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## **Harsh discipline in toddlerhood : A longitudinal study on maternal physiological and behavioral predictors**

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# Harsh discipline in toddlerhood

A longitudinal study on maternal physiological  
and behavioral predictors

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# Harsh discipline in toddlerhood

## A longitudinal study on maternal physiological and behavioral predictors

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ter verkrijging van  
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op gezag van Rector Magnificus prof.mr. P.F. van der Heijden,  
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# 1 Introduction

Harsh discipline is a parenting strategy that is used worldwide, especially in challenging child-rearing situations (Gershoff et al., 2010). Some studies report that more than 90% of the normal population of parents use harsh discipline with their children (for reviews see e.g., Gershoff, 2002; Paolucci & Violato, 2004). These high percentages are in sharp contrast to the fact that harsh physical discipline practices have been banned by law in several countries (including The Netherlands) due to the empirically proven negative consequences of such discipline strategies on children's development (Gershoff et al., 2010; Lansford, Deater-Deckard, Dodge, Bates, & Pettit, 2004). Children of parents who use harsh discipline have higher levels of externalizing behavior problems in childhood (e.g., Bender et al., 2007; Fine, Trentacosta, Izard, Mostow, & Campbell, 2004; O'Leary, Slep & Reid, 1999; Prinzie, Onghena, & Hellinckx, 2006), are more likely to become delinquent (Hoeve et al., 2009) and generally have lower levels of mental health (Gershoff, 2002) compared to children of non-harsh parents. Nonetheless, a controversy remains as to whether these negative consequences are related to the use of all forms of harsh or physical discipline including spanking, which has sometimes been labeled as 'discipline with reasonable force' (Baumrind, Larzelere, & Cowan, 2002). Adding to this debate, a recent study among a large ethnically diverse sample included spanking and found that across all subgroups the use of spanking as the sole measure of harsh discipline in kindergarten *was* predictive of more externalizing problem behavior in 3<sup>rd</sup> grade (Gershoff, Sexton, Lansford, Davis-Kean, & Sameroff, 2012).

## *Defining harsh discipline*

Contrary to the study of Gershoff et al. (2012), most empirical work on harsh discipline uses definitions including multiple disciplining (or punishing) behaviors. Because measures of harsh discipline generally encompass a multitude of different behaviors it is plausible that part of the explanation of the divergence in findings for effects of harsh discipline lies in the different and only partly overlapping definitions used across studies. The various harsh discipline strategies can be seen on a continuum ranging from subtle forms such as grabbing hard, to forms of corporal punishment in the middle of the continuum (such as hitting with a belt or paddle), to more extreme forms of physical punishment (such as beating or kicking causing injuries which could result in hospitalization) at the other end of this harsh discipline continuum. Thus, comparing results on child outcomes of harsh discipline is problematic when some studies include only part of the continuum (e.g., spanking) in their definitions, while other studies include the whole, or a different, range of harsh discipline behaviors.

Besides this continuum based solely on physical aspects of harsh discipline, the broader concept of overreactive discipline which includes parenting behaviors such as yelling, threatening, commanding, and name-calling has been used in several studies (e.g. Bugental & Happaney, 2004; Chang, Schwartz, Dodge, & McBride-Chang, 2003; Fine et al., 2004; Leung & Slep, 2006; Straus & Stewart, 1999). Such overreactive parenting behaviors are central to Patterson's coercion theory. Within this theoretical framework, parents respond with escalating coercive discipline strategies such as physical and verbal harshness when faced with challenging child behavior (Patterson, 1982). There is substantial evidence that this pattern of physically and verbally harsh discipline is related to negative child outcomes through processes such as modeling and lack of positive reinforcement (e.g., Patterson, Capaldi, & Bank, 1991; Shaw, Bell, & Gilliom, 2000). Following coercion theory and the idea of escalating discipline in multiple modalities, both physical (e.g., spanking, grabbing, pushing, and pulling) and verbal (e.g., yelling, name calling, and aggressive/irritated tone of voice) discipline strategies are included as aspects of harsh discipline in the current thesis.

Uncovering harsh discipline strategies during home observations is extremely difficult due to the social *undesirability* of this parenting behavior. When parents participate in a standardized discipline task in their own home environment, it seems reasonable to presume that they will at least try to show their best behavior in front of the camera. The fact that this minimizes the chance to observe severe forms of harsh discipline also implies that observations of subtler harsh discipline behaviors (such as grabbing) could potentially signal the use of more blatant harsher strategies without a camera person present. This would mean that even subtle forms of harsh discipline may be predictive of child development. This was confirmed, for example, by a study in which such subtle harsh discipline behaviors were observed in a laboratory setting and found predictive of a growth in child conduct problems at home and at school (Snyder, Cramer, Afrank, & Patterson, 2005). Therefore we included more subtle forms of physical and verbal harsh discipline in our operationalization of harsh parenting. Since harsh parenting has been shown to have a negative impact on children's development (e.g., Gershoff, 2002) it is especially important to examine maternal predictors of harsh discipline. If we can identify parents at risk for harsh discipline based on their parenting skills or characteristics in infancy, this could enhance early preventive intervention efforts.

#### *Predicting harsh discipline: Maternal sensitivity to infant signals.*

The construct of maternal sensitivity is rooted in the framework of attachment theory and was first studied in detail by Mary Ainsworth during her well-known Uganda study (1967). Based on this extensive, naturalistic, observational study of Ugandan mothers with their infants, she defined the construct of sensitivity as a mother's ability to perceive child signals, to interpret these signals correctly, and to respond to them promptly and appropriately (Ainsworth, Bell, & Stayton, 1974). Over the following decades maternal sensitivity has been the topic of an abundance of empirical work, which has shown the importance of this construct in predicting positive child outcomes such as secure attachment (Bakermans-

Kranenburg, Van IJzendoorn, & Juffer, 2003; De Wolff & Van IJzendoorn, 1997), self-regulation (Eisenberg et al., 2001), social functioning (e.g., Kochanska, 2002; Van Zeijl et al., 2006), and cognitive competence (e.g., Bernier, Carlson, & Wipple, 2010; Tamis-LeMonda, Bornstein, & Baumwell, 2001).

Even though maternal sensitivity has often been studied in relation to child outcomes, less empirical attention has been paid to the link between maternal sensitivity towards infants and future parenting strategies such as harsh discipline. This lack of studies linking early sensitivity to later harsh discipline can probably be explained by the fact that these constructs stem from very different research traditions, namely attachment and social learning theories respectively. However, the literature on the two parenting constructs shows substantial overlap in the way they are described and explained. Milner (1993, 2003) presented a four-stage model of social information processing, which describes high- risk and abusive parents as (1) more biased in the perception of, as well as less attentive to, their child's behavior, (2) more likely to interpret negative child behaviors as motivated by hostile intent, and to have child-centered attributions (i.e., to view this behavior as due to internal, stable, and global child factors), (3) less likely to use situational cues when evaluating their children's behavior, and (4) less likely to have well-developed skills or abilities to implement and modify child-directed responses and parenting strategies. These four stages clearly resemble the main elements of Ainsworth's maternal sensitivity construct (i.e., awareness and interpretation of signals and appropriate responding), but are formulated in terms of the absence of these skills. Thus, there is reason to believe that a lack of sensitivity in infancy may predict harsh discipline strategies in toddlerhood.

Over the years the large amount of empirical work centered around the construct of maternal sensitivity has led to a great variety in operationalizations. Part of this variety is accounted for by the setting in which maternal sensitivity is observed. In principal any dyadic interaction can be used to observe maternal sensitivity. Ainsworth's exploratory work in both Uganda (Ainsworth, 1967) and Baltimore (Ainsworth, Blehar, Waters, & Wall, 1978) was based on elaborate naturalistic observations of mother-infant dyads during a variety of daily routines (i.e., bathing, feeding, etc.). Even though this strategy provides an extensively detailed picture of maternal behaviors across different situations it is also very time consuming. Therefore, shorter naturalistic observations of single daily routines such as bathing or feeding have been employed in many studies over the years (e.g., Albers, Riksen-Walraven, Sweep, & De Weerth, 2008).

At other times the choice of setting to observe maternal sensitivity depends on the type of maternal responsiveness one wishes to observe. For example, maternal sensitivity to distress has been shown to be a stronger predictor of infant attachment security than maternal sensitivity to non-distress (McElwain & Booth-LaForce, 2006). An observation paradigm that includes both non-distressing and potentially distressing interactions is the Still-Face Paradigm (SFP; Tronick, Als, Adamson, Wise, & Brazelton, 1978). This standardized face-to-face dyadic interaction consists of three episodes: (1) a baseline with normal interaction, (2) the 'still-face' episode in which the adult becomes unresponsive whilst maintaining a neutral facial expression, and (3) a reunion in which normal

interaction is resumed. Especially the so-called 'carry-over effect' evident from a continuation of increased negative affect from the still-face into the reunion episode makes the reunion episode suitable for observing maternal sensitivity to distress.

*Predicting harsh discipline: The role of the autonomic nervous system (ANS).*

From a biological perspective, individual differences in parental physiological reactivity to (negative) infant stimuli have been related to differences in the quality of parenting. For example, greater heart rate (HR) reactivity to infant crying has been shown to distinguish parents at risk for abuse from controls (for a review see McCanne & Hagstrom, 1996). Furthermore, there has been empirical support for a direct relation between greater maternal HR reactivity and more use of overreactive discipline strategies (Lorber & O'Leary, 2005). However, greater HR reactivity in response to infant crying has also been found in mothers with a prompt response to infant crying (Del Vecchio, Walter, & O'Leary, 2009); an aspect of maternal sensitivity. The fact that greater HR reactivity seems to be related to both harsh and sensitive parenting may be due to the fact that activation of both the sympathetic and the parasympathetic branch of the autonomic nervous system (ANS) can lead to increases in HR (see Berntson, Cacioppo, Quigley, & Fabro, 1994). These dual mechanisms influencing HR create a problem for the interpretation of HR reactivity.

To examine the underlying mechanisms of physiological reactivity, Porges' polyvagal theory (1995, 2001, 2007, 2011) describes three subsystems of the ANS, namely the social communication circuit (involving the myelinated vagus and the PNS), the mobilization circuit (involving the SNS and fight-flight behaviors), and the most primitive circuit of immobilization (involving the unmyelinated vagus and e.g., feigning death or freezing behaviors). These three subsystems developed in three phylogenetic stages and are, therefore, hierarchically activated when responding to external stressors. The activation of a specific subsystem also depends on the perception of the environment as either safe or threatening. In a safe environment the PNS circuit for social communications is activated to promote survival by facilitating social interactions and social bonds.

This newest circuit of social communication depends on the functioning of the ventral vagal complex (VVC), which originates in the nucleus ambiguus. The VVC functions as an active vagal brake by controlling cardiac output via the sino-atrial node (Porges, 2001, 2007). The degree of cardiac control by the vagal brake can be quantified by measurement of the amplitude of respiratory sinus arrhythmia (RSA; Porges, 1995). Efficient disinhibition of the vagal brake (i.e., RSA withdrawal) seems to be associated with increased behavioral and emotional control, which enables rapid mobilization as well as calm and self-soothing behavioral states in response to environmental demands (Porges, 1996). In other words, an efficiently functioning vagal brake points to physiological flexibility when reacting to environmental demands. Individuals with stronger RSA withdrawal are supposedly better able to respond adequately to external stressors (Porges, Doussard-Roosevelt, & Maiti, 1994). Since parental sensitivity refers to an adequate and prompt response to infant signals (Ainsworth et al.,

1974), sensitivity in response to infant distress may be related to functioning of the vagal brake, with more sensitive parents showing stronger RSA withdrawal.

However, when the environment is perceived as dangerous or threatening the autonomic system switches to the more primitive circuits and activates the SNS to regulate defensive strategies through a fight-or-flight response. Since harsh parents, given their negative and child-blaming attributions, seem to operate from a threat rather than a safety perspective, they may be expected to show physiological overreactivity of especially the mobilization circuit (SNS) in response to infant crying. Thus, the negative behavioral overreactivity to infant signals seen in parents at risk for abuse (Milner, 2003) may signal a chronically overactivated SNS resulting from a *poorly* functioning vagal brake (Porges, 2001). Therefore, the difference between parents who do use harsh discipline and those who do not would be the combination of an overreactive SNS with an unresponsive PNS.

### *Study design*

The current thesis is based on two waves of a longitudinal study that was conducted in a sample of 103 families with a newborn second child. In the first wave participants were approached through midwifery practices in the western region of the Netherlands. Of the 72 practices that were asked to assist the approach of participants, 53 participated in handing out pamphlets and letters on the study to pregnant women expecting a second child. Due to a self-selection of higher educated families during the first wave, a second method was implemented to include a larger group of lower educated mothers. During the second wave, the Regional Coordination Programs of the Dutch National Institute (NIPHE) assisted in approaching families from the lower socioeconomic strata *after* the birth of their second child. Postal codes were selected of areas in which more than 30% of inhabitants had a low income (less than 14,200 Euro per year; as defined by the Dutch Central Bureau of Statistics). Families with a newborn infant living in these areas received a letter from the NIPHE with information about the study by mail.

Families were included when: 1) the first child scored either low or high on externalizing behavior (cutoffs based on Van Zeijl et al., 2006), 2) the first child was younger than six years old, 3) the newborn second child was neither premature nor handicapped, 4) both children and parents lived together in one household and 5) both parents were Caucasian and of Dutch ethnicity. The first wave resulted in a total of 57 families fitting all criteria, of which a total of 50 families agreed to participate in the home visits (25 'high externalizing' families; 25 'low externalizing' families). An additional 76 families were selected with this second method, of which 53 participated in the study (27 'low externalizing' families and 26 'high externalizing families').

All families were visited at home a total of 7 times during the first two years after birth of the second child. These home visits were scheduled at regular intervals when the youngest child was 3, 6, 9, 12, 18 and 24 months old. Home visits up to 9 months included various dyadic settings to observe maternal sensitivity, which were videotaped and coded later. Furthermore, among the wave 2 sample

a cry paradigm was administered at 3 and 6 months, during which physiological data was collected. Home visits from 12 months onwards included videotaped observations of discipline strategies as well as of maternal sensitivity. Attrition rates were low during the 2 years of data collection. Of the 50 families included during the first wave, 36 (72%) families continued to participate in the study up to and including the final home visit at 24 months. Attrition was even lower in the second wave sample of participants from lower socioeconomic strata. Of the 53 families included at the start, 47 (88.7%) also participated in the last home visit.

*Aims and outline of the current thesis*

In the current thesis we investigate both maternal sensitivity and physiological reactivity to infant crying as potential early indicators of later harsh discipline. The chapters are organized in the following manner. In Chapter 2 the relation between maternal sensitivity and physiological reactivity to repeated infant crying is described. Specifically, we describe the differences in physiological reactivity to a standardized set of repeated infant crying bouts between highly sensitive mothers and less sensitive mothers using repeated measures analyses. Chapter 3 focuses on the predictive role of early maternal sensitivity on harsh discipline in toddlerhood, for which we use a mediational model. Furthermore, we investigate maternal sensitive behavior across various settings and examine whether maternal sensitivity to infants is a stable construct over time. Chapter 4 addresses the question whether observed harsh discipline at 12 months can be predicted by sympathetic (SNS) overreactivity to repeated infant crying. In this chapter harsh mothers are compared to non-harsh mothers on their physiological reactivity to repeated infant crying. Chapter 5 presents a general discussion in which the main findings of the current thesis are summarized and discussed. Limitations of the current thesis are addressed and some suggestions for further research are formulated. In addition this chapter includes a discussion of both theoretical and practical implications of the results.

## Physiological reactivity to infant crying and observed maternal sensitivity

*Katharina J. Joosen, Judi Mesman, Marian J. Bakermans-Kranenburg, Suzanne Pieper, Philip S. Zeskind, Marinus H. van IJzendoorn  
Infancy, 1-18, 2012*

### ABSTRACT

Relations between maternal sensitivity and physiological reactivity to infant crying were examined using measures of heart rate (HR) and respiratory sinus arrhythmia (RSA) in 49 mothers of second-born infants. Using the Ainsworth Sensitivity Scale, an independent assessment of maternal sensitivity was made during maternal free play and bathing of their infants. Physiological reactivity was measured while mothers listened to three blocks of infant cry sounds in a standard cry paradigm. Mothers scoring high on sensitivity were compared to less sensitive mothers on both their physiological reactivity to the presented crying sounds and their physiological mean-level differences. Significant interaction effects were found for both HR and RSA. Highly sensitive mothers showed a larger increase in HR and stronger RSA withdrawal in response to the first block of cry sounds compared to less sensitive mothers. Main effects showed that highly sensitive mothers had lower mean overall HR, and higher mean RSA levels across all three blocks of crying sounds compared to less sensitive mothers. RSA withdrawal and accompanying HR increases are discussed from a polyvagal perspective as indicative of a better capability in responding to infant signals of negative affect.

*Key words: infant crying, HR reactivity, RSA withdrawal, maternal sensitivity*

### INTRODUCTION

The sound of infant crying is the first acoustic signal a newborn infant sends to the parent. The functionality of this intense signal lies in evoking parenting responses (Bowlby, 1969/1982; Lagasse, Neal & Lester, 2005; Zeifman, 2001; Zeskind & Lester, 2001), partly by eliciting physiological reactions (Frodi & Lamb, 1980; Frodi, Lamb, Leavitt & Donovan, 1978; Groh & Roisman, 2009; Wiesenfeld, Malatesta & DeLoach, 1981). Individual differences in parental physiological reactivity to infant crying have been linked to differences in the quality of parenting. Greater heart rate (HR) reactivity to negative infant stimuli,

for example, distinguishes those at risk for child abuse from controls (for a review see McCanne & Hagstrom, 1996). However, greater HR reactivity to infant crying has also been related to more prompt maternal responses to these negative infant signals (Del Vecchio, Walter & O'Leary, 2009), which is one of the aspects defining maternal sensitivity (Ainsworth, Bell & Stayton, 1974). Thus, a greater HR reactivity to infant crying has been associated with negative as well as positive parenting behaviors, which indicates a need for further examination of the mechanisms underlying physiological reactivity to infant crying. In this study we examine the relation between observed maternal sensitivity and physiological reactivity to infant crying following the theoretical framework of Porges' polyvagal theory (1995, 2001, 2007).

In his polyvagal theory Porges (1995, 2001, 2007) describes how the autonomic nervous system developed in three phylogenetic stages, resulting in three distinct autonomic subsystems: the social communication circuit (involving the myelinated vagus and parasympathetic nervous system; PNS), the mobilization circuit (involving the sympathetic nervous system (SNS) and fight-flight behaviors), and the most primitive circuit of immobilization (involving the unmyelinated vagus and e.g., feigning death or freezing behaviors). These subsystems are hierarchically organized, and when responding to external stressors humans first rely on the newest circuit. This newest circuit of social communication depends on the functioning of the ventral vagal complex (VVC), which originates in the nucleus ambiguus. The VVC functions as an active vagal brake by controlling cardiac output via the sino-atrial node (Porges, 2001, 2007). The degree of cardiac control by the vagal brake can be quantified by measurement of the amplitude of respiratory sinus arrhythmia (RSA; Porges, 1995). Efficient disinhibition of the vagal brake (i.e., RSA withdrawal) seems to be associated with increased behavioral and emotional control, which enables rapid mobilization as well as calm and self-soothing behavioral states in response to environmental demands (Porges, 1996). In other words, an efficiently functioning vagal brake points to physiological flexibility when reacting to environmental demands. Individuals with stronger RSA withdrawal are supposedly better able to respond adequately to external stressors (Porges, Doussard-Roosevelt & Maiti, 1994). Since parental sensitivity refers to an adequate and prompt response to infant signals (Ainsworth et al., 1974), sensitivity in response to infant distress may be related to functioning of the vagal brake, with more sensitive parents showing stronger RSA withdrawal.

In line with this suggestion, a stronger RSA withdrawal has been linked to indices of positive parenting behavior in reaction to negative infant signals. For example, maternal RSA withdrawal was shown to moderate the relation between negative infant affect and maternal sensitivity. More infant negative affect was related to higher maternal sensitivity only in case of stronger maternal RSA withdrawal (Mills-Koonce et al., 2007). In addition, stronger maternal RSA withdrawal has been related to mobilization of maternal soothing behaviors during infant distress (Ham & Tronick, 2006; Moore et al., 2009). Due to its function of rapid mobilization, partly through control of the sino-atrial node, RSA withdrawal would likely lead to increased HR (Porges, 2001). Thus, it seems that

the existing literature is somewhat contradictory. Greater HR reactivity has been linked to a risk for child abuse (e.g., McCanne & Hagstrom, 1996) while at the same time greater HR reactivity as well as stronger RSA withdrawal have been related to a greater ability for adequate responsiveness to negative child signals (e.g., Del Vecchio et al., 2009; Mills-Koonce et al., 2007) These seemingly contradictory findings may be the result of different underlying neurophysiological mechanisms influencing HR reactivity. Since RSA withdrawal enables physiological flexibility to environmental stressors, HR increases in response to infant crying may be related to parasympathetic functioning, especially amongst highly sensitive mothers.

