The Relationship between Maternal Perceptual Sensitivity and Postpartum Depression: Does Poor Maternal Perception Toward Infant Signals Predict Postpartum Depression?

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Abstract

More than 10% of new mothers suffer from postpartum depression (PPD) in the first months after giving birth. Seeing that PPD does not only negatively affect the mother, but has several lasting negative effects on child development, we have taken on the challenge to further investigate possible causes and risk factors for PPD symptom onset. The overriding goal of this study was to better understand the relationship between maternal perceptual sensitivity (MPS) and postpartum depression (PPD). We ask, in particular, whether causal predictive factors can be identified that raise the risk for the onset of PPD. Based on research, showing that mothers with depression display lower levels of sensitivity toward their infants and that unipolar depression is often accompanied by difficulties in perceiving emotions, why hypothesized that lower MPS prior o delivery would be correlated with higher levels of depression symptoms after birth. We also investigated if auditory and visual MPS were related to each other and whether MPS was a stable trait or whether there were systematic changes after the arrival of and interaction with a new baby. We furthermore explored whether there were biases toward either negative or positive stimuli across groups (higher vs. lower severity of depressive symptoms). Finally, we looked if any sociodemographic variables and maternal factors were correlated with the onset of depression in the first 12 weeks after delivery. Expectant mothers were measured for MPS toward infant cries, happy infant faces, and sad infant faces. MPS was again measured 6-weeks postpartum. For this, signal detection method was employed. Depression was measured for before birth, at 6- and 12-weeks postpartum. The results showed that more sever levels of depression symptoms in the postpartum period were correlated with higher scores in sensitivity toward negative expressions and higher accuracy at in detecting low intensity sad infant facial expressions. While these findings suggest heightened maternal sensitivity toward negative signals is related to depression, a more plausible explanation is that in fact a *sensitivity error* is correlated with depression. This interpretation should be tested in further studies. Additional findings show that multiparous mothers experience a drop in sensitivity toward positive facial expressions 6 weeks after delivery. This is possibly due to the fact that infants in the first 6 weeks of life mainly communicate through negative signals. Concerning maternal factors, we found a history of mental health disorders other than depression and a history of miscarriage to be antenatal predictors of PPD; in contrast, family support and nursing served as protective factors in the postpartum period. Our findings bring further insights into predictive factors for the onset of PPD, but also call into question the definition of MPS used within this thesis, as it

is likely that hypersensitivity toward negative signals poses a risk factor for the development of PPD.

Zusammenfassung

Mehr als 10% aller neuen Mütter leiden unter Postpartaler Depresson (PPD) in den ersten Monaten nach der Geburt ihres Babys. Leider konnte gezeigt werden, dass sich PPD nicht nur negativ auf die Mutter auswirkt, sondern auch die Entwicklung des Kindes dauerhaft negativ beeinflusst wird. Dadurch motiviert untersucht diese Arbeit mögliche Gründe und Risikofaktoren, die PPD auslösen oder zumindest beeinflussen können. Dabei wurde das Hauptaugenmerk auf mögliche Relationen zwischen mütterlicher Wahrnehmungssensitivität (MPS) und PPD gelegt. Gibt es eventuell sogar einen direkten, kausalen Zusammenhang? Untersuchungen haben gezeigt, dass Mütter, die unter Depression leiden, geringere MPS zeigen und dass unipolare Depression häufig mit Schwierigkeiten in der Emotionswahrnehmung einhergeht. Basierend auf diesen Observationen wurde die Hypothese aufgestellt, dass geringe MPS schon vor der Geburt des Kindes PPD vorhersagen könnte. Neben der Hypothese wurde auch untersucht, ob auditiver und visueller MPS korrelieren und auch ob MPS sich nach der Geburt systematisch verändert. Zusätzlich wurde untersucht ob es Unterschiede in der Grundeinstellung respektive positiver bzw. negativer Signale zwischen Müttern mit PPD und denen ohne geben könnte. Zu guter Letzt wurden auch soziodemographische Faktoren erhoben und mit PPD 12 Wochen nach der Geburt in Bezug gebracht. Um dies alles zu untersuchen, wurde ein Maß für die auditive und visuelle MPS bei Schwangeren erhoben, wobei visuelle MPS sowohl für die Detektion von traurigen als auch glücklichen Gesichtern erhoben wurde. Die gleichen Maße wurden dann nochmals 6 Wochen nach der Geburt erhoben. Außerdem wurde auf Depression vor der Geburt, sowie 6 und 12 Wochen nach der Geburt getestet. In der Tat zeigen die Daten sowohl, dass höhere visuelle Signaldetektionswerte bezogen auf traurige Gesichter nach der Geburt mit den Depressionswerten signifikant interagieren, als auch, dass die Depressionswerte mit korrekteren Antworten bei nur sehr leicht traurigen Gesichtern einhergehen. Auch wenn diese Daten suggerieren, dass Depression somit scheinbar eher mit höherer als mit niedrigerer Sensitivität in Bezug steht, erscheint eine plausiblere Erklärung zu sein, dass eine übertriebene Sensitivität vorliegt, die als Sensitivitätsfehler bezeichnet werden kann. Diese interessante Einsicht verlangt allerdings nach weiteren Studien. Des Weiteren zeigen die Ergebnisse, dass sich MPS durchaus nach der Geburt verändern kann: vergleicht man Erstgebärende mit Müttern, die ein weiteres Kind zur Welt bringen, so zeigte sich, dass

letztere im Vergleich zu den Erstgebärenden etwas an Sensitivität bezogen auf fröhliche Gesichter 6 Wochen nach der Geburt verlieren – möglicherweise, weil sie nun (wieder) nur mit dem traurigen Babygesicht konfrontiert sind, denn das Lächeln kommt erst etwas später. Respektive der mütterlichen Faktoren zeigte sich, dass frühere psychische Krankheiten (aber nicht Depression) und auch eine oder mehrere vorangegangene Fehlgeburten pränatale Prädiktoren für PPD sind; während gute familiäre Unterstützung und auch erfolgreiches Stillen des Säuglings als Schutzfaktoren ausgemacht werden konnten. Somit offeriert die Arbeit insgesamt weitere Einsichten bezüglich möglicher Einflussfaktoren auf die Entwicklung von PPD und verlangt danach, dass das Konzept von MPS weiter unter die Lupe genommen werden sollte, denn womöglich hat eine Übersensitivität auf negative Reize einen sehr starken Einfluss auf die Entwicklung von PPD.

1 Introduction

Approximately 353,000 babies are born into this world every day (United Nations, 2013). According to estimates (O'Hara & Swain, 1996), 45,890 of these new mothers will end up suffering from postpartum depression (PPD) and 45,890 children will suffer the aftermath of the disorder. This is a serious problem, made direr by the rapid effect PPD has on child development, which can already be seen within the first few months after birth. Such babies show dysregulation, observable in sleep/awake patterns, and excessive crying (Field, 1992). These infants also show delayed development in social response, which is already observable by 6-months of age. By 12 months, babies of depressed mothers achieve lower scores in mental and motor skills on standard tests as well as lower weight percentiles compared to infants born to healthy mothers, (Cohn, Matias, Tronick, Connell, & Lyons-Ruth, 1986; Field, 1995). Also observable around 12-months, is a pattern of less exploratory behavior, indicating insecure mother-child attachments (Field, 1992; Murray & Cooper, 1996). Suboptimal cognitive development and behavioral problems have been shown at the preschool age (Lyons-Ruth, Zoll, Connell, & Grunebaum, 1986). School-age and adolescent children of mothers with depression have elevated risks for depression, reaching around 20 – 41%; well above that of control groups.

While the exact relationships between maternal depression, poor maternal sensitivity, and the developmental impairments shown in children of depressed mothers is not yet clearly understood, these abnormalities are thought to be due to reduced maternal sensitivity in the form of poor perceptual abilities and responsiveness toward infant cues seen in depressed mothers (Laurent & Ablow, 2012).

Devastatingly, research suggests that as much as 80% of women who experience symptoms of depression during pregnancy remain undetected (Appleby, Fox, Shaw, & Kumar, 1989) and that less than half will ever be treated (Oates & Cantwell, 2011; Yonkers et al., 2001). One longitudinal study found that if remission occurred within the first three postpartum months, there were significantly less mood symptoms among the children at ages 7-10 years (Weissman et al., 2006). This is, however, in contrast to the findings of other studies indicating that even with therapeutic support neither the mother-infant attachment nor infant behavior is improved past the time of therapy (Forman et al., 2007).

These findings along with copious amounts of research documenting the negative correlates of PPD make the need for further research identifying causes and risk factors crucial. Profound negative effects have been shown in many aspects of the child's life including mental and physical health, social and cognitive development, and early relationships – most significantly the mother-child dyad (Beardslee, Versage, & Giadstone, 1998; Beck, 1995, 1998; Field, 1992; Goodman & Tully, 2008; Murray & Cooper, 1997). Not surprisingly, children of depressed mothers are exposed to much higher rates of acute and chronic stress starting from a very early age and continuing for at least the first two decades of life (Hammen, Hazel, Brennan, & Najman, 2012). These children are at a much higher risk than the rest of the population for developing depression themselves. Depression rates of between 20% and 41% for school-aged and adolescent children of depressed mothers have been reported (Goodman, 2007), as compared to the overall rates of 1-2% for school-aged children and 3-8% for adolescents (Kapornai & Vetró, 2008). Furthermore, the etiology of depression within the subgroup differs from that seen in the general childhood population: Onset is earlier than for same-aged children with non-depressed parents with depressed mood styles observable as early as 3 months after birth (Field, 1992). Symptoms also last longer and have a more significant rate of impairment. What is more, and making the need for further research into factors influencing onset most dire, these abnormal patterns are measurable even in cases of minor maternal depression and they outlast the maternal depressive episode, indicating that suboptimal developmental trajectories can begin even if the mother only has only a very brief minor depressive episode very early in the postpartum period (Moehler, Brunner, Wiebel, Reck, & Resch, 2006)

The further detection of factors associated with women at risk will contribute to the development of programs and tools for healthcare workers. The ultimate goal of this and further studies should be to minimize the negative impact of maternal depression in the sufferers and their children as early as possible, thereby hedging the life-long damaging impact this disorder has on child development.

This study was motivated by the desire to better understand and identify risk factors for the onset of PPD. Our immediate goal was to investigate the possible role of maternal perceptual sensitivity (MPS) during pregnancy as a predictive factor of PPD. Our definition of MPS is the ability to accurately recognize and interpret infant signals of emotion. To further gain understanding of the relationship between MPS and PPD, we explored several open questions: Are auditory and visual MPS related? Is MPS stable over time and experience? Is a higher

level of depressive symptoms correlated with better accuracy in identifying sad faces at lower emotional intensities? Finally, which antenatal and sociodemographic factors are associated with PPD?

In this thesis we look first at the current literature and understanding of PPD including the epidemiology, pathology, and risk factors as they are presently understood. Following this, is a discussion on maternal sensitivity as a broader characteristic, what it is, how it is measured, and what factors are known to influence one's sensitivity. Then we expounded upon current understandings and theories about the relationship between PPD. We look first at maternal sensitivity at large and then focus on maternal perception. Sections detailing the methodology, procedures, and statistical analyses employed are then presented, followed by the results and a discussion thereof. The conclusion summarizes the findings of this study and provides recommendations for further studies. Suggestions are also provided aimed at the healthcare community working with pregnant women and new mothers based on the findings and experiences gained.

2 Background

With the arrival of a new baby mothers are faced with countless new challenges. Particularly in modern Western society, in which many adults have little or no experience caring for infants prior to the birth of their own children, the first year of parenthood can certainly be characterized for most as a very steep learning curve. In addition to learning how to care for the baby, new mothers can face a list of other stressors, such as financial changes, changes in the partnership and social life, physical changes, and sleep deprivation – just to name a few. Most women learn relatively quickly the basics of infant care and how to meet their baby's needs and do adjust in time to their new lives. And of course, many find that the joys of parenthood more than make up for the hours of lost sleep and other sacrifices that are unavoidable with the addition of a new baby. Unfortunately, about 13% of new moms face an additional challenge that make both enjoying parenthood and overcoming the difficulties it brings with it considerably more difficult: the onset of PPD.

Postpartum Depression

Postpartum affective disorders are divided into three levels of severity: baby blues (or maternity blues), postpartum depression, and postpartum psychosis (O'Hara, 1997). Baby blues is the least severe form of the disorder and is experienced by 30 – 75% of mothers after delivery. The onset for baby blues peaks at three to four days after birth and can last from a few hours to 13 days. Symptoms include crying, anxiety, confusion, and general mood lability. The symptoms do not interfere with a woman's ability to function as she would normally and treatment is not necessary (O'Hara & Swain, 1996; Robertson, Grace, Wallington, & Stewart, 2004).

On the other end of the spectrum is postpartum psychosis, which has a prevalence rate of 0.1 – 0.2%. The onset of symptoms is often rapid and occurs typically within two weeks of delivery. Symptoms can include hallucinations, delusions, confusion, disorganized behavior, and a rapidly fluctuating mood. Episodes can last from weeks to months(O'Hara, 1997). Due to the high risk of self-inflicted harm and injury to the infant – including infanticide – treatment and usually hospitalization is required (O'Hara & Swain, 1996; Robertson et al., 2004; Sit, Rothschild, & Wisner, 2006).

Prevalence

Between baby blues and postpartum psychosis on the spectrum is postpartum depression, also called postnatal depression, a clinical form of depression. Nailing down a precise prevalence

rate is extremely difficult, as rates reported in the literature vary greatly. Variances are due in large to a lack of universal consensus on the definition of the disorder– most notably, with differences in the time criteria (Crockenberg & Leerkes, 2003). Many authors refer to an overall prevalence rate of approximately 13%, as is reported in the heavily cited meta-analysis by O'Hara and Swain (1996), based on a total of 12,810 subjects. However, rates vary in studies reporting only a period prevalence. 10.1% was reported for women 18 years of age and older by Eaton et al. (2012) for a one year period, for example. Strict application of the Diagnostic and Statistical Manual of Mental Disorders, 3rd Edition DSM-III-R (American Psychiatric Association, 1987) (the most current version of the DSM at time of publication) time criteria of only one month, as used by a study from the National Comorbidity Survey, resulted in rates of only 5.9% for women between 15 and 54 years of age (Blazer, Kessler, & McGonagle, 1994).

Broad ranges in prevalence are also shown when comparing rates in various countries or cultures. In their meta-analysis of 143 studies from 40 countries, Halbreich and Karkun (2006) report percentages ranging from 0 – 60%. According to the authors, true variance in prevalence across cultures may be due to "reporting style, differences in perception of mental health and its stigma, differences in socio-economic environments (e.g. poverty, levels of social support or its perception, nutrition, stress), and biological vulnerability factors" (p. 97). Two recent studies conducted in Europe report numbers lower than those seen in studies run in the United States. 9.6% prevalence was seen in an Italian sample for a one year period (Banti et al., 2011), whereas 9.2% was reported for a 6-week period prevalence in Spain (Navarro et al., 2008).

It may be that stigma is an influential factor in studies reporting numbers much lower than the commonly accepted 13%, as reported by O'Hara and Swain (1996). An estimated 80% of women who experience symptoms of depression during pregnancy remain undetected (Appleby et al., 1989). One reason may be that healthcare workers often overlook the clinically depressed parent, assuming that visible symptoms are simply signs that the mother is still adjusting to the infamously difficult first weeks of parenthood. Indeed, Campbell and Cohn (1991) reported that 39% of the women in their large low-risk sample (N= 1,033) presented with at least one somatic symptom six weeks after delivery. For health care workers lacking specific training in PPD awareness, the telltale signs may not seem out of the norm for new parents. Still more likely is that depression carries a heavy stigma in many cultures and

mothers who are unwell may not feel that they are able to openly discuss their problems or even seek help[1].

Diagnosis

As mentioned above, the criterion used to define PPD in the literature varies, with most papers focusing on symptomology rather than using the disorder criteria dictated by the American Psychiatric Association's (APA) diagnostic manual. In the DSM-V (5th ed.; American Psychiatric Association, 2013), as was also the case in the DSM-IV (4th ed.; American Psychiatric Association, 2000), there is no distinct classification for PPD. Rather, patients receive a diagnosis of a major depressive disorder with a sub-classification of a postpartum onset. A diagnosis for a major depressive disorder is given if at least five of the following symptoms are present nearly every day during the same two weeks and there is a marked change in the person's previous level of functioning: A depressed mood or irritability, loss of interest or pleasure in most activities, significant changes in weight or appetite, changes in sleep, psychomotor agitation or retardation, fatigue or loss of energy, feelings of worthlessness or guilt, trouble concentrating or making decisions, thoughts of death or suicidal ideation or attempts thereof. Finally, there must be a significant level of impairment in the sufferer's life. The majority of studies investigating PPD, however, have focused on symptoms rather than disorders, using questionnaires such as the Edinburgh Postnatal Depression Scale (EPDS) or the Center for Epidemiological Studies –Depression scale (CESD) as measurement tools. These questionnaires measure moods, feelings, and cognitions and purposefully stay away from the physical symptoms of depression, as many of them can be easily confounded with normal states in the postpartum period (e.g. fluctuations in weight, sleeping, and eating patterns). Cutoff rates used in studies, however, are not consistent and are at times not even stated (Halbreich & Karkun, 2006).

Timing of and peak onset

The largest discrepancy between the APA's definition of PPD and those more frequently used in research contexts is the question of onset time, which would differentiate a postpartum episode from a non-postpartum episode of depression. The sub-classification of a depressive episode with a postpartum onset was given when using the DSM-IV as the diagnostic tool if onset was within four weeks of birth. The International Classification of Diseases – 10th

[1] The 2012 German TV drama "Herbstkind," in which the main character suffers from PPD after the birth of her first child, was widely discussed in the media for having been the first film to touch on the topic, which is still very much considered a taboo topic in the country (Feld, 2012).

Edition (ICD-10) (World Health Organization, 1992) gives a 6-week postpartum timeframe for onset. The DSM-V has expanded the timeframe to include the most recent episodes during pregnancy. Measurement times used in the studies, however, span from 1 week (e.g. Gürel & Gürel, 2000; Saks et al., 1985) to 17 months (Leiferman, 2002) after delivery. Adding to the confusion, some studies examined a period of time (e.g. Affonso, De, Horowitz, & Mayberry, 2000), while others report point prevalence of symptomology (e.g. Wolf, De Andraca, & Lozoff, 2002).

Tendencies show that women are at more risk for PPD in the first half of the postpartum year, with 60% of all cases occurring within the first 6 postpartum weeks (Stowe, Hostetter, & Newport, 2005). It should not, however, be dismissed that many cases are still reported beyond the 4- and 6-week diagnostic timeframe dictated by the *DSM-IV* and *DSM-V* and the *ICD-10*, respectively (Stowe et al., 2005). An onset past 6-weeks postpartum, for example, is more frequently seen in women who have a history of reoccurring PPD (O'Hara, Zekoski, Philipps, & Wright, 1990).

The duration of depressive episodes with postpartum onset do not differ significantly from other episodes of depression, lasting several weeks to months (O'Hara, 1997; Robertson et al., 2004).

Whether or not women are at higher risk for depression during pregnancy and in the postpartum period than in other times of life, is a contentious issue. To the best of our knowledge, the only study that matched pregnant and non-pregnant women, found that mothers 3 weeks postpartum reported significantly higher depression symptoms and poorer social and marital adjustments at 6 and 9 weeks postpartum compared to controls (O'Hara et al., 1990). Studies using other methods of comparison have shown that overall women are not at a higher risk during pregnancy and the postpartum period than they are in other times of life (Dave, Petersen, Sherr, & Nazareth, 2010; Kuehner, 2003; O'Hara & McCabe, 2013).

Risk Factors

Three large meta-analyses have been published summarizing the risk factors correlated with PPD (Beck, 2001; O'Hara & Swain, 1996; Robertson et al., 2004). Most of the factors found to be associated with PPD overlap in all three meta-analyses. We discuss these factors in the following section as well as some additional factors that appear only in Robertson et al. (2004), as well as more recent research findings.

The antenatal factors most frequently found to have moderate to strong effect size can be categorized as follows: 1) maternal mental health, 2) life events, 3) social support, 4) socioeconomic factors, and 5) obstetric factors. Depression, including minor depressive episodes, followed by anxiety during pregnancy is the strongest predictor of PPD (Cohen's *d* = 0.75) (Beck, 2001; Johnstone, Boyce, Hickey, Morris-Yates, & Harris, 2001; Josefsson et al., 2002; Neter, Collins, Lobel, & Dunkel-Schetter, 1995; O'Hara & Swain, 1996) as shown in a meta-analyses by Robertson et al. (2004)[2]. Previous lifetime episodes of depression or dysthymia is also a risk factor (Beck, 2001; Johnstone et al., 2001; Josefsson et al., 2002; O'Hara & Swain, 1996), but the effect size (*d* = 0.58) is smaller than that of life events and social support. Self-esteem is also negatively associated with depression in the postpartum period and was calculated to have an effect size of *r* = .45 when the articles were weighted by Beck (2001).

Life events include experiences such as failure at work, the loss of a loved one, and moving to a different location (Beck, 2001; Lee, Yip, Leung, & Chung, 2000; O'Hara & Swain, 1996) for which a moderate effect has been found (*d* = 0.61). While less researched than the previous mentioned life stressors, miscarriage has also been associated with the onset of depression after the birth of a child in low socioeconomic status (SES) groups (Cryan et al., 2001).

Poor social support from friends and family, or a mismatch in desired and received social support is a moderate risk factor, (*d* = -0.64) (Beck, 2001; Logsdon, Birkimer, & Usui, 2000; Nielsen, Videbech, Hedegaard, Dalby, & Secher, 2000; O'Hara & Swain, 1996; Séguin, Potvin, St-Denis, & Loiselle, 1999). Problems within the marital relationship occurring during pregnancy, is also a risk factor with moderate effect size, (*d* = 0.39) (Beck, 2001; O'Hara & Swain, 1996).

