d; henceforth U). In such a case a secondary (organized) classification of F, Ds, or E is assigned for the remaining narrative. Finally, interviews in which a singular organized state of mind cannot be identified (for instance, because marked indications of several states of mind are present) are coded as unclassifiable ("cannot classify"; CC). U and CC classifications are overrepresented in clinical samples (Bakermans-Kranenburg & Van IJzendoorn, 2009; Van IJzendoorn & Bakermans-Kranenburg, 1996).

Unresolved Attachment and Dissociative Parenting

Unresolved and unclassifiable states of mind regarding attachment have been conceptually related to the clinical phenomenon of dissociation (e.g., Liotti, 2004; Main & Morgan, 1996), and there is evidence to support this contended link. In clinical samples, U/CC attachment classifications were associated with pathological dissociative processes (Riggs et al., 2007; Steele, 2003) and with PTSD symptomatology (Harari et al., 2009; Stovall-McClough & Cloitre, 2006), which share core features with dissociation. In non-clinical samples, adults with a U/CC state of mind showed elevated levels of pathological dissociation and non-pathological absorption tendencies (Hesse & Van IJzendoorn, 1999;

Thomson & Jaque, 2014). Generically speaking, dissociation involves a lack of integration of psychological processes such as memory, consciousness, and perception, for example characterized by intrusive, uncontrolled disruptions of awareness, an inability to recall personal memories, and/or experiential disengagement (Cardeña & Carlson, 2011; Spiegel et al., 2011). Inferentially, this seems similar to what occurs during the AAI for people with an unresolved state of mind. During discussion of loss or trauma, they may display anomalous ideation (e.g., speaking of a dead person as if they were alive) or disoriented discourse (e.g., visual-sensory images intrude the discourse while an episode of childhood abuse is recounted), both unremarked upon by the interviewee. This suggests a lack of integration of specific memories with the current sense of self, and absorption in the event under discussion, since speech is no longer successfully monitored.

It has been suggested that if parents display such lapses of a dissociative nature during the AAI, similar behavior is likely to intrude their parenting behavior during interactions with their children (Hesse & Main, 2006). A U classification on the AAI was found to be related to various expressions of anomalous parenting behavior (Schuengel, Bakermans-Kranenburg, & Van IJzendoorn, 1999), some of which are dissociative or contain dissociative elements, in that they suggest an alteration in psychological state disconnected from current interactive context (Hesse & Main, 2006). Anomalous parenting behaviors can be observed with validated coding systems (AMBIANCE, Lyons-Ruth, Bronfman, & Parsons, 1999; DIP, Out, Bakermans-Kranenburg, & Van IJzendoorn, 2009), which include more subtle forms of disrupted parenting. A meta-analysis has shown an association between a U classification on the AAI and both FR and disrupted parenting behavior (Madigan et al., 2006).

From Anomalous Parenting to Child Maltreatment

The boundaries between anomalous or disrupted parenting and child maltreatment seem nebulous. Although the former two may occur in non-maltreating parents (see Hesse & Main, 1999; Schuengel et al., 1999), higher levels of affective errors and negative behaviors have been observed in maltreating mothers (Skowron, Cipriano-Essel, Benjamin, Pincus, & Van Ryzin, 2013; Skowron et al., 2011). Beyond their correlation, pervasive forms of intrusive/negative behavior and withdrawal could *themselves* be conceived as child emotional abuse and neglect, respectively (Barnett, Manly, & Cicchetti, 1993). A small, heterogeneous body of research seems to further point to a link between an AAI U classification and substantiated perpetration of child maltreatment. In a sample of mothers clinically referred for Münchausen syndrome by proxy, 60% were assigned a U classification on the AAI (Adshead & Bluglass, 2005), while 18% is the normative rate in non-clinical mothers (Bakermans-Kranenburg & Van IJzendoorn, 2009). In a subgroup of mothers under surveillance from the public social services for the protection of juveniles, average continuous U scores were significantly higher than in a comparison group of mothers living in poverty and a low-risk control group (Frigerio, Costantino, Ceppi, & Barone, 2013). On an extreme level, more mothers who had killed their children had a U classification (61%) than both mentally ill mothers and mothers from the normative population (Barone, Bramante, Lionetti, & Pastore, 2014). However, no elevated prevalence of U (12%) was found in mothers with substantiated child neglect (Lindhiem, Bernard, & Dozier, 2011). So far, studies on AAI classifications of maltreating parents are relatively scarce and results have not been unequivocal.

Attachment and Autonomic Regulation

Adult attachment dimensions have been related to different responses of the autonomic nervous system (ANS) during the AAI. The ANS is part of the peripheral nervous system, which connects the central nervous system (i.e., the brain and spinal cord) with the

rest of the body (Kiernan & Rajakumar, 2014). The ANS innervates the internal organs through the sympathetic and parasympathetic subsystems (Larsen, Schneiderman, & DeCarlo Pasin, 1986). Generally, the sympathetic branch mobilizes the body to deal with environmental demands, while the parasympathetic system restores energy during rest. Skin conductance levels (SCL; electrodermal activity of the skin) and vagal tone (heart rate variability associated with respiration; Porges, 1991) are examples of frequently used autonomic parameters (Kreibig, 2010). Integrated with its role in behavioral preparation, the interest in ANS response patterns as reflective of emotion has increased over recent decades (see Kreibig, 2010, for an overview). For instance, stress or anxiety has been quite unequivocally associated with increases in SCL and a decrease in parasympathetic indices such as vagal tone.

During the AAI, individuals using a deactivating strategy toward attachment memories (associated with a dismissing state of mind) showed increased SCL reactivity to attachment-related questions as compared to hyperactivating interviewees (pertinent mostly to preoccupied classifications; Dozier & Kobak, 1992). This validated the notion that a person with a dismissing state of mind copes by suppression of negative emotions. The finding was replicated in a study that further suggested the association to be unique to electrodermal activity, since no effects were found for cardiovascular measures (Roisman et al., 2004). Preoccupied individuals showed no change in SCL during the interview, which seems incongruent with the "involving/preoccupying anger" inferred from their answers (i.e., abundant, apparently angry discussions of negative experiences with caregivers, indicative of current mental entanglement with caregiving experiences; the most common subtype of AAI preoccupation). Studies that have examined autonomic regulation in relation to an unresolved state of mind are lacking, probably in part because the rate of U classifications in community samples is such that substantial subgroup sizes are hard to obtain. One study that did test the

association with an unresolved state of mind found no differential autonomic regulation during the AAI for adopted adolescents (Beijersbergen, Bakermans-Kranenburg, & Van IJzendoorn, 2008), which, as the authors noted, may have been partly due to their focus on ANS arousal during questions regarding loss or trauma. U indices may occur outside of the context of these questions, and furthermore tend to be brief. It may therefore be worthwhile to measure autonomic regulation associated with unresolved attachment outside of the direct AAI context.