In addition to physiological reactivity to specific stressors, some authors have also examined overall mean physiological levels regardless of experimental phase. For instance, Disbrow, Doerr and Caulfield (1977) compared three groups (physical abusers, neglectors and controls) on their HR reactivity and HR variability in response to videotaped parent-child interactions of a pleasant or stressful nature. Their results showed higher HR levels and lower HR variability during the entire stimulus presentation for abusers and neglectors as compared to the controls. In another study of Pruitt and Erickson (1985) high and low abuse potential groups were created based on Child Abuse Potential Inventory (CAPI) scores. HR levels in response to videotapes of smiling, crying or quiescent infants were higher in the high-risk group during all presented videotapes as compared to HR levels of the low-risk group. Thus, abusive/neglecting parents and at-risk individuals may have higher HR levels in general. Their results concerning HR variability suggested overall lower RSA levels for the abuse prone group.

Empirical research linking observations of actual parenting behavior to physiological reactivity to negative infant signals is very limited. Furthermore, existing literature does not yet provide a clear answer to the question whether greater HR reactivity to infant crying should be seen as either a risk factor for abuse or as a correlate of sensitive parenting behavior. Regarding overall physiological mean levels, highly sensitive parents could have opposite mean level patterns compared to abusive and at-risk parents, meaning lower overall HR levels in combination with higher levels of RSA for highly sensitive parents. Several studies have shown an empirical link between harsh parenting and insensitivity; low levels of maternal sensitivity during infancy predicted later use of harsh discipline (Engfer & Gavranidou, 1987; Joosen, Mesman, Bakermans-Kranenburg, & Van IJzendoorn, 2012). Harsh parents seem to lack the skills necessary for sensitive parenting behavior (Milner, 1993, 2003), which could possibly be related to different physiological overall mean level patterns for highly sensitive parents.

The current study tests the hypothesis that increased HR reactivity and stronger RSA withdrawal in response to repeated infant cry sounds are related to higher levels of maternal sensitivity. Sensitive mothers are hypothesized to have a more efficient vagal brake in comparison to less sensitive mothers, which would be shown by a stronger RSA withdrawal as well as greater HR reactivity for sensitive mothers, especially from baseline to the first presented cry sounds. Furthermore, in exploratory analyses we examine whether highly sensitive and

less sensitive mothers differ in their overall mean levels of HR and RSA across the entire cry paradigm.

## METHOD

### *Participants and Procedure*

In the context of a longitudinal study on early indicators of harsh discipline, mothers with a newborn second child were recruited by mail with help of the Regional Coordination Programs of the Dutch National Institute for Public Health and Environment. Two-child families were deliberately chosen to enable a selection of families based on the level of problem behavior of the first child. This strategy was used to increase the likelihood of observing a wider range in the quality of parenting practices. Caucasian mothers with a low or medium educational level living with a partner and both children were selected. Participating families also had to fit the following additional criteria for selection: 1) the oldest child scored either low or high on externalizing behavior (cutoffs based on Koot, Van den Oord, Verhulst & Boomsma, 1997; Van Zeijl et al., 2006), 2) the oldest child was younger than six years old, 3) the newborn second child was neither premature nor handicapped, and 4) both parents were Caucasian and of Dutch ethnicity. A total of 76 families were selected of which 53 participated in the study. Three families were excluded from the analyses due to missing data and one due to a third pregnancy (and related changes in HR) at the time of assessment, resulting in a final sample size of 49. In these 49 families, 25 first-borns (51%) had low levels of problem behavior, while 24 first-borns (49%) had high levels of problem behavior at the time of selection. Maternal mean age was 29.2 years ( $SD$ : 5.1, 19-38 years).

Mothers participated in a series of home visits during the first two years after the birth of the second child. The first home visit was scheduled when the second child was 3 months old and included the assessments used in the current paper: observations of the dyad in a variety of naturalistic situations (i.e., bathing and free play), and a 20-min cry paradigm (Out, Pieper, Bakermans-Kranenburg & Van IJzendoorn, 2010; Zeskind & Lester, 1978) with the mothers, during which an ECG signal was recorded. In all participating families both parents signed informed consent forms. Families were compensated for the home visit by means of a gift coupon with a value of 20 Euros and a small present for the baby.

### *Measures*

*Maternal sensitivity.* Maternal sensitivity was assessed with the Ainsworth Sensitivity scale (Ainsworth et al., 1974) during free play on the mother's lap without toys (5 minutes) and bathing (10-20 minutes). Mothers were instructed to interact with their infants as they would normally do. Observations of the bathing ritual included the undressing and redressing of the infant. Maternal behavior during the bath and lap sessions was rated on a 9-point scale with higher scores indicating more maternal sensitivity, resulting in two separate scores for both sessions. Maternal sensitive behavior was defined as an accurate perception of the infant's signals, followed by a prompt and appropriate response (Ainsworth

et al., 1974). In the Ainsworth Sensitivity scale each uneven score is labeled: 9 = highly sensitive, 7 = sensitive, 5 = inconsistently sensitive, 3 = insensitive, 1 = highly insensitive. The same coder rated both sessions ( $r = .48, p < .01$ ) after which scores were averaged into an overall score for maternal sensitivity. Intercoder reliabilities (intraclass correlation, single rater, absolute agreement) for six coders ranged from .75 to .92. The overall sensitivity score was used to create two groups based on a cut-off score of 7. This cutoff was chosen to distinguish mothers labeled as (highly) sensitive ( $n = 17$ ) from those labeled as (partially) insensitive ( $n = 32$ ), given that ratings below 7 necessarily include a moderate level of insensitive behavior.

*Cry Paradigm.* The cry paradigm was administered using a laptop with E-prime software. The cry stimuli as well as the design of this particular paradigm have been used in previous studies on physiological reactivity to infant crying (Out et al., 2010; Riem, Pieper, Out, Bakermans-Kranenburg & Van IJzendoorn, 2010). Mothers listened to three blocks of each three cry sounds that varied in fundamental frequency within each block. Cry stimuli were derived from the spontaneous crying of a healthy 2-day old, full birth-weight and full term female infant and were recorded midway between scheduled feedings. A 10-sec portion of the sustained period of crying, containing seven expiratory sounds, was selected for presentation. The seven cry expirations had a mean duration of 1055 msec (range: 0.6195 to 1899 msec) and a mean Peak  $F_0$  of 452.6 Hz (range 425.2 to 515.6 Hz). To provide cry stimuli with a wide range of fundamental frequencies, the original cry (averaging approximately 500 Hz) was digitally altered to increase the fundamental frequency while holding temporal and other spectral aspects of the cry constant. Two new 10-sec cry stimuli were created by digitally increasing the original cry by approximately 200 and 400 Hz, respectively, resulting in two new cry sounds with an overall Peak  $F_0$  of 714.5 Hz (700 Hz Cry) and 895.8 Hz (900 Hz Cry) (see Out et al., 2010). Each of the three blocks of cry sounds contained each of the three cry sounds (i.e., 500 Hz, 700 Hz, 900 Hz) presented in a random order. Significant associations between perception and frequency have been found in previous studies using digitally increased cry sounds (Schuetze & Zeskind, 2001; Schuetze, Zeskind & Eiden, 2003). The cry stimuli were presented at a constant volume through Sennheiser HD202 headphones.

Prior to the cry paradigm mothers were asked to fill out a short questionnaire on smoking and physical exercise. Furthermore, following every cry sound mothers answered four questions on perceived characteristics of the cry sound (not aroused – aroused, not aversive – aversive, healthy – sick and not urgent – urgent) on a 5-point rating scale (Zeskind & Lester, 1978; Zeskind & Marshall, 1988). Given the high internal consistencies (alphas ranging from .77 to .83), answers to the four questions were averaged in an overall perceived urgency score for each of the three frequencies. Following a 4-min baseline period (during which neutral pictures were presented on the screen) and a practice trial in which the 500 Hz cry was presented, mothers listened to the three blocks of three cry sounds each. After each cry sound mothers paused for a minimum of 1 minute to answer the perception questions before the next cry sound was presented. The paradigm was concluded with a 2-min recovery period. Mothers' ECG signals were recorded continuously during the entire cry paradigm.

*HR and RSA.* The ECG signal was measured with an ambulatory monitoring system (VU-AMS5fs; TD-FPP, Vrije Universiteit, Amsterdam, the Netherlands) and recorded continuously using three disposable pre-gelled Ag-AgCl electrodes (ConMed, New York, USA) that were placed below the right collar bone 4 cm to the right of the sternum, 4 cm under the left nipple and at the lateral right side. The full ECG signal was stored at a 16-bit sampling rate. HR responses were synchronized to the cry sounds using a marker button on the AMS device. The experimenter pushed the button two seconds before the stimulus was presented, leaving markers that allowed for accurate labeling of each cry sound.

Inter beat interval time series (IBIs) were derived by visual peak-detection of the R-wave through accompanying VU-AMS5fs software packages. Each recorded ECG complex was inspected and corrected by hand when necessary. The mean IBI per labeled segment was used to calculate mean HR during baseline, recovery and each cry presentation. RSA was indexed by calculation of the root mean square of successive differences (RMSSD) of inter beat intervals for each of the labeled segments. RMSSD has been shown to highly correlate with other time and frequency domain measures of RSA across various ambulatory conditions (Goedhart, Van der Sluis, Houtveen, Willemsen, & De Geus, 2007). Considering the small sample size a careful check for outliers was conducted. We checked for outliers within each variable (prior to calculation of block means) as well as within the pattern for each individual subject. No outliers were detected for mean HR levels. For RMSSD, values for one participant were winsorized to values corresponding to a standardized value of 3.29, whilst preserving the participant's response pattern. Finally, based on earlier findings by Out et al. (2010) which showed significant differences in maternal responses across blocks instead of between frequencies, mean HR and RMSSD levels were aggregated within each of the three blocks (i.e., average of three consecutive episodes of 10 seconds).

### *Data analysis*

Pearson's Chi square tests were run to compare sensitive mothers to less sensitive mothers on smoking and physical exercise. *T*-tests were performed to examine differences in age between the two groups of mothers and to check for the influence of smoking and physical exercise on HR and RMSSD baseline values. Pearson's correlation coefficients were calculated for the relation between maternal age and both physiological baseline values. To examine the relation between maternal sensitivity and the perceived urgency per frequency, a repeated measures analysis was performed with perceived urgency as outcome measure, frequency as within-subjects factor, and maternal sensitivity (highly sensitive vs. less sensitive) as between-subjects factor. Another two repeated measures analyses were administered to examine the association between maternal sensitivity and the development of HR and RMSSD reactivity across the cry paradigm, with HR or RMSSD as the outcome measure, episode (baseline, three blocks of cry sounds, and recovery) as the within-subjects factor, and maternal sensitivity (highly sensitive vs. less sensitive) as the between-subjects factor. Greenhouse-Geisser Epsilon was used to correct for violation of sphericity in all repeated measures

analyses. To examine maternal sensitivity group differences in mean HR and RMSSD values per block, separate analyses of covariance were run for each block and the recovery, in which baseline values for respectively HR and RMSSD were entered as covariates.

## RESULTS

### *Preliminary analyses*

Highly sensitive mothers did not differ significantly from less sensitive mothers concerning smoking, physical exercise, or age (all  $p > .05$ ). Sample distributions, means and standard deviations are presented in Table 2.1. Neither smoking nor maternal age had a significant influence on baseline levels of mean HR and RMSSD, nor were these variables significant covariates in any of the repeated measures analyses. Physical exercise was significantly related to RMSSD baseline

Table 2.1.

*Background and physiological data of highly sensitive and less sensitive mothers*

	Observed maternal sensitivity					
	Highly sensitive mothers			Less sensitive mothers		
	<i>n</i> (%)	<i>M</i>	<i>SD</i>	<i>n</i> (%)	<i>M</i>	<i>SD</i>
Smoking during day of homevisit (yes)	2 (4.1)			12 (24.5)		
Physical exercise during week prior to homevisit (yes)	10 (20.4)			18 (36.7)		
Age in years		30.59	5.33		28.44	4.89
Mean perceived urgency 500 Hz		1.75	0.41		1.76	0.67
Mean perceived urgency 700 Hz		2.41	0.56		2.60	0.79
Mean perceived urgency 900 Hz		2.37	0.83		2.61	0.83
Baseline mean HR		64.79**	9.07		73.69	7.82
Mean HR during block 1		68.84*	8.69		74.83	8.12
Mean HR during block 2		69.54*	9.37		75.76	8.20
Mean HR during block 3		69.69**	9.30		76.03	8.75
Mean HR during recovery		66.86	9.75		74.33	9.24
Baseline mean RMSSD		63.92*	35.29		41.60	19.08
Mean RMSSD during block 1		52.72	28.43		40.62	20.01
Mean RMSSD during block 2		53.55	26.54		42.18	22.21
Mean RMSSD during block 3		55.45	28.98		40.15	21.60
Mean RMSSD during recovery		56.63	32.30		41.22	19.91
Total	17 (34.7)			32 (65.3)		

\*  $p < .05$ , \*\*  $p < .01$ .

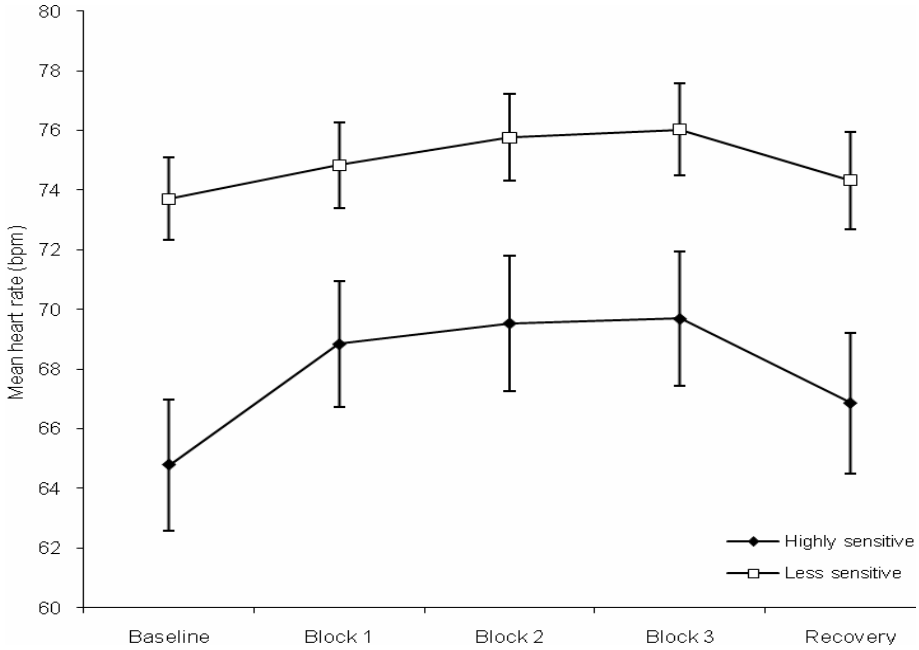


Figure 2.1. HR reactivity to infant crying ( $M$ ,  $SE$ ) in highly sensitive ( $n = 17$ ) and less sensitive mothers ( $n = 32$ )

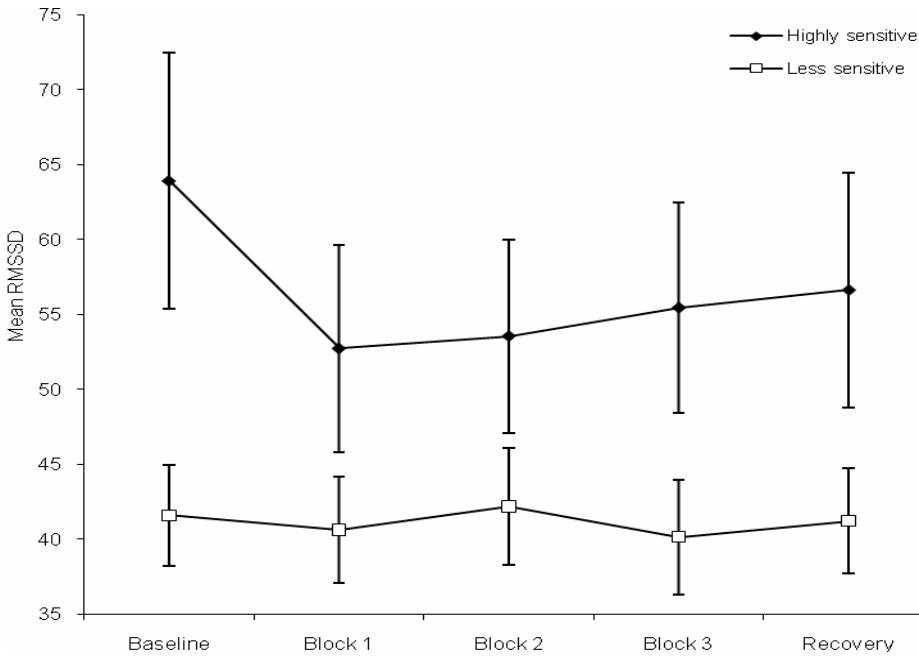


Figure 2.2. RSA withdrawal in response to infant crying ( $M$ ,  $SE$ ) in highly sensitive ( $n = 17$ ) and less sensitive mothers ( $n = 32$ )

values, but was not significant as covariate in the repeated measures analysis for mean RMSSD. Therefore, analyses are reported without these variables.

#### *Perception of urgency*

Means and standard deviations are presented in Table 2.1. A repeated measure for perceived urgency of the three cry sounds (500, 700 and 900 Hz) showed that all mothers perceived the 700 as well as the 900 Hz cry sound as significantly more urgent than the 500 Hz cry sound,  $F(1.80, 84.73) = 51.07, p < .01$ , partial  $\eta^2 = .52$ . No significant differences in perceived urgency were found between the 700 and 900 Hz cry sound,  $F(1, 47) = 0.06, p > .05$ , partial  $\eta^2 = .00$ . Harsh mothers and non-harsh mothers also did not show different patterns in their ratings of perceived urgency for all three cry frequencies,  $F(1.80, 84.73) = 1.07, p > .05$ , partial  $\eta^2 = .02$ .

#### *HR*

Means and standard deviations are presented in Table 2.1. The independent *t*-test showed a significantly lower baseline HR for highly sensitive mothers compared to less sensitive mothers,  $t(47) = 3.59, p < .01, r = .46$ .

Separate analyses of covariance showed lower mean HR for highly sensitive mothers compared to less sensitive mothers in block 1 ( $F(1,46) = 4.71, p < .05$ , partial  $\eta^2 .09$ ), block 2 ( $F(1,46) = 7.30, p < .05$ , partial  $\eta^2 .14$ ), and block 3 ( $F(1,46) = 9.97, p < .01$ , partial  $\eta^2 .18$ ) when correcting for baseline HR values.

A repeated measures analysis showed a significant rise in mean HR from baseline to all three cry sound blocks as well as a significant decrease in mean HR from block 3 to recovery,  $F(2.64, 124.20) = 20.88, p < .01$ , partial  $\eta^2 = .31$ . Furthermore, an interaction effect between HR increase and maternal sensitivity was found. Highly sensitive mothers showed a significantly more pronounced increase in HR from baseline to all three cry sound blocks compared to less sensitive mothers,  $F(2.64, 124.20) = 3.34, p < .05$ , partial  $\eta^2 = .07$ . The repeated measures analysis did not show a significantly different pattern in HR reactivity between the two groups from block 3 to the recovery. Concerning overall mean-level HR (across the paradigm), a significant between-subjects effect showed that highly sensitive mothers had lower mean HR levels compared to less sensitive mothers across the cry paradigm,  $F(1,47) = 7.51, p < .05$ , partial  $\eta^2 = .14$ . Mean HR response patterns for both groups are presented in Figure 2.1

#### *RSA*

Means and standard deviations are presented in Table 2.1. The independent *t*-test showed a significant higher baseline RMSSD value for highly sensitive mothers compared to less sensitive mothers,  $t(21.09) = -2.43, p < .05, r = .47$ . Separate analyses of covariance did not show group differences for mean RMSSD in any of the blocks or the recovery, when controlling for baseline values. Means and standard deviations are presented in Table 2.1.

A repeated measures analysis for mean RMSSD showed a significant drop in mean RMSSD from baseline to block 1 and from baseline to block 2, but only for the highly sensitive mothers,  $F(3.17, 149.11) = 2.96, p < .05$ , partial  $\eta^2 = .06$ , indicating a stronger RSA withdrawal for highly sensitive mothers than for less

sensitive mothers. The drop in mean RMSSD for sensitive mothers from baseline to block 3 approached significance ( $p = .07$ ). With regard to overall mean-level RMSSD, highly sensitive mothers had higher mean RMSSD values compared to less sensitive mothers across the cry paradigm,  $F(1,47) = 4.82, p < .05$  partial  $\eta^2 = .09$ . Mean RMSSD response patterns for both groups are presented in Figure 2.2.