Although the effect sizes for SES where small (*d* = -0.14) (Beck, 1996; Campbell & Cohn, 1991; Logsdon et al., 2000; O'Hara & Swain, 1996), the relationship between SES and PPD is likely under detected: Symptoms of depression are more frequent in the lower SES population in the postpartum period, which is in part likely due to the poor social support and high levels of life stressors, including those affecting finances and health services that are associated with poverty (Hobfoll, Ritter, Lavin, Hulsizer, & Cameron, 1995; Séguin et al., 1999). Furthermore, unlike life events, SES has been shown to be a risk factor across countries and

[2] All given effect sizes are from Robertson et al. (2004), unless otherwise stated.

cultures (Lund et al., 2010; Patel, Araya, de Lima, Ludermir, & Todd, 1999; Robertson et al., 2004). It is likely that women belonging to lower SES groups do not take part in psychological studies at the same rates as other women.

Interestingly, obstetric stresses that led to a difficult birth, caesarian section, or difficulties during pregnancy have only small effects (d = 0.26) (Beck, 2001; Boyce & Todd, 1992; Hannah, Adams, Lee, Glover, & Sandler, 1992; Johnstone et al., 2001; Nielsen et al., 2000; O'Hara & Swain, 1996; Robertson et al., 2004), although it has been shown that when a history of depression is present and high levels of stressors during pregancy or birth occurred, the risk for PPD increased (Murray & Cartwright, 1993; O'Hara, Schlechte, Lewis, & Varner, 1991). The roll of breastfeeding has recently entered the discussion about risk or protective factors. Breastfeeding, or nursing, and postpartum depression have been shown to be inversely correlated, with women who have more depressive symptoms at 6-weeks postpartum less likely to nurse their children (Hatton et al., 2005). The causal relationship remains however unknown. That is, it is unknown whether women who have a high risk for depression more frequently choose not to breastfeed or if hormones perhaps even offer a protection against the onset of symptoms.

Several factors as measured in the postpartum period have also been correlated with PPD, including infant characteristics, and some biological factors[3]. Some studies show that some specific factors of infant temperament have a concordance with PPD, such as maternal reports of high irritability and poor motor control at eight weeks postpartum (Murray, Stanley, Hooper, King, & Fiori-Cowley, 1996), as well as rhythmicity, attention span, and persistence (Sugawara, Kitamura, Toda, & Shima, 1999), albeit these factors are only significant when combined with other maternal characteristics, such as negative maternal parental memories (Crockenberg & Leerkes, 2003). As depressed women do rate their infants as having more difficult temperaments compared to control groups (McGrath, Records, & Rice, 2008) and as compared to trained neutral observers observing the same child (Field, Morrow, & Adlestein, 1993), it is questionable whether infant temperament precedes the onset of symptoms or rather, vice versa, the symptoms of PPD bias maternal perceptions of their infant's temperament.

[3] A meta-analyses for these factors could not be found, thus no effect sizes are given.

Finally, the literature on the heritability of PPD gives a mixed message. While some genetic polymorphisms have been indicated to lead to PPD, there is a lack of large and long-term studies that clearly prove this (Corwin, Kohen, Jarrett, & Stafford, 2010).

Maternal Perceptual Sensitivity

What is maternal sensitivity?

As mentioned in the sections above, maternal sensitivity is correlated with PPD, and there is reason to believe the MPS is even a causal factor. Below is a summary of the literature.

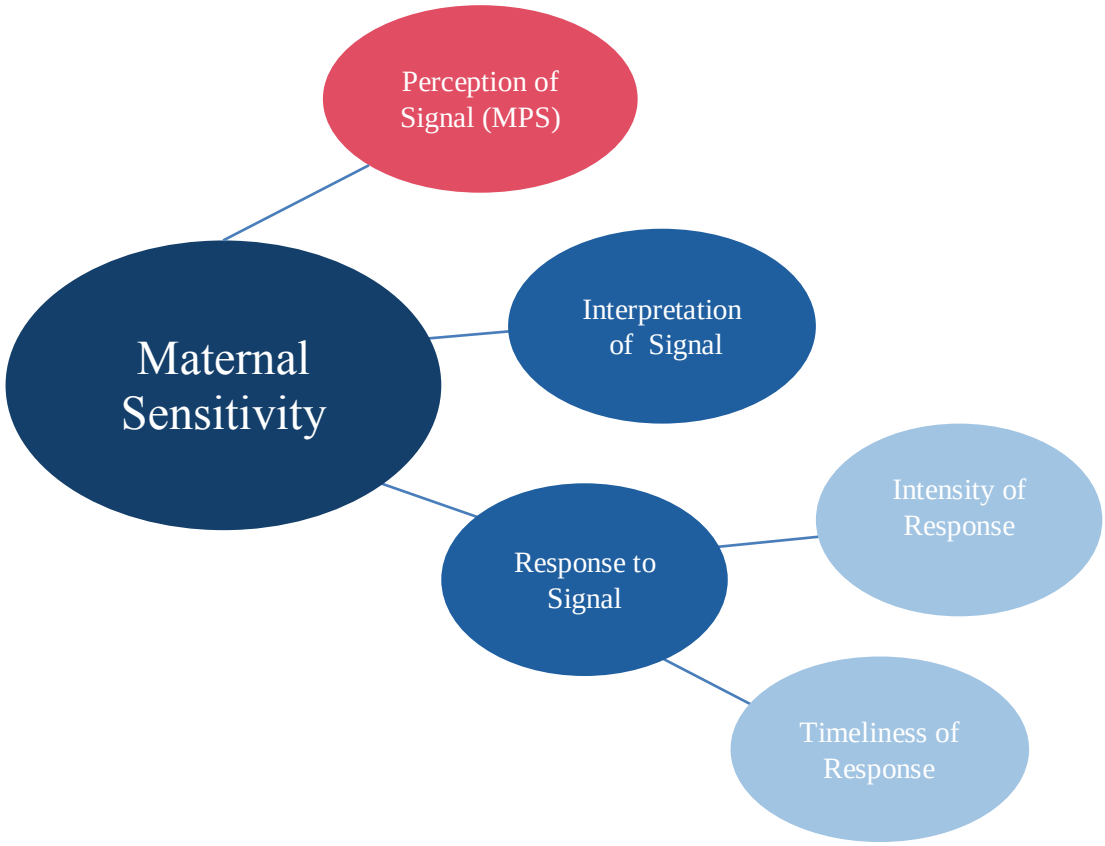
The term maternal sensitivity is often used interchangeably with terms referring to parenting and caregiving style, mother-child relationship, maternal responsiveness, maternal competency, and attachment. Maternal sensitivity differentiates from these terms, however, as it includes empathy, or the infant-oriented perspective of maternal behavior. While Donovan, Leavitt, and Walsh (1997) define sensitivity as "…how well one is able to make correct judgments and avoid incorrect ones" (p. 760) it is important to note that maternal sensitivity is comprised of both affective and behavioral factors (Jones, Pearson, & Evans, 2013), as reflected in the definition given by Meins, Fernyhough, Fradley, and Tuckey (2001): "[Sensitive mothers] use information from their children's outward behavior in making accurate inferences about the mental states governing that behavior. This feature of maternal cognition would thus appear to go beyond a basic ability merely to recognize and respond to the child's physical states, such as hunger, and emotional states, such as distress" (p. 638). Both elements are also reflected in Mary Ainsworth's (1978) original definition of maternal sensitivity, the definition that we prefer in this study, as a mother's ability to perceive and correctly interpret her baby's signals and then to respond to them in an appropriate and timely manner.

For her ground breaking studies beginning in the 1970s (Ainsworth, Bell, & Stayton, 1971), Ainsworth created scales to measure what she considered the key elements of maternal sensitivity: *1) Sensitivity vs. Insensitivity to the Baby's Signals, 2) Cooperation vs. Interference With Baby's Ongoing Behavior, 3) Physical and Psychological Availability vs. Ignoring and Neglecting, and 4) Acceptance vs. Rejection of the Baby's Needs*. Our study has a focus on Ainsworth's first scale, which consists of four elements: awareness of the signal, interpretation, response to the signal, and timeliness of the mother's response. We investigated awareness and interpretation of the signal.

These four aspects of Ainsworth's first scale are not necessarily mutually dependent as can be seen in the following example. A child may grimace slightly, but the mother misinterprets the brief moment of discomfort as being extreme pain or fear. The mother then quickly picks up the child and desperately tries to "calm" the baby and to get a positive response. If the baby was indeed frightened or in pain the response and timeliness would be appropriate, but in this case the mother misinterpreted the signal. It is also possible to observe a mother who is aware of her infant's signal, yet interprets the meaning incorrectly, thereby eliciting an inappropriate response, e.g., an infant cries because it is frightened, but the mother responds by changing the infant's diaper rather than trying to comfort the child in her arms. In another example, an infant cries because it is hungry, but the mother (perhaps wanting to get her child onto a more regular feeding schedule) decides to wait and not feed the baby for another 30 minutes. Here the mother is aware of the signal, interprets it correctly, even responds correctly, but not in a timely manner. A mother may also be sensitive in three of the elements, but shows insensitivity in response by being too intense, by, for example, playing a hand game too loudly or close to the infant's face thereby startling rather than amusing the baby. With these examples we see how these four elements that comprise maternal sensitivity include both affective and behavioral factors, should be considered at least partly independent of each other.

This study focuses on the awareness and interpretation of the infant signals of emotion, which we call maternal perceptual sensitivity (MPS).

Figure 1. The Elements of Maternal Sensitivity.



Note. The figure shows the five elements of maternal sensitivity. The element in red is investigated in this study.

How is maternal sensitivity measured?

The large majority of studies investigating maternal sensitivity have used observational tools in laboratory settings to quantify sensitivity in terms of behavior. These tools include the Stillface Paradigm (SFP) (Tronick, Als, Adamson, Wise, & Brazelton, 1979), the Strange Situation Procedure (SSP) (Ainsworth et al., 1978), and the Maternal Behavior Q-Sort (MBQS) (Pederson, Moran, & Bento, 1999). Mary Ainsworth is notable for her naturalistic observations, for which she developed the Ainsworth Maternal Sensitivity Scales (AMSS) (Ainsworth, 1969). Bilgin and Wolke (2015) have a comprehensive list of studies investigating maternal sensitivity using observational measures. In addition, there have been a handful of studies in which awareness and interpretation of signals have been measured via experiments conducted on computers, where sensitivity was quantified using Signal Detection Theory (SDT) (Donovan, Leavitt, & Taylor, 2005; Donovan, Leavitt, & Walsh, 1998; Donovan, Taylor, & Leavitt, 2007; Green & Swets, 1966).

Measures based on actual observations of maternal behavior toward, and interactions with, her own child are arguably more valid than responses given in subjective questionnaires or quantifications of maternal sensitivity as measured by a women's response to stimuli that are not her own child on a computer. However, the benefit of both questionnaires and techniques such as SDT is timeliness, whereas observational paradigms require training and take considerable time to code the interactions.

Why is maternal sensitivity important?

Early parental care affects short and long-term development, thought patterns, and child behavior as shown in behavioral as well as neurological studies (Gerhardt, 2006; Swain, Lorberbaum, Kose, & Strathearn, 2007). Higher maternal sensitivity is correlated with securely attached children (Musser, Ablow, & Measelle, 2012) and better developmental trajectories, while lower sensitivity correlates with diminished attachment security and higher risk for "developmental delays, behavioral problems, neglect, and abuse" write Jones et al. (2013, p. 26). On the biological level, maternal sensitivity in early life provides a proactive factor against stress. Mammals that are exposed to more maternal care in infancy show more adaptive hypothalamic-pituitary-adrenal (HPA) responses to stress (Liu et al., 1997). Conversely, infants of women showing poor maternal sensitivity show more frequent signs of distress (Gable & Isabella, 1992) and less positive affect (Pickens & Field, 1993). By 6 months of age, abnormally low levels of visual and verbal communication are shown and problems with nursing and sleeping are increased compared to children of non-depressed mothers (Field, 2010). This trajectory of poor development compounds in subsequent years.

The pattern of negative outcomes associated with poor maternal sensitivity likely has a starting point in poor MPS. At the most basic and evolutionary sense, a mother's ability to perceive and respond to her infant's cries is absolutely necessary for survival. A baby whose hunger cries are not responded to will not survive. In ideal dyads, the infant cry elicits activation of the sympathetic nervous system in the caretaker, thereby propelling her to quell the crying via appropriate parental care, e.g. feeding and comforting the child (LaGasse, Neal, & Lester, 2005). As infants get older, their communication skills become more refined and astute parents are able to differentiate between high-alarm (e.g. pain, hunger) and low-alarm (e.g. boredom) communications and adjust their responses accordingly, both in action and timeliness. Babies of mothers who can correctly identify their baby's cry as being either high or low pitched produce better scores on language and development scales at 18 months (LaGasse et al., 2005) and babies of mothers who respond promptly and appropriately to their

distress signals show better self-regulatory skills and social and behavioral skills (Leerkes, Blankson, & O'Brien, 2009). Malfunctions in this dyadic system can either stem from abnormal cry signals – for example, in infants with central nervous system abnormalities – or from suboptimal parental perceptions (Michelsson & Michelsson, 1999).

Both under- and over-responsiveness to baby's signals can be detrimental, with child neglect and child abuse – most notably shaken baby syndrome – at the two extremes of the spectrum (LaGasse et al., 2005). Insensitive mothers that are under-responsive react indiscriminately to all cries from their infant. They respond with the same manner and timing to distressed and non-distressed crying, thereby creating a maladaptive basis for attachment and child development (Del Vecchio, Walter, & O'Leary, 2009). Over-responsiveness is sometimes seen in the form of abuse, the root of which is likely the inability to perceive and thereby respond in an appropriate manner to the baby's negative emotions. Evidence for this can be seen in studies showing that mothers who physically abuse their children have more difficulties interpreting their baby's signals (Kropp & Haynes, 1987).

Just as the negative trajectory continues in childhood development, the pattern of insensitive mothering, particularly in response to negative emotion, has been shown to continue as the breadth of behavior in the child expands. Mothers who are unable to sensitively respond to their infants' negative emotions are not better equipped to deal with other forms of negative emotions expressed by older children, such as temper tantrums or withdrawal (Karen, 1994). Furthermore, insensitive parenting is often carried from one generation to the next, as poor parental behavior is imitated in offspring with their own children (Brisch, 2014). Given the clinical and societal significance of insensitive maternal care, and indications that this insensitivity as a whole has roots in MPS, it is clear that this is an area that needs to be given more attention within the scientific community.

Is maternal sensitivity stable?

The question of whether maternal sensitivity is a stable construct has yet to be clearly answered. When looking at parity (number of children) there are indications that sensitivity is at least in part a learned attribute: Non-parents perceive the infant to be more distressed than do parents and non-parents have greater heart rate reactions than parents (Irwin, 2003; Out, Pieper, Bakermans-Kranenburg, & Van Ijzendoorn, 2010). One could interpret these findings as evidence that experience enables parents to better differentiate more distressed from less distressed cries and that their physiological responses adjust accordingly.

Some researchers, on the other hand, argue that sensitive maternal behavior may be better understood as a biological mechanism rather than a learned skill, whereby less sensitive mothers have fewer physiological resources they can tap into when interacting with their infants. Musser et al. (2012) write, "...many of the maternal characteristics associated with sensitivity…are traitlike, long-standing predispositions" (p. 352). This is evident in studies showing that parents and non-parents are similarly sensitive and others showing that sensitivity did not significantly change in the longer postpartum period. Zeskind, Klein, and Marshall (1992) found that women without children rated high pitched cries the same as did women who had children. Joosen, Mesman, Bakermans-Kranenburg, and van Ijzendoorn (2012) found that sensitivity was stable over both time – 3 and 6 months postpartum – and situation, e.g. bathing baby versus baby playing on mother's lap. Additional studies showed that the interaction style in mother-infant dyads was moderately stable over time as measured at 6-8 weeks and 24 months postpartum (Donovan, Leavitt, Taylor, & Broder, 2007; Kemppinen, Kumpulainen, Raita-Hasu, Moilanen, & Ebeling, 2006). To the best of our knowledge, the stability of characteristics that constitute maternal sensitivity has not been compared by comparing measurements taken before the birth of the first child and after several weeks of interaction with the baby after birth.

Risk and Protective Factors

There are factors that have been shown to be correlated with varying levels of maternal sensitivity, though the research varies and the findings frequently are not consistent. As with studies on PPD, variances are certainly in part due to ranges in measurement tools, the exact element of sensitivity that is being investigated, as well as variances in measurement times present within the literature. Of the factors that have been shown to influence sensitivity, these can generally be categorized as follows (as partly adapted from Elmadih, 2013): 1) social context (SES and social support); 2) remembered parental rejection or acceptance; 3) obstetric factors and biological aspects; 4) infant temperament; and 5) maternal mental state. The research on the first four points will be discussed in this section. As the focus of this study is the relationship between maternal sensitivity and depression, depression as a risk factor for poor maternal sensitivity will be expounded upon in the next main section, the *Relationship between Depression and Maternal Sensitivity*.

Studies have shown that SES is positively correlated with maternal sensitivity, in particular, women with higher sensitivity are more highly educated (e.g. Mistry, Biesanz, Taylor, Burchinal, & Cox, 2004; Sacker, Schoon, & Bartley, 2002). One explanation for this finding

is that women with higher education have more knowledge about child development – be it learned in a formal setting or they are more motivated to educate themselves on the subject – and have therefore better insights into and empathy for negative infant cues and realistic expectations of their child's behavior at various developmental stages.

Higher incomes are also associated with more sensitive behavior toward infants (Pederson et al., 1990). However, this correlation is unlikely to be a direct relationship. Women with more monetary resources have more flexibility in childcare options and may be able to afford to spend more time with their infant before returning to work. Furthermore, a lower SES brings a considerable amount of compounding physical, social, and psychological stress factors, including poorer access to health care and childcare, higher crime rates, and notably, less social support (Evans, Boxhill, & Pinkava, 2008). It is likely that the presence of continuous stress depletes a mother's resources for sensitive parenting.

Age, which is frequently linked with income and education level, also plays a role as seen in a study comparing teenage (< 19 years) and more mature mothers (>25 years). More mature mothers showed greater amounts of physical interaction, i.e. kissing, patting, and stroking than did teenage mothers, whereas teenage mothers displayed higher amounts of instrumental behaviors, such as changing diapers and adjusting cloths (Krpan, Coombs, Zinga, Steiner, & Fleming, 2005). Again, it is likely that factors such as education, financial security, and social support, which differentiate teenage from older mothers, explain these results. However, significant differences are only found when comparing teenage to adult mothers and the relationship does not continue in a linear fashion in adulthood (Drake, Humenick, Amankwaa, Younger, & Roux, 2007) Conversely, other studies have found no links between SES and maternal sensitivity (Drake et al., 2007).

Social support has also been shown to be positively correlated with maternal sensitivity. Both partner and family/friend support has been investigated. Some studies have found a direct correlation between support received and maternal sensitivity (Kivijärvik, Räihär, Virtanen, Lertola, & Piha, 2004), while others found correlations only when combined with other adverse factors such as depression or being a teenage mother (Mertesacker, Bade, Haverkock, & Pauli-Pott, 2004; Stiles, 2010). Social support may improve maternal sensitivity by improving maternal self-esteem as well as ameliorating the perception of parenthood as being stressful (Andresen & Telleen, 1992).

As with the factors previously discussed, the relationship between early care experiences and maternal sensitivity does not appear to be a direct correlation, rather, these experiences act as a moderating factor. Crockenberg and Leerkes (2003) found that having memories of supportive parents (i.e. perceived support) as a child ("parental acceptance") can reduce the negative impact of PPD on maternal sensitivity, whereas memories of rejecting parents predicts PPD symptoms. While this effect is mediated by self-esteem, having an aggressive marital partner can increase the negative impact. Consistency of care (having had at least one consistent caregiver) during the first 12 years of life also correlates to more affectionate (stroking, kissing, and patting) maternal behavior. Mothers who had inconsistent care at the beginning of life show less affectionate behavior and more maintenance behaviors (e.g. changing diapers and adjusting clothes), which require less physical contact (Krpan et al., 2005).

The most heavily researched obstetric factor that has been looked at within the framework of maternal sensitivity is breastfeeding. Mothers who breastfeed are more sensitive toward infant distress, as measured by attentional bias toward pictures of infants faces in distress (Pearson, Lightman, & Evans, 2011a) and in interactions with their own infants (Britton, Britton, & Gronwaldt, 2006). This effect is also reflected in biological correlates; Breastfeeding mothers show more neural activation in the superior frontal gyrus, insula, precuneus, striatum, and amygdala regions – regions associated with infant-maternal bonding – when hearing recordings of their own babies crying than do women who use infant formula (Kim et al., 2011). The exact process underlying the link between breastfeeding and sensitivity is unknown. It may simply be that breastfeeding mothers spend more time in very close proximity to their infant, thereby witnessing more of their infant's subtle signals. Noteworthy is that it is not that mothers who are more sensitive during pregnancy are those who breastfeed their infants, thereby discounting the tempting explanation that it is simply more sensitive women who breastfeed (Pearson et al., 2011a).