Although it remains unclear to what extent the potentially traumatic experiences discussed during the AAI are the direct causes of the unresolved state of mind (Lyons-Ruth et al., 2003), early experiences of maltreatment have commonly been associated with unresolved attachment, either directly (Bailey, Moran, & Pederson, 2007), or, as postulated by Riggs and Jacobvitz (2002), indirectly by heightening vulnerability to subsequent adversity. Early trauma such as childhood abuse and neglect has mainly been associated with subsequent increased ANS reactivity (e.g., Heim et al., 2000; Oosterman, De Schipper, Fisher, Dozier, & Schuengel, 2010). However, differential autonomic response patterns may be discerned according to *state of mind* toward the trauma. For instance, traumatized individuals with a dissociative coping strategy may show a dampened autonomic response during trauma-related confrontation (Griffin, Resick, & Mechanic, 1997). A neurobiological model was proposed in which certain manifestations of dissociation were associated with inhibition of the amygdala by the medial prefrontal cortex, resulting in dampened autonomic output and emotional experience (Sierra & Berrios, 1998). More recently, evidence was presented for a dissociative subtype of PTSD, following a similar model of excessive prefrontal inhibition of limbic regions (Lanius et al., 2010). Consistent with this line of findings, PTSD and an unresolved state of mind towards attachment were highly associated in a sample of war veterans, probably due to their commonality of an inherently dissociative lack of integration (Harari et

al., 2009). Indirect evidence thus suggests that individuals with an unresolved state of mind, through their dissociative features, may show autonomic hyporeactivity to trauma-related stimuli.

Autonomic Regulation and Parenting

Maternal autonomic dysregulation within attachment-related settings has also been related to inappropriate parenting behavior. Mothers with ANS hyperarousal during the Strange Situation Procedure (SSP) displayed more harsh/intrusive caregiving behavior, while mothers with an autonomic hypoarousal pattern scored highest on maternal insensitivity, disengaged *and* intrusive parenting as compared to a normative group (Sturge-Apple et al., 2011). Several studies have looked at decreases in vagal tone (labeled vagal withdrawal and taken as a sign of active and flexible emotion regulation) in relation to parenting. Mothers of infants with an avoidant attachment strategy showed less vagal withdrawal than mothers of securely attached infants during the final reunion episode of the SSP (Hill-Soderlund et al., 2008). Mothers of avoidant dyads have been characterized by, inter alia, consistently low responsiveness to negative child signals (Ainsworth, Blehar, Waters, & Wall, 1978; Belsky, Rovine, & Taylor, 1984; Raval et al., 2001). Also in mothers of avoidant children, low vagal withdrawal predicted decreased maternal sensitivity during episodes of child negative affect (Mills-Koonce et al., 2007). Low vagal withdrawal in combination with high cortisol was associated with maternal negative intrusiveness during the reunion of the Still Face Paradigm (Mills-Koonce et al., 2009). Finally, *more* vagal withdrawal was associated with episodes of increased positive parenting in abusive and neglectful mothers during a joint teaching task with their children (Skowron et al., 2013). Combined, these results point to an association between diminished autonomic regulation and less optimal caregiving.

The Current Study

In the current study we assessed state of mind with regard to attachment in a sample of maltreating and demographically matched non-maltreating mothers. For the maltreating group physical and emotional child abuse and neglect were substantiated, which provides an important addition to the existing literature. We evaluated the association between the three constructs outlined above: between attachment and child maltreatment perpetration; between attachment and autonomic regulation; and between autonomic regulation and child maltreatment. With an exploratory aim, we tested whether autonomic regulation mediated the relationship between attachment and child maltreatment. SCL and vagal tone (RMSSD; root mean square of successive differences) were measured during standardized attachment-based video clips. The clips displayed a separation between abstract animated representations of a caregiver and infant, followed by a *responsive caregiver* and an *unresponsive caregiver* outcome scenario, shown alternately (Johnson, Dweck, & Chen, 2007).

First, we hypothesized that more maltreating mothers than non-maltreating mothers would have an unresolved state of mind towards attachment, and more maltreating mothers would be assigned an insecure (Ds, E, or U/CC) classification. Second, we expected that maltreating mothers as well as mothers with unresolved and insecure attachment representations would show autonomic dysregulation during the attachment-based videos.

Method

Participants

We recruited 45 maltreating and 45 non-maltreating mothers from a mental health clinic. Mothers in the maltreating group received therapy that revolved around their parenting problems and received a brochure about the study from their therapists at the beginning of treatment. The clinic kept family records for all mothers, which included CPS referrals and life histories of family members. We coded these records to substantiate recent or ongoing

abuse and neglect perpetrated by the mother using the Maltreatment Classification System (MCS; Barnett et al., 1993). When records were inconclusive, we interviewed the mother's psychiatrist about her parenting problems using a semi-standardized interview. For three mothers, neither their records nor their psychiatrists provided proof of maternal maltreatment. In these cases, we conducted a Dutch adaptation of the Maternal Maltreatment Classification Interview (MMCI; Cicchetti, Toth, & Manly, 2003) which verified absence of maltreatment in two mothers. We considered them as non-maltreating in the analyses. One mother could not be reached for a follow-up MMCI and was excluded from analyses because of her inconclusive current maltreatment status.

Non-maltreating mothers were recruited by research assistants in a clinical subdivision of the facility, where their child was in therapy for developmental or learning problems. Because having a child with these types of problems may constitute a specific challenge for caregiving, we also coded the family files of maltreating mothers for their children's clinical diagnoses to ensure the two groups were comparable in this respect. To verify the absence of maltreatment in the non-maltreating group, the MMCI (Cicchetti et al., 2003) was used. For three mothers incidents of maltreatment were coded from the interview. All of these incidents had taken place less than five years ago, so that the recency of the problems matched these mothers to the maltreating group. Therefore they were excluded from the non-maltreating group and transferred to the maltreating group. For 16 participants physiological and/or AAI data were missing due to technical problems or because the participant's psychiatrist had advised against conducting the AAI. Additionally, one interview could not be scored because of the participant's language difficulties. The final sample consisted therefore of 38 maltreating mothers and 35 non-maltreating mothers. The 17 excluded mothers did not differ on maltreatment status from the mothers with complete data ($p = .55$). Excluded mothers and those included in the final sample were also similar on

number of children, maternal mean age, children's mean age, and education (ps > .18). They differed on ethnicity (p = .01): 96% of included mothers were of Caucasian ethnicity, compared to 77% (n = 13) in the excluded group.