## DISCUSSION

The aim of the present study was to examine physiological reactivity to cry sounds comparing highly sensitive with less sensitive mothers. We hypothesized that highly sensitive mothers would have a greater HR reactivity in combination with stronger RSA withdrawal in response to repeated cry sounds when compared to less sensitive mothers. Our results showed that highly sensitive mothers indeed had a greater increase in HR and a stronger RSA withdrawal in reaction to infant crying than less sensitive mothers, even though both groups did not differ in perceived urgency of the various frequencies. In other words, mothers who were highly sensitive during interaction with their own infants showed greater physiological reactivity to repeated cry sounds.

Our results on RSA withdrawal are in line with earlier research showing stronger RSA withdrawal in mothers of secure infants than in mothers of insecure-avoidant infants during the final reunion episode of the Strange Situation Procedure (Hill-Soderlund et al., 2008). Our results on HR reactivity are partially in line with the finding that greater reactivity to infant crying is related to more prompt caregiving (Del Vecchio et al, 2009), because the promptness of caregiving is an integral part of the sensitivity construct. However, as mentioned in the introduction, greater HR reactivity to negative infant signals has also been reported for parents at risk for abuse (McCanne & Hagstrom, 1996). This apparent contradiction may be explained by the fact that HR increases can be driven both by the PNS through withdrawal of the vagal brake as well as by activation of the SNS (see Berntson, Cacioppo, Quigley & Fabro, 1994).

The three subsystems of the autonomic nervous system as described by Porges (1995, 2001, 2007) are hierarchically activated when responding to external stressors. The activation of a specific subsystem further depends on the perception of the environment as either safe or threatening. In a safe environment the circuit for social communications is activated to promote survival by facilitating social interactions and social bonds. With an activated social communications circuit fostering calm behavioral states, maternal sensitivity during dyadic interaction would also be promoted. Among highly sensitive mothers a well-functioning vagal brake may then be responsible for a heightened and adequate physiological reactivity to external demands such as infant crying, without activation of the 'older' and biologically more taxing sympathetic system (Porges, 2001, 2009). However, when the environment is perceived as dangerous or threatening the autonomic system switches to the more primitive circuits and activates the SNS to regulate defensive strategies through a fight-or-flight response. Heightened perceptions of danger and threat have been found in parents at risk for abuse, as evidenced by more hostile interpretations of child behaviors, often in combination

with feelings of powerlessness (e.g., Bugental & Happaney, 2004; Leung & Slep, 2006; Lin, Bugental, Turek, Martorell & Olster, 2002; Smith & O'Leary, 1995). Furthermore, the behavioral overreactivity to infant signals seen in parents at risk for abuse (Milner, 2003) may signal a chronically overactivated SNS resulting from a poorly functioning vagal brake (Porges, 2001). Thus, greater HR reactivity to child negative affect signals in parents at risk for abuse (as compared to controls) is likely to stem from activation of the SNS.

In sum, we suggest that parents at risk for abuse as well as highly sensitive parents may show heightened HR reactivity to negative child signals, but that this HR reactivity originates from different autonomic subsystems. Abusive parents may perceive infant signals of negative affect such as crying as threatening, resulting in a stronger activation of the SNS (and greater HR increases). Highly sensitive parents are unlikely to perceive infant signals of negative affect as threatening. Operating from a safety rather than a threat perspective, in these mothers such infant signals lead to efficient activation of the (parasympathetic) social communication circuit in responding to the environmental demands of infant crying, resulting in greater HR increases compared to less sensitive parents.

To test this hypothesis, future studies may examine differences between harsh/abusive parents and highly sensitive parents in both sympathetic and parasympathetic reactivity to negative infant signals such as crying. To further specify the influence of each branch of the nervous system, salivary alpha-amylase, skin conductance level, and pre-ejection period (PEP) should be collected simultaneously. In addition, measures of cortisol indicating the activity of the hypothalamic-pituitary-adrenal axis could also be included as a correlate of SNS activation since both systems are involved in stress management (e.g., El-Sheikh, Erath, Buckhalt, Granger & Mize, 2008; Gordis, Granger, Susman & Trickett, 2008; Van Stegeren, Wolf & Kindt, 2008). However, even though harsh and sensitive parenting are linked both empirically (Engfer & Gavranidou, 1987; Joosen, Mesman, Bakermans-Kranenburg, & Van IJzendoorn, 2012) and conceptually (Milner 1993, 2003), it should be noted that some subtypes of insensitive parenting may be unrelated to harsh parenting. An overall absence of responses to infant signals also results in low scores on maternal sensitivity. Therefore, distinguishing between insensitive-passive mothers and insensitive-intrusive mothers is highly relevant for understanding the underlying physiological processes of maternal responses to infant signals.

Concerning overall mean-level differences in HR and RSA across the cry paradigm we found that highly sensitive mothers had lower mean HR in combination with higher mean RSA levels compared to less sensitive mothers. For RSA, this result was mainly due to baseline differences between highly sensitive and less sensitive mothers. Following Porges' suggestion that baseline parasympathetic tone may represent stress vulnerability (Porges, 1995), the difference in overall levels might suggest a better capability for efficient responsiveness to environmental demands in highly sensitive mothers, both physiologically as well as behaviorally. Furthermore and as expected, these findings extend earlier findings showing a complementary pattern of overall

high HR levels and low RSA levels for mothers at risk for abuse (Bugental, Lewis, Lin, Lyon & Kopeikin, 1999; Disbrow et al., 1977; Pruitt & Erickson, 1986). Our results seem to suggest that a pattern of high mean HR and low mean RSA also applies to mothers showing non-optimal levels of sensitivity to infant signals, even if they are not (yet) at risk for abuse (Milner, 1993, 2003).

One might argue that according to the 'law of initial values' differences in baseline values for both HR and RSA could (partially) account for lower physiological reactivity in the less sensitive group. However, even if their lower reactivity is caused by baseline levels, the implication remains that less sensitive mothers are significantly less aroused by infant crying, which could be a reason for the less optimal responsiveness in interaction with their infants. As a limitation of the current study it should be noted that concurrent maternal stress was not measured. Stress levels may affect both physiological baseline values (Thayer, Friedman & Borkovec, 1996) as well as maternal sensitivity (Belsky, Crnic & Woodworth, 1995; Van IJzendoorn, Bakermans-Kranenburg & Mesman, 2008). Furthermore, continuing challenges in the search for accurate baseline measurements, especially concerning vagal tone (Butler, Wilhelm & Cross, 2006), complicate the interpretation of physiological reactivity. Therefore, extending the focus to individual differences in overall levels of physiological measures instead of studying reactivity to stressors exclusively might provide better insight into parenting correlates of physiological stress vulnerability. Last, sample sizes, especially for the highly sensitive group, were small, but to ensure valid conclusions the data was rigorously checked for outliers.

Given the importance of the quality of maternal care for the development of infant stress reactivity (Albers, Riksen-Walraven, Sweep & De Weerth 2008; Hane & Fox, 2006), future studies should investigate the pathways that relate maternal stress reactivity and quality of parenting to infant stress reactivity. Furthermore, future studies should investigate the underlying mechanisms for HR reactivity in greater detail, with special attention to differences between parasympathetically and sympathetically driven HR reactivity to infant signals of negative affect in parents with different parenting profiles. Such studies may further contribute to our understanding of the nature of intergenerational transmission of physiological vulnerability beyond genetic influences, which in turn could facilitate the identification of those infants at risk for impaired stress regulation and subsequent psychopathology.

In conclusion, the current study shows that mothers who were highly sensitive during interaction with their own infants displayed greater physiological reactivity to repeated cry sounds indicative of a more flexible physiological capability in responding to infant signals of negative affect.

## Maternal sensitivity in various settings predicts harsh discipline in toddlerhood

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### ABSTRACT

In a longitudinal study with 73 mothers and their second-born child, stability and main-level differences between measures of maternal sensitivity across settings and over time were examined. Furthermore, the predictability of harsh discipline by these different maternal sensitivity measures was studied. Maternal sensitivity was assessed at 3 and 6 months during bathing, free play on mother's lap and the baseline and reunion episode of the Still Face Paradigm (SFP; Tronick, Als, Adamson, Wise, & Brazelton, 1978). Harsh discipline was observed during three home visits in the second year of life. Results showed a single underlying factor for all maternal sensitivity settings at both time points and significant stability over time. Harsh discipline was predicted by maternal sensitivity at 3 months, which was fully mediated by maternal sensitivity at 6 months. Early failure to respond appropriately to infant signals is an important indicator of risk for future harsh parenting.

*Keywords: maternal sensitivity, naturalistic settings, SFP, harsh discipline*

### INTRODUCTION

Within the framework of attachment theory, Mary Ainsworth was the first to provide a detailed description of maternal sensitivity, defined as mothers' ability to perceive child signals, to interpret these signals correctly, and to respond to them promptly and appropriately (Ainsworth, Bell, & Stayton, 1974). The extensive attention for sensitive parenting behavior is certainly not without ground, since many studies have shown significant relations between maternal sensitivity and a variety of positive outcomes such as secure attachment (Bakermans-Kranenburg, Van IJzendoorn, & Juffer, 2003; De Wolff & Van IJzendoorn, 1997), self-regulation (Eisenberg et al., 2001), social functioning (e.g., Kochanska, 2002; Van Zeijl et al., 2006), and cognitive competence (e.g., Bernier, Carlson, & Wipple, 2010; Tamis-Lemonda, Bornstein, & Baumwell, 2001). Furthermore, the absence of skills needed to respond sensitively to child signals has been linked to a risk for harsh parenting and maltreatment (Engfer & Gavranidou, 1987; Milner, 1993, 2003).

What started with Ainsworth's elaborate full-day observations developed into more efficient methods used across a variety of settings ranging from naturalistic daily routines to (semi-)structured play and stress-inducing paradigms (e.g., Alink et al., 2009; Braungart-Rieker, Garwood, Powers, & Wang, 2001; Susman-Stillman, Kalkoske, Egeland, & Waldman, 1996). However, it remains unclear what the consequences are of using one observational setting instead of another for the observation of maternal sensitivity. In the current study we aim to investigate maternal sensitivity in infancy in different situations in terms of (1) mean-level differences, (2) interrelations, (3) 3-month stability, and (4) the prediction of harsh discipline in toddlerhood.

Originally, Ainsworth's work in both Uganda (Ainsworth, 1967) and Baltimore (Ainsworth, Blehar, Waters, & Wall, 1978) was based on elaborate naturalistic observations of mother-infant dyads during all sorts of daily routines (i.e., bathing, feeding, etc.). The value of longer naturalistic observations lies in the fact that it gives a more detailed picture of the variety of maternal behaviors across different situations and under different conditions. However, due to time constraints naturalistic observations have generally been limited to single daily routines in more recent studies (such as bathing or feeding sessions, e.g., Albers, Riksen-Walraven, Sweep, & De Weerth, 2008). Nonetheless, some researchers still continue to collect extensive naturalistic observational data as well. (Highly & Dozier, 2009; Van IJzendoorn & Hubbard, 2000).

Structured play situations form an alternative and frequently used strategy in observing mother-infant interactions (e.g., Vereijken, Riksen-Walraven, & Kondo-Ikemura, 1997). Mothers generally receive instructions to interact with their infants with or without toys for a duration ranging from 5 to 15 minutes. By recreating part of the infant's daily experiences (e.g., play) this method does assure the observation of at least some dyadic interaction without the time investment of longer naturalistic observations. However, this method is not necessarily 'naturalistic' for all mothers, since not all mothers engage in this kind of dyadic play as a part of their daily routines.

Another shortcoming of structured play settings is that it limits the number of observations of maternal sensitivity to distress, whereas infant distress is particularly salient to the concepts of sensitivity and attachment (Bowlby, 1969/1982). In studies focusing on sensitivity to distress, dyads were only included in the final analyses when the infants displayed distress during a free play observation. Thus, when a non-distressing setting is used for the measurement of sensitivity to distress there is the danger of selecting subgroups of children prone to distress even in neutral situations (Leerkes, Blankson, & O'Brien, 2009; McElwain & Booth-LaForce, 2006). Nonetheless, sensitivity to distress measured in this setting does seem to be a stronger predictor of attachment security than sensitivity to non-distress (McElwain & Booth-LaForce, 2006), which is in line with findings that more sensitive nighttime responses to infant distress are related to more secure infant attachment (Aviezer, Sagi, & Van IJzendoorn, 2002; Higley & Dozier, 2009). Furthermore, sensitivity to distress has also been found to predict fewer behavioral problems and greater social competence in toddlerhood, while sensitivity to non-distress did not (Leerkes et al., 2009).

An observation paradigm that includes both non-distressing and potentially distressing interactions is the Still-Face Paradigm (SFP; Tronick, et al., 1978). Since its original development, the SFP has been used for a variety of purposes ranging from the assessment of dyadic interaction patterns to the measurement of infant coping strategies to stressful events. In general this standardized face-to-face dyadic interaction consists of three steps: (1) a baseline normal interaction, (2) the 'still-face' episode in which the adult becomes unresponsive whilst maintaining a neutral facial expression, and (3) a reunion in which normal interaction is resumed. The break in typical social interaction that takes place during the still face segment induces stress in the infant (Mesman, Van IJzendoorn, & Bakermans-Kranenburg, 2009). The classic 'still-face effect' consists of a decrease in positive affect and an increase in negative affect from baseline to still-face. In addition, the increased negative affect continues into the reunion episode ('carry-over effect'), which makes the reunion episode suitable for observing maternal sensitivity to distress. One study, for example, showed that during the reunion episode maternal involvement was related to more positive affect and less negative affect in infants (Rosenblum, McDonough, Muzik, Miller, & Sameroff, 2002).

In addition to being a predictor of various child outcomes, maternal sensitivity in infancy has also been found to predict sensitive parenting in later years (e.g. Jaffari-Bimmel, Juffer, Van IJzendoorn, Bakermans-Kranenburg, & Mooijaart, 2006). Similarly, a lack of sensitivity towards infants may be a risk for future negative parenting strategies, such as harsh discipline. In the literature on parents at risk for physical abuse, skills closely related to sensitive responsiveness play an important role. Milner (1993, 2003) describes a four-stage social information processing model in relation to physical abuse. The first stage in this model describes the fact that high-risk and abusive parents are less attentive to and less aware of their children's behavior as compared to nonabusive and low-risk parents. The second stage refers to interpretations of child signals and shows that high-risk and abusive parents are more likely to attribute hostile intent to (negative) child behavior and to view this behavior as due to internal, stable, and global child factors. The third stage of Milner's model describes a lack of adequate information integration for abusive and high-risk parents; these parents are unlikely to use situational or mitigating information in their response selection process. Furthermore, response selection of high-risk and abusive parents is limited by a more rigid use of punishment following child noncompliance. In the fourth stage, abusive and high-risk parents are less capable of monitoring and modifying their responses and parenting strategies.

These four stages show remarkable overlap with the main elements of Ainsworth's maternal sensitivity construct (i.e., awareness and interpretation of signals and appropriate responding), but are formulated in terms of the absence of these skills. Previous studies have also shown a link between maternal intrusiveness (a subscale of maternal sensitivity) and harsh or abusive parenting (Lyons-Ruth, Connell, Zoll & Stahl, 1987). The concept of intrusiveness, which can be defined as the lack of respect for the child's autonomy and (physical) interference with the child's behavior, especially during exploration, seems to be theoretically in line with the biased interpretations of, and rigid responding to (negative) child

behavior of harsh or abusive parents. In other words, intrusive as well as harsh or abusive parents seem to share a lack of empathy or understanding of the child's behavior and motives, which interferes with an appropriate interpretation of and responding to these signals during both normal interaction as well as discipline situations. Thus, there is reason to believe that a lack of sensitivity in infancy may predict harsh discipline strategies in toddlerhood.

Examining early predictors of harsh discipline is especially important since this parenting strategy has been shown to increase the risk for the development of problem behavior in (later) childhood (e.g., Bender et al., 2007; Kerr, Lopez, Olson & Sameroff, 2004; McKee et al., 2007). Beyond infancy, maternal discipline strategies become important as toddlers typically seek autonomy in the form of exploration of boundaries and noncompliance (Sroufe, 1995). If we can identify parents at risk for harsh discipline based on their parenting skills in infancy, this could enhance early preventive intervention efforts. To our knowledge there is no direct empirical evidence about the predictive value of sensitivity towards infants in relation to observed harsh discipline in toddlerhood, let alone in which situations sensitivity can best be measured to achieve optimal predictions.

In the current study we first examined whether levels of maternal sensitivity in infancy significantly differ across situations. Second, we investigated the stability of sensitivity in different situations over a 3-month period. Last, we tested whether maternal sensitivity assessed in different situations during infancy predicts harsh discipline in toddlerhood.

## METHOD

### *Sample and procedure*

Participants were recruited via midwifery practices in the western region of the Netherlands, and the Regional Coordination Programs of the Dutch National Institute for Public Health and Environment (NIPHE). Inclusion criteria were (1) the first child scored either low or high on externalizing behavior on the Child Behavior Checklist (CBCL/ 1½ -5; Achenbach & Rescorla, 2000; cutoffs based on Van Zeijl et al., 2006), (2) the first child was younger than six years old, (3) the newborn second child was neither premature nor handicapped, (4) both children and parents lived together in one household and (5) both parents were Caucasian.

Fifty-three midwifery practices handed out pamphlets about the study to pregnant women expecting a second child. Interested mothers could send in a card with their details after which they would receive a questionnaire including the CBCL and questions about demographic characteristics by mail. The NIPHE assisted in approaching families from the lower socioeconomic strata, which appeared to be underrepresented in the midwifery sample. Postal codes were selected of areas in which more than 30% of inhabitants had a low income (less than 14,200 Euro per year; as defined by the Dutch Central Bureau of Statistics). Families with a newborn infant living in these areas received a letter from the NIPHE with information about the study. Interested mothers of a second newborn infant were requested to fill out a card with their address, phone number, and the

name, gender and birth date of their newborn. Mothers were then contacted by phone to find out the educational level of both parents (1 *elementary school*, 2 *four years of Dutch high school*, 3 *vocational education or five or six years of high school*, 4 *higher professional education*, and 5 *university*). When both parents had a low (level 1 or 2) educational level or no more than one of the parents scored level 3, a home visit was planned to complete the CBCL about the first child. All mothers who completed the CBCL received a coupon with a value of 10 Euro.

The recruitment resulted in a total of 103 families (51 with a 'high externalizing' first child, and 52 with a 'low externalizing' first child). Of the 103 families originally included, a total of 73 families had sufficient data on all variables included in this paper (nine families were excluded from analyses due to missing data, and 21 families dropped out before the final home visit and were therefore excluded from the analyses for this paper). The 30 families that were excluded from the analyses did not differ from the final sample on maternal age, education, child gender, and maternal sensitivity during bathing and lap sessions (all  $p > .05$ ). Excluded mothers were less sensitive in the still face baseline (excluded mothers:  $M = 1.60$ ,  $SD = 0.91$ , included mothers:  $M = 2.01$ ,  $SD = 0.75$ ;  $t(96) = -2.04$ ,  $p < .05$ ) and reunion (excluded mothers:  $M = 1.76$ ,  $SD = 0.88$ , included mothers:  $M = 2.21$ ,  $SD = 0.76$ ;  $t(96) = -2.42$ ,  $p < .05$ ) at 3 months but not at 6 months.

Within the final group, educational level of the mothers was divided as follows: 6.8% of mothers finished elementary school, 32.9% finished the first four years of Dutch high school, 28.8% obtained a degree in vocational education or finished five or six years of high school, 19.2% obtained a degree in higher professional education, and 12.3% completed at minimum a bachelor degree at university. Maternal mean age at time of birth of their second child was 31.17 years ( $SD: 0.54$ , range 19-40 years). The mean age of the first children at the time of selection was 31.64 months ( $SD: 1.35$ , range 15-70). Of the first-born children 52.1% were boys, and of the second-born children 35.6% were boys. In 41 families (56.2%) the first-born child showed low levels of externalizing behavior at the time of recruitment, and in 32 families (43.8%) the first-born showed high levels of externalizing behavior.

All 73 families participated in a total of six home visits during the first two years after the birth of the second child. Home visits were scheduled when the second child was 3, 6, 9, 12, 18 and 24 months old. During the first year, home visits included videotaping of the dyad in naturalistic situations (i.e., bathing and free play) as well as in the Still Face Paradigm (Mesman et al., 2009; Tronick et al., 1978). At 12 and 24 months mothers were observed with both children simultaneously during two discipline tasks. At 18 months mothers were observed with the second child only during discipline tasks.

In all participating families both parents signed informed consent forms. To limit loss of participants through attrition, families were given gift coupons and small presents for the children after each home visit. Families also received two DVD's with a compilation of video footage from all home visits. Procedures and measures used in this study were approved by the ethical committee of the Institute of Education and Child Studies at Leiden University.