It is also plausible that hormones released during nursing or in the postpartum period in general influence a mother's sensitivity. A large number of studies have focused on the hormone oxytocin, a hormone that has been shown to be linked with opioid-based social reward systems (Panksepp, Nelson, & Siviy, 1994) as well as emotion regulation and affective behaviors (Boccia & Pedersen, 2001) as it relates to maternal sensitivity. Many of these studies have shown that the hormone influences both social behavior and maternal engagement with infants. Oxytocin released during nursing is connected with lower levels of

anxiety and physical stress (Chiodera & Coiro, 1987). Higher levels of plasma oxytocin are seen in non-human mammals that show more maternal caregiving (Robinson, Twiss, Hazon, & Pomeroy, 2015; Ross & Young, 2009). Higher levels are also seen in mothers who displayed high levels of affectionate contact, including affectionate touches and "motherese" in play interactions with their infants. Those mothers who show low levels of affectionate contact have correspondingly lower levels of oxytocin (Feldman, Gordon, Schneiderman, Weisman, & Zagoory-Sharon, 2010; Gordon, Zagoory-Sharon, Leckman, & Feldman, 2010). Oxytocin levels have also been looked at in relation to maternal sensitivity and to the mother's own parental experiences, with higher oxytocin levels shown in both parents and non-parents who recall more positive parental care (Feldman et al., 2012) and attachment (Strathearn, Fonagy, Amico, & Montague, 2009). It is possible that mothers who shared good relationships with their parents not only benefited from the bevy of advantages well attached children have at the behavioral level, but also inherited an ability to be more sensitive. Mileva-Seitz et al. (2011) were able to show that the presence of a particular genotype predicted maternal sensitivity at 6-months postpartum, indicating that, at least to some degree, a mother's ability to be sensitive may be co-determined by genetic or epigenetic factors

When the oxytocinergic system is hijacked by certain chemicals, sensitivity decreases. Mothers exposed to cocaine during or after pregnancy are less attentive toward their infants and show more negative engagement and dyadic mismatches in face-to-face interactions (Tronick et al., 2005), a finding that has also been shown in animal studies (Panksepp et al., 1994). This population is less likely to respond to an infant's cry by picking up and feeding the infant than mothers who were not exposed to cocaine and more likely to respond by giving a pacifier or by simply waiting to see if the crying will stop (Schuetze, Zeskind, & Eiden, 2003). Additionally, mothers exposed to cocaine during pregnancy perceive infant cries as less arousing, aversive, urgent and sick sounding (Schuetze et al., 2003). It is thought that by flooding the opioid receptors, mammals feel more comfort and therefore less need for social contact (Panksepp et al., 1994). Ergo, mothers whose oxytocinergic systems are not in proper balance are neither triggered by their infant's cries into action nor receive the same positive feedback when in contact with their baby.

Neural coordinates have also been found in both human and animal studies. Swain et al. (2007) write, "networks of highly conserved hypothalamic–midbrain–limbic–paralimbic–cortical circuits act in concert to support aspects of parent response to infants, including the

emotion, attention, motivation, empathy, decision-making and other thinking that are required to navigate the complexities of parenting" (p. 262). In short, infant stimuli (crying) activate sensory-motor behavioral sequences aimed at meeting the infant's needs (e.g. feeding) and soothing her. Basal forebrain areas are important structures in maternal care, as shown in animal studies in which lesions to areas around the medial preoptic area result in the obliteration of maternal behavior (Numan, McSparren, & Numan, 1990). Mammals with lesions in this area show less maternal motivation, i.e. nursing and calling young back when they have wandered away.

While there is an ever increasing volume of research investigating the relationship between infant temperament (almost exclusively negative emotionality) and maternal sensitivity, there does not seem to be a consensus on the matter. In her 1986 review of the literature, Crockenberg found nine studies supporting the theory that negative infant emotionality correlates with less sensitive mothering. However, the other seven articles in the review showed that difficult infant temperaments are correlated with particularly sensitive maternal behavior. In one of the few studies investigating the relationship between maternal sensitivity and positive infant emotionality, Mertesacker et al. (2004) also failed to show a positive correlation. Notably, babies who are labeled as being colicky or as having a difficult temperament are also shown to have cries that are rated as more grating, piercing, or irritating. However, it is likely that a difficult infant temperament only negatively affects maternal sensitivity in the absence of protective factors or in the presence of stressors (Crockenberg, 1986). One such stressor may be the average pitch of a baby's cry; Babies who have consistent abnormally high pitched cries, such as those made by a healthy infant only in pain, are likely to suffer from less sensitive care including harsh caregiving responses (LaGasse et al., 2005; Out et al., 2010).

Finally, musical training has been shown to be a mediating factor for sensitivity. Thompson, Schellenberg, and Husain (2004) found that people with at least 8 years of music lessons are more accurate at identifying emotions via prosody in speech. Young, Parsons, Stein, and Kringelbach (2012) looked at musicians (with at least 4 years of musical training; mean years of musical training were 8.87 and 8.15 respectively) with and without depression. They found that musicians with depression did better at interpreting stress levels in infant cries varying in pitch than did depressed non-musician participants and that their abilities were comparable to participants without depression.

To summarize the current literature on risk and protective factors for maternal sensitivity, the take-home message is that while the list of factors that have been shown to be a risk factor for low maternal sensitivity is long, the findings can frequently be countered with studies showing no correlations, and most of these factors serve as mediating or moderating roles in combination with other factors. Nonetheless, further detailed factor and factor interaction analyses may enable the development of a deeper understanding of the involved factors and their interactions.

The Relationship between Depression and Maternal Sensitivity

A great deal of research has been conducted investigating the relationship between maternal sensitivity and depression with differing results. Variances in terminology for maternal sensitivity (other terms include, for example, attentional sensitivity, maternal bias to crying/emotional expression), measurement tools and stimuli used (e.g. adult versus infant stimuli, own versus other child), as well as deviations in definitions and diagnostic tools for PPD are likely the cause of some of the differences. The literature provides fairly clear evidence of the correlation between poor maternal responsiveness and depression. This is also the aspect of sensitivity that has received the most scientific attention in the scope of depression. There are, however, indications, as seen in studies about both depression, and depression in the peripartum period in particular, indicating that perception of emotion is a mediating factor. Finally, vast amounts of research show neurobiological correlates of depression in the human body. We will focus mainly on those studies that looked at PPD in particular.

Behavior

Mothers with depression respond to their infant's emotional expression in patterns that differ from those of healthy women. Murray et al. (1996) found that depressed mothers responded more to negative emotions from their infants than to positive emotions and that the mothers showed fewer positive expressions, were less engaged, showed less eye-to-eye contact and more negative behavior to signals of distress from their infant. Women with severe depression were the least likely to choose social behavioral responses to high pitched crying, such as picking up and cuddling, preferring the options of feeding and cleaning the baby (Schuetze & Zeskind, 2001). These findings are in agreement with previously published studies showing that mothers with PPD do not play as much with their children, nor do they interact with them as much verbally as do healthy mothers (Goodman, Brogan, Lynch, & Fielding, 1993).

However, it may be for some women that poor maternal sensitivity is only present within the context of depression when other factors are also present. For example, in one study, interactions between depressed mothers and their infants deviated from patterns seen with healthy dyads only when the mother was placed in a stressful situation (Weinberg, Olson, Beeghly, & Tronick, 2006). In another, high PPD symptoms were only negatively correlated with maternal sensitivity when mothers reported having experienced high rates of rejection as children (Leerkes, 2010). Whether or not mediating factors are involved, the question remains, why is it that mothers in the midst of a depressed episode show less optimal behavior toward their infants? Evidence in the literature points to perception as a root factor.

Perception

Perceptual studies have investigated participant's ability to perceive and interpret signals of emotion and behavior. These studies inquired into perceptions of the participant's own child's behavior, as well as perceptions of audio and visual stimuli from data banks. Further studies show the presence of biases affecting the perception of depressed patients. Some of the studies mentioned below were conducted in the context of postpartum depression while others explored depression at large. The studies investigating PPD varied in their use of adult or infant stimuli.

Bouhuys, Geerts, and Gordijn (1999) postulate that a negative bias toward emotion is a static trait that precedes the onset of depression, and which is furthermore "amplified" with the onset of symptoms. Consistent with this theory are the findings of a seminal study on the effects of cortisol exposure and the psychosocial state of the mother during pregnancy on the infant's temperament. Davis et al. (2007) found that anxiety and depression during pregnancy significantly correlated with maternal reports on infant temperament at 8-weeks postpartum. Maternal psychological state at the time when the temperament questionnaire was completed by the mother did not influence the correlation. In a univariate analysis Austin, Hadzi-Pavlovic, Leader, Saint, and Parker (2005) found that higher rates of anxiety and depression, as measured during the third trimester of pregnancy, predicted subjective reports of a "difficult" infant temperament at 4 or 6 months after birth (thus, not the infant behavior but rather maternal factors explained the findings).

These are similar to findings from studies with low SES samples. Depressed mothers in low SES classes perceive their own children's behavior to be more negative than do trained observers (while, interestingly rating their own maternal behavior to be more positive than do controls) (Field et al., 1993). One proposed explanation was that the mothers viewed their

own children from a dysphoric state characterized by negativity and that the children of low SES families do not actually display significantly more negative behavior. Thus, the perception mothers had of their children, rather than the behavior itself, deviated from the healthy population.

Studies show that the general depressed population, as well as depressed women in the perinatal period, perceive vocal emotions differently than not depressed individuals. In a study by Peron et al. (2011), depressed participants did overall significantly worse than did healthy controls in recognizing emotional prosody in voices and furthermore rated positive emotions as being more negative than did the controls. In an earlier study, depressed patients showed diminished perceptual sensitivity toward both positive and negative words (Wexler, Levenson, Warrenburg, & Price, 1994).

Further evidence toward a correlation between poor auditory sensitivity and depression can be found in depressed mothers and infant cries. Whereas the accurate perception of human emotion is a keystone in social interactions, the proper perception of an infant's cries is in fact vital to his or her survival. Indicative of the necessity in human evolution of this skill is the fact that most humans can perceive salient information in different fundamental pitches in infant cries (Zeskind et al., 1992). High-toned cries indicate pain or hunger – needs that need to be promptly met by the caretaker on a regular basis if baby is to thrive. Depressed women, however, are not able to derive the same level of salience from infant cries as healthy women. Donovan, Leavitt and Walsh (1997, 1998) found that mothers who were more depressed were less sensitive in a task measuring participants' sensitivity to infant cries that varied in pitch; depressed women were not as able to differentiate higher pitched cries from lower pitched cries compared to controls. Similarly, Schuetze and Zeskind (2001) found that women with severe depression perceived very high pitched cries to be less urgent and sick sounding than did healthy women and women with less severe depressive symptoms.

The literature also shows that the perception of depressed people is affected by the presence of attentional or cognitive biases regarding the interpretation of emotions via facial expression (e.g. Bouhuys et al., 1999; George et al., 1998; Gur et al., 1992; Joormann & Gotlib, 2006; Mogg, Millar, & Bradley, 2000; Surguladze et al., 2004), but the results do not uniformly suggest a bias toward either positive or negative emotions.

Several studies show that happy faces are more easily identified and at lower intensities than sad expressions for both the depressed and non-depressed populations (e.g. Cavanagh &

Geisler, 2006; Joormann & Gotlib, 2006; Surguladze et al., 2004). This positivity bias has also been shown in parents in general (Spangler, Geserick, & von Wahlert, 2005). Joormann and Gotlib (2006) found that depressed patients need more intensity to identify positive expressions than control groups, but were able to identify sad expressions at low levels of intensity. And while Arteche et al. (2011) found that depressed mothers are less accurate in identifying happy faces than are healthy mothers, but equally as accurate in identifying sad faces, Broth, Goodman, Hall, and Raynor (2004) found differences in sensitivity only in regards to severity of symptoms: Participants with more severe depression were less accurate than participants with less severe symptomology at recognizing positive emotions, but the depressed and non-depressed groups as a whole did not significantly differ from each other. This suggests that severity of symptoms may be a more crucial factor in the relationship between depression and sensitivity toward expressions of emotion rather than a diagnosis of depression.

Stein et al. (2010) found no group differences in the correct perception of neutral and happy faces. However, depressed mothers in their study rated negative infant faces as being more negative than did control or anxious mothers when the stimuli were exposed for 2000 milliseconds as opposed to shorter exposure times, suggesting that the pictures need to be consciously processed for biases to be activated. Negativity bias has been shown in other studies with depressed patients in response to negative valence (e.g. Bouhuys, Bloem, & Groothuis, 1995; George et al., 1998; Gur et al., 1992) and in studies with depressed mothers and negative infant expressions of emotion.

The results of two studies indicate that sensitivity toward negative expressions of emotion could be a predicative factor for the onset of a depressive episode. Lopez-Duran, Kuhlman, George, and Kovacs (2013) found that before the onset of any symptoms boys with high familial risk for the development of depression were able to identify sad faces at much lower intensities than were children with no risk. In their study, Bouhuys et al. (1999) showed that a better perception of negative emotions both during an episode and during remission was correlated with a relapse. What is more, patients identified more negative emotions during states of depression compared to times of remission, showing that the negativity bias is a constant trait that is “amplified” during depressive episodes.

Whether the bias is purely negative or if there is a broader bias indicating a more extensive theory of mind deficit is unclear (Wolkenstein, Schönenberg, Schirm, & Hautzinger, 2011) as is also reflected in studies with depressed mothers.

Neurobiology

New findings in neurobiological studies have revealed some unique aspects of PPD as compared to depression at other times in the lifespan. They have shown in part how the maternal caregiving brain network is also affected during PPD and why maternal sensitivity toward infant emotion may be altered in the face of depression.

Biological correlates have been looked at to measure maternal sensitivity in depressed and healthy mothers. In line with neuroimaging studies with non-postpartum depressed samples, depressed mothers show diminished neural activity in the left dorsomedial prefrontal cortex, a region of the brain associated with social cognition, in response to negative emotional expressions (fear and anger) in contrast to non-depressed mothers (Moses-Kolko et al., 2010). In addition, the "preceding (top-down) connectivity between the left dorsomedial prefrontal cortex and left amygdala" was only seen in healthy but not in depressed mothers (p. 1,379).

A recent study using functional magnetic resonance imaging (fMRI) data confirmed these findings and additionally was able to show that the neurobiological patterns of depressed patients in the postpartum period do differ from those of depressed patients who were not recently delivered of a baby, with, most notably, areas of the brain correlated with maternal behavior being more acutely affected in postpartum cases of depression (Pawluski, Lonstein, & Fleming, 2017). Women with PPD have hypoactivity in the cortical (dorsolateral prefrontal cortex [DLPFC] and anterior cingulate cortex [ACC]) and subcortical regions (amygdala and hippocampus) when in resting state compared to healthy women in the postpartum period. Depressed patients not in the postpartum period, on the other hand, write Pawluski et al., "typically find hypoactivity in more lateral cognitive regions (DLPFC, posterior cingulate, and precuneus/cuneus) and hyperactivity in medial affective and subcortical limbic regions (the perigenual ACC, ventromedial [prefrontal cortex], dorsomedial thalamus, pulvinar, ventral pallidum/putamen, ventral tegmental area (VTA), substantia nigra, tectum, and periaqueductal gray)" (p. 7). In short, part of the circuitry necessary to produce empathy when confronted with negative emotion normally seen in healthy subjects was less active in the clinical sample. It is possible that depression during pregnancy may hinder neurological changes that would normally occur during pregnancy that are thought to benefit maternal sensitivity in the postpartum period (Pearson, Cooper, Penton-Voak, Lightman, & Evans, 2010; Pearson, Lightman, & Evans, 2011b). Indeed, findings from studies on non-human mammals investigating brain circuits and maternal behavior show that abnormalities or disruption in said circuits will necessarily negatively affect maternal behavior. Depression

thus may disrupt the development of sensitivity in the peripartum period as well as hinder its improvement, which would be expected in a healthy mother-infant relationship. Depression and grief have been shown to change brain areas in this circuit (Najib, Lorberbaum, Kose, Bohning, & George, 2004), which is the likely explanation for why women who have had previous episodes of depression are at a much higher risk for developing PPD than other women (O'Hara, 2009).

Differing physiological reactions have been measured across low and high sensitive mothers. Donovan, Leavitt, and Walsh (1997) compared heart rate responses of highly sensitive mothers, intermediately sensitive mothers, and those with low sensitivity scores. Only the mothers in the high sensitivity group showed habituation to the infant cries. Their heart rates ceased to accelerate with each new trial cry as the trials proceeded. Furthermore, higher sensitivity correlated with faster response times. One interpretation of these findings is that mothers that are highly sensitive possess better physiological resources to deal with stress and can tap into those resources and engage better emotion regulation. Furthermore, these same resources may act as a protective factor against the onset of depression.

Mothers with PPD have problems responding in appropriate ways to infant signals. What underlies these problems is still unclear. Biological correlates show that many of the neural systems associated with maternal behavior show abnormal patterns of activity in the face of depression. Studies investigating perception also show that emotion recognition differ both in those at risk for depression and those in a depressive episode. It is likely that depressed mothers have more difficulties perceiving the signals from their babies and that abnormal perception leads to poor sensitivity. Thus we asked the question: Is perception the key link between depression and maternal sensitivity? And if so, could the onset of postpartum depression be predicted by abnormal perception toward infant expression of emotion before the onset of symptoms? To the best of our knowledge to date no studies have been conducted investigating maternal perceptual sensitivity (MPS) as a predictive factor for the onset of PPD.

3 Methods

Model

O'Hara and colleagues (1982) proposed a cognitive-behavioral model for the development of PPD in which a woman's "psychological vulnerabilities" (the authors give the example of negative attributional style) before and during pregnancy predicts the increase of depressive symptoms after a stressful event, such as a stressful birth or other non-childbearing related events. Results from a study by O'Hara, Schlecht, Lewis, and Wright (1991) supported the model.

Beck's (2002) model for the onset of depression put forward an interpersonal element when he and colleagues suggested that it is the difference between the desired social support on the expectant mother's part for the postpartum period and the level of social support she actually receives in that period most influences the degree of depressive symptoms she will experience.

To date, little other research has been done to further investigate the applicability of these models or to investigate other cognitive-behavioral models in the development of PPD.

In our study, we sought foremost to gain a better understanding of the relationship between PPD and MPS. Specifically, we wanted to know if poor MPS during pregnancy is a predicative factor for the onset to PPD. To the best of our knowledge, no study thus far has investigated the role of MPS toward infant signals as a possible predictive factor of PPD. Yet there is reason to look at poor sensitivity as a possible predictive factor for the onset of depression in the postpartum period as outlined below.

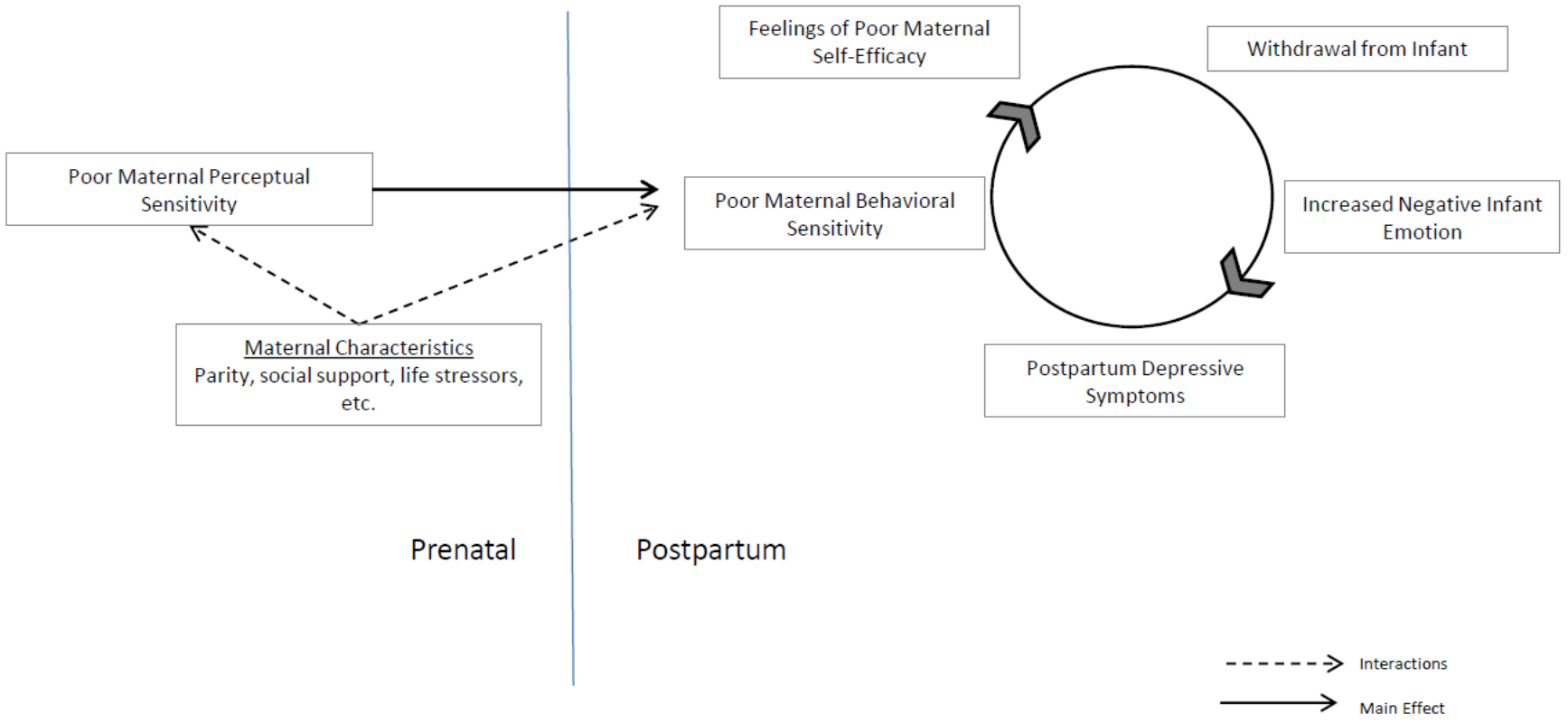
It has been shown that poor social skills and intrapersonal problems are associated with depression (Segrin, 2000). In his 1976 papers, Coyne (1976a, 1976b) proposed the model of depression in which the disorder is maintained by the patient's behavior towards other people and the rejection resulting from the poor social skills often seen in this population. Similarly, Lewinsohn and colleagues (1969) postulated that poor social skills resulting in a lack of positive reinforcement, not only increase levels of depression but may also precede and lead to the development of the disorder. The model underwent alterations in the next decades with the addition of both cognitive and interpersonal aspects (Lewinsohn, Hoberman, Teri, & Hautzinger, 1985).