In the final sample, 45% had completed secondary school, and 34% had finished elementary school or a short track of secondary school. The mean age of the mothers was 41.32 years (SD = 7.15) and on average they had 2.41 children (SD = 1.19).

The study was approved by the Medical Ethics Review Committee for Mental Health Care (METiGG). All mothers gave informed consent for participation and, in the maltreating group, for researchers' access to the family files. As a compensation for participation, mothers received 40 Euros and travelling expenses.

Procedure

Two individual appointments took place at the facility, on average no more than about a week apart. All mothers were tested by young, female research assistants who had memorized a structured script to standardize the procedure as much as possible. The first session took place in the morning to prevent the influence of diurnal fluctuations in ANS activity. Mothers completed three computer tasks, including a comfort paradigm (Johnson et al., 2007), during which electrocardiogram (ECG) and impedance cardiogram (ICG) signals were recorded. Afterwards, mothers completed a questionnaire on health-related issues, such as smoking and exercising prior to the session, and on their family situation, including educational level, number of children, and children's ages. Furthermore, we administered the MMCI to the non-maltreating group. During the second appointment we conducted the Adult Attachment Interview (George et al., 1985).

Measures

Maltreatment Classification System. We used the Maltreatment Classification System (MCS; Barnett et al., 1993), which has been found a reliable and valid system to code

incidents of maltreatment (e.g., English et al., 2005). The MCS may be applied to all available documents from families' Department of Human Services (DHS) records, thereby maintaining independent criteria that comprehend more than legally recognized cases of maltreatment (Cicchetti, Rogosch, Gunnar, & Toth, 2010). In accordance with operational definitions, we coded abuse (physical and emotional) and neglect (again, physical and emotional). The fact that certain types of maltreatment were recorded in the files suggests them to be of a chronic rather than incidental nature. Only incidents of *maternal* maltreatment were considered. Coding was done by trained research assistants. Inter-rater reliability for maltreatment type on 15 files was excellent, with $\kappa = .82$ for abuse and $\kappa = 1.00$ for neglect. For the presence versus absence of maltreatment there was full agreement ($\kappa = 1.00$). Subsequently, all records were coded by two different research assistants and discrepancies were resolved through discussion. We found that all mothers in the maltreatment group had been neglectful towards their children, either physically or emotionally, and 55% ($n = 21$) of the maltreating mothers had also abused their child(ren) physically or emotionally.

Maternal Maltreatment Classification Interview. The MMCI (Cicchetti et al., 2003) is a semi-structured interview that evaluates whether the mother has maltreated any of her children recently and during their lifetime. Mothers are asked about incidents of physical and emotional abuse and neglect, as well as sexual abuse, and about any contact the family may have had with CPS. We translated the interview into Dutch for this study. Coding was done by trained research assistants. Inter-rater reliability on 12 interviews was excellent, with full agreement for the presence versus absence of maltreatment, incidents of neglect versus abuse, and severity of the incidents (for all $\kappa = 1.00$). Interviews were coded by two different research assistants and discrepancies were resolved through discussion.

Comfort Paradigm. The comfort paradigm (Johnson et al., 2007) consists of two different video clips showing two animated ellipses, one larger (the "caregiver") and one

smaller (the "child"). Both started with a 10-sec introductory clip in which caregiver and child enter the scene together. When the ground slopes upward, the caregiver continues unto a mid-slope plateau, whereas the child is held back and starts to cry. This is conveyed using the sound of a human infant cry, visually emphasized by the pulsation and change of color of the child ellipse (see Figures 1a and b). In the 8-sec *responsive* caregiver outcome clip, the caregiver then returns to the child, as the infant cry sound continues but diminishes towards the end (Figure 1c). In the other outcome, the 8-sec *unresponsive* caregiver clip, the caregiver ellipse continues higher up the slope, leaving the child behind (Figure 1d). The crying sound continues but eventually fades just as in the responsive clip.

The paradigm has previously been used with infants (Biro, Alink, Van IJzendoorn, & Bakermans-Kranenburg; Johnson et al., 2007; Johnson et al., 2010). Based on the infant working model of attachment, the authors of the paradigm hypothesized that infants with secure attachment would spend more time looking at the *un*responsive caregiver scenario (contrary to their expectation), while insecurely attached infants would look longer at the responsive caregiver outcome, and this was indeed the case (Johnson et al., 2007; Johnson et al., 2010). This shows that people may respond differently to the paradigm's caregiving outcomes according to their mental representation of attachment. This is the first study to use the paradigm with adult participants.

The comfort paradigm was presented on a laptop with E-prime software. We started the task with a 4-min baseline of neutral images. We then showed the introductory clip, immediately followed by either the responsive or the unresponsive clip (counterbalanced). The same combination of introductory and outcome clip was repeated 4 times. A second baseline of neutral images lasting 2 minutes was shown, after which we presented the introductory clip combined with the *other* outcome scenario (responsive when the first series were unresponsive, or unresponsive when the first series were responsive), 4 times in a row.

The order of the responsive and unresponsive clips was counterbalanced. The task was finalized with a 2-min recovery segment of neutral images.

[Insert Figure 1 here]

Skin Conductance Level (SCL) and Vagal Tone (RMSSD). During the cry paradigm, SCL, an electrocardiogram (ECG), and an impedance cardiogram (ICG) were measured using an ambulatory monitoring system (VU-AMS5fs; TD-FPP, Vrije Universiteit, Amsterdam, the Netherlands). Before the assessment of SCL mothers washed their hands with a mild soap. Then two Ag-AGCI electrodes, filled with isotonic GEL101 electrode paste, were placed on the middle and index finger of mothers' non-dominant hand. For the ECG, three disposable pre-gelled Ag-AgCI electrodes (ConMed, New York, USA) were placed slightly below the right collar bone 4 cm to the right of the sternum, between the two lower ribs on the right side, and under the left breast (4 cm under the nipple). For the ICG, four electrodes were attached at the top end of the sternum between the tips of the collarbones, on the spine (at least 3 cm above the previous one), at the low end of the sternum where the ribs meet, and again on the spine (at least 3 cm under the previous one). E-prime had been programmed so that markers were sent to the ECG and SCL recording during baseline, the display of each video clip, and recovery. We labeled the data according to these markers.