### Measures

*Maternal sensitivity 3 and 6 months – naturalistic settings.* Maternal sensitivity was assessed with the Ainsworth Sensitivity scale (Ainsworth et al., 1974) during free play on the mother's lap without toys (5 minutes), and during bathing (10-20 minutes). Observations took place during home visits at 3 and 6 months after the birth of the second child. All observations were rated independently by two trained coders. Intercoder reliabilities (intraclass correlation, single rater, absolute agreement) for each pair of the six coders ranged from .75 to .92. When the scores of the two independent coders differed two or more points (on the 9-point scale) tapes were discussed and a consensus score was assigned. For smaller differences the average of both scores was used. Within the same home visit the bath and lap sessions were rated by the same coder, but observations from different home visits were coded independently.

*Maternal sensitivity and intrusiveness 3 and 6 months - Still Face Paradigm.* The Still Face Paradigm (SFP; Tronick et al., 1978) was used to measure maternal sensitivity and intrusiveness. The SFP consisted of three steps: (1) a baseline normal interaction (2 minutes), (2) the 'still-face' episode in which the adult becomes unresponsive while looking at the child with a neutral facial expression (1 minute at age 3 months and 2 minutes at age 6 months), and (3) a reunion in which normal interaction is resumed (2 minutes) (Mesman et al., 2009). Additionally, mothers were allowed to touch the infant as they would do so normally during baseline interaction as well as reunion, but were not allowed to touch the child during the still face segment.

Observations of maternal sensitivity and intrusiveness during baseline interaction and reunion were coded with an adapted version of the Mother-Infant Coding System (Miller, 2000). An overall scale for *Sensitivity* was used, with scores on a 4-point subscale defined as: 0 *No sensitivity*, 1 *Minimal or low sensitivity*, 2 *Mixed or moderate sensitivity*, and 3 *Predominant or high sensitivity*. A 4-point subscale for *Intrusiveness* was defined as: 0 *No intrusiveness*, 1 *Minimal intrusiveness*, 2 *Mixed or moderate intrusiveness*, 3 *Predominant or high intrusiveness*. The SFP at ages 3 and 6 months were independently coded by two trained coders (intercoder reliabilities i.e., intraclass correlation, single rater, absolute agreement for *Sensitivity*: .69 for *Intrusiveness*: .75). Baseline interaction and reunion within one assessment were scored by the same person. All tapes were double coded for *Sensitivity* since this scale was considered the more difficult one. When the two scores were not identical, a final score was given by two expert coders who were reliable on the initial reliability set (intercoder reliability: .79).

*Harsh discipline 2<sup>nd</sup> year.* Maternal discipline was observed during all home visits in the second year (12, 18 and 24 months). Observations consisted of two tasks: a don't-touch task and a clean-up task. In the don't-touch task mothers were presented with a bag full of attractive toys. They were instructed to take the toys out of the bag, place them in front of the child and to make sure the child would not touch the toys. After 2 minutes (3 minutes at 24 months) the child was allowed to play only with the least attractive toy: a simple stuffed animal. After another 2

minutes the child was allowed to play with all the attractive toys as well as a bag of extra toys. Following 15 minutes of free play with all toys (not coded for this study), mothers received an empty bag with the instruction that all toys had to be cleaned up by the child. Instructions specified that she could help and encourage the child as she would normally do, but that it was important for the observation that the child would clean up as much as possible. The clean-up session was finished when all toys were back in the bag or when ended by the experimenter after a maximum of 10 minutes.

The observations were coded with an adapted version of the discipline rating scales used by Verschueren, Dossche, Marcoen, Mahieu and Bakermans-Kranenburg (2006). Adaptations included a further division of the harsh discipline scale in a physical and a verbal subscale. Discipline strategies were rated as *'harsh physical discipline'* when mothers used unnecessary physical force, either when preventing their child from touching a forbidden object or when forcing the child to clean up (i.e., slapping, grabbing the child, pulling an arm too hard, grabbing toys from the child, pinching an arm, or grabbing/holding face of the child). The action also had to cause a noticeable physical impact on the child (e.g., body movement, facial or vocal expression of shock or discomfort). Scores for harsh physical discipline were assigned using a 5-point rating scale. Because observing harsh physical discipline in relatively short episodes is rare, the scale was defined in a way that would allow more subtle as well as blatant harsh acts to be included: 1 *no physically harsh acts*, 2 *a hint of harshness, but not severe or unclear impact on child*, 3 *at least one harsh act but not as physical punishment and not used to emphasize a verbal command*, 4 *either more than one harsh act or a single act of physical punishment (e.g., slapping) or emphasizing a command (e.g., by grabbing the child's face)*, and 5 *more than one harsh act of which at least one act of physical punishment; mother has clearly lost control*.

*'Harsh verbal discipline'* was defined as irritation and anger in the tone of voice (i.e., impatient, irritated, angry voice, yelling, screaming.). Scores for harsh verbal discipline were also defined on a 5-point scale as follows: 1 *no harsh verbal discipline*, 2 *mild irritation*, 3 *irritation and anger*, 4 *obvious irritation and or anger on more than one occasion*, and 5 *almost constant irritation and/or anger*.

At both the 12 and 24-month home visits both children participated simultaneously with their mother in the discipline tasks (during the 18-month visit only the second child participated). Discipline strategies of the mother directed to each child were scored independently. In the current analyses only the mother's discipline strategy towards her second child was used in the analyses. Intercoder reliabilities (intraclass correlations, single rater, absolute agreement) of six coders ranged from .76 to 1.00 for *'Harsh physical discipline'* and from .78 to 1.00 for *'Harsh verbal discipline'*. At each time point, the maximum score for each scale was used (so either the score for the 'do' or the 'don't' situation). Maximum scores from all three time points were then averaged, resulting in average harsh *physical* and harsh *verbal* discipline scores during the second year. When families missed one of three home visits, the maximum scores of the remaining two home visits were averaged instead ( $n = 7$ ). A total score for harsh discipline was calculated by aggregating the averaged scores during the second year for both

the physical and the verbal subscale. Fifty-nine percent of the sample showed at least a hint of physical harshness during one of the observation episodes in the second year. Of those, 10 mothers showed at least one clear physically harsh act. Fifty-one percent of the sample showed at least some verbal overreactivity during one of the observation episodes in the second year. Of those, 3 mothers showed at least irritation and anger. Combining the two types of harshness, 55% of the sample showed at least some physical or verbal harshness.

Data inspection revealed a single outlier which was winsorized by adding the difference between the two next highest values and adding this difference to the next highest value (with a  $z < 3.29$ ), thereby replacing the outlying score (Tabachnik & Fidell, 2001). A logarithmic transformation was calculated for the final total harsh discipline score to correct for positive skewness (Tabachnik & Fidell, 2001).

*Externalizing behavior.* The Child Behavior Checklist for ages 1½ to 5 (CBCL/1½ -5; Achenbach & Rescorla, 2000; Van Zeijl et al., 2006) was used to assess externalizing behaviors of the first-born child and was obtained from mothers via the preliminary questionnaire by mail or during the selection home-visit. Mothers indicated whether their child displayed any of the 100 behavioral descriptions in the last 2 months on a 3-point scale (0 *not true*, 1 *somewhat or sometimes true*, and 2 *very or often true*). The distribution of CBCL Externalizing Problems scores reported by Van Zeijl et al. (2006) was used to determine cut-off scores in identifying low versus high levels of externalizing behaviors. Families were selected for the low externalizing group when scores on externalizing behavior of the oldest child did not exceed the lowest 50% of scores in the norm group of the same age. Families were placed in the high externalizing group when scores were within the highest 25% of scores in the norm group of the same age. The two groups did not differ significantly on sensitivity and harsh discipline towards their second child.

*Difficult temperament at 3 months.* Child temperament of the second child was measured with the Infant Characteristics Questionnaire (ICQ; Bates, Freeland, & Lounsbury, 1979) completed by the mother. The ICQ was translated into Dutch and found reliable by Kohnstamm (1984). The Dutch ICQ contains 33 items, describing concrete behaviors in well-defined situations. Because in the larger project the ICQ (at some of the home visits) was used in combination with the aforementioned CBCL/1½-5, five items in the ICQ were not included in the questionnaire due to content-overlap between items of both instruments (Van Zeijl et al., 2006). Furthermore, four items were removed due to lack of applicability on young infants, resulting in a final 24-item temperament questionnaire (Van Zeijl et al., 2006). The first 22 items were rated on a 5-point scale, ranging from 0 *not true* to 4 *true*. However, item 23 (fussy/irritated behavior) was rated on a 5-point scale (ranging from 0 *never* to 5 *10 or more times a day*), while item 24 (general perceived difficultness of infant) was rated on a 7-point scale (ranging from 0 *very easy* to 7 *very difficult*). A total score for difficult temperament was calculated based on standardized scores of all 24 items. Missing values for eight participants were replaced by the total standardized mean score of the group. Internal consistency

(Cronbach's alpha) of the scale for difficult temperament was .77. Data inspection revealed a single outlier which was winsorized by adding the difference between the two next highest values and adding this difference to the next highest value (with a  $z < 3.29$ ), thereby replacing the outlying score (Tabachnik & Fidell, 2001).

## RESULTS

### *Maternal sensitivity and intrusiveness across time and situations*

Paired *t*-tests were conducted to examine differences in means across the various time-points and measures. In the naturalistic settings maternal sensitivity was significantly lower during free play on the lap than during bathing at both 3 and 6 months. During the SFP mothers were significantly more sensitive and less intrusive during the reunion than during the baseline at 3 months but not at 6 months. Last, maternal sensitivity was significantly lower during the 6 months visit than during the 3 month visit across all settings, while maternal intrusiveness levels rose from 3 to 6 months. Means across time and situations are presented in Table 3.1.

### *Stability of maternal sensitivity across time*

Pearson product-moment correlation coefficients for all sensitivity measures at 3 months and 6 months are presented in Table 3.1. With the exception of the Lap observations, all sensitivity measures were positively and significantly correlated over time. Especially the SFP baseline intrusiveness measure showed high stability.

To check for a possible influence of infant temperament on maternal sensitivity, the relation between all sensitivity variables and the ICQ at 3 months was examined. Except for a significant negative correlation between 6 month SFP baseline intrusiveness and difficult temperament ( $r = -.30, p < .05$ ), no significant relations were found. Furthermore, difficult temperament at 3 months was not significantly related to the discipline outcome measure. Difficult temperament was thus not included in further analyses.

Table 3.1

*Differences in means and stability of sensitivity and intrusiveness across time and situations (N = 73)*

	3 months	6 months	<i>t</i>	Stability ( <i>r</i> )
Sensitivity Bath	7.00 (0.83)	6.25 (1.18)	4.04**	.32**
Sensitivity Lap	6.14 (1.27)	5.35 (1.35)	5.25**	.22
Bath vs Lap <i>t</i> -value	-5.96**	-6.05**		
Sensitivity SFP baseline	2.01 (0.75)	1.64 (0.79)	3.91**	.45**
Sensitivity SFP reunion	2.21 (0.76)	1.64 (0.81)	5.35**	.35**
Baseline vs Reunion <i>t</i> -value	-2.57*	0.00		
Intrusiveness SFP baseline	1.30 (1.00)	2.01 (0.79)	-6.73**	.51**
Intrusiveness SFP reunion	0.99 (0.95)	1.96 (0.82)	-8.82**	.44**
Baseline vs Reunion <i>t</i> -value	3.72**	0.56		

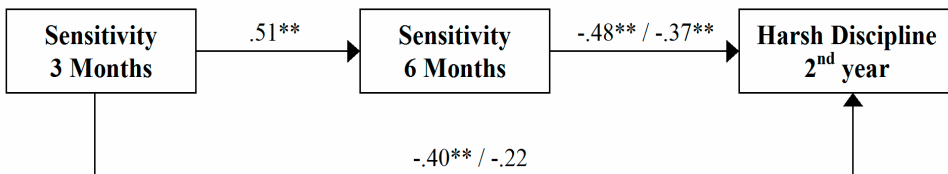
\*  $p < .05$ , \*\*  $p < .01$ .

*Principal component analysis for maternal sensitivity measures*

We conducted principal component analyses for Time 1 and Time 2 separately, including all sensitivity and intrusiveness measures. On the basis of the Scree test a one-factor solution (54% and 51% of the variance explained at Times 1 and 2 respectively) was selected. Factor loadings were high, ranging from  $|.46$  to  $.88|$  at 3 months and from  $|.39$  to  $.84|$  at 6 months (factor loadings for intrusiveness were negative). Based on the factor loadings, all sensitivity scores were aggregated into one overall sensitivity variable. For each time point, standardized scores for bath, lap, and sensitivity during baseline and reunion of the SFP were added after which standardized intrusiveness scores for SFP baseline and reunion were subtracted. Cronbach's alphas for the aggregated sensitivity measures were  $.79$  at 3 months and  $.77$  at 6 months. Stability of the overall sensitivity factor between Time 1 and Time 2 was high ( $r = .58, p < .01$ ).

*Prediction of harsh discipline from sensitivity in infancy* Correlations between sensitivity in the first year and harsh discipline in the second year were strongly negative and significant at both 3 months ( $r = -.50, p < .01$ ) and 6 months ( $r = -.57, p < .01$ ). Mothers who were less sensitive in interaction with their infant in the first 6 months after birth used more harsh discipline in the second year. The effect size ( $R^2$ ) of the relationship between maternal sensitivity in infancy and harsh discipline in the second year was  $.36$  (regression analysis with both 3-month and 6-month sensitivity predicting harsh discipline).

A mediation model was tested to investigate whether the relation between sensitivity at 3 months and harsh discipline in the second year was mediated by sensitivity at 6 months. Maternal education and age were both positively associated with maternal sensitivity (education at 3 months  $r = .33, p < .01$  and 6 months  $r = .39, p < .01$ ; age at 3 months  $r = .28, p < .05$  and 6 months  $r = .26, p < .05$ ), and negatively related to harsh discipline (education,  $r = -.39, p < .01$ , age  $r = -.40, p < .01$ ). To control for the influence of maternal age and education, we computed standardized residuals for the sensitivity and harsh discipline scores. The mediation model was tested using Baron and Kenny's (1986) four conditions. Results confirmed all four conditions. First, sensitivity at 3 months significantly predicted sensitivity at 6 months,  $R^2 = .26, F(1,71) = 24.33, p < .01$ .



\*\*  $p < .01$ .

Figure 3.1. Predicting maternal harsh discipline in the second year from sensitivity in infancy ( $N = 73$ )

Second, sensitivity at 3 months was significantly related to harsh discipline,  $R^2 = .16$ ,  $F(1,71) = 13.77$ ,  $p < .01$ . Third, sensitivity at 6 months was also predictive of harsh discipline,  $R^2 = .23$ ,  $F(1,71) = 21.25$ ,  $p < .01$ . Fourth and last, when adding sensitivity at 6 months, sensitivity at 3 months was no longer significantly related to harsh discipline ( $\beta = -.22$ ,  $p > .05$ ), whereas 6-month sensitivity did remain significant, indicating full mediation (Final model:  $R^2 = .27$ ,  $F(2,70) = 12.61$ ,  $p < .01$ ). This was confirmed by a Sobel test ( $z = -3.38$ ,  $p < .01$ ). Standardized B for each step are presented in Figure 3.1, with the standardized B after each slash presenting the values in step 4 of the test for mediation. Thus, less sensitivity at 3 months predicted less sensitivity at 6 months, which in turn predicted more use of harsh discipline in the second year.

#### *Sensitivity in different settings in relation to harsh discipline*

Pearson product-moment correlation coefficients were calculated for the relation between each of the separate sensitivity settings in infancy and harsh discipline during the second year. For this purpose composite variables were created in which scores from the 3 and 6 month home visits were aggregated for bath, lap, and the SFP baseline and reunion (sensitivity minus intrusiveness). Again, standardized residuals were used to control for the influence of maternal education and age. All correlations of sensitivity in all separate settings with harsh discipline were significant ( $p < .01$ ) and negative (for lap  $r = -.43$ ; bath  $r = -.35$ ; SFP baseline  $r = -.47$ ; SFP reunion  $r = -.34$ ). Thus, in each of the settings lower sensitivity during infancy was related to more use of harsh discipline during the second year. To further examine the influence of intrusiveness and sensitivity in the SFP on harsh discipline, two composite variables were calculated combining baseline and reunion scores for both time points. Both these composite variables were significantly related to harsh discipline in the expected directions (i.e., positive for intrusiveness  $r = .42$  and negative for sensitivity  $r = -.40$ ). Because sensitivity and intrusiveness scores for the separate settings were highly intercorrelated and all loaded on one factor, multivariate analyses were not conducted.

## DISCUSSION

The results from this study showed significant 3-month stability of maternal sensitivity within observation settings, as well as mean-level differences across different settings. Furthermore, the results showed that lower levels of maternal sensitivity at 3 as well as 6 months predicted more harsh discipline use in toddlerhood. Virtually all settings showed significant stability of maternal sensitivity from 3 to 6 months. This stability was not due to coder stability since sensitivity observations at both time points were independently coded. Existing empirical work has shown mixed results concerning the degree to which maternal sensitivity can be seen as a stable factor during infancy and later development. Several studies have found significant stability over time (e.g., Ainsworth et al., 1978; Kemppinen, Kumpulainen, Raita-Hasu, Moilanen, & Ebeling, 2006; Vereijken et al., 1997) while other studies have failed to do so (e.g., Lohaus, Keller, Ball, Voelker, & Elben, 2004). Time periods between measurements in these studies

varied from 9 months (Lohaus et al, 2004), up to almost 24 months (Kemppinen et al., 2006). Furthermore, the time of the first measurement also varied strongly from an age of 6 to 8 weeks old (Kemppinen et al., 2006) up to 14 months old (Vereijken et al., 1997). It has been suggested that part of the non-stability in maternal sensitivity may be attributed to changing levels of experienced family stress and social support (Belsky & Fearon, 2002; Pianta, Sroufe, & Egeland, 1989). However, these factors seem more likely to influence the stability of maternal sensitivity over longer time periods (up to 42 months; Pianta et al., 1989).

Besides significant stability of maternal sensitivity over time, we also found significant mean-level differences over time and between settings. First, within each setting maternal sensitivity declined significantly from 3 to 6 months. Between 3 and 6 months infants become more active participants in the dyadic interaction through, for example, the development of laughter and the social smile (Sroufe, 1995). Thus, there are more signals for a mother to pick up on and adequately respond to, and therefore also more signals that can be missed; possibly resulting in lower sensitivity scores. For the SFP, we also found a significant increase in intrusiveness over time during the baseline interaction and the reunion. An increase in intrusiveness over time may also be linked to the development of infant laughter, 'encouraging' mothers to engage their infants in more intrusive game playing. Thus, the drop in maternal sensitivity scores over time may be partly due to increasing intrusiveness.

Significant differences were also found across the various settings for the observation of maternal sensitivity within the same home visit, which could suggest that some settings create circumstances in which it is easier for mothers to respond sensitively, while other settings prove to be more challenging. Our results showed, for example, that mothers were more sensitive during bathing than during free play at both time points. This could be explained by the degree of routine and practice mothers have within certain settings and the accompanying infant signals. Bathing is a daily and therefore well-practiced routine for most mothers, which may not necessarily be the case for free play on mother's lap. For example, during home visits several mothers mentioned how special and unusual it was for them to have their baby on their lap just for free play. In addition, free play without toys is less defined by a clear-cut task than bathing, which could prove to be more difficult for some mothers. Furthermore, infants will be increasingly likely to look around for exploration due to the development of gaze shifting (Hunnus & Geuze, 2004). This may result in less undivided attention for the mother's attempts to establish interaction, which could be especially challenging for mothers during free play. Therefore, a possible explanation for lower sensitivity scores during free play as compared to bathing could be that mothers try to force a playful interaction (possibly by means of intrusive game playing) instead of responding adequately to the infants attempts to explore.

A second between-setting mean-level difference was found for the baseline and reunion of the SFP at 3 months. Mothers were more sensitive and less intrusive during the reunion than during the baseline interaction of the SFP. This could be caused by higher levels of infant negative affect during the reunion, which is carried over from the still face segment (Mesman et al., 2009). Infant

crying provides a clear signal for the mother and can hardly be missed in a face-to-face setting, which makes it easier to perceive the signal and to respond to it with at least some sort of soothing behavior. In contrast, during the baseline interaction, infants generally show higher levels of positive affect and lower levels of negative affect as compared to the reunion episode (Mesman et al., 2009). Therefore, during the baseline interaction mothers do not necessarily have clear signals (such as infant distress) to respond to and might have to be attuned to more subtle infant signals (i.e., of exploration). However, it remains unclear why we did not find these mean level differences for sensitivity and intrusiveness between baseline and reunion at 6 months. According to a recent meta analysis, this result can not be attributed to a less pronounced increase in negative affect during the SFP, since no age differences were found for the 'carry-over effect' of negative affect from still face to reunion (Mesman et al., 2009).