We believe that the role of social skills in the form of maternal sensitivity and MPS in particular must be considered when looking for causal factors for the onset and pathology of PPD. Specifically, we look at the ability to understand the emotional signals received from infants, as the mother-infant dyad also being a social interaction and the one that will most preoccupy a mother after the birth of a child.

While testing an entirely new model of onset was not within the scope of the larger study from which the data from this thesis came, we nevertheless felt it beneficial to present in a visual format a model that we believe reflects the way in which MPS and PPD are associated. The overall model contains MPS and maternal characteristics, which we investigated in this study. Motivated by research showing that feelings of helplessness, or low self-efficacy, are also correlated with depression in the postpartum period (Coleman & Karraker, 1998; Haslam, Pakenham, & Smith, 2006; Henkel, Bussfeld, Möller, & Hegerl, 2002), we included these aspects in our model to ensure completeness, although they were not investigated in our study.

In our model, low MPS makes is difficult for a mother to perceive the emotional signals from her baby. Thus, she is not able to sooth a crying baby in need, nor does she share the same joy in subtle positive expressions from her infant that other mothers do. This leads to feelings of low self-efficacy and a lack of positive reinforcement, which further leads to depression. The end result is a vicious cycle with her withdrawing more from her child, thereby causing the child more distress and disengagement, which again, the mother feels inadequate to quell.

Figure 2. A Model for the Development of Postpartum Depression



Hypotheses and Explorative Questions for the Current Study

First, (H1) we investigated our hypothesis that poor maternal perceptual sensitivity during pregnancy would predict the onset of PPD. According to our model, we expect MPS to be negatively correlated with depression and that sensitivity will predict depression symptoms in a linear fashion.

Secondly, (H2) we explored the relationships across auditory and visual MPS. We wanted to know if there was a relationship between auditory and visual MPS and if or how visual MPS towards positive and negative baby expression were related, as it has yet to be explored in the literature.

Thirdly, (H3) we wanted to know whether or not MPS is a static characteristic or changes after the birth. Can new mothers become more attuned to their infants' emotions with time and experience or is the ability to correctly perceive infant signals a relatively stable trait?

Fourthly, (H4) we explored whether or not there were biases toward negative or positive emotion across groups. In particular, we wanted to know a) if all participants were more accurate in response to positive visual emotional stimuli than negative visual emotional stimuli; b) Whether or not participants with more depressive symptoms were more accurate in response to negative stimuli than participants with fewer symptoms; c) and if so, whether this was particularly the case with low intensity sad expressions; Finally, d) we investigated if participants with higher levels of depression symptoms differed significantly from those with lower levels of symptoms at 6-weeks postpartum, in their ability to differentiate the manipulated cries with fewer semitone differences from the standard cry as compared to the cries with larger differences from the standard cry.

Finally (H5), we explored what ante- and postnatal maternal characteristics posed a risk for the development of postpartum depression within the postpartum period, with the specific hypothesis that a history of depression would increase the risk for depressive symptoms in the postpartum period.

Study Sample

Women were recruited at local birthing and other prenatal classes, birthing clinics, gynecologist practices, as well as through two non-profit walk-in counseling organizations that offer support for women during and after pregnancy (ProFamilia and the Jugend- und

Familienberatung des Landeskreis Tübingen). In order to avoid self-selecting and biased answers on the questionnaires, potential participants were not told that the study investigated PPD. Rather, it was explained that the two goals of the study were to investigate the effects of maternal sensitivity and maternal emotion regulation on the infant's temperament and the mother's state of wellbeing after the birth. The study was approved of by the local ethics committee. A total of *N*= 133 women participated at T1. Of those four participants did not meet the inclusion criteria at T2 and were therefore excluded from analyses and 10 participants dropped out of the study at T2 and were therefore also omitted from analyses. Dropouts from the study were due to an inability to contact participant or scheduling difficulties. Several data cases were not fully complete, but were still included in analyses for which the data was present. Missing data was due to technical difficulties.

Mean age at the time of recruitment was 31 years (*SD* =5.11). The mean duration of gestation at the time of recruitment was 31.94 weeks (*SD* = 3.72). 93.2% (*N* = 110) had German nationality. Nearly 70% were expecting their first child and 92% co-habited with their partner.

Inclusion and Exclusion Criteria

Women were invited to participate in the study who had reached the 27th week of gestation, were having healthy singleton pregnancies, and who had a sufficient command of the German language. Excluded were women diagnosed within the study via the SCID I and II (see Table 1 below) as having any affective mood disorders at T1 (complete remission was considered 8 weeks prior to the T1 without symptoms), borderline personality disorder (2 years prior to T1 without symptoms), psychotic disorders (lifetime), or anorexia nervosa (6 months prior to T1 without symptoms). This was done so, because we were interested in factors that predicted PPD before the onset of this disorder and we felt that borderline and psychotic disorders would possible present confounding and unseen factors in the likelihood to develop PPD. Participants with current anorexia nervosa were excluded as maternal malnutrition during pregnancy could affect the infant's health. Infants and their mothers were invited back to the study at T2 if the baby was healthy and full-term at birth. Prematurity was defined as a birth occurring 22 or more days prior to the due date. Several of the measurement tools employed in the larger study measured infant behavior. We believed that our hypotheses could most accurately be investigated if infants who were not healthy at the time of birth were excluded from the sample pool. All participants signed informed consent forms and statements on data security and confidentiality.

Table 1. Data and Participant Exclusions

T1 (N = 133)	T2 & T3 (N = 119)	
Excluded from all analyses	**Excluded from within factor analyses with auditory sensitivity data**	**Excluded from within factor analyses with visual sensitivity data**
n = 2: premature birth	n = 1: deafness in one ear, no auditory data	n = 1: technical difficulties with visual T1
n = 2: birth defects	n = 1: technical difficulties with audio T1	n = 4: technical difficulties with visual T2
n = 9: dropout at T2	n = 4: missing T2 auditory data	n = 4: missing T2 visual data
n = 1: technical difficulties with all sensitivity T1 data		

Note. Shown are number of participants who were excluded posteriori at T2 due to obstetric complications, those who dropped out at T2 and remained out of the study at T3, as well as number of missing data sets due to technical difficulties.

Dropout Analyses

Approximately 19% (N=23) of the study sample had at least one episode of major depressive episode prior to the study. This is within epidemiological estimates for lifetime risk for women, which is 10-25% (Kessler et al., 2003). Rates for depression as well as other mental illnesses as measured at T1 can be seen in Table 2.

As diagnosed with the SCID, 4.2% (N=5) and 3.4% (N=4) were diagnosed with major depression at T2 and T3, respectively. Of these one participant that had a diagnosis of MDE prior to the study received the same diagnosis at T2 and T3, respectively. Depression symptoms were also measured. At T2 5.9% and 9% were above the cutoff rates for IDS-C (≥ 16) and the EPDS (≥ 10), respectively. At T3 3.4% and 5% were above the cutoff rates, as shown in Table 3. Rates for depression were slightly higher at T2 than at T3 as measured by all instruments. This pattern is also reflected in the average scores for the two symptom measurement tools (EPDS and IDS-C) across measurement times, with the highest mean scores occurring at T2, 6-weeks postpartum, as can be seen in Table 4.

Table 2. Frequencies of Lifetime Mental Disorders

Diagnosis	***N***	**%**
Unipolar depression	23	19.5
Eating disorder	16	13.6
Anxiety disorder	9	7.6
Substance use disorders	4	3.4
OCD	3	2.5
Adjustment disorder	2	1.7
Bipolar disorder	1	0.8
Minor depression	1	0.8
PTSD	1	0.8
Somatization disorder	1	0.8
Comorbidity		
With unipolar depression	11	9.3
With other diagnosis	2	1.7

Note. Diagnoses were made via the SCID-IV

Table 3. Frequencies of Depression and Depression Symptoms at T2 and T3

	Depression at T2		Depression at T3	
Measure of Depression	***n***	**%**	***n***	**%**
Diagnosis of major depression with DSM-IV	5	4.2	4	3.4
Depressive Symptoms				
IDS-C [a]	7	6	4	3.4
EPDS [b]	9	7.6	6	5.1
Both instruments	5	4.1	2	1.7

Note. Sample size *(n),* Structured Clinical Interview – Fourth Edition (*DSM-IV*), The Inventory of Depression Symptomology – Clinician rated (*IDS-C*), Edinburgh Postnatal Depression Scale (*EPDS*). a Score of ≥ 16. b Score of ≥ 10.

Table 4. Depression Symptoms across All Three Measurement Times

Measure of Depression	*n*	*M*	*SD*	Range
EPDS T1[a]	118	4.03	3.38	0 - 16
EPDS T2	119	4.17	3.44	0 - 19
EPDS T3	117	3.43	3.10	0 - 13
IDS-C T1[b]	118	5.75	4.55	0 - 19
IDS-C T2	117	6.46	5.99	0 - 52
IDS-C T3	117	5.89	4.80	0 - 32

Note. *n* = sample size, *M* = mean, *SD* = standard deviation. a Possible scores from 0 – 30. b Possible scores from 0 – 84.

Of the 133 original participants four had to be excluded post-hoc due to exclusionary criteria at T2: Two premature births and two babies born with severe health problems. The data from one participant was excluded due to gross technical problems at T1, resulting in missing MPS scores. In addition, nine participants failed to return at both T2 and T3.

The average scores for the depression scales at T1 for the participants who dropped out at T2 (N=9) from those who remained in the study (N=119) did not differ significantly. The mean EPDS score for the former group was, M = 3.67 (SE = 3.12) and for the latter group, M = 4.03 (SE = 3.42), $t(130) = 0.312$, $p = .756$. The mean IDS-C score for the dropout group at T1, was M = 4.0 (SE = 2.96) and for the non-dropout group, M = 5.83 (SE = 4.55), $t(130) = 1.186$, $p = .238$. Of the self-selecting dropout participants, four of them had a previous diagnosis of a MDE as measured with the SCID at T1. A chi-square test comparing the dropout group with the remaining participants in this regard was not significant, X^2 (1, N = 133) = 2.902, $p = .104$. One dropout had an additional comorbid diagnosis of anorexia nervosa. There were no other comorbid diagnoses in the dropout group. Here too, there was not a significant difference between the two groups concerning the presence of comorbidity as diagnosed at T1, X^2 (1, N = 133) = 0.015, $p = .622$.

Attempts were made to contact all dropouts and participants that had to be excluded at T2 and T3 due to premature births and severe infant health complications in order to obtain diagnostic information. Only three of the self-selecting dropout participants were able to be reached at T2 and only two at T3. Of the participants that were able to be interviewed by telephone at T2, none were diagnosed with an MDE at that time. One participant who had to be excluded from the study post hoc-due to a premature birth was diagnosed with depression via the SCID as conducted by telephone at T2 and T3. Two dropouts were above the cutoff rate for EPDS at T2 and one dropout was above the cutoff rate at T3. None of the available dropouts who were successfully contacted were above the cutoff rate for the IDS-C at either T2 or T3. As shown in an exact significance chi-square test there was no significant association between non-participation at T2 and the diagnosis of MDE at T2, X^2 (1, N = 133) = 5.143, $p = .144$.

T-tests comparing the MPS *d*' scores at T1 for the dropout versus not-dropout groups revealed no significant differences. The mean score for the audio *d*' for the dropout group was, M = 2.01 (SE = 0.16) and for the non-dropout group, M = 1.8 (SE = 0.06), $t(124) = -0.20$, $p = .342$. For the happy visual block at T1 the mean score for the dropout group was, M = 1.96 (SE = 0.21) and the non-dropout group had a mean of, M = 2.21 (SE = 0.08), $t(124) = 0.85$, $p = .395$.

Finally, the mean score for the dropout group in the sad visual block at T1 was, M = 2.20 (SE = 0.21) and the non-dropout group had a mean of, M = 2.3 (SE = 0.06), $t(124) = 0.47$, p = .642.

The only sociodemographic variable that was significantly different between the two groups was whether or not the participant had ever had an abortion. A chi-square conducted with the exact option showed that participants who chose to stay in the study had a higher rate of abortions than did the dropout group, X^2 (1, N = 119) = 9.095, p = .003.

Replacing missing values

For the depression questionnaires if only one value was missing (one question was not answered), this value was replaced using expectation maximization (EM) (Enders, 2003). Three single values for the EPDS scales and two for the IDS-C were missing. Missing values in the sociodemographic questionnaires were not replaced.

Materials and Measurement Tools

The study discussed in this dissertation was part of a larger study. Only the measurement tools relevant for the current study are described here. Table A1 in the appendix shows a complete list of measurements and measurement tools used within the larger study.

Structured Clinical Interview for DSM-IV (SCID I and II)

The German version (Wittchen, Zaudig, & Fydrich, 1997) of the Structured Clinical Interview for DSM-IV (SCID; First, Spitzer, Gibbon, & Williams, 1996) for the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., *DSM–IV*; American Psychiatric Association, 1994) was employed for this study. The SCID-I is a semi-structured interview designed to measure Axis I major mental disorders: affective, psychotic, substance abuse, anxiety, somatoform, eating, and adjustment disorders. Reliability for the disorders of interest for this study has been proven (Skre, Onstad, Torgersen, & Kringlen, 1991). All interviewers had training in the administration of the SCID. A screening interview is conducted previous to the SCID-I directing practitioners to sections that need to be completed.

The SCID-II (First, Gibbon, Spitzer, & Williams, 1997) measures 12 different personality disorders: avoidant, dependent, obsessive-compulsive, passive-aggressive, depressive, paranoid, schizotypal, schizoid, histrionic, narcissistic, borderline, and antisocial. The screening questionnaire for SCID-II is filled out by participants/patients themselves in which

they answer each item by checking either "yes" or "no". Both the reliability and validity for the SCID have been proven to be sound (Wittchen et al., 1997).

Edinburgh Postnatal Depression Scale (EPDS)

The most frequently used screening and diagnostic tools used in research on PPD is the Edinburgh Postnatal Depression Scale (EPDS) (Cox, Holden, & Sagovsk, 1987) The German version was used for this study (Bergant, Nguyen, Heim, Ulmer, & Dapunt, 1998). The EPDS is a 10-item multi-choice self-administered questionnaire used to measure symptoms specific to PPD (as opposed to general depressive symptoms) in the last seven days, focusing on cognitive depressive symptoms rather than physical behaviors (i.e. sleep and appetite changes), that may be a normal part of the postpartum period. Each item can be answered on a scale, reflecting the frequency with which the participant experienced the symptom, from 0 ("no, not at all") to 3 ("yes, quite a lot"). The EPDS has been validated for use both during pregnancy (Gawlik et al., 2013; Murray & Cox, 1990) and after pregnancy (Cox, Chapman, Murray, & Jones, 1996). The overall psychometric soundness is in the moderate range: Sensitivity, 79% and specificity, 85% (Cox et al., 1996). Cutoff rates in the literature range from 9 to 13. For this study, a cut-off rate of 10 was used, as was the practice in many previous studies (Matthey, Henshaw, Elliott, & Barnett, 2006)

Inventory of Depression Symptomology (IDS-C)

The Inventory of Depression Symptomology – Clinician rated (IDS-C) (Rush et al., 1986) contains 30-items for measuring the severity of depressive symptoms and is appropriate for both in- and outpatients. Each item is given a score between 0 and 3, with zero indicating that the symptom is not present and 3 being the most sever. Validity and reliability of the inventory are high in both the English and the German version, which was used in this study (Drieling, Schärer, & Langosch, 2007; Rush, Gullion, Basco, Jarrett, & Trivedi, 1996). A cut-off rate of 16 has been used within this study as has been used in previous studies (Boyd, Le, & Somberg, 2005).

Sociodemographic Questionnaire

Three questionnaires collecting sociodemographic information were created for this study – one for each of the measurement times. The entire sociodemographic questionnaires for T1-T3 used within the larger study can be found in Appendix B. Not all of the items were included in the statistical analyses for this study. Information collected included age, income and education level, marital status, and questions regarding the participant's satisfaction with the support from their partners, family and friends, as well as obstetrics, were included in this

study. The T1 questionnaire included questions about the desirability of the current pregnancy and any obstetric complications that may have occurred. Questions for T2 and T3 also included those concerning complications during and after the birth as well inquiries about breastfeeding and subjective views about the infant's behavior. Furthermore, some of the items were regrouped from the original Likert scales into dichotomous items. The dichotomous items are as follows: Parity (1 = has children, 0 = expecting first child), cohabitation (1 = lives together with partner, 0 = does not live with partner), previous miscarriage, previous MDE, other mental illness, current stress, pregnancy complications, birth complications, nursing and miscarriage (1 = yes, 0 = no), spouse support and family support (1 = satisfied with, 0 = not satisfied with). Finally, the German education degrees were translated into the following groups 1= lower secondary education (Haupt- and Realschulabschluss); 2 = high school degree (Abitur and Fachhochschulreife); 3 = college degree (Universitätsabschluss). Tables 5 and 6 show the descriptive statistics for the sociodemographic items.

Table 5. One-time-measurement Sociodemographic Items and their Values

Variable	
Age	
Mean	31
Range	22 – 46
Standard Deviation	4.24
Parity	
Expecting first child	69.7% (83)
Expecting 2+ child	30.3% (36)
Cohabitation	
Lives with partner	92% (103)
Does not live with partner	8% (9)
Total household income per month	
0-399 Euro	2.7% (3)
400-799 Euro	3.6% (4)
800-1199 Euro	1.8% (2)
1200-1799 Euro	12.6% (14)
1800-2300 Euro	15.3% (17)
2400-2999 Euro	16.2% (18)
3000-3999 Euro	18.0% (20)
4000-4999 Euro	16.2% (18)
5000 Euro or more	12.6% (14)
Education	
Lower secondary education (Haupt- and Realschulabschluss)	5.3% (6)
High school degree (Abitur and Fachhochschulreife)	25.4% (29)
College degree (Universitätsabschluss)	65.8% (75)
Other	3.5% (4)
Music lessons in years	
Mean	5.24
Range	0 – 16
Standard Deviation	4.50
Previous miscarriage	
Suffered a miscarriage	10.1% (12)
Did not have a miscarriage	89.9 (107)
Pregnancy complication for current pregnancy	
Yes	22,6% (26)
No	77.4% (89)
Birth complications for current birth	
Yes	29.6% (34)
No	70.4% (81)

Note. The German education degrees were translated into the following categories for the better comprehension of non-German readers: Real- und Hauptschulabschluss = lower secondary education; Abitur und Fachhochschulabschluss = high school degree; Hochschullabschluss = university degree.

Table 6. Repeated Measurement Sociodemographic Items and their Values

Variable	T1	T2	T3
Current stress			
Yes	57.1% (68)	42% (47)	28.9% (33)
No	42.9% (51)	58% (65)	71.1% (81)
Nursing			
Yes	-	96.5% (111)	95.7% (110)
No	-	3.5%(4)	4.3% (5)
Satisfied with support from spouse			
Yes	91.6% (109)	93.9% (107)	95.7% (110)
No	8.4% (10)	6.1% (7)	4.3% (5)
Satisfied with support from family			
Yes	98.3% (117)	97.4% (112)	97.4% (111)
No	1.7% (2)	2.6% (3)	2.6% (3)

Maternal Perceptual Sensitivity

Both audio and visual sensitivity experiments were performed on a Fujitsu Siemens Esprimo computer with an 18 inch (20 zoll) screen. Experiments were programed and conducted with E-prime (Version 2.0, Pittsburgh; Psychology Software Tools Inc.) experimental software. Participants sat 10 inches from the screen.

Audio Sensitivity Stimuli and Task Description

Healthy newborn infants have a mean fundamental frequency ($F_{0)}$ between 400 and 600 Hz (Michelsson & Michelsson, 1999). Hyperphonation, an indication of extreme pain or abnormalities in an infant's neural system, starts at 1000 Hz (LaGasse et al., 2005). Crying is a graded signal, with higher F_0 reflecting more distress and eliciting quicker responses from caregivers (Del Vecchio et al., 2009; Wood & Gustafson, 2001). F_0 in adults is also linked to emotion (Segrin, 2000), so that new parents are not learning a new set of communication signals, rather they need only adopt their behavior to the need the infant is expressing.

The original audio recordings of the infants cries used within this study were obtained from Dr. Philip Zeskind, MD and his colleagues of the University of North Carolina at Chapel Hill from a dataset of infant cries used in previous studies (Schuetze & Zeskind, 2001). From the five recordings received, four were selected for use in the study that had the most similar ratings in perceived valiance as determined in a pilot study. The recording not used in the data analysis was used for the practice round in the audio experiment.

The recordings are of spontaneous cries taken between feedings using an Olympus DM-20 digital audio recorder. Infants were between 12-72 hours old, full-birthweight (>2500 grams) and full-term (>36 weeks gestation). For the experiment one male and three female infant cries were used. The practice round stimuli were from a male infant. Table 7 shows the physical properties for the infants whose cries were used as well as the frequencies of the cries that were employed as the standard cries in the experiment. All original cries were within the frequency range that is heard in healthy newborn infants (Michelsson & Michelsson, 1999). The average expiration duration ranged from 0.85 to 1.99 seconds.

Table 7. Descriptive Information for the Original Baby Cries

Stimuli Baby	Gender	Weeks of Gestation	Birth Weight[a]	Expirations[b]	Average Peak F_0[c]	Minimum Peak F_0	Max Peak F_0
Baby A	Female	39	3500	2	419.90	409.13	430.66
Baby B	Female	38.5	2555	4	457.58	430.66	473.73
Baby C	Male	40	3710	3	545.51	516.80	581.40
Baby D	Female	38.6	2905	2	473.73	473.73	473.73
Practice Baby	Male	40.1	3468	4	479.11	473.73	495.26

Note. a. Birth weight in grams. b. Expiration durations in seconds. c. All fundamental frequency (F0) values given in hertz.