Out of the various autonomic measures assessed during the paradigm, we focused on SCL and vagal tone (RMSSD) in our analyses to reduce the number of statistical tests. These two measures were selected over other indices for several reasons. First of all, they allowed us to separately evaluate both sympathetic (SCL) and parasympathetic (RMSSD) nervous system activity (whereas heart rate, for instance, is a mixed index). Second, in previous studies on autonomic functioning in an attachment-related context SCL and vagal tone have each been used as singular measures of the ANS (e.g., respectively Dozier & Kobak, 1992; Mills-Koonce et al., 2007). In other studies, SCL was measured in addition to salivary alpha-

amylase, and vagal tone in addition to cardiovascular measures such as inter-beat intervals, and effects were found only for SCL and vagal tone, respectively (Hill-Soderlund et al., 2008; Roisman et al., 2004). Average SCL and RMSSD were derived per labeled segment, after which the mean over the segments was calculated per clip content (introductory, responsive, unresponsive) in SPSS. We checked for outliers (using standardized scores of -3.29 and 3.29 as cut-off) per labeled segment as well as per aggregated episode. For SCL two participants and for RMSSD six participants showed outliers for individual segments, which were winsorized (Tabachnik & Fidell, 2001), so that the least extreme outlier was replaced with a value .10 above the highest non-outlying score, and for the next more extreme outlier .10 was added to the preceding value, thus preserving the original order. For RMSSD the combined episodes further showed four outliers, which were winsorized as well. Combined episodes showed no further outliers.

Adult Attachment Interview (AAI). The AAI (George et al., 1985) is a semi-structured interview aimed at assessing the interviewee's state of mind regarding attachment. The protocol includes questions about participants' relationship with their parents in childhood, important losses during their lifetime, and other potentially traumatic experiences, as well as how each of these affects their current functioning (see Hesse, 2008, for a detailed discussion of the AAI). Each interview was transcribed verbatim by a trained research assistant, after which the transcript was checked by another trained research assistant.

Attachment classifications are coded based on discourse *coherence* (rather than on content), and a continuous score for *coherence of mind* is assigned. Three organized or resolved (i.e., "definitive and singular," Hesse, 2008, p. 563) classifications are distinguished. Generally, the *secure-autonomous* (F) classification is assigned when the interviewee openly values attachment, yet discusses relationships with certain objectivity, and is associated with high coherence of mind; the *dismissing* classification reflects a dismissal or devaluing of

attachment; *preoccupied* speakers appear overly involved with attachment experiences. The latter two correspond to low coherence of mind scores. Apart from the three organized classifications, the *unresolved/disoriented* (U/d; henceforth U) classification may be primarily assigned when during discussion of loss or a potentially traumatic experience, the speaker displays a clear lapse in the monitoring of discourse or reasoning (e.g., talking about a dead person as if they were still alive, or expressing the belief of having caused one's own childhood abuse). This lapse is indicative of a disoriented state of mind with regard to the event under discussion, and when sufficiently unequivocal results in a high U score and a pertinent primary U classification. Finally, *cannot classify* is a rare, unorganized classification that mostly involves clear indications of two contradictory representations for different stretches of the same interview. U and CC share the lack of a single, organized attachment representation and in research have been pragmatically combined to form one category (e.g., Harari et al., 2009). AAI classifications were dichotomized into U/CC vs non-U (Ds, F, or E) as well as F vs non-F (Ds, E, U/CC) groups. Transcripts contained no identifying information and were coded by two certified coders using the standard AAI classification system (Main et al., 2003). The coders were unaware of the participants' maltreatment status or physiological data. Inter-rater reliability ($n = 16$) was satisfactory for the three-way classification Ds, F, E 75% , for the four-way classification Ds, F, E, U 69% , for F vs non-F 88% , for U vs non-U 75%. In the case of disagreement, the scores of the expert coder (MJBK) were used.

Data Analysis

For the preliminary analyses, we performed *t*-tests to compare Ds and E mothers on their autonomic levels, in order to assess whether they could be grouped into one insecure category. Once attachment groupings were established, we performed Pearson's chi-square tests to compare maltreating vs non-maltreating, U vs NonU (Ds, F, E), and F vs NonF (Ds, E, U/CC) mothers on ethnicity, educational level, medication, hearing problems, exercise, and

smoking, and whether their children had a clinical diagnosis. *T*-tests were done to check for differences in maternal age, children's mean age, and number of children. We calculated Pearson's correlation coefficients for the relation between the continuous background variables and baseline levels of the autonomic measures. We performed *t*-tests to evaluate whether exercise and smoking had an effect on baseline levels of the physiological variables. Univariate ANCOVAs, with maternal age as covariate (see below), were done to compare maltreating and non-maltreating mothers on baseline levels of SCL and RMSSD.

Next, we tested the associations between attachment, autonomic regulation, and child maltreatment perpetration with a series of regression analyses. The association between state of mind toward attachment and child maltreatment was tested using logistic regression. Two attachment constructs were entered as predictor variable in separate regressions: (1) Unresolved vs resolved attachment, and (2) Insecure (Ds, E, or U/CC) vs autonomous attachment. Next, we tested whether attachment representation was associated with autonomic regulation during the comfort paradigm with a series of hierarchical multiple regressions. Again, the attachment constructs mentioned above were entered as predictor variable in separate regressions with SCL and RMSSD during the responsive and unresponsive outcome scenario of the comfort paradigm as dependent variables. With an exploratory aim, the same set of logistic and multiple regressions were done using a continuous approach to the unresolved and autonomous attachment constructs, entering the unresolved score and coherence of mind score as predictors, respectively. Results can be found in the online supplementary materials. To test whether autonomic regulation during the comfort paradigm predicted maltreatment status, we performed two logistic regressions, one for the responsive clips and one for the unresponsive clips, with child maltreatment as dichotomous dependent variable and SCL and RMSSD as predictor variables. Finally, we did exploratory analyses to test whether autonomic regulation mediated the association between state of mind toward

attachment and child maltreatment, using the Preacher and Hayes' (2008) SPSS macro for indirect effects. The macro includes a bootstrapping procedure, and the number of bootstrap resamples k was set at 1,000.

Missing Data

To test the associations between attachment, autonomic responses, and child maltreatment, the series of logistic and multiple regressions were performed both in the group of participants with complete data ($N = 73$) and on an imputed dataset ($N = 90$). Multiple imputation was carried out with the mice package in R (Van Buuren & Groothuis-Oudshoorn, 2011), using Predictive Mean Matching (Van Buuren, 2012; Van Buuren, Brand, & Groothuis-Oudhoorn, 2006). In total, missing data were imputed 100 times, and the analyses were pooled in SPSS, using Rubin's combination rules (1987). Analyses performed on imputed and non-imputed data gave the same results. Results based on the non-imputed data are reported below.

Covariates

For the logistic regression predicting child maltreatment from attachment, demographics on which the maltreating and non-maltreating group differed (i.e., maternal age and children's mean age) were initially entered as covariates in the first block. Neither was significant, so they were excluded.