Results of the factor-analysis showed that sensitivity in all settings had high factor loadings on a single factor at both time points. This supports the idea that in the various sensitivity settings the same underlying construct of sensitive parenting is measured. Also, both sensitivity and intrusiveness loaded on the same factor, suggesting a strong overlap between these constructs. However, this does not eliminate the potential importance of separate subscales for the measurement of maternal sensitivity. For instance, even though higher levels of intrusiveness generally lead to lower scores on maternal sensitivity ratings, this does not mean that a low score on maternal sensitivity automatically indicates high levels of intrusiveness. Lower scores on maternal sensitivity can also be due to an overall absence of responses to infant signals, which would indicate low intrusiveness. Distinguishing between insensitive-passive mothers and insensitive-intrusive mothers may be highly relevant for specific processes and outcomes.

As a second aim we investigated whether sensitivity during the first 6 months would predict harsh discipline use in toddlerhood. Results showed that maternal sensitivity at 3 months predicted harsh discipline use in the second year. This relationship was completely mediated by maternal sensitivity at 6 months. Mothers who were less sensitive at 3 months were also less sensitive at 6 months, which predicted more harsh discipline use during the second year. This finding extends an earlier finding by Engfer and Gavranidou (1987), which showed that maternal sensitivity on the maternity ward directly after birth was a significant predictor of ideas and attitudes on punishment use at 4 and 18 months after birth. To our knowledge there have been no previous longitudinal studies linking extensive observations of maternal sensitivity in infancy directly to observations of harsh discipline in toddlerhood.

Theoretical definitions of maternal sensitivity can be fit easily into the social information processing model proposed by Milner (1993, 2003), which is often referred to in the harsh discipline and child abuse literature. The various stages in the social information processing model all define a lack of parenting skills and behaviors that are central to the concept of maternal sensitivity. One aspect of maternal sensitivity that has been specifically linked to harsh discipline use is the degree of maternal intrusiveness during interaction (Lyons-Ruth et al., 1987). Maternal intrusiveness as well as the use of harsh discipline seems

to be the result of a lack of respect and/or empathy for the child's autonomy and behavioral motivations. Parents who do not perceive or even ignore their infants' signals and interfere (physically) with their infants' behavior could also be more likely to misread their children's motivations during toddlerhood due to a lack of empathy and child-centered attributions; leading in turn to harsh discipline (Dadds, Mullins, McAllister & Atkinson, 2003; Dopke & Milner, 2000; Milner 1993, 2003; Milner, Halsey, & Fultz, 1995). Nonetheless, in our results the relation between intrusiveness and harsh discipline was not stronger than the relation between the other sensitivity measures and harsh discipline. Therefore, the results point to a more general lack of perspective-taking which hampers the capability for maternal sensitivity and nonintrusive responsiveness in the first months after birth and leads to the use of harsh discipline in toddlerhood. Since maternal sensitivity can be relatively easily observed during the first months after birth, this would provide excellent opportunities for early identification of those mothers who are possibly at risk for using harsh discipline in toddlerhood. This in turn would give room for timely interventions to prevent the development of more negative dyadic interactions.

The current study has several limitations. First, a different measure was used to rate maternal sensitivity and intrusiveness in the SFP as compared to the bath and free play sessions. Contrary to the SFP, there were no separate subscales for sensitivity and intrusiveness in the bath and free play sessions, which may have limited the comparability of the different settings. Nevertheless, a single underlying factor was shown for all included sensitivity measures at both time points. Second, within time points sensitivity during bath and free play were rated by the same coder, as were the baseline and reunion of the SFP. Therefore, it is possible that mean levels of sensitivity within time points were influenced by same-coder stability. Furthermore, significant mean-level differences in maternal sensitivity at a certain age could be less reliable due to the use of one coder for both settings. However, same coder-stability would have sooner resulted in a lack of significant mean-level differences between the settings. This was not the case; we found significant mean-level differences between bath and free play sessions as well as between the baseline and reunion of the SFP within time points. Last, we did not find a significant relation between infant difficult temperament and maternal sensitivity, which was found in previous studies (Kivijärvi, Räihä, Kaljonen, Tamminen & Piha, 2005; Pederson et al., 1990; Seifer, Schiller, Sameroff, Resnick & Riordan, 1996). This could have been due to the use of questionnaires filled out by the mothers, since it has been shown that observed infant temperament is not always strongly related to mother-reported infant temperament (Seifer, Sameroff, Barrett & Krafchuk, 1994).

The current study is the first to show that maternal sensitivity in various observation settings refers to a single underlying construct. Nevertheless, sensitivity as observed in specific settings may be more predictive of specific parenting or child outcomes. It may therefore be advantageous to include multiple observation settings. In addition, the assessment of paternal sensitivity may require different observation settings than in studies focusing only on mothers (Feldman, Gordon, Schneiderman, Weissman & Zagoory-Sharon, 2010;

Grossmann, Grossman, Kindler & Zimmermann, 2008; see for a meta-analysis Lucassen et al., 2011).

Our study is also the first to show that a lack of sensitivity in infancy predicts harsh discipline in toddlerhood. We have also highlighted the similarities between the social information processing model of abusive parenting and the sensitivity hypothesis in attachment theory. The two models not only converge in terms of their description of the process of response selection, but also in their views on the origins of such processes. Both models refer to beliefs about parenting that have been formed before the child has even been born and which are based at least partly on the parents' childhood experiences with their own caregivers. And in both models, it is not the childhood experiences themselves that cause insensitive or abusive parenting, but rather the extent to which such experiences have been resolved or remain salient and/or traumatic (Milner et al., 2010; Hesse, 2008). Thus the two models appear to be rather similar in their explanation of insensitive and abusive parenting, even though they come from quite different theoretical backgrounds.

Despite remarkable similarities in the theoretical backgrounds of both research areas, there are few studies exploring the nature of the link between early lack of sensitivity and later harsh discipline. Future research should also identify protective factors that break this pattern of maladaptive parenting. Finally, early identification of families at risk for developing negative parenting strategies, such as harsh discipline, could provide mental health care professionals with more time for efficient intervention strategies (Heckman, 2006), thereby improving the prognosis of young infants at risk.



## Predicting harsh discipline of infants: Overreactive sympathetic nervous system responses to repeated infant crying predict maternal harsh discipline

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### ABSTRACT

Physiological reactivity to repeated infant crying was examined as a predictor of harsh discipline use with 12-month olds in a longitudinal study with 48 mother-infant dyads. Physiological reactivity was measured while mothers listened to three blocks of infant cry sounds in a standard cry paradigm when their infants were three months old. Harsh discipline use was observed in two tasks during a home visit when the infants were 12 months old. Mothers who used harsh discipline with their 12-month-olds were compared to mothers who did not on their sympathetic and parasympathetic reactivity to the presented cry sounds. Results showed a significant interaction effect for sympathetic reactivity only. Mean Skin Conductance Levels (SCL) of harsh mothers continued to rise across the repeated exposures to cry sounds, while after an initial increase the mean SCL of the other mothers showed a steady decline. Results are discussed from a polyvagal perspective, and we suggest that harsh parenting reflects behavioral as well as physiological overreactivity to negative infant signals.

*Key words: harsh discipline, physiological reactivity, infant crying, polyvagal theory*

### INTRODUCTION

Parental harsh discipline plays an important role in the development of problem behavior in childhood and adolescence (e.g., Bender et al., 2007; Miner & Clarke-Stewart, 2008; Prinzie, Onghena & Hellinckx, 2006). Harsh parenting can be seen as an overreactive strategy used by parents with negative, blame-oriented, and child-centered attributions about their children's (mis)behavior (Bugental & Happeney, 2004; Bugental, Lewis, Lin, Lyon, & Kopeikin, 1999). On a biological level, harsh parenting has been related to physiological hyperreactivity to (negative) infant signals (for a review see McCanne & Hagstrom, 1996). More specifically, studies have shown a stronger activation of the sympathetic nervous system (SNS) in response to infant crying among harsh or abusive parents when compared to control groups (Crowe & Zeskind, 1992; Disbrow & Caulfield, 1977; Frodi & Lamb, 1980), which may indicate that harsh parents perceive their

children's behavior as more threatening (Martorell & Bugental, 2006). Porges' polyvagal theory (1995, 2001, 2011) suggests that the perception of negative infant signals as threatening, leads harsh parents to rely more on physiological defensive strategies supported by the SNS than on the functioning of the vagal brake supported by the parasympathetic nervous system (PNS). In this longitudinal study we examined sympathetic and parasympathetic activation in response to infant crying in relation to observed harsh parenting.

In the existing literature on harsh parenting, or more specifically harsh discipline, ample evidence can be found of the detrimental effects of this parenting strategy on the behavioral and emotional development of children and adolescents (for a meta-analysis see Gershoff, 2002). Children of parents who use harsh discipline have higher levels of externalizing behavior problems in childhood (e.g., Bender et al., 2007; Fine, Trentacosta, Izard, Mostow, & Campbell, 2004; O'Leary, Slep & Reid, 1999; Prinzie, Onghena, & Hellinckx, 2006), are more likely to become delinquent (Hoeve et al., 2009) and generally have lower levels of mental health (Gershoff, 2002) compared to children of non-harsh parents. Nonetheless, a controversy remains as to whether these negative consequences are related to the use of all forms of harsh or physical discipline including spanking, which has sometimes been labeled as 'discipline with reasonable force' (Baumrind, Larzelere, & Cowan, 2002).

Most empirical work on harsh discipline uses definitions including multiple disciplining or punishing behaviors. Because measures of harsh discipline generally encompass a multitude of different behaviors it is plausible that part of the explanation of the divergence in findings for effects of harsh discipline lies in the different and only partly overlapping definitions used across studies. The various harsh discipline strategies can be seen on a continuum ranging from subtle forms such as grabbing hard, to forms of corporal punishment in the middle of the continuum (such as hitting with a belt or paddle), to more extreme forms of physical punishment (such as beating or kicking causing injuries which could result in hospitalization) at the other end of this harsh discipline continuum. Thus, comparing results on child outcomes of harsh discipline is problematic when some studies include only part of the continuum (e.g., spanking) in their definitions, while other studies include the whole or a different range of harsh discipline behaviors.

Besides this continuum based solely on physical aspects of harsh discipline, the broader concept of overreactive discipline which includes parenting behaviors such as yelling, threatening, commanding, and name-calling has been used in several studies (e.g. Bugental & Happaney, 2004; Chang, Schwartz, Dodge, & McBride-Chang, 2003; Fine, Trentacosta, Izard, Mostow, & Campbell, 2004; Leung & Slep, 2006; Straus & Stewart, 1999). Such overreactive parenting behaviors are central to Patterson's coercion theory. Within this theoretical framework, parents respond with escalating coercive discipline strategies such as physical and verbal harshness when faced with challenging child behavior (Patterson, 1982). There is substantial evidence that this pattern of physically and verbally harsh discipline is related to negative child outcomes through processes such as modeling and lack of positive reinforcement (e.g., Patterson, Capaldi, & Bank, 1991; Shaw, Bell,

& Gilliom, 2000). Following coercion theory and the idea of escalating discipline in multiple modalities, both physical (e.g., spanking, grabbing, pushing, and pulling) and verbal (e.g., yelling, name calling, and aggressive/irritated tone of voice) discipline strategies are included as aspects of harsh discipline in the current study.

In characterizing parents who are (at risk for) using harsh or even abusive discipline, Milner (1993, 2003) presented a four-stage model of social information processing. Across these four stages high-risk and abusive parents are described to be (1) more biased in the perception of, as well as less attentive to, their children's behavior, (2) more likely to interpret negative child behaviors as motivated by hostile intent, and to have child-centered attributions (i.e., to view this behavior as due to internal, stable, and global child factors), (3) less likely to use situational cues when evaluating their children's behavior, and (4) less likely to have well-developed skills or abilities to implement and modify child-directed responses and parenting strategies. These processes are also relevant in the study of harsh discipline, since several studies have shown significant relations between harsh discipline and child-centered, or child-blaming attributions as included in Milner's model for child abuse. For example, mothers who rated videotapes of children's negative affect in mother-infant interactions higher on child-blaming attribution also scored higher on harsh parenting (Smith & O'Leary, 1995).

From a biological perspective, individual differences in parental physiological reactivity to negative infant stimuli have also been related to differences in the quality of parenting. For example, greater heart rate (HR) reactivity to infant crying has been shown to distinguish parents at risk for abuse from controls (for a review see McCanne & Hagstrom, 1996). Furthermore, there has been empirical support for a direct relation between HR reactivity and overreactive discipline. One study observed mothers with their toddlers in two discipline tasks in a lab setting, during which HR reactivity of the mothers was measured. Overreactive discipline was measured as the degree and frequency of anger or irritation through vocal (e.g., yelling) or non-vocal (e.g., grabbing) channels during a clean-up task and a competing-demand task. Results showed that a greater HR reactivity was associated with more overreactive discipline strategies (Lorber & O'Leary, 2005). However, greater HR reactivity in response to infant crying has also been found in highly sensitive mothers (Joosen, Mesman, Bakermans-Kranenburg, Pieper, Zeskind, & Van IJzendoorn, 2012) and in mothers with a prompt response to infant crying (Del Vecchio, Walter, & O'Leary, 2009). The finding that greater HR reactivity seems to be related to both harsh and sensitive parenting may be due to the fact that activation of both the sympathetic and the parasympathetic branch of the autonomic nervous system (ANS) can lead to increases in HR (see Berntson, Cacioppo, Quigley, & Fabro, 1994). These dual mechanisms influencing HR create a problem for the interpretation of HR reactivity.

To examine the underlying mechanisms of physiological reactivity, Porges' polyvagal theory (1995, 2001, 2007, 2011) describes three subsystems of the ANS, namely the social communication circuit (involving the myelinated vagus and the PNS), the mobilization circuit (involving the SNS and fight-flight behaviors), and the most primitive circuit of immobilization (involving the unmyelinated

vagus and e.g., feigning death or freezing behaviors). These three subsystems developed in three phylogenetic stages and are, therefore, hierarchically activated when responding to external stressors. The activation of a specific subsystem also depends on the perception of the environment as either safe or threatening. In a safe environment the PNS circuit for social communications is activated to promote survival by facilitating social interactions and social bonds. However, when the environment is perceived as dangerous or threatening the autonomic system switches to the more primitive circuits and activates the SNS to regulate defensive strategies through a fight-or-flight response.

Since harsh parents, given their negative and child-blaming attributions, seem to operate from a threat rather than a safety perspective, they may be expected to show physiological overreactivity of especially the SNS in response to infant crying. Activation of the SNS can be measured by an individual's electrodermal activity, operationalized as changes in SCL. Whereas HR is influenced by both branches of the ANS, electrodermal activity is exclusively regulated by the SNS (Boucsein, 1992). When the SNS is activated, sweat in the eccrine sweat glands accumulates, causing rising sweat levels in the sweat ducts (of the palmar surfaces), resulting in higher levels of skin conductance (Boucsein, 1992; Dawson, Schell, & Filion, 2000). An early study of physiological reactivity to infant signals by Frodi and Lamb (1980) indeed showed a greater increase in SCL for abusive mothers as compared to control mothers in response to infant crying. Another study including both males and females with high and low scores on the Child Abuse Potential Inventory confirmed this finding, by showing greater SCL reactivity amongst the high-Child Abuse Potential group for phonated cry sounds specifically (Crowe & Zeskind, 1992).

Greater HR reactivity in sensitive mothers has been suggested to result from activation of the PNS and not from activation of the SNS (Joosen, Mesman, Bakermans-Kranenburg, Pieper et al., 2012). The PNS, depends on the functioning of the ventral vagal complex (VVC), which originates in the nucleus ambiguus. The VVC functions as an active vagal brake by controlling cardiac output via the sino-atrial node (Porges, 2001, 2007). The degree of cardiac control by the vagal brake can be quantified by the amplitude of respiratory sinus arrhythmia (RSA; Porges, 1995). Efficient disinhibition of the vagal brake (i.e., RSA withdrawal) seems to be associated with increased behavioral and emotional control, which enables rapid mobilization as well as calm and self-soothing behavioral states in response to environmental demands (Porges, 1996). In other words, an efficiently functioning vagal brake points to physiological flexibility when reacting to environmental demands. In contrast, the negative behavioral overreactivity to infant signals seen in parents at risk for abuse (Milner, 2003) may signal a chronically overactivated SNS resulting from a *poorly* functioning vagal brake (Porges, 2001). Thus, the difference between those parents using harsh discipline and those who do not, would be the combination of an overreactive SNS with an unresponsive PNS.

To effectively distinguish these mechanisms in relation to parenting behavior, sympathetic *and* parasympathetic activation in reaction to stressors such as infant crying should be measured simultaneously to unravel the unique effects

of the two branches and to identify meaningful differences between them. In the current longitudinal study we tested the hypothesis that parents with a stronger activation of the SNS in response to standardized infant cry sounds (measured when their infants were 3 months old with a cry paradigm) would be more likely to use harsh discipline with their infants at 12 months. We expect mothers who will show harsh discipline to have a greater increase in SCL in response to infant cry sounds when compared to mothers not showing harsh discipline. Concerning PNS reactivity to infant cry sounds, we expect mothers who will show harsh discipline to have significantly less RSA withdrawal than the other mothers in response to the cry sounds.

## METHOD

### *Sample and procedure*

Participants were recruited via the Regional Coordination Programs of the Dutch National Institute for Public Health and Environment (NIPHE). Inclusion criteria were (1) both parents were low to middle educated, (2) the first child was younger than six years, (3) the newborn second child was neither premature nor handicapped, (4) both children and parents lived together in one household and (5) both parents were Caucasian, and (6) the first child scored either low or high on externalizing behavior on the Child Behavior Checklist (CBCL/ 1½ -5; Achenbach & Rescorla, 2000; cutoffs based on Van Zeijl et al., 2006). We added the final criterion in order to increase the chance of including both low- and high-risk mother-infant dyads very early without relying on more distal risk factors such as parental education level or stress.

Since the focus of the recruitment was to approach families from the lower socioeconomic strata, we pre-selected postal codes of areas in which more than 30% of inhabitants had a low income (less than 14,200 Euro per year; as defined by the Dutch Central Bureau of Statistics). Families with a newborn infant living in these areas received a letter from the NIPHE with information about the study. Interested mothers of a second newborn infant were requested to fill out a card with their details and were then contacted by phone to find out the educational level of both parents (1 *elementary school*, 2 *first four years of Dutch high school*, 3 *vocational education or five or six years of high school*, 4 *higher professional education*, and 5 *university*). When both parents had a low (level 1 or 2) educational level or no more than one of the parents scored level 3, a home visit was planned to complete the CBCL about the first child. All mothers who completed the CBCL received a coupon with a value of 10 Euro.

A total of 53 families met our criteria (26 with a 'high externalizing' first child), of whom 48 families were included in this paper (three families dropped out during the first 12 months and two mothers had unreliable ECG data). Within the final sample 13% of mothers finished elementary school, 60% finished the first four years of Dutch high school, and 27% obtained a degree in vocational education or finished five or six years of high school. Maternal mean age at time of birth of their second child was 29.65 years (*SD*: 4.93, range 19-39 years). The mean age of the first children at the time of selection was 35.42 months (*SD*: 12.65,

range 18-70). Of the first-born children 54% were boys, and of the second-born children 35% were boys.

All 48 families participated in a total of four home visits during the first year after the birth of the second child. Home visits were scheduled when the second child was 3, 6, 9, and 12 months old. For the current study, we used the assessments at 3 and 12 months. At the 3-month home visit mothers participated in a 20-min cry paradigm (Out, Pieper, Bakermans-Kranenburg, & Van IJzendoorn, 2010; Zeskind & Lester, 1978) during which an electrocardiogram (ECG) signal as well as the SCL were recorded. Prior to the cry paradigm mothers were asked to fill out a short questionnaire concerning possible smoking habits and their frequency of physical exercise to control for any influence on the ECG data (De Geus, Boomsma, & Snieder, 2003; Farrington, 1997; Vander, Sherman, & Luciano, 2001). At the 12-month home visit mothers were observed with both children simultaneously during two discipline tasks.

In all participating families both parents signed informed consent forms. To limit loss of participants through attrition, families were given gift coupons and small presents for the children after each home visit. Procedures and measures used in this study were reviewed and approved by the ethical committee of the Institute of Education and Child Studies at Leiden University.

### *Measures*

*Externalizing behavior.* The Child Behavior Checklist for ages 1½ to 5 (CBCL/ 1½-5; Achenbach & Rescorla, 2000; Van Zeijl et al., 2006) was used in the screening phase to assess externalizing behaviors of the first-born child and was obtained from mothers during the selection home-visit. Mothers indicated whether their child displayed any of the 100 behavioral descriptions in the last 2 months on a 3-point scale (0 *not true*, 1 *somewhat or sometimes true*, and 2 *very or often true*). The distribution of CBCL Externalizing Problems scores reported by Van Zeijl et al. (2006) was used to determine cut-off scores in identifying low versus high levels of externalizing behaviors. Families were selected for the low externalizing group when scores on externalizing behavior of the oldest child did not exceed the lowest 50% of scores in the norm group of the same age. Families were placed in the high externalizing group when scores were within the highest 25% of scores in the norm group of the same age.