The infant cry stimuli were 6 seconds in length with segments being chosen that had the most similar frequency and temporal measures. Sound values for the original recordings were determined using the Multi-Speech Lab (Dublin; KayPENTAX) spectrum analytic software program.

The audio files as received from the University of North Carolina at Chapel Hill had a sampling rate of only 22.05 kilohertz (kHz), which was adjusted for this study to 44.1 kHz, in order to create a better sound quality, thus, while we attempted to use the original average frequencies for the standard cry, there were some slight changes, which we felt were warranted due to the gain in sound quality. These recordings were then artificially adjusted by raising or lowering the fundamental frequency (F_0). The frequencies of the original cries were between 415 and 495 hertz (Hz) (*M = 451, SD = 26.88*). The variations in semitones (pitch)

were made by uniformly raising or lowering the F0 of the recordings in 1 semitone steps, while maintaining the temporal and other spectral qualities of the cries, as has been done in similar studies (Joosen, Mesman, Bakermans-Kranenburg, Pieper, et al., 2012; Out et al., 2010). Since the note range corresponds to the frequency range logarithmically, there's no fixed conversion value between the two domains. The higher the notes, the larger the frequency difference between the notes. For example, G#7 and G7 (one semitone difference) differ in frequency by about 186 Hz. G#2 and G2 (also one semitone) differ only by about 6 Hz. While attempts were made to be exact as possible, there are some slight variations in the exact Hz differences for each variation. Equivalent values for the pitches and frequencies were determined using calculations from Eberhard Sengpiel (Sengpiel, n.a.). All variations to the original recordings were done using the Celemony Melodyne (Version 2.1.2., Munich; Celemony Software GmbH) software program. All cry stimuli were played at a constant volume via Hercules HDP DJ M40.1 headphones (La Gacilly Cedex, France; Guillemot Corporation S.A.).

The variation cries employed for the study were chosen based on previous studies employing similar method. However, other studies were investigating the physiological responses to various cry pitches and considerably large variations were used: Joosen et al. (2012) and Out et al. (2010) used +200 and +400 Hz increases, Schuetze et al. (2003) used +100 and +200 Hz increases. We chose to use finer increments, as seen in Donovan et al. (1998) and more variation cries in order to measure MPS. These values are shown in Table 8.

Table 8. Descriptive Information for the Moderated Baby Cries

	- 2 semitones	-1 semitone	Standard	+1 semitone	+2 semitones	+3 semitones	+4 semitones
Baby A	370Hz	392Hz	415Hz	440Hz	461Hz	494Hz	523Hz
Baby B	392Hz	415Hz	440Hz	466Hz	490Hz	523Hz	554Hz
Baby C	440Hz	466Hz	494Hz	523Hz	554Hz	587Hz	622Hz
Baby D	392Hz	415Hz	440Hz	466Hz	490Hz	523Hz	554Hz
Practice Round Baby	415Hz	440Hz	466Hz	494Hz	523Hz	554Hz	587Hz

The audio experiment consisted of one practice round and one experiment block. The experiment block was comprised of 40 randomized trials, the practice round of five randomized trials. Participants were asked to determine if a pair of infant cries contained the same the same cry repeated or if the second cry, the test cry, was different. A standard cry was first presented, followed by a test cry. If the pair contained the same cry, participants were to press a green button. If the pair contained two different cries, a red button was to be pressed. Participants were instructed to give their answer during the 6 second test cry phase. The instructions for the experiment were read aloud to participants before the task was begun. A written copy of the instructions was then shown on the computer screen. Participants were allowed to take as long as they wanted to read the instructions. All rounds were started once the participant pressed the spacebar.

The instructions as read aloud and seen by the participants were as follows:

> „Im Folgenden werden Ihnen nacheinander zwei Tonaufnahmen eines weinenden Babys vorgespielt. Sie hören die zweite Tonaufnahme kurz nach der ersten. Diese beiden Tonaufnahmen werden durch eine kurze Pause voneinander getrennt. Während der Pause sehen Sie einen schwarzen Bildschirm. Bei beiden Aufnahmen handelt es sich um das gleiche Baby. Bitte beurteilen Sie, ob die beiden Tonaufnahmen exakt identisch oder verschieden sind. Für „ja die Tonaufnahmen sind GLEICH“ drücken Sie bitte die GRÜNE Taste. Für „nein die

> Tonaufnahmen sind VERSCHIEDEN“ drücken Sie bitte die ROTE Taste. Bitte antworten Sie bereits während der zweiten Tonaufnahme. Nutzen Sie hierzu Ihre beiden Zeigefinger.“[4]

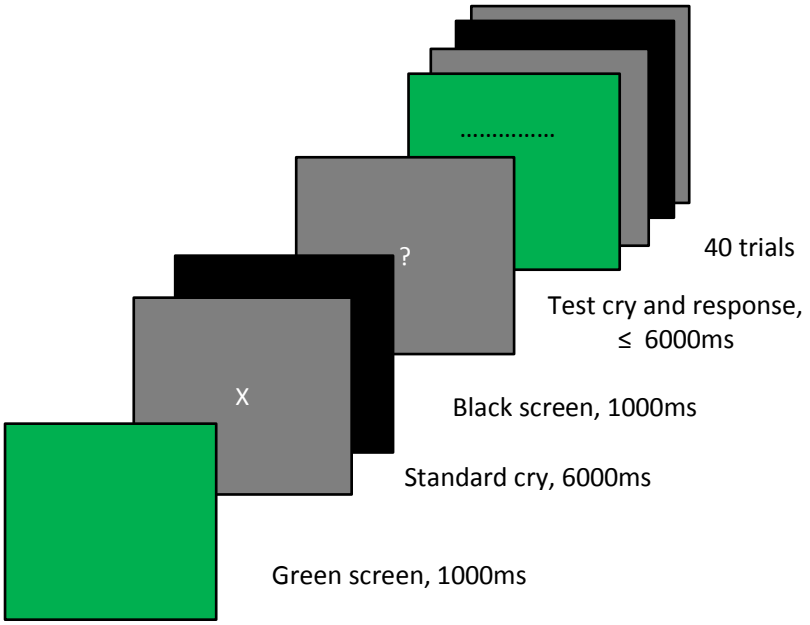
A practice round was completed by all participants before the test block was begun to ensure that the participant understood the instructions. Five trials were presented in the practice round. If the participant achieved an accuracy rate of 80% (correctly responded to 4 out of the 5 trials), the instructions were presented once again. If they failed to achieve 80% accuracy, the practice round was repeated until the threshold was achieved. During the practice round participants were given feedback shown on the computer as to whether their responses were correct or incorrect. If the participant failed to give a response within the test cry phase, they were shown the message “no response”. Feedback was not given during the experiment. Once the practice round was successfully completed, a screen appeared informing the participant of their accuracy rate and that they were now to proceed with the experiment.

The test block was comprised of 40 trials. For each of the four babies, there was a single standard cry and six variation cries: -2 semitones (st), -1 st, +1st, +2st, +3st, +4st. Each of the four babies had one standard cry, so that only four different standard cries were presented. The standard cry was used as the test cry for four trials for each baby, for which the correct participant response would be *same*. The remaining variations for each baby were presented for one trial each. Thus, *same* was the correct response in 16 trials and *different* in 24 trials.

The practice round consisted of five trials, for which the same standard cry was used for all trials. Two of the practice trials had identical standard and trial cries. The three remaining test cries had the following properties: +4 st, +3 st, and -2 st.

[4] “Shortly you will hear two recordings of crying babies played one after the other. You will hear the second recording right after the first recording. The recordings are separated from one another by a short pause. During the pause you will see a black screen. Both recordings are made of the same baby. Please assess whether both the recordings are exactly the same or different. For, ‘yes, the recordings are the SAME’, please push the green button. For, ‘no, the recordings are DIFFERENT’ please push the red button. Please give your answer during the second recording. Use both of your pointer fingers”.

Figure 3. Procedure for the Auditory MPS Experiment



Each trial had the following sequence: A green screen was presented for 1000 milliseconds (ms) before each new pair of cries. During the 6000 ms standard cry participants saw a black screen with a white fixation cross. There was 1000 ms pause between cries during which an all-black screen was shown. During the 6000 ms test cry a black screen with a white question mark was shown. The next trial (green screen) began as soon as the participant gave a response. The procedure can be seen in Figure 3 above. The complete experiment lasted approximately 10 minutes.

Signal Detection Theory

In order to quantify MPS the signal detection theory (SDT) was implemented (Green & Swets, 1966). Several studies with emotional expressions, both auditory and visual, have employed the signal detection method (Donovan, Leavitt, et al., 2007; Donovan et al., 1997, 1998; Donovan, Taylor, et al., 2007; Grimshaw, Bulman-Fleming, & Ngo, 2004; Wilberta Donovan, 2007).

SDT is used to quantify human behavior, or more precisely, how one detects, "signals" to the sensory organs. What makes this method particularly useful when applied to forced-choice experiments is that a response accuracy is calculated in which error due to criterion is removed, that is, one can obtain the level of discernibility independent of the criterion (Kantowitz, Roediger, & Elmes, 2014).

Sensory sensitivity was quantified according to the signal detection method, by generating four response conditions (Green & Swets, 1966). Within this design, there are four categories of responses: hit, miss, false alarm, and correct rejection, as seen in Figure 4. A hit is a positive response to a signal. A miss is a negative response to a signal. A false alarm is a positive response when no signal is present. Finally, a correct rejection is a negative response when there is no signal. A *d*'prime value is then quantified via the following formula:

$d' = Z(\mathrm{H}) - Z(\mathrm{F}),$

where (H) is the hit rate and (F) is the false alarm rate. Note that the function Z(x) here is not to be confused with the traditional z score.

From this a *d'* prime value is calculated using the percentage rate of the two conditions hits and false alarms. Hits within the audio paradigm were when the standard and test cry were identical and so correctly identified thusly. A non-identical test cry incorrectly identified as being the same, was a false alarm. Hits in the happy block of the visual paradigm were those trials in which the test picture was correctly identified as displaying a positive picture and false alarms when the participant incorrectly identified the emotion as positive. Finally, in the sad block when a negative emotion was correctly identified this was a hit and a false alarm occurred when the participant identified a non-negative emotion as being negative.

Figure 4. Signal Detection Contingency Square

		Reality	
		Match	No Match
Participant sees/hears	„Match“	Hit	False Alarm
	„No Match“	Miss	Correct Rejection

Problems arise within SDT when either the hit or false alarm rate equals zero, which can occur due to sampling variability (Hautus, 1995). In this case the corresponding inverse

normal variate, or function Z(x), scores would be -∞ or +∞, respectively, thereby rendering *d'* incalculable. There are several different methods for dealing with this issue (see Stanislaw & Todorov, 1999). For this study the *loglinear* method was universally applied, as it results in comparatively less biased estimates of *d'* over other methods *(Hautus, 1995)*. The method simply requires the addition 0.5 to each of the four cells in the two-by-two contingency table.

Accuracy

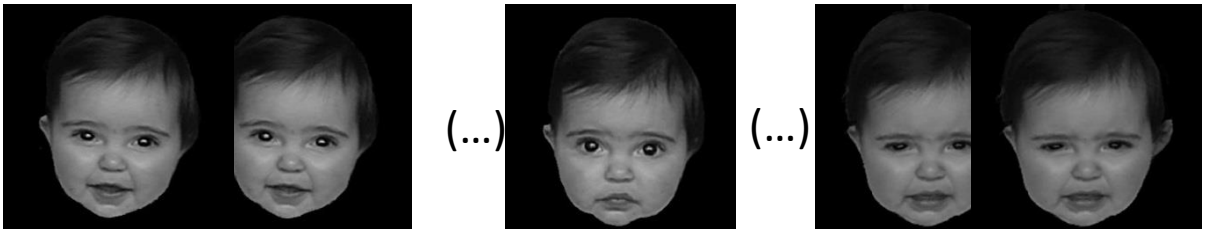
In addition to *d',* MPS was also measured in performance accuracy. For this measurement both incorrect responses and trials in which no response was given were considered incorrect. Accuracy was included in the analyses as *d'* does not reflect missing responses. Thus, for example, a participant who chose only to give responses in trials in which she was more confident but failed to give responses to 20% of the trials, may have a high *d'* value, but would have a lower accuracy value than a second participant who had the same hit to false alarm ratio, but provided responses in 100% of the trials. Furthermore, the accuracy rate could be calculated for each trail, that is for different intensities and emotions (e.g. 56% sad versus 60% sad), which was necessary for some of the hypotheses.

Visual Sensitivity Stimuli and Task Description

The infant faces used were drawn from the Oxford Infant Faces database from the University of Oxford. The database is comprised of digital photographs of 27 infants who were filmed at home (3 months – 12 months of age) (Kringelbach et al., 2008; Parsons, Young, Kumari, Stein, & Kringelbach, 2011). From the films still face images were created for each infant displaying positive, negative, and neutral facial expressions. Head direction and eye gaze were controlled for as best as possible. Both head size and luminosity were matched for. Each image was 16 cm in height and the pictures were shown in gray scale. Of the 27 infants, two female and two male babies were chosen for this study. The babies were chosen based on the results of a pilot study in which participants rated the attractiveness of the babies. The babies with the most equal ratings of attractiveness were chosen.

Based on findings indicating that the depressed population may differ in their identification of expression most particularly when they are presented in lower intensities – arguably those intensities that one is more likely to encounter daily (Balge & Milner, 2000; Cavanagh & Geisler, 2006; Gartstein & Rothbart, 2003; Joormann & Gotlib, 2006; Stein et al., 2010; Surguladze et al., 2004) – morphed pictures of infants displaying positive and negative emotions at varying levels of intensity were presented as stimuli. For each of the four babies,

there was one neutral expression image (0% intensity), 12 test images with positive expression with intensities ranging from 56 – 100% in 4% increments and 12 test images with negative expressions, also ranging from 56 – 100% in 4% increments. Examples of the stimuli can be seen in Figure 5. We believe that displaying subtle expressions is more ecologically valid than using only full-blown expressions and that the stimuli more accurately reflect the facial expressions one encounters in everyday life. The exposure time of 2000 milliseconds was chosen based on previous research (Donaldson, Lam, & Mathews, 2007; Stein et al., 2010).



60% happy 56% happy Neutral 56% sad 60% sad

Figure 5. Examples of the Stimuli from the Visual MPS Experiments

The visual sensitivity experiment consisted of two practice blocks, a so-called *happy* and a so-called *sad block*. These were randomized, but were balanced in order in ensure that one emotion was not more frequently conducted prior to the other. The experiment also contained two test blocks (happy and sad), the order of which was randomized and counterbalanced. The practice blocks contained 5 trials each, the test blocks 144 trials, respectively. Participants were read aloud the instructions for both the happy and sad blocks before the practice round was begun. Participants were allowed to ask questions and the instructions could be repeated if requested.

The instruction for the *happy block* were as follows:

> "Im Folgenden werden Ihnen Fotos von Baby-Gesichtern gezeigt. Bitte beurteilen Sie für jedes Foto, ob das Baby einen GLÜCKLICHEN Gesichtsausdruck zeigt. Wenn das Baby einen GLÜCKLICHEN Gesichtsausdruck zeigt, drücken Sie bitte die GRÜNE Taste. Wenn das Baby KEINEN glücklichen

> Gesichtsausdruck zeigt, drücken Sie bitte die ROTE Taste. Bitte nutzen Sie zur Beantwortung beide Zeigefinger.“[5]

The instructions for the *sad block* were as follows:

> “Im Folgenden werden Ihnen Fotos von Baby-Gesichtern gezeigt. Bitte beurteilen Sie für jedes Foto, ob das Baby einen TRAURIGEN Gesichtsausdruck zeigt. Wenn das Baby einen TRAURIGEN Gesichtsausdruck zeigt, drücken Sie bitte die GRÜNE Taste. Wenn das Baby KEINEN traurigen Gesichtsausdruck zeigt, drücken Sie bitte die ROTE Taste. Bitte nutzen Sie zur Beantwortung beide Zeigefinger.“[6]

Once ready to begin the practice rounds the participant was to press the spacebar. At this point the one set of instructions corresponding to whatever block they were randomly assigned first appeared on the screen. Participants began the first trial by pressing the spacebar. Feedback was given after each trial in the practice round on whether the correct or incorrect response was given, or the message “no response” if the participant failed to respond within the allotted time. Again, no feedback was given during the test blocks. If 80% accuracy was achieved the participant was allowed to proceed to the next practice round block of the experiment. If the participant failed to achieve 80%, they were requested to repeat the block, at which time they were once again presented with the instructions for the corresponding blocks. Once both blocks of the practice round were successfully completed, a screen appeared informing the participant of their accuracy rate and that they were now to proceed with the experiment.

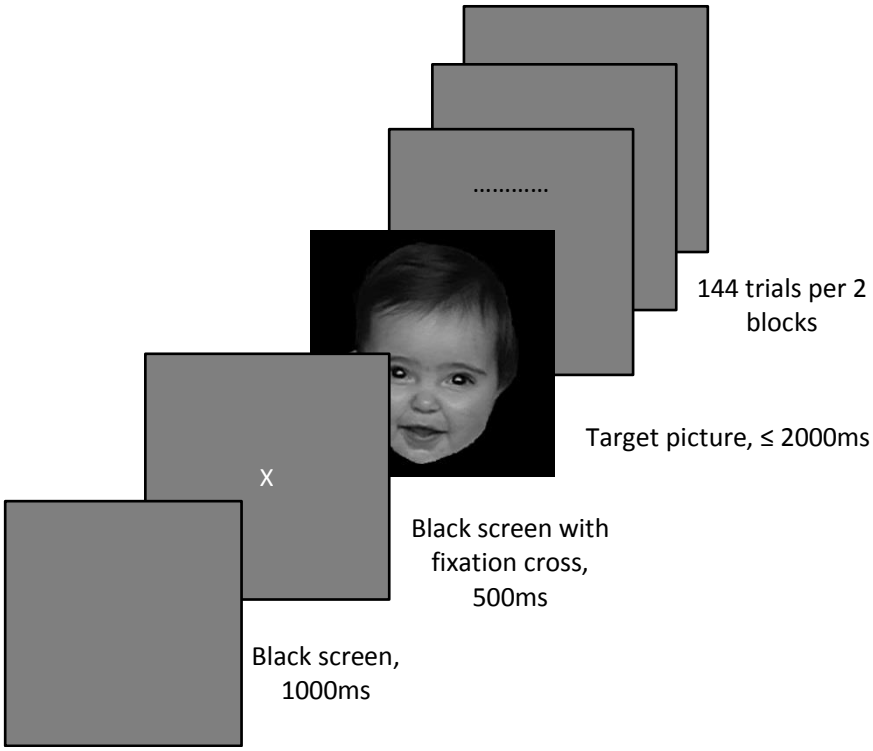
---

[5] “Shortly you will be shown photographs of baby faces. Please assess for each picture whether the baby is showing a happy facial expression. If the baby is showing a HAPPY facial expression, please press the GREEN button. If the baby does NOT show a happy facial expression, please push the RED button. Please use both index fingers”.

[6] “Shortly you will be shown photographs of baby faces. Please assess for each picture whether the baby is showing a sad facial expression. If the baby is showing a SAD facial expression, please press the GREEN button. If the baby does NOT show a happy facial expression, please push the RED button. Please use both index fingers”.

Each participant completed both a so-called *happy* and a so-called *sad block*. The blocks differed only on the instructions given. The neutral picture for each baby was presented 12 times, whereas each morphed test picture was shown a single time per block.

Figure 6. Procedure for the Visual MPS Experiments



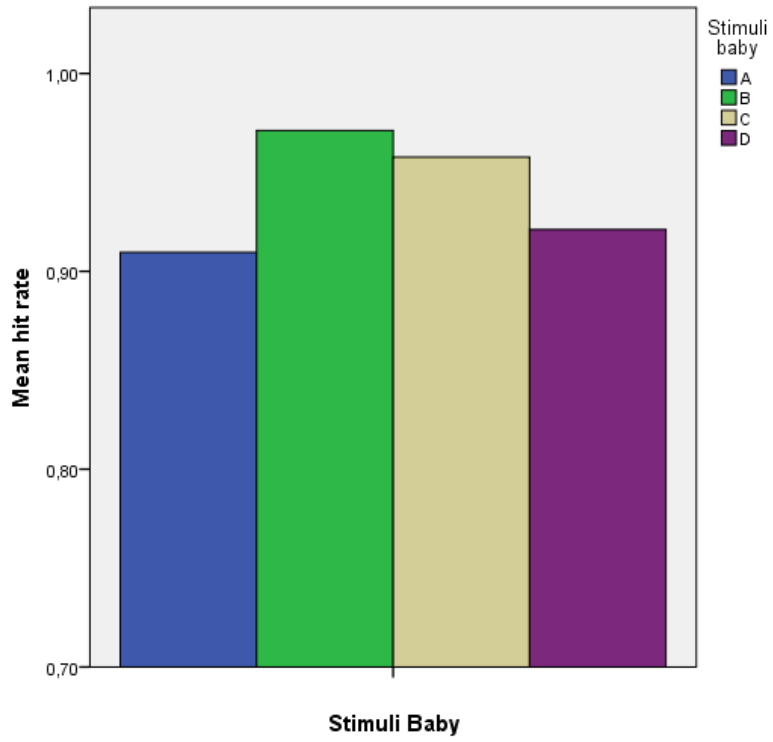
Note. The colors have been adjusted from the original trial in order to better see the figure.

Each trial had the following sequence: First a black screen was presented for 1000 ms followed by a black screen with a fixation cross for 500 ms. The target picture was then shown for a maximum of 2000 ms or until the participant responded. This can be seen in Figure 6. The complete experiment lasted approximately 17 minutes.

Data Reduction for the Sensitivity Data

Data was reduced for the visual blocks but not for the audio blocks. Graph 1 shows the relatively equal distribution of hit rates across all babies for the audio block; an indication that data reduction was not needed.