For the association between attachment and autonomic regulation, hierarchical multiple regressions were initially done to identify significant covariates. In the first block we entered: (1) demographics on which maltreating and non-maltreating mothers differed (i.e., maternal age and children's mean age; (2) circumstantial factors / habits (i.e., whether mothers smoked, whether they had exercise in the week prior to participation); (3) testing characteristics (i.e., the order in which responsive/unresponsive clips were presented, autonomic baseline levels). A second block was created for the predictor variable of interest

(i.e., attachment representation). Smoking, order of clip presentation, and autonomic baseline levels emerged as significant covariates. The results presented below are therefore based on hierarchical multiple regressions with smoking, clip presentation order, and autonomic baseline levels in the first block, and attachment in the second block.

For the logistic regressions predicting child maltreatment from autonomic regulation, we repeated the procedure described above. Smoking and exercise emerged as significant covariates, and were therefore retained in the first block of the logistic regression, with autonomic regulation added in the second block.

Finally, for the mediation analyses, maternal age, children's mean age, smoking, exercise, order of clip presentation, and autonomic baseline levels were initially defined as covariates in the SPSS macro. Smoking and exercise were significant and retained in the analyses.

Results

Preliminary analyses

T-tests showed Ds and E mothers did not differ on SCL and vagal tone values at baseline, nor during the responsive and unresponsive clips of the paradigms (ps ≥ 0.10), and could therefore be jointly compared to U and F mothers. With regard to demographics and background information, maltreating and non-maltreating mothers did not differ on ethnicity, educational level, medication affecting heart rate, number of children, or whether their children had been clinically diagnosed (ps $> .14$). However, mothers and children in the maltreating group were significantly younger (38.16 years, $SD = 7.36$ and 9.52 years, $SD = 5.21$) than their counterparts in the non-maltreating group (44.74 years, $SD = 5.11$ and 14.04 years, $SD = 3.73$), $t(66.17) = 4.47$, $p < .001$ and $t(67.04) = 4.28$, $p < .001$, respectively. Furthermore, fewer maltreating mothers than non-maltreating mothers had exercised in the week prior to the research appointment, $\chi^2 (1, N = 73) = 5.51$, $p = .02$, and more maltreating

mothers than non-maltreating mothers had smoked on the morning of the assessment, χ^2 (1, N = 73) = 8.02, p = .01. There were no other significant group differences (ps > .06)

Maternal age and children's mean age were negatively correlated with baseline SCL (r = -.27, p = .02 and r = -.30, p = .01, respectively) and maternal age also correlated with baseline RMSSD (r = -.26, p = .03). There were no significant associations between having exercised or smoked and baseline levels of SCL or RMSSD (ps > .06). For the maltreating group, the number of days in therapy before participating in the study was not related to baseline levels of the autonomic measures or to mothers' attachment representation (ps ≥ .32). No differences were found between maltreating and non-maltreating mothers for baseline levels of any of the physiological variables, when controlling for maternal and children's age (ps > .83).

Attachment Representation and Child Maltreatment

AAI classifications and scores for maltreating and non-maltreating mothers are displayed in Table 1. Logistic regression showed that the U/CC classification significantly increased the likelihood of being classified as a maltreating mother, χ^2 (1, N = 73) = 5.56, p = .02. For one non-maltreating mother her U classification was based on a recent loss. Excluding her from the analyses did not affect the reported results. Autonomous attachment did not significantly decrease the odds of being classified as a maltreating mother, χ^2 (1, N = 73) = 2.42, p = .12 (see Table 1 and Figure 2).

Attachment Representation and Autonomic Regulation

A series of multiple hierarchical regressions showed that having a U/CC classification was associated with lower SCL during the responsive outcome scenario of the comfort paradigm, significantly adding to the predictive value of the covariates, F change (1, 68) = 6.76, p = .01 (see Figure 3). In the same direction, an autonomous attachment representation significantly predicted *higher* SCL during the responsive clip, F change (1, 68) = 5.48, p =

.02. Neither U/CC nor F status predicted SCL during the unresponsive clips or vagal regulation during the comfort paradigm (ps ≥ .16; see Table 1 and Figure 2).

Autonomic Regulation and Maltreatment Status

In two separate logistic regressions, neither SCL nor RMSSD during either outcome scenario of the comfort paradigm were related to maltreatment status (ps ≥ .24).

Mediation

Preacher and Hayes (2004) have argued that the separate testing of the *c*, *a*, and *b* paths may be compromised by low statistical power, and that the only a priori condition for testing a mediation effect should be the association between the independent and the dependent variable. For the significant *c* path (i.e., the total effects of U attachment) we therefore tested with an exploratory aim whether autonomic regulation during the comfort paradigm mediated the association between attachment and child maltreatment. The *c'* paths (i.e., direct effect of attachment on child maltreatment, after controlling for autonomic regulation) were significant (ps < .05). The 95% confidence intervals for the indirect effect of attachment on child maltreatment, the *ab* paths, all contained zero. In sum, no mediating effects were found.

<center>**Discussion**</center>

In line with our expectations, an unresolved state of mind toward attachment was associated with child maltreatment perpetration. Although a robust link between an unresolved state of mind and anomalous parenting behavior had already been established (Madigan et al., 2006), our finding is an important addition to the small body of research that has identified an unresolved state of mind in maltreating parents (e.g., Adshead & Bluglass, 2005; Barone et al., 2014). Whereas some of these studies were marked by homogeneity in (relatively rare) maltreatment types (Münchausen by proxy in Adshead & Bluglass, 2005; filicide in Barone et al., 2014), for the mothers in our sample a wide range of maltreatment

incidents were substantiated, including emotional and physical child abuse and neglect, which renders them more representative of the population of maltreating mothers. Contrary to our expectations, maltreating and non-maltreating mothers did not differ on the distinction between autonomous and insecure states of mind. This seems in contrast with studies that have associated insecure states of mind with less optimal caregiving (Van IJzendoorn, 1995; Verhage et al., 2016). It is relevant to reiterate here that due to the clinical nature of our sample we only performed 4-way analyses on the AAI classifications, which resulted in an overlap between our U versus Non-U and our F versus Non-F comparisons. The difference between the two comparisons resided in a subgroup of $n = 12$ (maltreating $n = 5$) who had neither a U nor an F classification, hence, a primary Ds or E classification. The similarity in insecure-organized classification rates between maltreating and non-maltreating mothers therefore rendered the F versus Non-F comparison non-significant. The low Ds/E prevalence further underscores the clinical relevance of the U state of mind.