*Cry Paradigm.* The cry perception stimuli and paradigm (Out et al., 2010) were administered using a laptop with E-prime software. Mothers listened to three blocks of each three cry sounds that varied in fundamental frequency within each block. Cry stimuli were derived from the spontaneous crying of a healthy 2-day old, full birth-weight and full term female infant and were recorded midway between scheduled feedings. A 10-sec portion of the sustained period of crying, containing seven expiratory sounds, was selected for presentation. The seven cry expirations had a mean duration of 1055 msec (range: 0.6195 to 1899 msec) and a mean Peak  $F_0$  of 452.6 Hz (range 425.2 to 515.6 Hz).

To provide cry stimuli with a wide range of fundamental frequencies, the original cry (averaging approximately 500 Hz) was digitally altered to increase the fundamental frequency while holding temporal and other spectral aspects of

the cry constant. Two new 10-sec cry stimuli were created by digitally increasing the original cry by approximately 200 and 400 Hz, respectively, resulting in two new cry sounds with an overall Peak  $F_0$  of 714.5 Hz (700 Hz Cry) and 895.8 Hz (900 Hz Cry; see Out et al., 2010). Each of the three blocks of cry sounds contained each of the three cry sounds (i.e., 500 Hz, 700 Hz, 900 Hz) presented in a random order.

The cry stimuli were presented at a constant volume through Sennheiser HD202 headphones. Following a 4-min baseline period and a practice trial in which the 500 Hz cry was presented, mothers listened to the three blocks of three cry sounds each. The paradigm was concluded with a 2-min recovery period. Following every presented cry sound mothers answered four questions on perceived urgency (not aroused – aroused, not aversive – aversive, healthy – sick and not urgent – urgent) on a 5-point rating scale (Zeskind & Lester, 1978; Zeskind & Marshall, 1988). Given the high internal consistencies (alphas ranging from .77 to .82), answers to the four perceived urgency questions were averaged to form an overall perceived urgency score for each of the three frequencies. Missing values for one participant (2%) were replaced with the standardized mean scores of the group for the overall perceived urgency per frequency. During the entire cry paradigm mothers' ECG and SCL signals were recorded continuously.

*RSA and SCL.* ECG and SCL signals were measured with an ambulatory monitoring system (VU-AMS5fs; TD-FPP, Vrije Universiteit, Amsterdam, the Netherlands). For the ECG signal, three disposable pre-gelled Ag-AgCl electrodes (ConMed, New York, USA) were used, which were placed below the right collar bone 4 cm to the right of the sternum, 4 cm under the left nipple and at the lateral right side. The full ECG signal was stored at a 16-bit sampling rate. SCL was measured with two Ag-AgCl electrodes, which were filled with Biopac isotonic paste. After washing both hands with a mild soap solution, the electrodes were attached to the volar surfaces of the medial phalanges of the middle and index finger of the nondominant hand. The SCL signal was stored on the VU-AMS5fs at 10 samples per second (10 Hz). Both physiological responses were synchronized to the cry sounds using a marker button on the AMS device. The experimenter pushed the button two seconds before the stimulus was presented, leaving markers that allowed for accurate labeling of each cry sound.

Inter beat interval time series (IBIs) were derived by visual peak-detection of the R-wave through accompanying VU-AMS5fs software packages. Each recorded ECG complex was inspected and corrected by hand when necessary. RSA was measured through calculation of the root mean square of successive differences (RMSSD) of inter beat intervals for each of the labeled segments (baseline, recovery and each of the cry presentations). Mean SCL was also calculated for each of these labeled segments.

For mean RMSSD, missing values for two participants were replaced with the mean scores for each labeled segment. For mean SCL, missing values for four participants were replaced with the mean scores for each labeled segment. Outliers were only detected for mean RMSSD and were winsorized for three participants to values corresponding to a standardized value of 3.29, whilst preserving the participant's response pattern. Mean SCL and RMSSD levels were aggregated

within each of the three blocks (i.e., average of three consecutive episodes of 10 seconds).

*Smoking and Physical exercise.* Mothers were asked to fill out a short questionnaire prior to the cry paradigm in which they answered whether and how much they had smoked prior to the home visit that day (0 *no*, 1 *yes one or two*, and 2 *more than two*). Furthermore, mothers answered how often they had engaged in physical exercise in the week prior to the home visit (0 *no*, 1 *yes once or twice*, and 2 *more than twice*). For both smoking as well as physical exercise, scores were dichotomized creating a smoking (scores of 1 and 2) and a non-smoking (score of 0) group as well as an exercise and non-exercise group. Missing values for one participant (2%) were replaced with the modus for both variables. Groupings for smoking and physical exercise are presented in Table 4.1.

*Maternal sensitivity.* Maternal sensitivity was assessed with the Ainsworth Sensitivity rating scale (Ainsworth et al., 1974) during free play on the mother's lap without toys (5 minutes), and during bathing (10-20 minutes). Observations took place during the 3-month home visit and only involved the mother with her second-born infant. Arrangement were made to ensure that the first-borns

Table 4.1.

*Background and physiological data of harsh (n = 10) and non-harsh mothers (n = 38)*

	Observed harsh discipline						F
	Harsh mothers			Non-harsh mothers			
	n (%)	M	SD	n (%)	M	SD	
Smoking during day of homevisit (yes)	5 (10.4)			8 (16.7)			
Physical exercise during week prior to homevisit (yes)	4 (8.3)			24 (50.0)			
Maternal sensitivity at 3 months		6.23	0.84		6.51	1.00	
Age in years		30.47	5.54		29.44	4.81	
Mean baseline SCL		9.41	3.11		9.66	3.07	
Mean SCL during block 1		11.11	3.70		10.85	3.64	1.50
Mean SCL during block 2		11.32	4.10		10.66	3.67	4.96*
Mean SCL during block 3		11.39	3.90		10.57	3.56	5.70*
Mean SCL during recovery		11.06	3.73		9.96	3.10	13.46**
Mean baseline RMSSD		35.22	14.98		51.64	25.73	
Mean RMSSD during block 1		35.96	15.07		45.50	21.88	0.14
Mean RMSSD during block 2		38.15	16.40		46.06	20.23	0.82
Mean RMSSD during block 3		34.28	14.95		45.91	21.74	0.02
Mean RMSSD during recovery		33.69	18.31		47.67	23.01	0.03
Total	10 (20.8)			38 (79.2)			

\*  $p < .05$ , \*\*  $p < .01$ .

were not at home, or would play with a research assistant in a separate room. All observations were rated independently by two trained coders, but bath and lap sessions were rated by the same coder. Intercoder reliabilities (intraclass correlation, single rater, absolute agreement) for each pair of the six coders ranged from .75 to .92. When the scores of the two independent coders differed by two or more points (on the 9-point scale) tapes were discussed and a consensus score was assigned. For smaller differences the average of both scores was used. One missing value was replaced with the overall mean of the group and one outlying value was winsorized to a value corresponding to a standardized value of -3.29.

*Harsh discipline.* Maternal discipline was observed during the home visit at 12 months. Observations consisted of two tasks: a don't-touch task and a clean-up task. In the don't-touch task mothers were presented with a bag full of attractive toys. They were instructed to take the toys out of the bag, place them in front of the children and to make sure neither child would touch the toys. After 2 minutes the children were allowed to play only with the least attractive toy: a simple stuffed animal. After another 2 minutes the children were allowed to play with all the attractive toys as well as a bag of extra toys. Following 15 minutes of free play with all toys (not coded for this study), mothers received an empty bag with the instruction that all toys had to be cleaned up by both children. She could help and encourage the children as she would normally do, but was told that it was important that the children would do as much of the cleaning up as possible. The clean-up session was finished when all toys were back in the bag or when ended by the experimenter after 10 minutes.

The observations were coded with an adapted version of the discipline rating scales used by Verschueren et al. (2006). Adaptations included a further division of the harsh discipline scale in a physical and a verbal subscale. Discipline strategies were rated as *'harsh physical discipline'* when mothers used unnecessary physical force, either when preventing their child from touching a forbidden object or when forcing the child to clean up (i.e., slapping, grabbing the child, pulling an arm too hard, grabbing toys from the child, pinching an arm, or grabbing/holding the face of the child). The action also had to cause a noticeable physical impact on the child (e.g., body movement, facial or vocal expression of shock or discomfort). Scores for harsh physical discipline were rated on a 5-point rating scale. Because observing harsh physical discipline in relatively short episodes is rare, the scale was defined in a way that would allow more subtle as well as blatant harsh acts to be included: 1 *no physically harsh acts*, 2 *a hint of harshness, but not severe or unclear impact on child*, 3 *at least one harsh act but not physical punishment and not used to emphasize a verbal command*, 4 *either more than one harsh act or a single act of physical punishment (e.g., slapping) or emphasizing a command (e.g., grabbing child's face)*, and 5 *more than one harsh act of which at least one act of physical punishment; mother has clearly lost control*.

*'Harsh verbal discipline'* was defined as irritation and anger in the tone of voice (i.e., impatient, irritated, angry voice, yelling, screaming,). Scores for harsh verbal discipline were defined on a 5-point scale as follows: 1 *no harsh verbal discipline*, 2 *mild irritation*, 3 *irritation and anger*, 4 *obvious irritation and or anger on more than one occasion*, and 5 *almost constant irritation and/or anger*. However, *'harsh verbal*

*discipline'* scores showed too little variance at 12 months to include in further analyses, thus only *harsh physical discipline'* scores are included in this study.

At the 12-month home visit both children participated simultaneously with their mother in the discipline tasks. Discipline strategies of the mother directed to each child were scored independently. In the current analyses only the mother's harsh discipline score towards her second child was used. Intercoder reliabilities of six coders ranged from .76 to 1.00 for '*harsh physical discipline'*'. The highest score of the two situations observed (either of the don't-touch task or of the clean-up task) was used as indicator of the severity of maternal harsh physical discipline. Using this score we created two groups based on a cut-off score of 3. This cutoff distinguished mothers who performed at least one act of clear physical harsh discipline ( $n = 10$ ) from mothers who did not ( $n = 38$ ).

## RESULTS

### *Preliminary analyses*

Sample distributions, means and standard deviations are presented in Table 4.1. Mothers in the harsh discipline group did not differ significantly from the non-harsh group of mothers on smoking, physical exercise, or age (all  $ps > .05$ ). Smoking, physical exercise, and maternal age neither had a significant influence on baseline levels of RMSSD, nor were these variables significant covariates in any of the repeated measures analyses for RMSSD. Therefore, analyses are reported without these variables. All repeated measures analyses included a baseline value for SCL or RMSSD, respectively, as the reference point for reactivity and the Greenhouse-Geisser Epsilon was used to correct for violation of sphericity.

### *Perception of urgency.*

A repeated measures analysis for perceived urgency of the three cry sounds (500, 700 and 900 Hz) showed that all mothers perceived the 700 as well as the 900 Hz cry sound as significantly more urgent than the 500 Hz cry sound,  $F(1,75, 80.49) = 48.15, p < .01$ , partial  $\eta^2 = .51$ . No significant differences in perceived urgency were found between the 700 and 900 Hz cry sound. Mothers in both groups also did not differ significantly in their ratings of perceived urgency for all three cry frequencies.

### *SCL*

Mean SCL response patterns for both groups are presented in Table 4.1 and Figure 4.1. Separate analyses of covariance showed higher mean SCL for the harsh group of mothers compared to the non-harsh group in block 2 ( $F(1,45) = 4.96, p < .05$ , partial  $\eta^2 = .10$ ), block 3 ( $F(1,45) = 5.70, p < .05$ , partial  $\eta^2 = .11$ ), and the recovery ( $F(1,45) = 13.46, p < .01$ , partial  $\eta^2 = .23$ ) when corrected for baseline SCL values. A repeated measures analysis showed a significant rise in mean SCL from baseline to the three cry sound blocks ( $F(2.41, 111.04) = 23.57, p < .01$ , partial  $\eta^2 = .34$ ) as well as a significant decrease in mean SCL from block 3 to recovery ( $F(1, 46) = 10.29, p < .01$ , partial  $\eta^2 = .18$ ). A significant interaction effect between SCL reactivity over time and harsh discipline was found,  $F(2.41, 111.04) = 4.10, p < .05$ , partial  $\eta^2 =$

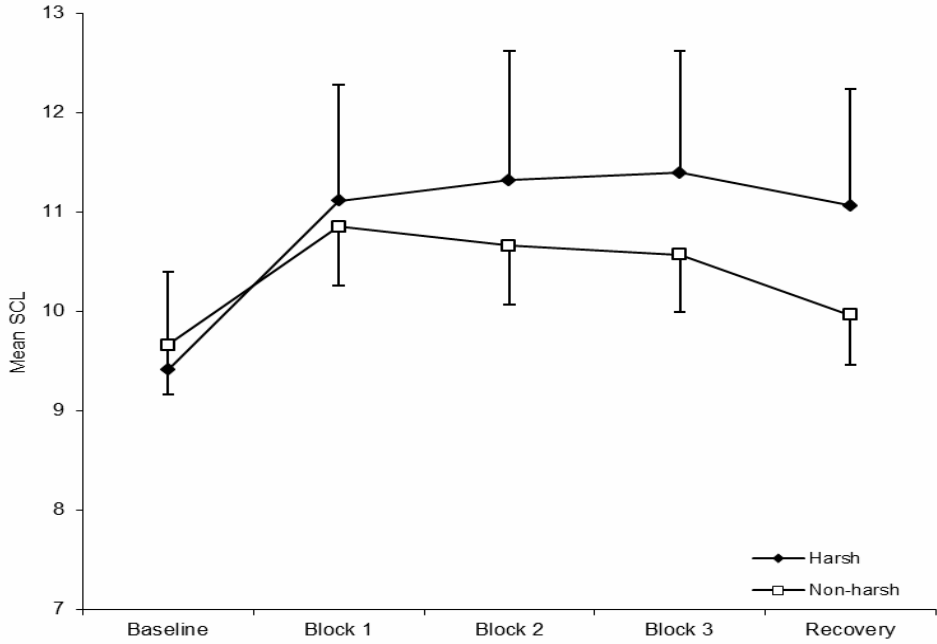


Figure 4.1. SCL reactivity to infant crying ( $M$ ,  $SE$ ) in harsh ( $n = 10$ ) and non-harsh ( $n = 38$ ) groups of mothers

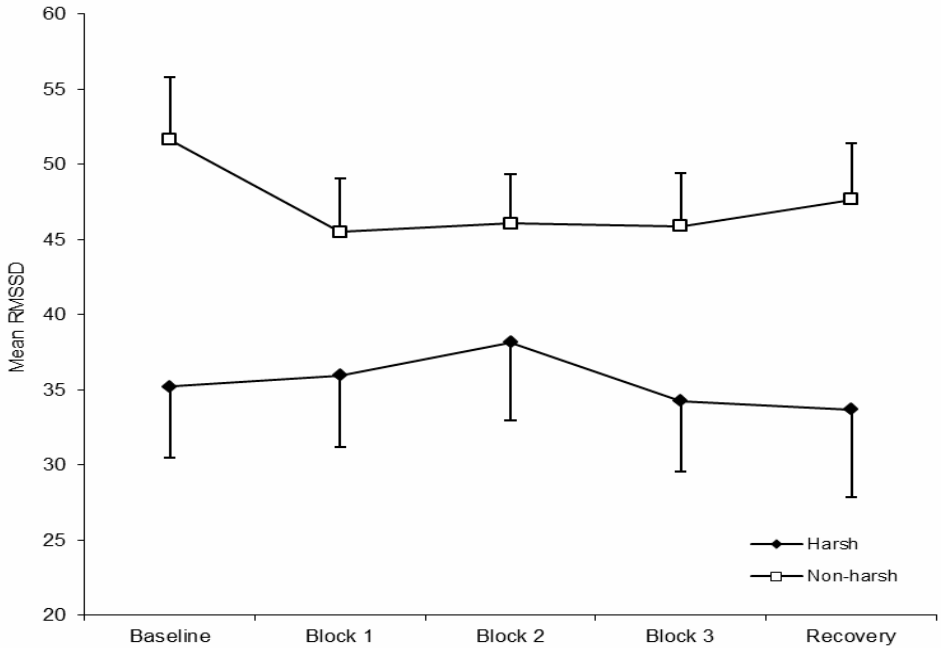


Figure 4.2. RSA in response to infant crying ( $M$ ,  $SE$ ) in harsh ( $n = 10$ ) and non-harsh groups of mothers ( $n = 38$ )

.08. Mothers in the harsh group showed a significantly different response pattern of SCL than the non-harsh group from baseline to block 3 ( $F(1,46) = 5.22, p < .05$ , partial  $\eta^2 = .10$ ) and from baseline to the recovery ( $F(1,46) = 13.79, p < .01$ , partial  $\eta^2 = .23$ ). While the mean SCL of the mothers in the non-harsh group declined after the first block of crying, harsh mothers' mean SCL continued to rise across the cry paradigm, resulting in significantly different response patterns from baseline to block 3 and remaining differences during recovery. Maternal sensitivity at 3 months was not a significant covariate when added to the analyses, and when controlling for 3-month sensitivity the interaction between SCL reactivity over time and harsh discipline remained significant,  $F(2.38, 107.13) = 3.51, p < .05$ , partial  $\eta^2 = .07$ .

#### RSA

Mean RMSSD response patterns for both groups are presented in Table 4.1 and Figure 4.2. Separate analyses of covariance for each block and the recovery did not show any significant differences between means for the harsh and non-harsh group when correcting for baselines values (test-statistics are presented in Table 4.1). A repeated measures analysis for RMSSD showed no significant main effect of RMSSD reactivity over time ( $F(3.04, 139.68) = 0.87, p > .05$ , partial  $\eta^2 = .02$ ), nor an interaction effect between RMSSD reactivity over time and harsh discipline,  $F(3.04, 139.68) = 1.38, p > .05$ , partial  $\eta^2 = .03$ . Thus mothers in the harsh group did not show a different RMSSD response pattern to the cry sounds compared to the other mothers. Maternal sensitivity at 3 months was not a significant covariate in the repeated measures analysis,  $F(3.08, 138.51) = 1.27, p > .05$ , partial  $\eta^2 = .03$ .

## DISCUSSION

This study investigated differences in physiological reactivity to cry sounds between mothers observed to use harsh discipline and mothers who were not. Specifically, we hypothesized that the mothers using harsh discipline would have a stronger reactivity of the SNS in response to cry sounds compared to other mothers. Furthermore, we expected mothers using harsh discipline to have a weaker RSA withdrawal compared to other mothers in response to cry sounds, due to the absence of a well-functioning vagal brake (Porges, 2001). Our results confirmed that mothers in the harsh discipline group showed more reactivity of the SNS, as shown by greater increases in SCL compared to mothers in the non-harsh group, especially after repeated exposure to cry sounds across the paradigm. Mean SCL of mothers using harsh discipline continued to rise across the cry paradigm, while the mean SCL of mothers not using harsh discipline declined after an initial increase in response to the first block of cry sounds. Where there was no significant difference in mean SCL baselines between the two groups, mothers in the harsh group continued to show increased SCL leading to significant mean level differences between groups from the second block of crying onwards.

Nonetheless, *both* groups did show an initial activation of the SNS in response to the first block of cry sounds, shown by an increase in mean SCL from baseline

to block 1 for all mothers. Furthermore, group differences in mean SCL were not yet significant during the first block of cry presentations as shown by the analysis of covariance for block 1. It thus seems that not the immediate activation of the SNS in response to infant crying differentiates between the two groups of mothers, but that only the enduring activation of the SNS in response to repeated cry sounds is linked to later observations of harsh parenting. These results are in line with results from a study that found a later peak for Shaken Baby Syndrome hospitalizations (10-13 weeks of age) than for the peak of the crying curve (5-6 weeks of age). This delay in peak for Shaken Baby Syndrome hospitalization could be due to the stress that is caused for some (at-risk) parents when they are confronted with persistent high crying levels that endure beyond the peak of the normal crying curve (Barr, Trent, & Cross, 2006). Thus, it seems that especially repeated exposure to crying is related to the experience of psychological stress in parents using harsh discipline, which in combination with negative, blame-oriented, and child-centered attributions (Bugental & Happeney, 2004; Bugental et al., 1999), leads to unremitting activation of their SNS.

Concerning our hypothesis on RSA withdrawal, results did not confirm a weaker RSA withdrawal in response to the cry sounds for the mothers using harsh discipline compared to the mothers who did not. A possible explanation for this unexpected finding could be the use of RMSSD as a quantification of RSA. In the present study, very short segments were used for the calculation of RMSSD: per block we averaged three segments of 10 seconds (the duration of each cry sound), each divided by a resting period of one minute. Unfortunately, RSA estimates in general have been found to be less reliable when measurement intervals are short (Berntson et al., 1997). Furthermore, RMSSD as a measure of RSA is known to have a large range of acceptable scores (see manual VU-AMS.5fs on <http://www.vu-ams.nl/support/previous-ams-versions/manuals/amsgra>), which in this study was shown by large standard deviations for the group averages per block. It is possible that these large standard deviations, in combination with the small group sizes (especially for the harsh group), were responsible for the lack of significant differences between the two groups of mothers on RMSSD levels.