Graph 1. Mean Hit Rates per Stimuli Baby



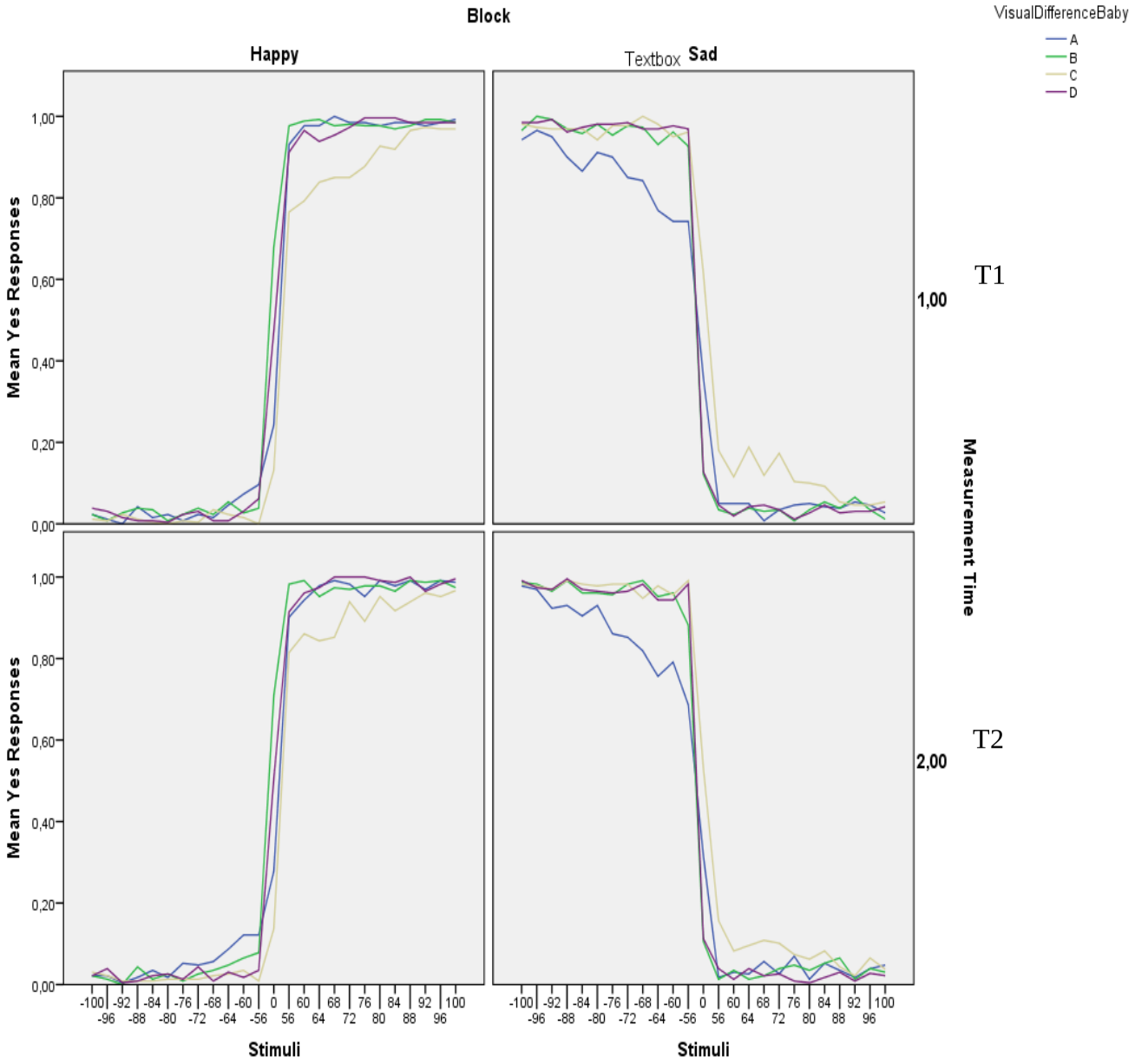
The visual data was reduced in the following manner: The original data contained morphed intensities of expressions ranging from 56 – 100% happy and 56 – 100% sad, shown in 4% increments, as well as a neutral picture. A focused group of trials was created containing only the trials with the neutral picture as the target and intensities from -60 (60% sad) to +60 (60% happy). Graphs 2-5 and Graphs 6-9 show strong improvements of performance at the 60% mark for the morphed pictures on either side of the spectrum rendering the trials with higher percentages to be less valuable for statistical purposes. This set of focused data was used in analyses to investigate hypotheses 1, 2, 3, 5, and 6 (these can be found on page 28). For calculations concerning the fourth hypotheses, the entire spectrum of intensity of expressions was included. The statistical analyses for the fourth hypothesis was in part the exploration of whether participants with higher rates of depression were more accurate at identifying lower intensity negative emotions and less accurate in identifying low intensity positive expressions. We felt it was important to look at the full scale of intensities in order to thoroughly investigate this question.

Two-tailed paired-samples t-tests were conducted to see if the overall *d'* for the complete visual data and the reduced focused visual data were significantly different. This was the case

with all differences being significant (all $p < .001$) and with large effect sizes, as calculated with Cohen's d (all $d \geq .654$). This data is presented in Table 9.

The average mean non-focused *d'* was consistently significantly higher for each block over the corresponding *d*' for the focused data. This result was expected as the focused *d*' measurements were taken from the neutral and most difficult trials, i.e. trials in which participants made more errors.

Graphs 2-5. The Mean Number of "Yes" Responses per Block Across All Stimuli Intervals



Graphs 6-9. The Mean Number of "Yes" Responses per Block Across Focused Stimuli Intervals

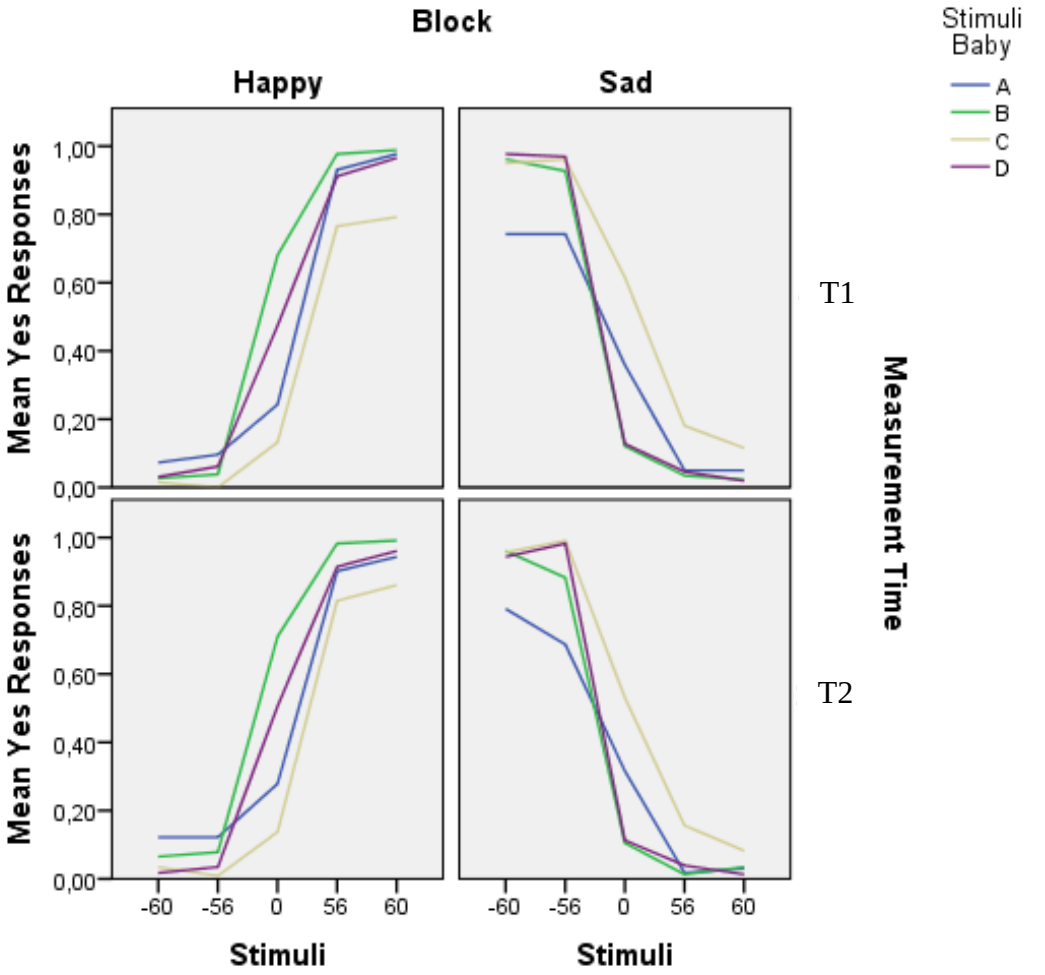


Table 9. T-tests between the non-Focused and the Focused d'

	M	SEM	*p*	*d*
T1 happy block all	2.85			
		.029	$p = <.001$	-0.796
T1 happy focused	2.21			
T1 sad all	2.83			
		.034	$p = <.001$	-0.855
T2 sad focused	2.30			
T2 happy all	2.80			
		.030	$p = <.001$	2.85
T2 happy focused	2.14			
T2 sad all	3.00			
		.046	$p = <.001$	-0.654
T2 sad focused	2.50			

Note. *M* = mean, SEM = standard error mean, *d* = Cohen's effect size.

Distribution and Description

As an initial step in the statistical analyses, normal distribution was tested for by means of Kolmogoroff-Smirnov tests and visual inspection of Q-Q plots for depression and MPS.

Depression

Distribution for the dependent variable "depression" was not normal, with strong positive skews and leptokurtic distributions. These values can be seen in Table 10. This was true for both of the symptoms scales (EPDS and IDS-C) at all three measurement times (all $D \geq .134$, all $p < .001$). Outliers were not removed from the diagnostic scores, as the scores were legitimate values and not due to data entry mistakes. The following transformations were attempted, but produced no significant changes in the distribution and were thus not applied in the final analyses: square root transformation, log transformation, reciprocal transformation, as well as reciprocal transformations to the 2nd and 3rd powers. However, as the sample size was fairly large (N=119) the lack of normal distribution is not controversial (Kaplan & Saccuzzo, 2012).

Table 10. Skewness and Kurtosis Values for the Depression Scores

	Skewness	SES	Kurtosis	SEK
EPDS T1	1.074	0.223	1.061	0.442
EPDS T2	1.774	0.222	4.245	0.440
EPDS T3	1.053	0.224	0.671	0.444
IDS-C T1	0.916	0.223	0.298	0.442
IDS-C T2	4.490	0.224	29.907	0.444
IDS-C T3	2.324	0.224	8.509	0.444

Note. Skewness and kurtosis values for the depression scores symptom scales at all three measurement times. SES = standard error of skewness. SEK = standard error of kurtosis.

MPS

Kolmogorov-Smirnov tests as well as a visual inspection of the data revealed that the distribution for the *d*' scores for the auditory block at T1, *D* (117) = 0.047, *p* = .200 and T2, *D* (113) = 0.051, *p* = .200 were normally distributed. The distribution of accuracy rates for the audio T1 data was normal, *D* (117) = 0.067, *p* = .200, but not for T2, *D* (110) = 0.093, *p* = .021, with a skewness of 0.535 (*SES* = 0.230) and a kurtosis of -0.020 (*SEK* = 0.457) showing that the mean score was larger than the median and platykurtic distribution.

For the full visual data set the distributions were as follows: The happy blocks as measured by *d*' at T1, *D* (117) = 0.073, *p* = .180 and T2, *D* (110) = 0.064, *p* = .200 did not deviate from normal. Nor did the sad block *d*' at T1, *D* (117) = 0.061, *p* = .200; but the sad block *d*' at T2 was not normally distributed, *D* (110) = 0.093, *p* = .021, with a skewness of 0.54 (*SES* = 0.230) and a kurtosis of -0.03 (*SEK* = 0.457). Attempts were not made to transform the distribution for the sad block at T2 as any applied transformations would have to be applied to all MPS blocks, which was undesirable (Field, 2013). The distribution of accuracy rates for the happy blocks at T1, *D* (117) = 0.147, *p* = .001 and T2 *D* (110) = 0.107, *p* = .004 were not normally distributed. The accuracy for the sad block at T1 was normally distributed: T1, *D* (117) = 0.073, *p* = .176, but not at T2, *D* (110) = 0.092, *p* = .023.

Table 11. Skewness and Kurtosis Values for the Accuracy Rates for the Reduced Focused MPS Visual Data

	Skewness	SES	Kurtosis	SEK
Happy Visual T1	-0.532	0.224	-0.879	0.444
Sad Visual T1	-0.552	0.224	-0.212	0.444
Happy Visual T2	-0.337	0.230	-0.987	0.457
Sad Visual T2	-0.844	0.230	0.125	0.457

Note. Skewness and kurtosis values for the MPS scores for the reduced data set as measured by accuracy at T1 and T2. SES = standard error of skewness. SEK = standard error of kurtosis.

Table 12. Skewness and Kurtosis Values for the Accuracy Rates for the Complete MPS Visual Data

	Skewness	SES	Kurtosis	SEK
Happy Visual T1	-0.525	0.225	-0.925	0.446
Sad Visual T1	-0.439	0.224	-0.540	0.444
Happy Visual T2	-0.794	0.230	1.156	0.457
Sad Visual T2	-0.694	0.230	-0.089	0.457

Note. Skewness and kurtosis values for the MPS scores for the complete data set as measured by accuracy at T1 and T2. SES = standard error of skewness. SEK = standard error of skewness.

The distribution for the reduced focused set of visual data, as described above, was as follows: The happy visual block at T1was normally distributed, D (117) = 0.049, p = .200, and at T2, D (110) = 0.071, p = .200. The sad visual block with the reduced data set was not normally distributed at T1, D (117) = 0.109, p = .002, with a skewness of 0.377 (*SES* = 0.224) and a kurtosis of -0.062 (*SEK* = 0.444). The distribution was normal for the sad block at T2, D

(110) = 0.072, p = .200. Again, attempts were not made to transform the data for the sad block at T1, as we did not wish to have to transform the other blocks.

Study Design

The study was a prospective longitudinal ex post facto design, with maternal sensory sensitivity toward infant signals as the independent variable and PPD as the dependent variable, with repeated measures. The main hypothesis was conducted via correlation calculations and regression analysis. Further hypothesis were investigated with the use of correlations, ANOVAs, ANCOVAs, and hierarchical multiple linear regression models. The audio MPS trials were a 2-alternative forced-choice (2AFC) test using Signal Detection Theory (SDT). Again using SDT, the visual tests were of a yes/no, or A Not-A design.

Procedure

Recruitment for the study took place from November 2013 to November 2015. Potential candidates were contacted by phone during or after the 26th week of gestation to make an appointment for the first session. A few preliminary questions were addressed by telephone concerning exclusion criteria (were twins expected, etc.). All participants received information about the study and signed consent forms before participation.

Table 13. Measurements Tools Employed and the Outcome of Interest by Measurement Time

Measurement Time	**Measurement Tool**	**Outcome of Interest**	**Type of Measure**
T1 ≥ 27th week of gestation	SCID I & SCID II	Depression diagnostics & Inclusion criteria	Clinician rated
	EPDS	Screening tool score	Self-report
	IDS-C	Depressive symptoms score	Clinician rated
	Sociodemographics	Identification of risk factors	Self-report
	Auditory MPS	*d'* score and accuracy	Labratory experiment
	Visual MPS	*d'* score and accuracy	Labratory experiment
T2 5-8 weeks postpartum	SCID I	Depression diagnostics	Clinician rated
	EPDS	Screening tool score	Self-report
	IDS-C	Depressive symptoms score	Clinician rated
	Sociodemographics	Identification of risk factors	Self-report
	Auditory MPS	*d'* score and accuracy	Labratory experiment
	Visual MPS	*d'* score and accuracy	Labratory experiment
T3 11-14 weeks postpartum	SCID I	Depression diagnostics	Clinician rated
	EPDS	Screening tool score	Self-report
	IDS-C	Depressive symptoms score	Clinician rated
	Sociodemographics	Identification of risk factors	Self-report

T1

T1 was conducted during or after the 26th gestational week. This timeframe was chosen so that the timing between T1 and T2 was not too great and in the hope that participants would be seen before the very last weeks of gestation when common complaints of late pregnancy might be confounded with symptoms of depression. All testing took place at the Psychology Department at the University of Tübingen in Germany. First, all sections of the SCID I and II were conducted, for both diagnostic information pertinent to the study as well as to be able to identify any potential candidates who did not qualify for the study. The presence and severity of depressive symptoms were further measured by the IDS-C and EPDS. Subsequently, participants filled out the sociodemographic questionnaire and other questionnaires needed for a parallel study conducted within the same sample group. After the completion of the interviews and questionnaires, participants completed the audio and visual sensitivity experiments on a computer located in the same room.

T2

Participants were contacted by phone two weeks after the expected due date for their babies and appointments were made for the second session (T2). T2 took place 5-8 weeks after the actual day of birth. The target T2 time of 6-weeks postpartum was chosen as prevalence rates peak for PPD peak around this time (Stowe et al., 2005). Nearly all of the same measurements were made during T2 as were during T1, see Table 13 above. The full SCID, however, was not conducted, as lifetime symptoms were no longer investigated, nor was a SCID II administered. The sociodemographic questionnaire for T2 and T3 were slightly altered from that administered during T1 to include questions relating to the birth and postpartum family constellation (see Appendix B). The audio and visual sensitivity experiments were identical to T1.

T3

Appointments for the third measurement session (T3) were made at the conclusion of T2. T3 took place 11 to 14 weeks postpartum. This timeframe was chosen as we wanted to see the participants before the 5 month mark, after which, as shown in research, PPD symptoms often dissipate (Cox, Murray, & Chapman, 1993). Again, depressive symptoms were measured and relevant sections of the SCID were conducted. The T2 and T3 sociodemographic questionnaires differ slightly in wording to account for the time frame between the two measurement times. The sensitivity experiments discussed here were not conducted at T3.

Analyses

The data in this study was analyzed using descriptive and correlational analyses, ANOVAs, and regression analyses. Pearson's correlations were conducted for items measured on an interval scale. Point-biserial correlations were reported for dichotomous variables. Pearson's r correlations and Cohen's *d* are labeled as follows: small *r* = .10, medium size *r* =. 30, and large effect size *r* = .50 or greater. Effect sizes are as follows: small effect size *d* = .20, medium effect size *d* = .50, and large effect size *d* = .80 or larger (Cohen, 1988). All correlations reported are two-tailed. Correlations were measured with a 95% confidence interval. No alpha corrections were applied throughout the entire statistical analyses, as it has been shown that such corrections increase the problem of low power and the risk of making a Type II error (Nakagawa, 2004). Effect sizes and *p* values were reported accordingly for each hypotheses providing complete transparency for the reader. Greenhouse-Geisser corrections were used in all ANCOVAs. The *F* values given are with this correction and are rounded up.

4 Results

H1: Does MPS Predict Depression?

According to our model, we expect MPS to be negatively correlated with depression and that sensitivity will predict depression symptoms in a linear fashion. Two-tailed Pearson's correlation coefficients were calculated a) between depression scores and MPS values, as measured by *d*' and accuracy rates across and b) within measurement times. c) Additionally, we investigated if depression scores and sensitivity at T1 predicted the change in depression scores from T1 to T2 and from T1 to T3 by calculating a hierarchal linear regression.

a Correlations across Measurement Times

Depression at T2 MPS at T1Correlations

Depression at T2 and MPS d' at T1

No significant correlations were present between the two depression scales as measured at T2 (EPDS and IDS-C) and sensitivity as measured with *d*' (audio, happy visual, sad visual) as measured at T1 (all $p \geq .250$, all absolute correlation values lower than .109). Table 14 shows the complete data.

Table 14. Correlations between Sensitivity d' at T1 and Depression at T2

		EPDS	IDS-C	Audio	Visual Happy	Visual Sad
EPDS	*r*					
	p					
	N					
IDS-C	*r*	.713**				
	p	.000				
	N	117				
Audio	*r*	-.001	-.005			
	p	.994	.961			
	N	117	115			
Visual Happy	*r*	-.059	.002	.058		
	p	.528	.983	.540		
	N	117	115	115		
Visual Sad	*r*	-.049	-.108	.088	.093	
	p	.601	.250	.348	.316	
	N	117	115	115	117	

Note. ** Correlation is significant at the 0.01 level (2-tailed).

Depression at T2 and MPS accuracy at T1

We investigated the relationship between accuracy rates that is the rate of correct over incorrect responses per block, for the sensitivity blocks at T1 and depression scores at T2 and T3, respectively. No significant correlations were revealed (all $p \geq 0.365$, all absolute correlation values lower than 0.085), as seen in Table 15.

Table 15. Correlations between Sensitivity Accuracy at T1 and Depression at T2

		EPDS	IDS-C	Audio	Visual Happy	Visual Sad
EPDS	*r*					
	p					
	N					
IDS-C	*r*	.713**				
	p	.000				
	N	117				
Audio	*R*	-.010	.020			
	p	.913	.834			
	N	117	115			
Visual Happy	*r*	-.073	.024	.082		
	p	.432	.800	.384		
	N	117	115	115		
Visual Sad	*r*	-.071	-.085	.036	-.039	
	p	.450	.365	.702	.677	
	N	117	115	115	117	

Note. ** Correlation is significant at the 0.01 level (2-tailed).

Depression at T3 MPS at T2

Depression at T3 and MPS d' at T2

A significant correlation was seen in the correlations between IDS-C scores and the *d'* score for the sad visual block (r = .233, p = .015). A bootstrapping performance shows that the likelihood of this correlation is in fact a Type I error is low, r = .232, 95% BCa CI [.004 - .442], p = .016. All values can be seen in Table 16.