Unresolved and non-autonomous attachment were associated with decreased SCLs during the comfort paradigm, particularly during the reunion between "caregiver" and "child". It may be that for these mothers watching a reunion episode is especially poignant because of the contrast with their own attachment experiences. Indeed, an overview of the literature on autonomic responses and their relation to emotions has shown that SCL decreases are relatively uniquely indicative of a deactivating response of (non-crying) sadness (Kreibig, 2010). We tentatively suggest that mothers' deactivating, rather than activating, response may indicate a passive, disengaging coping strategy, which seems congruent particularly with the dissociative nature of the unresolved state of mind. It may seem surprising that the reunion clip evoked such a response, but relevant studies (on parenting quality and children's attachment) have also found autonomic distinctions between mothers solely during the reunion episodes of the Strange Situation Paradigm and the Still Face Paradigm (respectively,

Hill-Soderlund et al., 2008; Mills-Koonce et al., 2009), suggesting its emotional salience. No associations with AAI state of mind were found for RMSSD. On the one hand this is congruent with research that has found attachment-related regulation for electrodermal but not for cardiovascular measures (Roisman et al., 2004). On the other hand, it may be due to our stimulus; the comfort paradigm may have been too mild to evoke a more complete autonomic response. However, the results suggest that incoherent and unresolved mothers were more affected by the comfort paradigm than organized mothers were. Thereby they highlight how even short and subtle attachment-related stimuli are able to evoke an autonomic response that distinguished unresolved from organized mothers, also out of the direct AAI context. This makes attachment-related autonomic regulation a promising area for future research, considering that stimuli of a longer duration and with real-life verisimilitude may reveal more clearly the differences in autonomic regulation inherent to attachment representation that our findings touched upon.

Maltreating and non-maltreating mothers did not differ in their autonomic responsiveness to the comfort paradigm, and no mediating effect of autonomic regulation was found. The lack of differential autonomic regulation may be due to the high level of comparability between the maltreating and non-maltreating group, particularly in terms of the caregiving challenges they faced having clinically diagnosed children. Interestingly, previous findings for the current sample have shown that another paradigm of infant cry sounds did elicit different autonomic responses for maltreating and non-maltreating mothers (Reijman et al., 2014), so the lack of autonomic differences may also be task-related. In the comfort paradigm, the visual presentation of the dyad gave meaning to the "child's" cry sounds, which may have evoked attachment-related emotions in mothers. In the previously used cry paradigm, cry sounds of different pitches were presented without any visual accompaniment, leaving the interpretation of the cries open, which may have resulted in a stronger activation

of mothers' *caregiving* system. Our findings converge with those of Riem and colleagues (2012), who found no mediating role for amygdala reactivity in the association between attachment security and participants' behavioral responses to infant cry sounds, as measured by force used when squeezing a handgrip dynamometer. However, as indicated by the authors, their sample was small and consisted of women without children of their own. The absence of neurobiological mediation found so far may then have methodological explanations, which future studies could try to rule out before firm conclusions are drawn.

Our study had several limitations. The sample was small, which may have led to insufficient statistical power to detect differences in attachment representations between maltreating and non-maltreating mothers. It also precluded the comparison of neglectful versus neglectful and abusive mothers. As mentioned, the comfort paradigm may have been too mild to evoke a pronounced pattern of autonomic regulation. Furthermore, as with any standardized task, it challenges the external validity of the findings, which need to be replicated in more natural settings. Although the arguably high-risk status of our non-maltreating group may have limited the differences found between maltreating and non-maltreating mothers, we ultimately consider this a strong point: it means that the differences we did find can be plausibly attributed to mothers' maltreatment status. Studies using more than one comparison group may shed light on attachment representation and autonomic regulation associated with different levels of caregiving quality. Finally, the unresolved state of mind toward attachment is only one way in which disorientation toward traumatic experiences may manifest. As described in previous sections, it is coded in the presence of narrations of loss or childhood abuse. Expanding on the U/d scale, the Helpless-Hostile scale was developed to code additional indications of an unintegrated state of mind throughout the AAI (Lyons-Ruth, Yellin, Melnick, & Atwood, 2003; Lyons-Ruth, Yellin, Melnick, & Atwood, 2005). Such indications include, for example, the devaluation of a caregiver in

combination with unconscious identification with same caregiver, and they have been associated with maternal disrupted communication as coded by the AMBIANCE system (Lyons-Ruth et al., 1999; Lyons-Ruth et al., 2005). Future studies might assess the Helpless-Hostile state of mind as an additional potential risk factor for child maltreatment.

Our finding of an unresolved state of mind in maltreating mothers supports the possible utility of attachment-based interventions. Although short, maternal behavior-focused interventions have overall been most effective (when sensitive parenting or infant attachment was the outcome measure; Bakermans-Kranenburg, Van IJzendoorn, & Juffer, 2003), intervention effectiveness may diminish with at-risk parents (Bakermans-Kranenburg, Van IJzendoorn, & Juffer, 2005). Promisingly, a short-term parenting-focused intervention improved parental sensitivity and child attachment quality in a sample of maltreating parents (Moss et al., 2011). However, in a systematic comparison of a behavior-focused program and an attachment-informed psychotherapeutic intervention in maltreating mothers and their preschool children, the latter was found more effective (at improving children's self and other representations; Toth, Maughan, Manly, Spagnola, & Cicchetti, 2002). Although both types of intervention programs were equally effective in maltreating families with younger infants (Cicchetti, Rogosch, & Toth, 2006), a 12-month follow-up showed that the beneficial effects of the psychotherapeutic intervention on child attachment security held up better than those of the parenting-focused program (Pickreign Stronach, Toth, Rogosch, & Cicchetti, 2013). Furthermore, unresolved attachment in parents may sometimes impede the effectiveness of brief, behavior-focused interventions, as in an intervention study with adolescent mothers, especially when it obstructs fruitful dyadic interactions (Moran, Pederson, & Krupka, 2005). Trauma processing focused on integrating traumatic experiences within one organized state of mind toward attachment may therefore be a prerequisite for effective interaction-focused intervention with unresolved maltreating mothers. The inclusion of ANS measurements pre-

and post-intervention could further show whether a shift from an unresolved to an organized

state of mind entails changes in attachment-related autonomic regulation.