It could also be that varying levels of sensitivity in the second year after birth have dampened the degree of RSA withdrawal in the non-harsh group. Previous findings have shown stronger RSA withdrawal for highly sensitive mothers (Joosen et al., 2012a) as well as a significant relation between low levels of early maternal sensitivity and the use of harsh discipline in toddlerhood (Joosen, Mesman, Bakermans-Kranenburg, & Van IJzendoorn, 2012). Therefore, we also controlled for the level of early maternal sensitivity (at 3 months after birth) in the current study. Nonetheless, since we did not include later levels of maternal sensitivity (during the second year) when creating the two groups, it is possible that the mothers in the non-harsh group included highly sensitive mothers as well as mothers with medium or low levels of sensitivity. Therefore, even though the lines in Figure 4.2 do suggest an absent RSA withdrawal for the mothers in the harsh group, the non-significance of this result may be due to a mix of mothers with various levels of sensitivity within the non-harsh group. In a larger sample one could distinguish between a highly sensitive and a moderately sensitive non-

harsh group. We would predict that this would uncover significantly less RSA withdrawal in mothers showing harsh discipline compared to highly sensitive mothers who do not show harsh discipline.

In sum, our results have shown endured persistent activation of the SNS in response to repeated infant cry sounds by mothers using harsh discipline when compared to other mothers. However, the cry paradigm did not evoke significantly different PNS response patterns over time between the two groups of mothers. From a polyvagal perspective, the current results for SNS reactivity seem to confirm that repeated cry sounds are experienced by mothers in the harsh group as more psychologically stressful and possibly threatening than by the other mothers, maybe causing both chronic overactivation of the SNS and a behavioral overreactivity (i.e., harsh discipline).

It has been suggested that negative parenting responses to crying are especially related to the aversive perception of hyperphonated (high pitched) cry sounds. Zeskind and Shingler (1991), for example, found that abusive parents perceived hyperphonated cries more similar to their own abused infant's cries than the parents in the comparison group. In the present study differences in physiological reactivity to infant crying could not be attributed to group differences in perception of urgency of the three frequencies. Our results are in line with a study showing that *both* low-Child Abuse Potential and high-Child Abuse Potential adults rated hyperphonated cries as significantly more urgent, arousing, distressing, aversive and sick-sounding than the phonated cries (Crowe & Zeskind, 1992). Inconsistencies in findings regarding the perception of cries with varying pitches could be related to the items used to rate the perception of the different cries, since only one of these items (not aversive – aversive) seems to distinguish between harsh and non-harsh parents. However, a lack of empathy in response to presentations of a crying infant has been shown for mothers with a high risk for physical abuse when compared to low risk mothers (Milner, Halsey, & Fultz, 1995). It would be interesting to investigate whether dimensions such as empathetic responsiveness or negative appraisals of infant crying, instead of perception ratings, are related differently to variations in cry pitch for parents who use harsh discipline and parents who do not.

Some limitations of the current study should be mentioned. First, the small sample sizes of especially the harsh group could have influenced the reliability of the results. Results on RSA withdrawal may have been affected by the small group sizes in combination with the large standard deviations for RMSSD mean levels per segment. Second, we based our split between the groups of mothers on the more subtle signs for harsh discipline, which resulted in a total of only 10 mothers in the harsh group. Home observations of moderate to severe harsh discipline are not to be expected in a non-clinical population, since any mother would be at her best in front of a camera. Therefore, when using home-observations cut-offs for harsh parenting can only be based on the milder and subtler signs of harsh discipline, registering therefore only the tip of the iceberg. Last, it could be seen as a limitation that we did not control for respiration rate in our estimation of RSA. Some studies have shown that RSA magnitude can be altered purely as a function of respiratory changes, even in conditions of mental

activation or emotion (Grossman & Taylor, 2007). In a comparative study between different quantification methods for RSA using data collected with a similar ambulatory device, RMSSD levels were proven as a reliable and valid estimate of RSA (Goedhart, Van der Sluis, Houtveen, Willemsen, & De Geus, 2007). Since all participants were seated during the entire cry paradigm (including baseline measurement), and did not speak during cry presentations, changes in respiration rate due to physical activity or talking could only have had a minimal effect on our estimation of RSA.

In conclusion, the current study shows a sympathetic overreactivity to repeated cry sounds among mothers observed to use harsh discipline when compared to mothers who did not. Mean SCL of harsh discipline using mothers continued to rise across the repeated exposure to cry sounds, while after an initial increase the mean SCL of the other mothers showed a steady decline. Therefore, we suggest that harsh parenting reflects behavioral as well as physiological overreactivity to negative infant signals.



The overall aim of the studies presented in the current thesis was to uncover early predictors of harsh discipline to enhance the early identification of potential risk groups for this form of inadequate parenting and related problematic child outcomes. More specifically, we studied early maternal behavioral and physiological indicators of harsh discipline in toddlerhood. We examined the influence of early maternal sensitivity as a behavioral predictor of harsh discipline. As physiological indicators we studied both the parasympathetic (PNS) and sympathetic (SNS) nervous systems responses to repeated infant crying. First, we examined the cross-sectional relation between the two predictors by investigating whether highly sensitive mothers have a significantly different heart rate (HR) reactivity and respiratory sinus arrhythmia (RSA) withdrawal in response to repeated infant crying as compared to less sensitive mothers. Second, we investigated longitudinally whether maternal sensitivity in early infancy, as measured in a variety of settings, is a significant predictor of harsh discipline in toddlerhood. Furthermore, we focused on the question whether a stronger sympathetic reactivity to repeated infant crying at 3 months predicts harsh discipline in toddlerhood. In this chapter the results are summarized and discussed, followed by a discussion on the study's limitations and some suggestions for future research.

*Physiological reactivity to repeated infant crying among highly sensitive mothers*

Our cross-sectional results showed that highly sensitive mothers responded to infant crying with a greater HR increase as well as a greater RSA withdrawal compared to less sensitive mothers. This greater physiological reactivity of highly sensitive mothers was more related to the initial presentation of cry sounds than to the repeated exposure to cry sounds, since their elevated physiological reactivity was found directly after presentation of the first cry sounds and remained at similar levels throughout the cry paradigm until the recovery phase. From a polyvagal perspective this greater HR reactivity to infant crying among highly sensitive mothers is likely to be related to their greater RSA withdrawal. Among highly sensitive mothers greater HR reactivity to infant crying (as compared to less sensitive mothers) would be the result of a more efficient vagal brake in response to the external demands of infant crying. The stronger RSA withdrawal of highly sensitive mothers equips them with a more efficient behavioral and emotional regulation by enabling rapid mobilization as well as calm and self-soothing behaviors in response to external demands such as infant crying (Porges, 1996, 2011).

Theoretically, it is also possible that a release from the vagal brake reflects an influence of the SNS on HR changes, since one of the functions of the vagal

brake is the suppression of sympathetic innervation of the heart. Following this line of reasoning, RSA withdrawal would imply that HR increases are the result of sympathetic activation rather than of parasympathetic activation. However, according to recent insights, the vagal system can also influence changes in HR *solely* through the right nucleus ambiguus (vagal brake). In other words, an efficiently working vagal brake enables rapid responsiveness to external demands by innervation of the heart without the activation of the phylogenetically older and biologically more taxing sympathetic (SNS) fight-flight system (Porges, 2011).

In a previous study on infant resilience to stress, greater maternal RSA withdrawal during the reunion episode of the Still Face Paradigm (SFP) was found especially for those mothers who managed to effectively sooth their infant (Ham & Tronick, 2006). This seems to be in line with our results since soothing behaviors that effectively calm a distressed infant can be considered a sensitive maternal response (Ainsworth, Bell, & Stayton, 1974). In addition, another study examining physiological correlates of maternal responsiveness during the SFP reunion episode found that mothers with high levels of cortisol were more intrusive in response to their infants during the SFP reunion, and that this relation was only found for mothers who also showed less RSA withdrawal during the SFP reunion (Mills-Koonce et al., 2009). Cortisol is generally used as a measure of an individual's HPA-axis activity and is involved in the physiological regulation of stress as is the SNS (e.g., El-Sheikh, Erath, Buckhalt, Granger, & Mize, 2008; Gordig, Granger, Susman, & Trickett, 2008; Van Stegeren, Wolf, & Kindt, 2008). With cortisol as a correlate of sympathetic activation, the results of Mill-Koonce et al. (2009) suggest that mothers with a *compromised* vagal brake, shown by less RSA withdrawal, respond to external demands by activation of the sympathetic system, because it is not efficiently suppressed by the vagal system.

Furthermore, our results also showed that highly sensitive mothers had lower mean HR and higher mean RSA levels than less sensitive mothers in general from the baseline onwards until the end of the recovery. Concerning RSA, this effect was mainly due to differences in resting RSA levels between the highly sensitive and less sensitive mothers. Therefore, this effect is in line with the idea that the higher *resting* RSA levels signal a greater capacity for emotional regulation in general (e.g., Beauchaine, Gatzke-Kopp, & Mead, 2007; Fabes & Eisenberg, 1997; Porges, 2011). For example, a study on the association between attachment to a romantic partner and resting RSA levels showed that men who experienced higher levels of security in their relationship also had higher resting RSA levels. Men with more experiences of attachment anxiety regarding their current partners had lower resting RSA levels. More importantly, when the experimenters induced anger in the men during a laboratory task, the more effective recovery found among securely attached men was mediated by higher resting RSA levels (Diamond & Hicks, 2005). Thus, these results suggest that the higher resting RSA levels of securely attached men are related to a more effective regulation of negative emotions.

However, higher resting RSA levels are not solely related to the regulation of negative emotions. As higher resting RSA also indexes the effective expression

of positive emotions from later infancy and toddlerhood onwards, Beauchaine concludes (2001) that higher resting RSA signals appropriate regulation of positive *and* negative emotions, and that this is true at all ages. Thus, it seems that individuals with higher resting levels of RSA are better equipped to regulate their emotions effectively in general regardless of the valence of the emotions, resulting in the expression of *appropriate* emotions in a given context. This line of reasoning also relates to the specific link between maternal sensitivity and (resting) RSA levels. The same brainstem nuclei that are involved in the regulation of the myelinated vagus (which is responsible for RSA levels), are also linked neuroanatomically as well as neurophysiologically to the neural regulation of the muscles that control eye gaze, facial expressions, listening ability, and prosody (Porges, 2007, 2011). These facets of social communication in combination with an effective regulation of emotions are necessary for a mother to respond sensitively to her infant's signals by, for example, making eye contact, smiling, listening or talking in a '*motherese*' tone of voice.

In addition to the link between maternal sensitivity and physiological responsiveness to infant signals, the development of systems underlying stress reactivity in infants themselves is also relevant. For example, Hane and Fox (2006) have shown that low levels of maternal caregiving behavior were related to greater right frontal electroencephalographic (EEG) asymmetry among their infants compared to infants receiving high-quality maternal caregiving. This result was not due to infant differences in temperament and supports Porges' (2011) suggestion that especially the right hemisphere has a role in the regulation and expression of (negative) emotions or in his words: "*Since cardiac vagal tone is neurophysiologically linked to the right hemisphere regulation of autonomic activity, it might index the individual's functional capacity to regulate autonomic function and to express emotion (p.140)*". Thus, a more efficient responsive vagal brake in mothers is related to higher levels of maternal sensitivity, which in turn positively influences the development of physiological systems underlying emotion regulation in their infants as well.

#### *Early maternal sensitivity predicting harsh discipline use in toddlerhood*

Lower levels of maternal sensitivity at 3 months were found to predict more harsh discipline use during toddlerhood. Furthermore, this relation was fully mediated by maternal sensitivity at 6 months in that less sensitivity at 3 months predicted less sensitivity at 6 months which in turn predicted more use of harsh discipline during toddlerhood. Concerning the assessment of maternal sensitivity we found that maternal sensitivity across various settings measured the same underlying construct. In addition maternal sensitivity showed significant stability from 3 to 6 months. Maternal sensitivity and intrusiveness predicted harsh discipline independently. Also, both sensitivity and intrusiveness loaded on the same underlying factor, suggesting a strong overlap between these constructs. Due to this strong overlap we did not further investigate whether either maternal sensitivity or intrusiveness uniquely predicted harsh discipline. However, this does not eliminate the potential importance of separate subscales for the measurement of maternal sensitivity. Although highly intrusive mothers will

never score very highly on a sensitivity scale, a low score on maternal sensitivity does not automatically indicate high levels of intrusiveness. Lower scores on maternal sensitivity can also be due to an overall absence of responses to infant signals, which would indicate low intrusiveness and a passive kind of maternal insensitivity.

Given the overlap in underlying behavioral style, especially intrusive-insensitive parenting seems likely to predict harsh discipline. Intrusive insensitivity as well as the use of harsh discipline seems to be the result of a lack of respect and/or empathy for the child's autonomy and behavioral motivations. Mothers who do not perceive or even ignore their infants' signals and interfere (physically) with their infants' behavior would also be more likely to misread their children's motivations during toddlerhood due to a lack of empathy and child-blaming attributions, leading to harsh discipline (Dadds, Mullins, McAllister & Atkinson, 2003; Dopke & Milner, 2000; Milner 1993, 2003; Milner, Halsey, & Fultz, 1995). Following this line of reasoning, harsh discipline as measured in this thesis may be indicative of a more global intrusive-insensitive parenting style, which can already be observed in early infancy. Furthermore, this global intrusive insensitivity describes exactly the link between Milner's social information processing (1993, 2003) model and the lack of maternal behaviors described by Ainsworth's et al. (1974) concept of maternal sensitivity.

*Physiological reactivity to repeated infant crying among mothers using harsh discipline*  
A stronger activation of the SNS in response to repeated cry sounds in early infancy predicted the use of harsh discipline in toddlerhood. Mean SCL of mothers using harsh discipline continued to rise across the cry paradigm, while the mean SCL of mothers not using harsh discipline declined after an initial increase in response to the first block of cry sounds. Without significant difference in mean SCL baselines between the two groups, mothers in the harsh group continued to show increased SCL leading to significant mean level differences between groups from the second block of crying onwards.

It was not the immediate activation of the SNS in response to infant crying that differentiated between the two groups of mothers, but the enduring activation of the SNS in response to repeated cry sounds appeared to be linked to later observations of harsh parenting. This could be explained by the fact that especially harsh parents are ill-equipped already in early infancy to cope effectively with the psychological stress that is provoked by prolonged exposure to infant crying. These results are in line with a study that found a later peak for Shaken Baby Syndrome hospitalizations (10-13 weeks of age) than for the peak of the crying curve (5-6 weeks of age). This delay in peak for Shaken Baby Syndrome hospitalization could be due to the stress that some (at-risk) parents experience when they are confronted with persistent high crying levels that endure beyond the peak of the normal crying curve (Barr, Trent, & Cross, 2006). In addition, a study on potentially damaging parenting reactions in response to infant crying showed that 5.6% of Dutch parents of a 6-month old infant had responded abusively at least once due to their infant's crying (Reijneveld, Van der Wal, Brugman, Hirasing, Verloove-Vanhorick, 2004).

These results seem to be in direct contradiction to the evolutionary hypothesis which states that excessive early infant crying signals vigor in the infant and has evolved with the function to prevent a reduction or withdrawal of parental care (Soltis, 2004). At least for infants of harsh or abusive parents it seems that the goal of receiving parental *care* is not best obtained by excessive crying. Alternatively it could be that these infants signal other negative emotions than distress, such as fear or anger, which are less successful in eliciting empathy from adult caregivers, but instead could provoke harsh responses (Mesman, Oster, Camras, 2012). According to Porges (2011) some individuals indeed experience a ‘mismatch’ between environmental cues and the physiological response of the ANS, causing an inappropriate appraisal by the ANS of the environment as being dangerous, resulting in fight-flight behaviors; translated to the case of harsh and abusive parents as behavioral overreactivity to (negative) infant signals. Heightened perceptions of danger and threat have been found in parents at risk for abuse, as evidenced by more hostile interpretations of child behaviors, often in combination with feelings of powerlessness (e.g., Bugental & Happaney, 2004; Leung & Slep, 2006; Lin, Bugental, Turek, Martorell & Olster, 2002; Smith & O’Leary, 1995). Thus, in the words of Porges (2011): *“It is not just the stimuli that elicit a response; rather, the response is determined by a complex system of behavioral-physiological responses that involve perception of the stimulus, afferent feedback, and the regulation of approach-withdrawal behaviors via the vagal system.(p.143)”*

The results of our study did not confirm the hypothesis of a weaker RSA withdrawal in response to infant crying among mothers using harsh discipline compared to mothers who did not. One of the reasons for the lack of confirmation could be that we used very short segments as measurement of RSA levels. RSA estimates in general have been found to be less reliable when measurement intervals are short (Berntson et al., 1997). Furthermore, varying levels of maternal sensitivity in the course of the second year after birth may have dampened the association. We did control for maternal sensitivity levels at the 3-month home visit, which did not influence the lack of group differences on RSA reactivity in response to infant crying. However, even though our results also showed significant stability in maternal sensitivity during early infancy and similar stability has been found in other studies over longer time periods (Lohaus, Keller, Ball, Voelker, & Elben, 2004; Kemppinen, Kumpulainen, Raita-Hasu, Moilanen, & Ebeling, 2006), it is unlikely that scores on maternal sensitivity would be completely fixed over time. Since we did not include later levels of maternal sensitivity (during the second year) when creating the two groups, we cannot eliminate the possibility that the mothers in the non-harsh group included highly sensitive mothers as well as mothers with (at a later point in time) medium or low levels of sensitivity. In a larger sample one could distinguish between highly sensitive and moderately sensitive non-harsh groups to find out whether mothers showing harsh discipline show significantly less RSA withdrawal compared to highly sensitive mothers who do not show harsh discipline.

In sum, mothers who are less sensitive in the interaction with their infant during the first 6 months after birth, have a less efficient vagal brake, shown by less RSA withdrawal in response to infant crying. Furthermore, mothers who are

less sensitive during early infancy are also more likely to employ harsh discipline strategies with their toddlers. Last, the small group of mothers that eventually was observed to use harsh discipline with their toddlers at 12 months after birth indeed seemed to rely more strongly on the defensive strategies of the SNS in response to external demands, shown by their greater SNS reactivity in response to repeated infant crying compared to the non-harsh group of mothers.

### *Limitations*

Several limitations of the current study should be mentioned. First, overall sample sizes were quite small. This holds especially for the first and third chapter on physiological responsiveness to infant crying, which featured small subgroups of highly sensitive and harsh discipline using mothers respectively. In Chapter 4 the small subsample of the mothers using harsh discipline could explain the unexpected lack of significant results on RSA withdrawal in response to infant crying when comparing the harsh and non-harsh group of mothers. Analyses on a larger sample would be less affected by the larger standard deviations found for RSA, which could have dampened a potential effect. Nonetheless, in both chapters data was rigorously checked for outliers to ensure valid conclusions.

Second, we did not control for respiration rate in our estimation of RSA. Some studies have shown that RSA magnitude can be altered purely as a function of respiratory changes, even in conditions of mental activation or emotion (Grossman & Taylor, 2007). However, in a comparative study between different quantification methods for RSA using data collected with a similar ambulatory device, RMSSD levels were indicated as a reliable and valid estimate of RSA (Goedhart, Van der Sluis, Houtveen, Willemsen, & De Geus, 2007). Since all participants were seated during the entire cry paradigm (including baseline measurement), and did not speak during cry presentations, changes in respiration rate due to physical activity or talking could only have had a minimal effect on our estimation of RSA.

Third, continuing challenges in the search for accurate baseline measurements, especially concerning RSA estimates, complicate the interpretation of physiological reactivity. There has been a debate in literature whether RSA resting levels should be measured during paced breathing tasks or not. Some argue that RSA is best measured when HR, respiration rate, and respiration volume are kept under control. It is argued that this would eliminate the possibility that RSA levels are caused by breathing parameters instead of a vagal influence on the heart (e.g., Butler, Wilhelm & Cross, 2006; Grossman, Karemaker, & Wieling, 1991). However, Porges (2007) has responded to this argument with the notion that RSA should not be interpreted as an equivalent of 'total' cardiac vagal tone, but is merely used as an index that should be studied uncorrected, especially, since the validity of these adjusted RSA measures has yet to be adequately proven.