Table 16 . Correlations between Sensitivity d' at T2 and Depression at T3

		EPDS	IDS-C	Audio	Visual Happy	Visual Sad
EPDS	*r*					
	p					
	N					
IDS-C	*r*	.618**				
	p	.000				
	N	116				
Audio	*r*	.148	-.032			
	p	.120	.738			
	N	112	112			
Visual Happy	*r*	.050	.134	.144		
	p	.607	.165	.132		
	N	109	109	110		
Visual Sad	*r*	.106	.233*	.180	.144	
	p	.272	.015	.060	.134	
	N	109	109	110	110	

*Note.***Correlation is significant at the 0.01 level (2-tailed), * correlation is significant at the 0.05 level (2-tailed).

Depression at T3 and MPS accuracy at T2

No significant correlations were present between the two depression scales as measured at T3 (EPDS and IDS-C) and MPS accuracy at T2 (all $p \geq .080$, all absolute correlation values lower than .166, as seen in Table 17.

Table 17. Correlations between Sensitivity Accuracy at T2 and Depression at T3

		EPDS	IDS-C	Audio	Visual Happy	Visual Sad
EPDS	*r*					
	p					
	N					
IDS-C	*r*	.618**				
	p	.000				
	N	116				
Audio	*r*	.166	.020			
	p	.080	.836			
	N	112	112			
Visual Happy	*r*	.094	.159	.139		
	p	.329	.098	.149		
	N	109	109	110		
Visual Sad	*r*	-.006	.119	.106	-.095	
	p	.951	.217	.271	.322	
	N	109	109	110	110	

*Note.***Correlation is significant at the 0.01 level (2-tailed).

Depression at T3 and MPS d' at T1

As can be seen in Table 18, no significant correlations were present between the two depression scales as measured at T3 (EPDS and IDS-C) and sensitivity as measured with *d*' (audio, happy visual, sad visual) at T1 (all $p \geq .240$, all absolute correlation values lower than .110).

Table 18. Correlations between Sensitivity d' at T1 and Depression at T3

		EPDS	IDS-C	Audio	Visual Happy	Visual Sad
EPDS	*r*					
	p					
	N					
IDS-C	*r*	.618**				
	p	.000				
	N	116				
Audio	*r*	.026	-.048			
	p	.780	.609			
	N	115	115			
Visual Happy	*r*	.002	.026	.058		
	p	.985	.783	.540		
	N	115	115	115		
Visual Sad	*r*	.006	.110	.088	.093	
	p	.484	.240	.348	.316	
	N	115	115	115	117	

Note. ** Correlation is significant at the 0.01 level (2-tailed),

Depression at T3 and MPS accuracy at T1

No significant correlations were present between the two depression scales as measured at T3 (EPDS and IDS-C) and MPS accuracy rates at T1 (all $p \geq .384$, all absolute correlation values lower than .082). This is shown in Table 19.

Table 19. Correlations between Sensitivity Accuracy at T1 and Depression at T3

		EPDS	IDS-C	Audio	Visual Happy	Visual Sad
EPDS	*r*					
	p					
	N					
IDS-C	*r*	.618**				
	p	.000				
	N	116				
Audio	*r*	.064	.025			
	p	.499	.787			
	N	115	115			
Visual Happy	*r*	.010	.053	.082		
	p	.916	.571	.384		
	N	115	115	115		
Visual Sad	*r*	.035	.082	.036	-.039	
	p	.714	.386	.702	.677	
	N	115	115	115	117	

Note. ** Correlation is significant at the 0.01 level (2-tailed).

b Correlations within T2

Note, within measurement time correlations were only conducted for T2 as current depression was an exclusionary criterion, thus the EPDS and IDS-C scores were necessarily low at T1 and MPS was not measured at T3.

Depression and MPS d' at T2

No significant correlations between the depression scales and the sensitivity data, both as measured at T2, were seen, with the highest *p* value reaching, $p = .079$ ($r = .170$), for the IDS-C scores and the d' scores for the visual sad blocks, as shown in Table 20.

Table 20. Correlations between Depression and Sensitivity d' at T2

		EPDS	IDS-C	Audio	Visual Happy	Visual Sad
EPDS	*r*					
	p					
	N					
IDS-C	*r*	.713**				
	p	.000				
	N	117				
Audio	*r*	.118	.139			
	p	.215	.147			
	N	113	111			
Visual Happy	*r*	.033	.078	.144		
	p	.730	.423	.132		
	N	110	108	110		
Visual Sad	*r*	.000	.170	.180	.144	
	p	.996	.079	.060	.134	
	N	110	108	110	110	

Note. ** Correlation is significant at the 0.01 level (2-tailed).

Depression and sensitivity accuracy at T2

Again, as can be seen in Table 21, no significant relationships were revealed between the depression scores and accuracy rates for the three sensitivity blocks at T2 (all $p \geq .207$, all absolute correlation values lower than .122).

Table 21. Correlations between Depression Scores and Sensitivity Accuracy at T2

		EPDS	IDS-C	Audio	Visual Happy	Visual Sad
EPDS	*r*					
	p					
	N					
IDS-C	*r*	.713**				
	p	.000				
	N	117				
Audio	*r*	.047	.101			
	p	.618	.294			
	N	113	111			
Visual Happy	*r*	.044	.122	.139		
	p	.650	.207	.149		
	N	110	108	110		
Visual Sad	*r*	-.109	.073	.106	-.095	
	p	.258	.450	.271	.322	
	N	110	108	110	110	

Note. ** Correlation is significant at the 0.01 level (2-tailed).

c Linear regression to predict changes in depression

Hierarchal linear regressions were calculated with the change in depression scores as measured by the EPDS from T1 to T2 and from T1 to T3, respectively, as the dependent variables. The independent variables were, depression at T1, entered in the first block and the MPS *d*' scores (audio, visual happy, and visual sad) at T1 – entered using the enter method – in the second block of the regression model.

An independence of residuals was proven as assessed by a Durbin-Watson tests, 2.321 and 2.116. The assumption of linearity was confirmed. All correlations were well below the 0.7 mark. All tolerance levels were well above the suggested 0.1 mark, the lowest having a level of 0.932 (Field, 2013), confirming that collinearity is not a problem with this dataset. Three outliers with standardized residuals greater than ± 3 standard deviations were present in the

first model, two in the second. These cases were not removed as their deviations are due to high scores on the depression scores which were valid values.

No cases with undesirable leverage were present, all were below 0.2. The Cook's Distance values showed no highly influential cases – none were above 1.0 (Cook & Weisberg, 1982). By investigating both a histogram and a P-P plot, it was determined that the assumption of normal distribution could be accepted.

The full model for predicting changes in depression scores from T1 to T2 was statistically significant $R^2 = .251$, $F(4, 109) = 9.136$, $p < .001$, adjusted $R^2 = .224$. It can be seen in Table 22. However, the addition of the MPS *d*' scores did not produce a significant change, $R^2 = .0251$, $F(3, 109) = 0.532$, $p = .661$.

Table 22. Hierarchical Multiple Regression Predicting Depression Changes from T1 toT2 from Depression and MPS d' at T1

	Changes in Depression from T1 – T2			
	Model 1		Model 2	
Variable	B	β	B	β
Constant	2.17**		4.08*	
Depression at T1	-0.51**	-0.49**	-0.52	-0.50**
Audio MPS			0.16	0.28
Happy Blocks Visual MPS			-0.35	-0.71
Sad Blocks Visual MPS			-0.41	-0.70

Note. $N = 114$. ** Significance is at the 0.01 level (2-tailed), * significance is at the 0.05 level (2-tailed).

Table 22 (continued). Hierarchical Multiple Regression Predicting Changes in Depression from T1 to T2: Changes in Models

	Model 1	Model 2
R^2	0.240	0.251
F	35.39*	9.14
ΔR^2	0.240	0.011
ΔF	35.39*	0.53

Note. * Significance is at the ≤ 0.01 level (2-tailed).

The full model for predicting changes in depression scores from T1 to T3 was also statistically significant R^2 = .420, F(3, 107) = 19.377, p < .001, adjusted R^2 = .398. And once again, the addition of the MPS *d*' scores did not produce a significant change, R^2 = .420, F(3, 107) = 0.482, p = .695.

Table 23. Hierarchical Multiple Regression Predicting Depression Changes from T1 toT3 from Depression and MPS at T1

	Changes in Depression from T1 – T3			
	Model 1		Model 2	
Variable	B	β	B	β
Constant	2.36**		0.70	
Depression at T1	-0.74**	-0.64**	-0.74	-0.64**
Audio MPS			0.47	0.01
Happy Blocks Visual MPS			-0.43	-0.01
Sad Blocks Visual MPS			0.60	0.10

Note. N = 112. ** Significance is at the 0.01 level (2-tailed).

Table 23 (continued). Hierarchical Multiple Regression Predicting Changes in Depression from T1 to T3: Changes in Models

	Model 1	Model 2
R^2	0.412	0.420
F	77.150*	19.377
ΔR^2	0.412	0.008
ΔF	77.150*	0.482

Note. * Significance is at the ≤ 0.01 level (2-tailed).

H1-Summary

A positive correlation was found between depression rates at T3 and d' scores in the sad block at T2. No other correlations were found between depression scores and MPS scores across measurement times, within measurement times, or between MPS and changes in depression scores. The increase in depression score from T1 to T2 as well as the increase from T1 to T3 were predicted by the T1 depression scores. That is, higher depression rates at T1 predicted a stronger increase at T2 and T3, respectively.

H2: Exploring the Relationship between Audio and Visual MPS

For H2 we explored the relationship between auditory and visual MPS toward both positive and negative expressions of emotions by means of Pearson's correlations. We wanted to know in particular if negative audio and negative visual signals of emotion correlated. If this were the case, it would indicate that similar strategies or pathways are employed across the senses to perceive the signals. Bootstrapping was performed because of the repeated measure design and in order to minimize Type I errors.

Tables A2 through A5, found in Appendix A, show the means and standard deviations for the *d*' scores and accuracy for all sensitivity blocks within this study. Descriptive statistics are provided for both the full data set and the reduced focus data set. The sample sizes vary slightly due to technical difficulties and dropouts at T2.

Tables 24 and 25 show Pearson's correlations for *d*' and for accuracy, respectively, between the sensitivity blocks. A significant correlation was found between audio and the sad visual block as measured with *d*' at T2, however bootstrapping shows that the significance may not reflect a true positive relationship, r (106)= .194, 95% BCa CI [-.011 - .379], p = .046. There were no other significant correlations between audio, happy, and sad visual MPS, respectively, within measurement times when measured with *d*'. This was also the case when MPS was measured by accuracy. A positive correlation between audio at T1 and the sad visual block at T2 as measured with *d*' and accuracy was present. Bootstrapping performance for *d*', r = .230, 95% BCa CI [.031 - .418], p = .018 and accuracy, r = .220, 95% BCa CI [.017 - .401], p = .023, show that the likelihood of this correlation being present due to a Type I error is low.

Table 24. Pearson's Correlations between Sensitivity Blocks for d'

			Audio T1	Happy Visual T1	Sad Visual T1	Audio T2	Happy Visual T2	Sad Visual T2
Audio T1								
Happy Visual T1		*r*	.038					
		p	.698					
	Bootstrap	Bias[a]	-.001					
		Std. Error	.108					
		Lower[b]	-.169					
		Upper	.244					
Sad Visual T1		*r*	.077	.046				
		p	.431	.642				
	Bootstrap	Bias	.005	-.003				
		Std. Error	.107	.090				
		Lower	-.139	-.147				
		Upper	.291	.210				
Audio T2		*r*	.560**	-.003	.045			
		p	.000	.978	.647			
	Bootstrap	Bias	- .001	.001	.003			
		Std. Error	.071	.104	.109			
		Lower	.412	-.206	-.177			
		Upper	.688	.215	.259			
Happy Visual T2		*r*	.055	.520**	.113	.152		
		p	.574	.000	.249	.120		
	Bootstrap	Bias	.000	.002	-.007	-.003		
		Std. Error	.098	.067	.096	.105		
		Lower	-.138	.389	-.093	-.058		
		Upper	.252	.642	.290	.355		
Sad Visual T2		*r*	.230*	.183	.540**	.194*	.142	
		p	.018	.061	.000	.046	.147	
	Bootstrap	Bias	.001	-.005	.003	.001	-.006	
		Std. Error	.099	.103	.067	.096	.104	
		Lower	.031	-.030	.402	-.011	-.065	
		Upper	.418	.372	.673	.379	.337	

Note. ** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed). a. Bootstrap results are based on 1,000 bootstrap samples. b. Lower and upper confidence levels for a 95% interval.

Table 25. Pearson's Correlations between Sensitivity Blocks for Accuracy

			Audio T1	Visual Happy T1	Visual Sad T1	Audio T2	Visual Happy T2	Visual Sad T2
Audio T1								
Visual Happy T1		*r*	.079					
		p	.420					
	Bootstrap[a]	Bias	-.001					
		Std. Error	.102					
		Lower[b]	-.123					
		Upper	.276					
Visual Sad T1		*r*	.062	-.072				
		p	.525	.465				
	Bootstrap	Bias	.004	.003				
		Std. Error	.101	.091				
		Lower	-.132	-.246				
		Upper	.266	.118				
Audio T2		*r*	.523**	.026	.016			
		p	.000	.791	.871			
	Bootstrap	Bias	-.002	.004	.003			
		Std. Error	.083	.100	.096			
		Lower	.347	-.166	-.164			
		Upper	.680	.218	.206			
Visual Happy T2		*r*	.069	.578**	.071	.148		
		p	.485	.000	.472	.130		
	Bootstrap	Bias	-.001	-.003	-.001	.004		
		Std. Error	.093	.074	.096	.089		
		Lower	-.113	.420	-.114	-.027		
		Upper	.256	.704	.252	.321		
Visual Sad T2		*r*	.220*	.038	.533**	.128	-.103	
		p	.023	.701	.000	.191	.296	
	Bootstrap	Bias	-.002	.001	.001	.003	.003	
		Std. Error	.098	.098	.087	.091	.093	
		Lower	.017	-.146	.356	-.042	-.280	
		Upper	.401	.229	.687	.307	.095	

Note. ** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed). a. Bootstrap results are based on 1000 bootstrap samples. b. Lower and upper confidence levels for a 95% interval.

T2 Summary

For T2 we investigated whether there were correlations across the senses for perceptual sensitivity, in order to better understand whether in part similar pathways are used to perceive signals of emotion with the same valence. A positive correlation was found between audio T1 and sad block T2 for *d'*, $r = .230$, 95% BCa CI [.031 - .418], $p = .018$ and accuracy, $r = .220$, 95% BCa CI [.017 - .401], $p = .023$ No other significant correlations were found between the *d'* or accuracy blocks (audio, happy visual, sad visual) either within or across measurement times.

H3: Is Sensitivity a Stable Trait?

a) We explore here the question if sensitivity is a plastic or static trait by looking at correlations across measurement times. b) Along these lines, we also wanted to know if women who birthed their first child improved in sensitivity significantly at T2 as compared to women who already had children. For this a mixed two-way ANOVA was conducted. Whether or not MPS is stable will help us better understand the nature of MPS as a whole and if it can be improved upon with intervention programs or treatment (or whether, for example, professionals should rather focus on maternal behavior).

a Correlations across time

Tables 24 and 25, shown above, display the Pearson's correlations for each of the sensitivity blocks across measurement times as measured by *d'* and accuracy. The T1 scores for each of the blocks are correlated at the 0.01 level with the T2 scores, respectively, for both the d' and accuracy scores. This shows a strong stability over time.

b Comparing means across group and measurement time

Additionally, we compared MPS scores of women who were expecting their first child and those who were expecting additional children using two-way mixed ANOVAS, with parity as the between-subject factor and measurement time as the within-subject factor. The audio, visual happy, and visual sad MPS were investigated separately. Mauchly's tests of sphericity showed a violation of the assumption for sphericity for both the audio and visual data. Thus, Greenhouse-Geisser corrections were employed for all three tests, as recommended in Maxwell and Delaney (2004) and the F values given are those with the correction in place and rounded up. The data for all three tests were normally distributed, as analyzed with Q-Q plots and there were no outliers (± 3). Homogeneity of variance ($p < .05$) and covariance were confirmed, ($p = .730$ for the audio and happy visual, $p = .869$ for the sad visual).

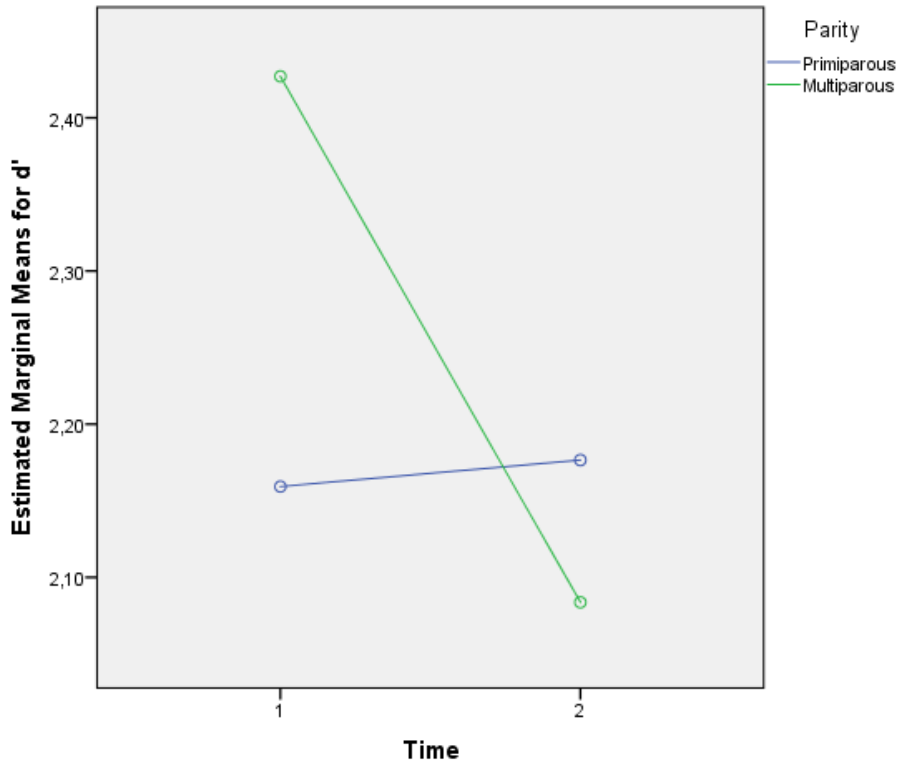
Audio

There was no significant interaction between parity and time on MPS audio *d*' scores $F(1, 109) = 0.449$, $p = .504$, partial $\eta^2 = .004$. There was also no significant time effect $F(1, 109) = 2.983$, $p = .087$, partial $\eta^2 = .027$. Finally, there was also no group effect $F(1, 109) = 0.158$, $p = .692$, partial $\eta^2 = .001$.

Visual Happy

There was not a main group effect $F(1, 106) = 0.320$, $p = .573$, partial $\eta^2 = .003$, nor for time $F(1, 106) = 3.507$, $p = .064$, partial $\eta^2 = .032$. A significant interaction was revealed between parity and time for MPS in the happy visual blocks $F(1, 106) = 4.291$, $p = .041$, partial $\eta^2 = .039$. For the group expecting their first child, there was no significant difference between T1 ($M = 2.43$, $SE = 0.93$) and T2 happy visual MPS *d*' scores ($M = 2.08$, $SE = 0.71$), but women who were expecting a child that was not their first had significantly lower *d*' scores in the happy block at T2 ($M = 2.08$, $SE = 0.13$) as compared to T1 ($M = 2.43$, $SE = 0.17$). This relationship can be seen in Graph 10. In order to understand this data, one is reminded that within the happy block, participants were to identify *only* positive expressions as "happy". The correct response to the negative as well as the neutral expressions was a rejection. The lower mean *d*' for the T2 reflects the tendency for participants to identify neutral and negative emotions as being positive (false alarms), reflecting a positivity bias.

Graph 10. Estimated Marginal Means of Happy Visual MPS



Note. Comparisons of mean *d*' scores for the happy block for participants expecting their first child and participants expecting an additional child during the third trimester and at 6-weeks postpartum.

An independent samples t-test was furthermore conducted to better understand possible causes for this result, specifically to understand if primiparous women differed significantly from multiparous women in the happy block at T1. The difference, -0.19, BCa 95% CI [-0.536 – 0.167], was not significant $t(115) = -1.09$, $p = .279$.

Visual Sad

There was not a significant interaction between parity and time for MPS in the sad visual blocks $F(1, 106) = 0.014$, $p = .908$, partial $\eta^2 = .000$. There was a significant time effect $F(1, 106) = 6.984$, $p = .009$, partial $\eta^2 = .062$ (which was discussed above), i.e. scores did change significantly across measurement times. This can be seen in Graph 10. There was not a significant group effect $F(1, 106) = 0.375$, $p = .542$, partial $\eta^2 = .004$.

H3 Summary

The MPS blocks as measured by both *d*' and accuracy were strongly correlated across measurement times, respectively, indicating stability of MPS over time. Primiparous participants did not show significant changes across measurement times in the happy visual blocks. On the other hand, multiparous women had significantly lower mean scores in the happy visual blocks at T2 as compared to T1 and to primiparous women.

H4: Exploring for the presence of biases across groups

In further explorative investigations we tested for the presence of biases in response to positive or negative stimuli across groups. We explored, a) if all participants were more accurate in response to positive visual emotional stimuli than negative visual emotional stimuli, b) whether or not participants with more depressive symptoms had higher accuracy rates in the negative block than participants with fewer symptoms c) and if so, whether this was due to higher accuracy in the lower intensity sad faces compared to healthy participants. d) Finally, we investigated if participants with higher levels of depression symptoms differed significantly from those with lower levels of symptoms at T2 in their ability to differentiate the manipulated variation cries with fewer semitone differences (the equivalent to low intensity differences in the visual blocks) from the standard cry as compared to the cries with larger differences from the standard cry. An ANOVA and several ANCOVAs were run for the visual data. Correlations were investigated for the audio data.