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Table 1
Summary of Regression Analyses

Path c: Logistic regressions AAI and Child Maltreatment[1]				
	Maltreating	Non-maltreating	Statistics	
	(*n* = 38)	(*n* = 35)	χ^2	*p*
AAI U/CC	42%	17%	5.56*	.02
AAI F	45%	63%	2.42	.12

Path a: Hierarchical regression AAI Classification and Autonomic Responses[2]							
		AAI U/CC		AAI Non-U/CC		Statistics	
		(*n* = 22)		(*n* = 51)		*t*	*p*
		M	*SD*	*M*	*SD*		
SCL	baseline	5.08	2.82	4.92	2.39	n/a	n/a
	responsive	4.88	2.89	4.90	2.49	-2.63*	.01
	unresponsive	4.93	2.82	4.87	2.46	0.13	.90
RMSSD	baseline	36.79	24.09	36.41	18.74	n/a	n/a
	responsive	33.59	19.72	33.22	16.72	-0.27	.79
	unresponsive	31.87	18.49	33.37	15.43	-1.00	.32
		AAI F		AAI Non-F		Statistics	
		(*n* = 39)		(*n* = 34)		*t*	*p*
		M	*SD*	*M*	*SD*		
SCL	baseline	5.11	2.39	4.81	2.63	n/a	n/a
	responsive	5.11	2.55	4.64	2.67	2.48*	.02
	unresponsive	5.09	2.49	4.65	2.64	0.62	.54
RMSSD	baseline	38.40	19.72	34.38	21.08	n/a	n/a
	responsive	35.19	17.12	31.20	18.02	0.99	.33
	unresponsive	35.29	15.96	30.19	16.49	1.55	.13

Path b: Logistic regressions Autonomic Responses and Child Maltreatment[3]							
		Maltreating		Non-maltreating		Statistics	
		(*n* = 38)		(*n* = 35)		χ^2	*p*
		M	*SD*	*M*	*SD*		
SCL	baseline	5.34	2.36	4.57	2.60	n/a	n/a
	responsive	5.21	2.46	4.55	2.74	-1.10	.28
	unresponsive	5.27	2.35	4.46	2.73	-1.37	.18
RMSSD	baseline	38.32	21.17	34.58	19.49	n/a	n/a
	responsive	35.13	19.26	31.37	15.49	-0.91	.36

unresponsive	34.36	16.76	31.35	15.88	-0.79	.43

Note: AAI U/CC = Unresolved or Cannot Classify classification; AAI F = secure-autonomous classification; SCL = skin conductance level; RMSSD = root mean square of successive differences (vagal tone); n/a = not applicable (SCL and RMSSD baseline levels were as covariates in the regressions).
[1] No covariates were included in the logistic regressions for path *c*; [2] Smoking, order of video clips, and autonomic baseline levels were entered as covariates in the regression analyses for path *a*; [3] Smoking and exercise were included as covariates in the logistic regressions for path *b*. * $p < .05$
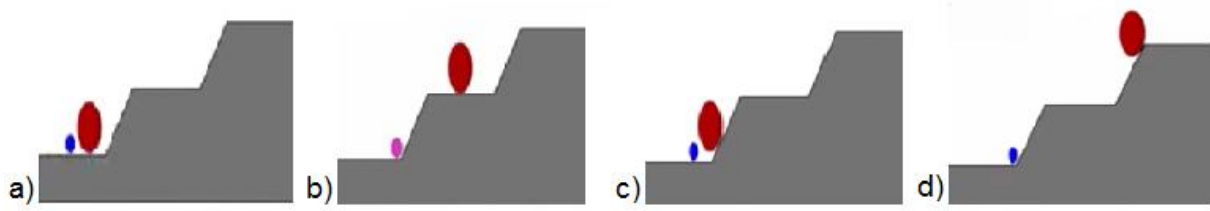
Figure 1. Stills from the comfort paradigm. a) and b) display the introductory clip of the comfort paradigm, in which a) "caregiver" oval and "child" oval enter the scene and, b) the caregiver mounts the slope, leaving the child behind, who starts to cry; c) displays the responsive clip, in which the caregiver returns to the crying child; d) shows the unresponsive clip, in which the caregiver leaves the crying child behind (Johnson, Dweck, & Chen, 2007). Participants watched c) and d) in counterbalanced order.
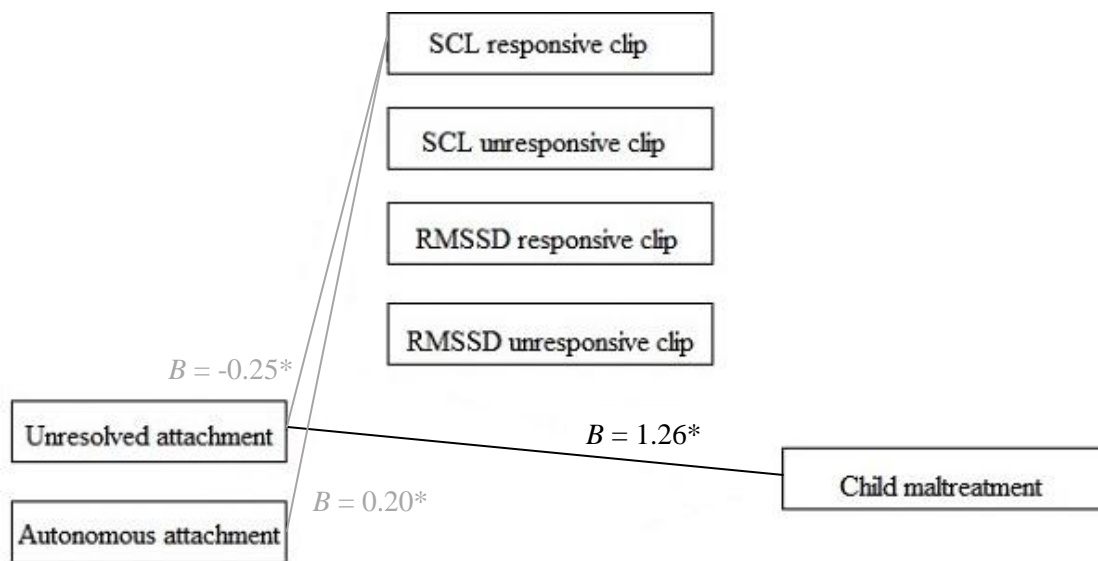
Figure 2. Summary of results. SCL = skin conductance levels; RMSSD = root mean square of successive differences (an index of vagal tone). Absence of a drawn pathway means regression analyses were not significant (*p*s > .05). * *p* < .05
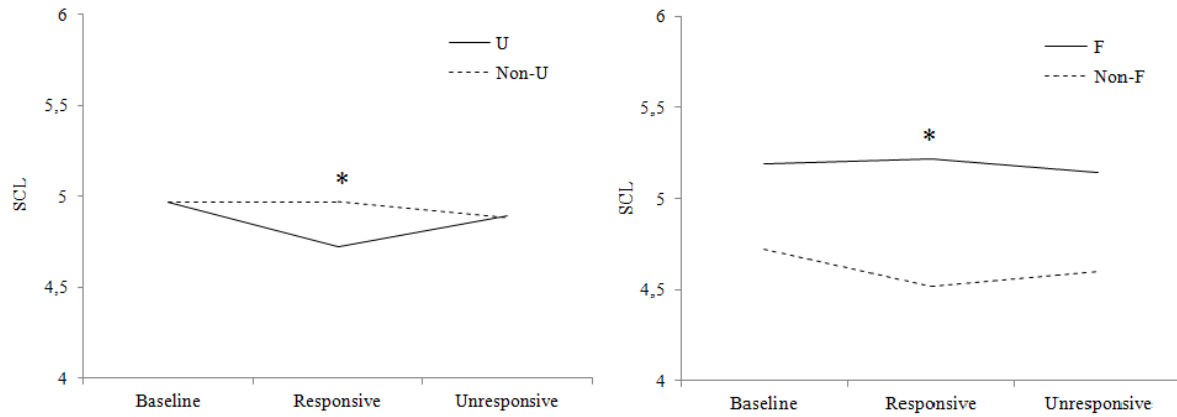
Figure 3. SCL response per AAI status. SCL responses from baseline
to the responsive clip differed between unresolved and organized mothers (left graph) and
between autonomous and non-autonomous mothers (right graph). * $p < .05$