Fourth, we used different measures to rate maternal sensitivity during the SFP on the one hand and during the bath and free play sessions on the other hand. There were no separate subscales for sensitivity and intrusiveness in the bath and free play sessions, which were used to rate the mothers during the SFP. This may have limited the comparability of the different settings. Nevertheless, a single underlying factor was shown for all included sensitivity measures at both

time points. Fifth, within time points sensitivity during bath and free play were rated by the same coder, as were the baseline and reunion of the SFP. Therefore, it is possible that mean levels of sensitivity within time points were influenced by intracoder stability. Furthermore, significant mean-level differences in maternal sensitivity at a certain age could be less reliable due to the use of one coder for both settings. However, intracoder stability would have sooner resulted in a lack of significant mean-level differences between the settings. This was not the case; we found significant mean-level differences between bath and free play sessions as well as between the baseline and reunion of the SFP within time points.

Last, it should also be noted that concurrent maternal stress was not measured. Stress levels may affect both physiological baseline values (Thayer, Friedman & Borkovec, 1996), maternal sensitivity (Belsky, Crnic & Woodworth, 1995; Van IJzendoorn, Bakermans-Kranenburg & Mesman, 2008), and the use of harsh discipline (Pinderhughes, Dodge, Zelli, Bates, & Pettit, 2000).

#### *Clinical implications and future directions*

The set of studies presented in the current thesis has shown that the use of harsh discipline in toddlerhood can be predicted from maternal sensitivity in infancy and maternal physiological reactivity to infant crying. Uncovering these potential risk factors for harsh discipline is of great importance for mental health care professionals since early identification of at risk parents creates the opportunity for early intervention strategies in breaking an otherwise continuing pattern of maladaptive parenting. Observation of maternal sensitivity during early infancy has a great potential for the identification of parents that are at risk for harsh parenting. These observations do not have to be time consuming and as this thesis has shown can be done in a variety of settings. Therefore, it would be a valid method to identify (extremely) insensitive parents who might profit most from a more intensive parenting support program.

However, we do not suggest that both behavioral and physiological predictors should be used in a similar way for the identification of at-risk parents by health care professionals. Since functioning and reactivity of both branches of the ANS are complex and multifaceted, the use of physiological markers of ANS reactivity to negative infant signals as identifier for parents at risk for harsh parenting or abuse is not advisable. Nonetheless, physiological markers are valuable in providing a more thorough understanding of the (neuro)biological underpinnings of ineffective parenting behaviors. In knowing more of the (neuro)biological mechanisms that influence parenting behaviors, health care professionals gain more insight into the challenge that is formed by striving for behavioral changes in intervention programs. Therefore, to increase this understanding future research should also aim to further unravel the underlying (neuro)biological mechanisms of parenting behaviors.

Furthermore, it would be especially interesting to study whether physiological reactivity of harsh parents differs in response to their own infant crying as opposed to their reaction to standardized infant cries. Some recent studies, for example, have used infant dolls, that can be programmed according to the amount of time the doll cries during a 24-hour observation period. These dolls are also equipped

with a device which registers various parenting behaviors (e.g., Bruning & McMahon, 2009; Roberts, Wolman, & Harris-Looby, 2004). With the existing ambulatory devices to record physiological reactivity continuously during longer periods, it should be no problem to simultaneously measure physiological data during the 24 hours that study subjects would take care of such a doll. In fact, such a study is already ongoing at the Centre for Child and Family Studies of Leiden University. Additionally, future studies could use similar dolls programmed with either standardized cry sounds or their own infant cry sounds to compare the influence of these different cry sounds on both behavioral and physiological reactivity of harsh or abusive parents. As maternal behaviors can even affect an infant's physiological lay-out for stress regulation (Hane & Fox, 2006), early identification of maladaptive parenting strategies could create the opportunity to break the intergenerational transmission of physiological vulnerability.

### *Conclusions*

In sum, we found that highly sensitive mothers in dyadic interactions with their 3-month old infants showed greater HR reactivity and RSA withdrawal in response to cry sounds when compared to less sensitive mothers. The construct of maternal sensitivity proved to be stable over time, with the same construct underlying observations of maternal sensitivity across various settings. Furthermore, mothers who displayed less sensitive behavior in response to their infants at 3 months were also less sensitive during interaction at 6 months, which in turn predicted more harsh discipline use during the second year after birth. Last, our results showed that mothers who were observed to be harsh with their infants at 12 months showed a stronger sympathetic activation in response to repeated infant crying at 3 months. This seems to suggest that harsh parents are behaviorally as well as physiologically overreactive to negative infant signals. Early identification of maladaptive parenting strategies could open the way for prevention of the adverse consequences for parent and child.

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## Nederlandse Samenvatting (Summary in Dutch)

Welke gedragsmatige en fysiologische kenmerken van moeders voorspellen de mate waarin zij hun peuters hardhandig disciplineren? Hangt de kwaliteit van de moeder-kind interactie samen met de effectiviteit van fysiologische reacties van moeders op het huilen van kinderen? Voorspelt de kwaliteit van de moeder-kind interactie tijdens de vroege kindertijd welke moeders wel en niet hardhandig zullen zijn bij het disciplineren van hun kinderen? Wijst een sterkere fysiologische reactie op het huilen van kinderen op het gebruik van hardhandige disciplineringsstrategieën door moeders? In dit proefschrift wordt aan de hand van een drietal hoofdstukken antwoord gegeven op deze vragen.

Binnen de huidige studie wordt hardhandige disciplinerende gedefinieerd aan de hand van het bredere concept van een hyperreactieve disciplineerstijl. Dit concept is gebaseerd op de *coercion* theorie van Patterson (1982) die beschrijft hoe het afdwingen van gehoorzaamheid bij kinderen door het gebruik van zowel verbale als lichamelijke hyperreactieve strategieën kan leiden tot een vicieuze cirkel van negatieve ouder-kind interacties. Op basis van deze theorie zijn zowel verbale gedragingen (e.g., schreeuwen, bedreigen, uitschelden en commanderen) als fysieke gedragingen (ruw vastgrijpen, trekken, sleuren en lichamelijk straffen) opgenomen in de definitie van hardhandige disciplinerende die gebruikt is in dit proefschrift. Hardhandige disciplinerende wordt over de hele wereld door ouders gebruikt bij de opvoeding van hun kinderen, terwijl in veel landen (inclusief Nederland) het gebruik van elke vorm van lichamelijk geweld tegen kinderen bij de wet verboden is. Het gebruik van hardhandige strategieën hangt samen met de ontwikkeling van probleemgedrag bij kinderen (e.g., Bender et al., 2007; Fine, Trentacosta, Izard, Mostow, & Campbell, 2004; O'Leary, Slep & Reid, 1999; Prinzie, Onghena, & Hellinckx, 2006), en vergroot de kans op delinquentie tijdens de adolescentie (Hoeve et al., 2009) en de ontwikkeling van meer psychische problemen in het algemeen (Gershoff, 2002).

Sensitief gedrag van moeders ten opzichte van hun tweede kind is binnen dit proefschrift onderzocht als vroege gedragsmatige voorspeller van hardhandige disciplinerende in de peupertijd. Het construct sensitiviteit is oorspronkelijk ontstaan vanuit de gehechtheidstheorie en werd als eerste geformuleerd door Mary Ainsworth (1967). Zij definieerde sensitiviteit als het vermogen van moeders om de signalen van hun kinderen op te merken, deze juist te interpreteren en daar vervolgens adequaat en prompt op te reageren (Ainsworth, Bell, & Stayton, 1974). De sensitiviteit van moeders in interactie met hun kind is in de afgelopen decennia veel bestudeerd. Een verscheidenheid aan studies heeft aangetoond dat sensitiviteit een positieve invloed heeft op de ontwikkeling van kinderen in verschillende domeinen, zoals gehechtheid (Bakermans-Kranenburg, Van IJzendoorn, & Juffer, 2003; De Wolff & Van IJzendoorn, 1997), sociaal gedrag

(e.g., Kochanska, 2002; Van Zeijl et al., 2006) en cognitieve vaardigheden (e.g., Bernier, Carlson, & Wipple, 2010; Tamis-LeMonda, Bornstein, & Baumwell, 2001). Deze studies kennen echter een grote diversiteit in de operationalisering van het construct sensitiviteit. Wanneer in onderzoek naar sensitiviteit gebruik wordt gemaakt van observaties kan worden gekozen voor naturalistische observaties (e.g., Albers, Riksen-Walraven, Sweep, & De Weerth, 2008), meer gestandaardiseerde observaties zoals gestructureerde taakjes en spelsituaties (e.g., Vereijken, Riksen-Walraven, & Kondo-Ikemura, 1997) of stressvolle situaties zoals bijvoorbeeld het Still Face Paradigma (SFP; Tronick, Als, Adamson, Wise, & Brazelton, 1978). Aangezien specifieke situaties mogelijk bepaald gedrag meer of minder kunnen uitlokken is het belangrijk om onderzoek te doen naar de rol die de keuze van setting speelt in de betekenis van sensitiviteit.

Ook de link tussen sensitiviteit en hardhandige disciplineren verdient aandacht in empirisch onderzoek. De relatie tussen beide opvoedingsaspecten is nog maar weinig onderzocht terwijl het uitgangspunt voor beide constructen op dezelfde pijlers lijkt te berusten. Zo beschrijft Milner (1993, 2003) in zijn theorie over sociale informatieverwerking dat mishandelende ouders met minder aandacht en precisie de signalen van hun kinderen waarnemen, deze vaker verkeerd en vijandig interpreteren en minder vaak informatie uit de omgeving gebruiken om het gedrag van hun kinderen beter op waarde te kunnen schatten. Deze beschrijving komt overeen met Ainsworth's definitie van sensitiviteit, maar is geformuleerd vanuit het oogpunt dat het mishandelende ouders aan deze vaardigheden ontbreekt. Het is dus aannemelijk dat minder sensitief gedrag van moeders in interactie met hun baby een voorspeller zou kunnen zijn van meer hardhandige disciplineren door moeders in de peutersjijde.

Vanuit een biologisch perspectief is binnen dit proefschrift bij moeders gekeken naar de reactie van het autonome zenuwstelsel op huilen van baby's als voorspeller van latere hardhandige disciplineren door moeders. Hierbij wordt onderscheid gemaakt tussen de reactiviteit van de twee afzonderlijke takken van het autonome zenuwstelsel, namelijk het parasympathische en het sympathische zenuwstelsel. Deze beide stelsels hebben (een vaak antagonistische) invloed op de werking van het hart en de hartslag. In voorgaande studies zijn verbanden gevonden tussen een sterkere hartslagtoename en hardhandige disciplineren (Lorber & O'Leary, 2005). Er wordt echter ook een sterkere hartslagtoename gevonden bij moeders die sneller, en dus in zekere zin sensitiever, reageren op het huilen van baby's door naar hen toe te gaan om te troosten (Del Vecchio, Walter, & O'Leary, 2009). Deze resultaten geven aan dat er binnen de bestaande literatuur nog onduidelijkheid is over de betekenis van verschillen in hartslagreactiviteit.

Binnen dit proefschrift is dit nader onderzocht aan de hand van Porges' *polyvagal theory* (1995, 2001, 2007, 2011), waarin drie subsystemen van het autonome zenuwstelsel worden beschreven. Deze bestaan uit (1) een sociaal communicatiesysteem, dat aangestuurd wordt door het parasympathische zenuwstelsel en de gemyeliniseerde nervus vagus; (2) het mobilisatiesysteem dat aangestuurd wordt door het sympathische zenuwstelsel en waarbij de zogenoemde '*fight-flight*' gedragingen een belangrijke rol spelen; (3) het systeem van immobilisatie dat tevens het meest primitief is en het functioneren van

de ongemyleiniseerde vagus betreft. Deze subsystemen zijn hiërarchisch georganiseerd en worden ook in die volgorde geactiveerd wanneer het organisme reageert op externe stressoren. De activatie van de desbetreffende subsystemen is verder afhankelijk van de mate waarin de omgeving als veilig wordt ingeschat door het individu. Als dit het geval is, wordt het sociaal communicatie systeem als eerste geactiveerd om overleving te bevorderen door het faciliteren van sociale interacties. Dit systeem reguleert de hartslag door middel van de nervus vagus die als een soort rem (*vagal brake*) op de hartslag werkt. Als deze rem wordt losgelaten onder invloed van het parasymphatische systeem zorgt dit voor een toename in de hartslag. Het functioneren van deze rem wordt gemeten aan de hand van de amplitude van de respiratoire sinus aritmie (RSA; Porges, 1995). Een efficiënt werkende *vagal brake* hangt samen met een betere regulatie van gedrag en emoties en wijst op een fysiologische flexibiliteit in de reactie op omgevingsstressoren. Wanneer echter de omgeving als gevaarlijk of bedreigend wordt ervaren, wordt het meer primitieve sympathische systeem geactiveerd om ervoor te zorgen dat het individu kan vluchten of vechten. Het is mogelijk dat hardhandige ouders vanwege hun negatieve en vijandige interpretaties van het gedrag van hun kinderen meer geneigd zijn om zich in zekere zin 'bedreigd' te voelen in uitdagende conflictsituaties. De verwachting is dat bij deze ouders dan ook met name het sympathische zenuwstelsel wordt geactiveerd in reactie op bijvoorbeeld het huilen van baby's.

De data voor dit proefschrift zijn verzameld binnen een longitudinale studie waarin gezinnen gedurende de eerste 2 jaar na de geboorte van hun tweede kind intensief werden gevolgd door middel van o.a. huisbezoeken. In totaal deden 103 gezinnen mee aan het onderzoek en werden deze gezinnen in twee rondes geworven. In de eerste ronde werden 50 gezinnen bereid gevonden om mee te doen en dit werd in de tweede ronde aangevuld tot een totaal van 103 gezinnen. Een tweede wervingsronde was noodzakelijk om ook gezinnen uit een lager sociaaleconomisch milieu aan de onderzoekspopulatie toe te voegen. Bij deze gezinnen werden vervolgens huisbezoeken afgelegd wanneer de tweede kinderen 3, 6, 9, 12, 18 en 24 maanden oud waren. Binnen deze huisbezoeken werd sensitief gedrag van de moeder geobserveerd in interactie met hun 3 en 6 maanden oude baby's. Deze observaties werden gedaan in twee naturalistische settingen (bad- en schootsessies) en tijdens de baseline en reünie episodes van de SFP. Vervolgens zijn de naturalistische observaties gecodeerd aan de hand van de Ainsworth Sensitivity scale (Ainsworth et al., 1974). Voor het coderen van de SFP is gebruik gemaakt van een aanpassing van de Mother-Infant Coding System (Miller, 2000).

Verder werd tijdens deze eerste twee huisbezoeken de fysiologische reactiviteit op huilen onderzocht met behulp van een huilparadigma (Out, Pieper, Bakermans-Kranenburg, & Van IJzendoorn, 2010; Zeskind & Lester, 1978). Tijdens dit huilparadigma luisterden de moeders naar drie blokken met elk drie huilgeluiden van wisselde toonhoogtes (fundamentele frequenties). Voor de meting van parasymphatische reactiviteit op de huilgeluiden werd gedurende het gehele huilparadigma een elektrocardiogram (ECG) geregistreerd. Op basis van dit ECG werd de *Root Mean Square of Successive Differences* van de

*Inter-Beat Intervals* berekend als maat van RSA. Hiernaast werd ook een continue huidgeleidingssignaal opgenomen als meting van de sympathische activatie tijdens het huilparadigma. Hardhandige disciplineren werd thuis geobserveerd tijdens een tweetal taakjes toen de kinderen 12, 18 en 24 maanden oud waren. Bij de eerste taak werd moeders gevraagd ervoor te zorgen dat de kinderen niet aan aantrekkelijke speelgoed zouden komen. Tijdens het tweede taakje werd moeders gevraagd ervoor te zorgen dat de kinderen speelgoed zouden opruimen. Deze observaties zijn gecodeerd aan de hand van een aangepaste versie van een disciplineringschaal van Verschueren et al. (2006). Hierbij werd gebruik gemaakt van twee subschalen: lichamelijke hardhandige disciplineren en verbale hardhandige disciplineren.

In Hoofdstuk 2 van dit proefschrift wordt allereerst onderzocht wat de relatie is tussen beide voorspellers: sensitiviteit van de moeders in interactie met hun baby's en de fysiologische reactiviteit op huilgeluiden. Hiervoor zijn de meest sensitieve moeders vergeleken met de minder sensitieve moeders. De resultaten van deze studie laten zien dat de meest sensitieve moeders een sterkere hartslagtoename lieten zien in reactie op de huilgeluiden dan de minder sensitieve moeders. Verder vertoonden de meest sensitieve moeders ook een sterkere daling van de RSA in reactie op de huilgeluiden. Dit suggereert dat de hartslagtoename bij de meest sensitieve moeders gerelateerd zou kunnen zijn aan de werking van hun parasympathische zenuwstelsel en sociaal communicatie circuit. Ten slotte werd gevonden dat de meest sensitieve moeders gedurende het gehele huilparadigma een lagere hartslag en een hogere RSA hadden vergeleken met de minder sensitieve moeders. Een hogere RSA (met name tijdens rust) hing in eerdere studies samen met een betere regulatie van emoties (e.g., Beauchaine, Gatzke-Kopp, & Mead, 2007; Fabes & Eisenberg, 1997; Porges, 2011). Deze resultaten suggereren dat de meest sensitieve moeders beter in staat zijn hun emoties te reguleren vanwege een efficiënter werkende *vagal brake* die ervoor zorgt dat deze moeders fysiologisch flexibeler zijn in hun reacties op omgevingsstressoren zoals huilen en ook in staat zijn om gedragsmatig op een sensitievere manier op de signalen van hun baby's te reageren dan de minder sensitieve moeders.

In Hoofdstuk 3 werd onderzocht of sensitiviteit van de moeder tijdens interacties met haar baby het toepassen van hardhandige disciplineren zou voorspellen tijdens de peutertijd. Ook werd gekeken of metingen van sensitief gedrag in verschillende situaties tot eenzelfde construct gerekend kunnen worden. Betreft de scores van sensitiviteit in verschillende settings werd inderdaad door factor analyses bevestigd dat alle settings hetzelfde onderliggende construct meten. De resultaten lieten verder zien dat moeders die minder sensitief waren in interactie met hun 3-maanden oude baby's significant vaker hardhandige disciplineren toepasten vanaf dat hun kinderen 1 jaar oud waren. Dit verband werd volledig gemedieerd door de mate van sensitiviteit van moeders toen de baby 6 maanden oud was. Lage sensitiviteit bij 3 maanden voorspelde lage sensitiviteit bij 6 maanden dat op zijn beurt meer hardhandige disciplineren in het tweede jaar voorspelde.

In Hoofdstuk 4 werd gekeken naar de voorspellende waarde van sympathische en parasympathische reacties op huilgeluiden in relatie tot hardhandige

disciplineren in de peutertijd. Hiervoor werden moeders die hardhandige disciplineren hadden gebruikt tijdens de observatie bij 12 maanden vergeleken met moeders die geen hardhandige disciplineren hadden gebruikt. De resultaten lieten zien dat het sympathische zenuwstelsel van hardhandige moeders langer geactiveerd bleef in reactie op de huilgeluiden dan bij de andere moeders. Voor de parasympathische reactiviteit op huilgeluiden werden geen significante verschillen gevonden tussen de groepen. Dit suggereert dat later hardhandige ouders al in de vroege kindertijd meer psychische stress ervaren bij het herhaald luisteren naar huilgeluiden.

### *Conclusie*

Zowel minder sensitief gedrag van de moeder in interactie met haar baby als een langdurige sympathische reactie op huilgeluiden voorspellen (meer) hardhandige disciplineren in de peutertijd. De resultaten in dit proefschrift laten zien dat hardhandige ouders gedragsmatig en fysiologische hyperreactief zijn als het gaat om negatieve signalen van hun kinderen.



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## Curriculum Vitae

Katharina Joosen werd op 13 oktober 1981 geboren in Tilburg. In 2000 behaalde zij haar VWO diploma aan het Cambreur College te Dongen en begon zij met een studie psychologie aan de Universiteit Utrecht. In 2005 studeerde zij af met als specialisatie Klinische en Gezondheidspsychologie. Haar afstudeerscriptie over heimwee onder studenten schreef zij gedeeltelijk aan de University of Gloucestershire in Cheltenham (G.B.). Verder liep zij in 2005 stage aan de Early Intervention Service for Psychosis in Norwich (G.B.) en behaalde tijdens deze stage ook haar basisaantekening diagnostiek. In september 2006 begon Katharina als promovenda op de afdeling Algemene en Gezinspedagogiek (AGP) van de Universiteit Leiden. Haar promotieonderzoek betrof gedragsmatige en fysiologische voorspellers van een hardhandige opvoeding. Naast haar aanstelling als promovenda was Katharina binnen de afdeling ook werkzaam als onderwijsmedewerkster (2006-2008) en codeur van Adult Attachment Interviews (2009-2011). Sinds 1 februari 2012 is zij als postdoc onderzoeker werkzaam bij het Nederlands Studiecentrum Criminaliteit en Rechtshandhaving (NSCR) binnen het 'VIP' project naar levenspaden van vrouwelijke gevangenen in Nederland.