ATTACHMENT IN MALTREATING MOTHERS

Supplemental Material

S.1: Continuous attachment variables as predictors

The association between state of mind toward attachment and child maltreatment was additionally tested with total U score (continuous) and coherence of mind (continuous) as predictor variable in separate logistic regressions. There were no significant covariates. Parallel to our categorical approach, we tested whether attachment was associated with autonomic regulation during the comfort paradigm with a series of hierarchical multiple regressions. The two attachment dimensions mentioned above were entered as predictor variable in separate regressions with SCL and RMSSD during the responsive and unresponsive outcome scenario of the comfort paradigm as dependent variables. Whether mothers had smoked on the day of the research appointment, the order of video clips during the comfort paradigm (i.e., responsive followed by unresponsive caregiver scenario, or vice versa), and autonomic baseline levels were entered as covariates. Results did not differ between analyses done on the non-imputed and the imputed dataset, and are reported based on the non-imputed dataset.

Significant regression pathways are summarized in Figure S.1. As displayed in Table S.1, total U score was not significantly associated with the likelihood of being classified as a maltreating or non-maltreating mother, χ^2 (1, $N = 73$) = 2.56, $p = .11$. However, coherence of mind lowered the odds of being classified as a maltreating mother, χ^2 (1, $N = 73$) = 7.08, $p = .01$. The continuous approach to the two main attachment constructs (i.e., unresolved and autonomous attachment) therefore led to different results than the dichotomous approach: in the latter, the U vs Non-U dichotomy was significantly related to child maltreatment (and F vs Non-F was not). Notably, these results are not incompatible, as all attachment variables correlated moderately to strongly (rs -.37, -.73).

In line with findings for categorical predictors, U score was associated with lower SCL during the responsive caregiver scene (*F* change [1, 68] = 6.80, $p = .01$), while coherence of mind predicted higher SCL during the responsive clip (*F* change [1, 68] = 5.33, $p = .02$; see Table S.1). Again, neither total U score nor coherence of mind predicted SCL regulation during the unresponsive clip or vagal regulation during either outcome scenario (ps $\geq .15$).

Table S.1.

Logistic and multiple regression with continuous attachment predictors

	Path c: Logistic regressions AAI Scores and Child Maltreatment[1]					
	Maltreating		Non-maltreating		Statistics	
	($n = 38$)		($n = 35$)			
	M	*SD*	*M*	*SD*	χ^2	*p*
AAI U/d score	4.18	2.13	3.33	1.91	2.56	.11
AAI CM score	4.64	1.85	5.76	1.65	7.08*	.01

	Path a: Multiple regressions AAI Scores and Autonomic Responses[2]							
	SCL responsive		SCL unresponsive		RMSSD responsive		RMSSD unresponsive	
	t	*p*	*t*	*p*	*t*	*p*	*t*	*p*
AAI U/d score	-2.65*	.01	-0.75	.46	-0.56	.58	-1.53	.13
AAI CM score	2.44*	.02	0.86	.39	0.23	.82	1.08	.28

Note: AAI = Adult Attachment Interview; U/d = continuous unresolved score; CM = coherence of mind score; SCL = skin conductance level; RMSSD = root mean square of successive differences (vagal tone).
[1] No covariates were included in the logistic regressions for path *c*; [2] Smoking, order of video clips, and autonomic baseline levels were entered as covariates in the regression analyses for path *a*. * $p < .05$
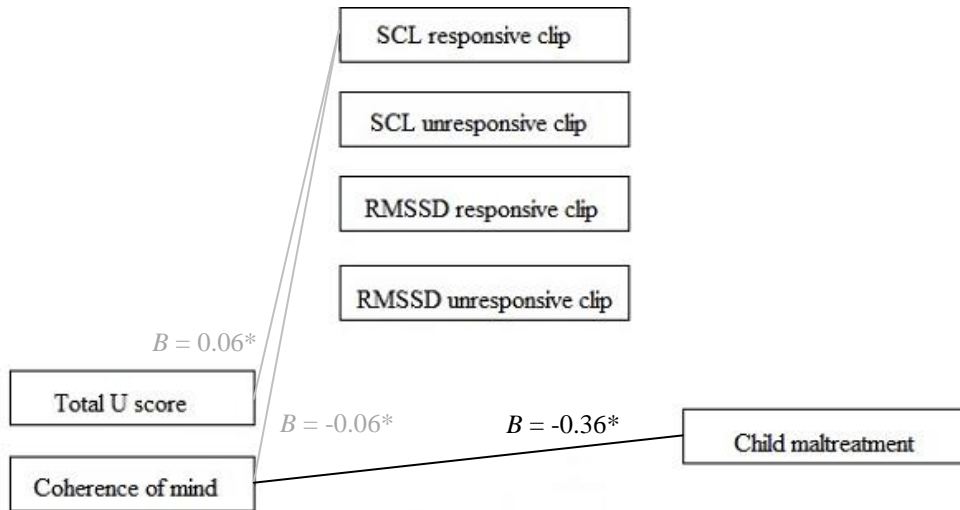
Figure S.1. Summary of significant regressions for continuous attachment variables. SCL = skin conductance levels; RMSSD = root mean square of successive differences (an index of vagal tone); U = continuous unresolved score. Absence of a drawn pathway means regression analyses were not significant (*p*s > .05). * *p* < .05.