For questions a, we ran an ANOVA with accuracy as the dependent factor, intensity and valence as the independent factors. For questions b and c, an ANCOVA was run with accuracy as the dependent factor, intensity and valence as the independent factor, and depression as the covariate. Moreover, two more ANCOVAs were run – for the data of the happy block and the sad block separately – with accuracy as the dependent factor and intensity as the independent factor, seeing that the ANOVA and the subsequent t-tests showed, as expected, that the factor valence yields an interaction with intensity. As assessed by Shapiro-Wilks tests, accuracy was not normally distributed for all levels of emotional intensity ($p > .05$). Two of the levels deviated from normal distribution: 56% positive ($p = 0.01$ for the happy block and $p = 0.02$ for the sad block) and 92% happy ($p = 0.27$ for the happy block and $p = 0.17$ for the sad block). Accuracy was normally distributed for the sad block as a whole ($p = .631$), but not for the happy block ($p = .002$). As ANOVAs and ANCOVAs are robust to violations of normality (Field, 2013), we proceeded despite the non-normal distributions. One outlier was found within the factor valence upon inspection of the boxplots and was removed from the analyses. Several outliers were present in various levels

of intensity, but were not removed from the data as they were not outliers uniformly across all or even most levels of intensity. The assumption of linearity between the covariate and the dependent variable, as assessed with the inspection of scatter plots, was violated. A linear relationship was present at some, but not all levels of intensity. The assumption of homogeneity of regression slopes was met, $F(20, 63) = 1.38$, $p = .304$. The homogeneity of variance assumption was tested with a Levene's Test of Equality of Error Variances test and was upheld for both of the factors intensity and valence, (all $p > .146$). Mauchly's tests of sphericity showed a violation of the assumption for sphericity. Thus, Greenhouse-Geisser corrections were employed, as recommended in Maxwell and Delaney (2004). The Greenhouse-Geisser corrected *F* values have been rounded up to the nearest whole number.

a Comparing accuracy across valence

The main effect valence was not significant, $F(1, 108) = 1.232$, $p = .270$ $\eta^2 < .001$. That is, participants did not give more accurate answers in either the happy or sad block.

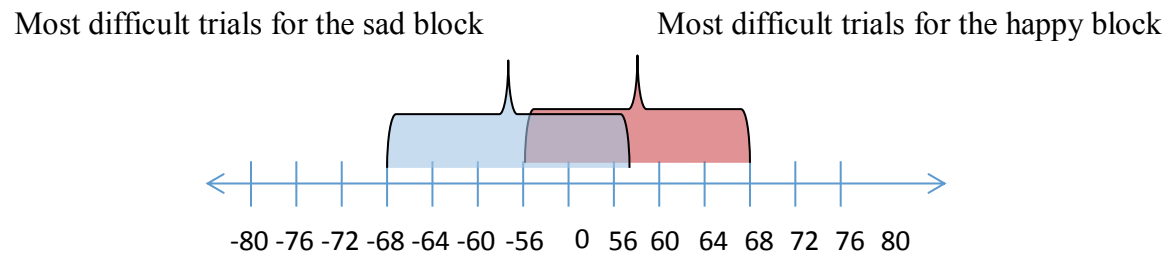
However, there was an interaction between valence and intensity, $F(9, 991) = 8.302$, $p < .001$. To further analyze this interaction, post hoc t-tests for each intensity level were run comparing accuracy between the happy and sad block, i.e. with respect to valence. Table 26 shows these t-test results, as well as the differences in means. Though not perfectly linear, the pattern that emerged is roughly as expected: The mean accuracy values for the sad block were higher in the low intensity happy faces (i.e., + 56, + 60). Vice versa, for the happy block the accuracy was higher in the low intensity sad faces (i.e., - 56, - 60). Figure 7 shows an exaggerated pattern of how the expected data distribution should look, which helps to explain the expected effects, whereby the lower intensity expressions that oppose the valence for that block are easier for the participants and the lower intensity expressions corresponding with the valence of the block are the hardest.

Table 26. Paired-samples t-tests for Each Intensity Level Comparing Blocks

Intensity	Difference in Means	SD	SEM	95% Confidence Interval of the Difference		*t*	*p*
				Lower	Upper		
-100	-0.011	0.124	0.012	-0.035	0.012	-0.962	.338
-96	-0.005	0.122	0.012	-0.028	0.019	-0.391	.697
-92	0.046	0.128	0.012	0.022	0.070	3.801	.000
-88	0.002	0.110	0.010	-0.018	0.023	0.217	.828
-84	0.027	0.128	0.012	0.003	0.052	2.230	.028*
-80	0.025	0.122	0.012	0.002	0.048	2.152	.034*
-76	0.036	0.151	0.014	0.008	0.065	2.529	.013*
-72	0.023	0.150	0.014	-0.006	0.051	1.592	.114
-68	0.031	0.158	0.015	0.001	0.061	2.057	.042*
-64	0.050	0.162	0.015	0.019	0.081	3.243	.002**
-60	0.027	0.196	0.019	-0.010	0.064	1.463	.146
-56	0.048	0.207	0.020	0.009	0.087	2.414	.017*
0	-0.160	0.410	0.039	-0.237	-0.082	-4.082	.000**
56	-0.041	0.196	0.019	-0.078	-0.004	-2.188	.031*
60	-0.018	0.161	0.015	-0.049	0.012	-1.182	.240
64	-0.025	0.173	0.016	-0.058	0.008	-1.520	.131
68	0.009	0.147	0.014	-0.019	0.037	0.647	.519
72	0.017	0.149	0.014	-0.011	0.046	1.223	.224
76	0.007	0.160	0.015	-0.024	0.037	0.446	.657
80	0.011	0.118	0.011	-0.012	0.033	0.943	.348
84	0.014	0.143	0.014	-0.013	0.041	1.000	.320
88	0.032	0.123	0.012	0.009	0.055	2.722	.008**
92	-0.016	0.123	0.012	-0.039	0.007	-1.352	.179
96	0.019	0.111	0.011	-0.002	0.040	1.790	.076
100	0.014	0.139	0.013	-0.013	0.040	1.029	.306

Note. N = 108. SE = standard deviation. SEM = standard error mean. ***p*-value is significant at the 0.01 level (2-tailed). * *p*-value is significant at the 0.05 level (2-tailed). A positive difference in means indicates that the respective trials in the sad block was more difficult.

Figure 7. A Representation of the Expected Data



b Comparing accuracy across depression levels and valence

There was no significant relationship between valence and depression, $F(1, 107) = 0.411$, $p = .523$, partial $\eta^2 = .004$, showing that participants with higher levels of symptoms did not differ significantly in accuracy in either the sad or happy block compared to women with fewer symptoms.

c Comparing accuracy rates across intensity and depression levels

The main effect intensity was significant, $F(10, 1080) = 26.477$, $p < .001$, partial $\eta^2 = .198$. The sample group was more accurate in correctly identifying emotions with larger intensities over lesser intensities. Moreover, there was a significant interaction between intensity and depression, $F(10, 1080) = 1.949$, $p = .035$, partial $\eta^2 = .018$. The three way interaction between intensity, valence and depression, however, was not present, $F(9, 980) = 1.217$, $p = .280$, partial $\eta^2 = .011$. Nonetheless, seeing that the ANOVA in Section *a* above yielded the expected significant interaction between valence and intensity due to the different distribution in difficulty in respect to the task for each block, we decided to additionally run separate ANCOVAs for each block. Essentially, the tasks for the happy and sad blocks are inherently different. In a sense, when comparing intensity-specific accuracies across blocks, one is comparing apples with oranges. As stated above, within the sad block, as can be seen in Figure 7, the decision boundary from answering correctly "yes" of correctly "no" is not identical to the decision boundary for the happy block. Thus, one can argue that the tasks are inherently different and by nature unbalanced when one is taking the intensity as a factor into the calculation (as a reminder, the *d*' calculations further above did not have intensity as a factor).

The separate ANCOVAs for the happy and sad blocks revealed no significant interaction between depression and intensity for the happy block $F(6, 667) = 1.007$, $p = .421$, partial $\eta^2 = .009$, but they did indeed reveal a significant interaction for the sad block $F(10, 1072) = 2.073$, $p = .024$, partial $\eta^2 = .019$. For completeness reasons, we ran further detailed

correlation analyses for all intensity levels with respect to both blocks (see Table 27). The differences in the correlations in the happy block are shown for explorative reasons. On the other hand, the differences in the correlations in the sad block reveal positive correlations for the critical intensity levels of -56 and -60, essentially implying that mothers with a tendency towards depression are somewhat better in identifying subtle signals of negative emotions than mothers with less symptoms of depression (as measure by EPDS).

Table 27. Depression and Accuracy across Intensity for the Happy and Sad Visual Blocks

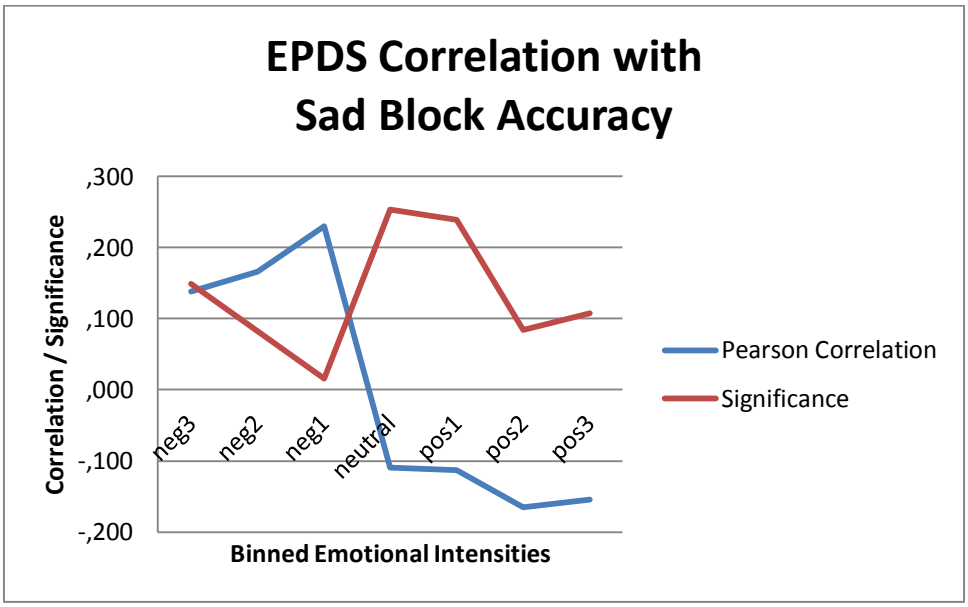
	Happy Visual Block		**Sad Visual Blocks**	
Intensity	Pearson Correlation	Sig. (2-tailed)	Pearson Correlation	Sig. (2-tailed)
-100	.108	.263	.034	.724
-96	-.116	.231	.092	.344
-92	.088	.361	.134	.165
-88	.072	.457	-.025	.793
-84	.087	.366	.102	.293
-80	.144	.134	.180	.061
-76	.129	.128	-.047	.625
-72	-.001	.990	.068	.480
-68	.024	.804	.136	.157
-64	.201*	.036	.152	.114
-60	.047	.624	.194*	.043
-56	.172	.074	.189*	.050
0	.037	.705	-.123	.202
56	.111	.251	-.099	.308
60	.071	.465	-.087	.370
64	-.106	.272	-.070	.471
68	.015	.878	.136	.158
72	-.057	.556	-.171	.076
76	-.095	.323	.091	.347
80	-.091	.348	-.161	.095
84	-.024	.807	-.132	-.170
88	.020	.836	-.076	.429
92	.110	.255	-.234*	.014
96	.046	.632	-.073	.450
100	-.080	.408	-.053	.581

Note. N = 109. * Correlation is significant at the 0.05 level (2-tailed). Depression scores as measured with the EPDS correlations with MPS accuracy at each level of intensity for the happy and sad blocks. Both measurements are from T2.

In order to best visually display this effect, we binned the visual data into groups of stimuli intensity: neutral emotions = L0; low intensity (56 - -62%) negative valence pictures = neg1; medium intensity (-63 - -74%) negative valence pictures = neg2; high intensity (-75 – 96%) negative valence pictures = neg3; low intensity (56 - 62%) positive valence pictures = pos1;

medium intensity (63 - 74%) positive valence pictures = pos2; high intensity (-75 – 96%) positive valence pictures = pos3. Accuracy proportions were used because of the unequal number of trials in each emotion intensity group. Graph 11 shows this observation: the correlation reaches its highest value and the significance its lowest value at the point of low intensity negative stimuli (neg 1).

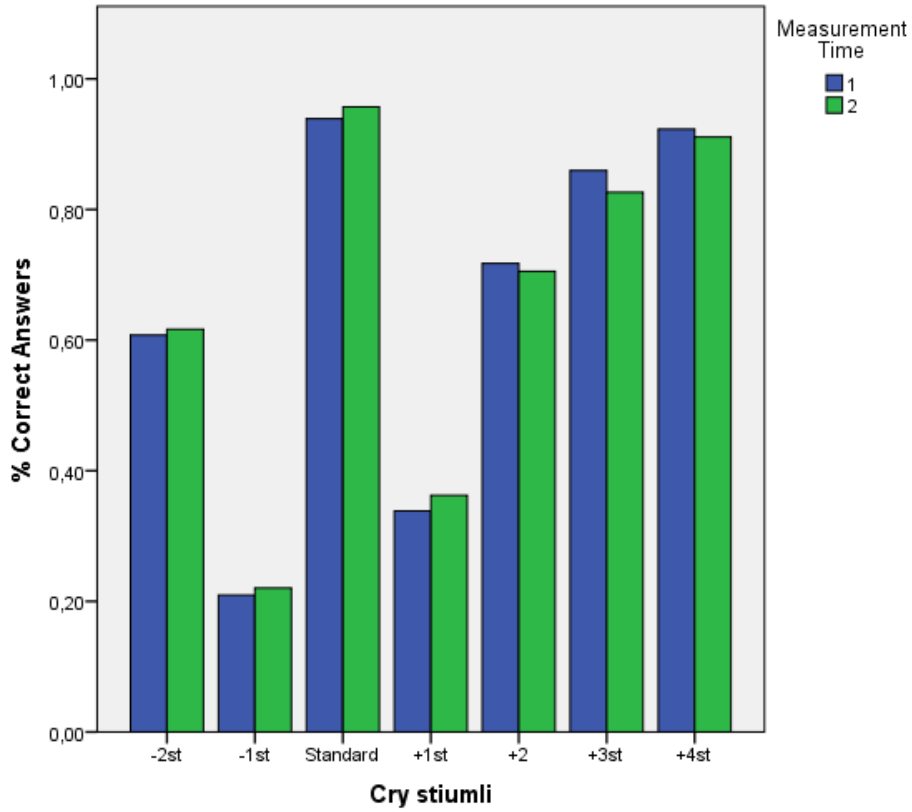
Graph 11. Correlations between EPDS depression scores and binned low intensity stimuli



d Comparing audio accuracy rates by intensity across groups

As with the visual blocks, we wanted to know if depression level was associated with accuracy in the lower "intensity" audio trials. Whereas in the visual blocks the intensity was in terms of expression of emotion, in the audio blocks we looked at the various deviations in semitones from the standard cry. Graph 12 shows the levels of accuracy per cry variation for the entire sample. Accuracy is lowest for the two variation cries that were not identical to the standard cry, but were closest in H_0 levels.

Graph 12. Mean Accuracy Rates by Deviation in Semitones



Note. st = semitone. Mean accuracy rates for each of the 7 variations of the cry stimuli for T1 and T2.

A repeated measures ANCOVA with accuracy as the dependent variable, cry variation as the independent variable, and depression as the covariate was attempted. However, as all assumptions were violated the results of the ANCOVA are not reported here. In lieu of this, Pearson's correlations were calculated between the depression scores and audio accuracy scores at T2, which can be seen in Table 28 below. No significant correlations between the depression scores and the accuracy for the different variations were revealed, (all $p \geq .177$, all absolute correlation values lower than .128).

Table 28. Correlations Between Depression Scores and Accuracy in the Audio Block

		IDS-C	EPDS	Standard	-2st	-1st	+1st	+2st	+3st	+4st
IDS-C	*r*									
	p									
EPDS	*r*	.713**								
	p	.000								
Standard	*r*	.040	.072							
	p	.680	.447							
-2st	*r*	.116	.076	-.111						
	p	.227	.426	.244						
-1st	*r*	.122	.128	-.164	.540**					
	p	.203	.177	.082	.000					
+1st	*r*	.078	.026	-.263**	.546**	.531**				
	p	.414	.788	.005	.000	.000				
+2st	*r*	.049	-.043	-.091	.602**	.430**	.503**			
	p	.613	.652	.336	.000	.000	.000			
+3st	*r*	.054	-.013	.013	.608**	.378**	.420**	.618**		
	p	.572	.891	.892	.000	.000	.000	.000		
+4st	*r*	-.074	-.057	-.071	.465**	.220*	.305**	.536**	.660**	
	p	.443	.550	.454	.000	.019	.001	.000	.000	

Note. ** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed). Depression scores as measured by the EPDS and IDS-C and accuracy rates in the audio block at T2 by variation in semitone. N = 111 for correlations with the IDS-C and 113 for correlations with the EPDS.

H4 Summary

Accuracy rates did not differ across valence either for the sample as a whole or when controlling for depression. Participants with higher levels of depressive symptoms at 6-weeks postpartum were better able to identify low intensity sad expressions than were participants with fewer depressive symptoms. There was not a significant interaction between depression and accuracy in low intensity happy faces. Finally, no significant relationship was found between depression scores and the accuracy in the different variations of baby cries.

H5: Identifying antenatal and postnatal risk factors for the development of depressive symptoms in the postpartum period

Finally, external factors that were measured in the study via sociodemographic questionnaires that have been shown in other studies to be a risk factor for the onset of PPD were scrutinized in order to identify any sociodemographic items that may influence the relationship between maternal sensitivity and depression in the postpartum period. We predicted that a history of depression followed by a history of other mental disorders would most strongly predict PPD. To this end hierarchical multiple linear regression models were run for which the independent variables were entered using the enter method. The correlation coefficients between the sociodemographic items included in this study and sensitivity scores can be found in Table A6 and Table A7, for T1 and T2. These are located in Appendix A. Table A8, also found in Appendix A, is a correlation table for sociodemographic items and the depression scales (EPDS and IDS-C) for T2 and T3

Hierarchical multiple regression for sociodemographic items and MPS at T1 and depression at T2

For the regression analysis calculated with respect to depression scores at T2 and sociodemographic factors at T1, the dependent factor was the EPDS score at T2 and the independent factors were entered in the following hierarchy:

Table 29. Variables in the Multiple Regression by Block and Level

Level	Block	Variables
1	Life events	Miscarriage
2	Social support	Satisfaction with partner support Satisfaction with family support
3	Previous mental illness	Previous MDE Previous other
4	Socioeconomic status	Education Income
5	Obstetric factors	Pregnancy complications
6	MPS in *d'*	Audio Visual happy Visual sad

Note. All listed items as measured at T1.

As assessed by a Durbin-Watson test, an independence of residuals was proven, 2.116. The assumption of linearity by visually investigating scatterplots could not be confirmed between the depression scores and any of the independent factors entered into the linear regression model. As discussed above, the distribution for depression scores was not normal, but attempts to coax the data into normal distribution with several transformation techniques failed. The assumption of homoscedasticity was assessed via a visual inspection of a plot of standardized residuals versus standardized predicted values had to be rejected. Again, heteroscedasticity could not be corrected via transformation. We recognize that in the face of heteroscedasticity the models must be interpreted carefully, as in such cases, the risk for a Type I error occurring is increased. No multicollinearity was found within the data. All correlations were well below the 0.7 mark. Furthermore, all tolerance levels were well above the suggested 0.1 mark, the lowest having a level of 0.745 (Field, 2013). Two outliers were present in which the standardized residual was greater than ± 3 standard deviations (3.265 and 3.905). These cases were not removed. However, seven cases in the data had leverage points above 0.2 and one case was above 0.5. Because of this, the Cook's Distance values were investigated. One case had a value greater than 1 and was removed from this model. By investigating both a histogram and a P-P plot, it was determined that the assumption of normal distribution could be accepted as the data points were approximately linear.

Table 30 below shows a summary of the full model. Model 1 was significant with only miscarriage as the predictive factor, $R^2 = .053$, $F(1, 98) = 5.480$, $p = .021$. Miscarriage was a significant coefficient in all six models. Only the change from model 2 to model 3 was significant. That is, the addition of previous MDE and previous other mental illness to miscarriage and support from partner and family led to a statistical increase in R^2 of .060, $F(2, 94) = 2.649$, $p = .044$. There were no significant correlations between previous MDE and depression at T2, but a previous mental illness other than MDE was a significant coefficient in the four models in which it was a factor. The full model was not significant $R^2 = .183$, $F(3, 88) = .805$, $p = .494$; adjusted $R^2 = .081$.

Table 30. Hierarchical Multiple Regression Predicting Depression at T2 from Sociodemographics and MPS at T1

Depression at 6-Weeks Postpartum												
	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Variable	B	β	B	β	B	β	B	β	B	β	B	β
Constant	3.88**		0.34		-1.36		-0.97		-1.04		0.10	
Miscarriage	2.73*	0.23	2.71*	0.23	2.56*	0.22	2.76*	0.23	2.75*	0.23	3.03*	0.26
Partner Support			-0.20	-0.03	-0.12	-0.02	-0.18	-0.03	-0.19	-0.03	-0.36	-0.06
Family Support			-1.01	-0.08	-1.68	-0.14	-1.59	-0.13	-1.62	-0.14	-1.45	-0.12
MDE					0.76	0.08	0.69	0.07	0.67	0.07	0.53	0.06
Other Mental Disorder					2.23*	0.88	1.91*	0.22	1.86*	0.22	1.92*	0.24
Education					.		0.43	0.07	0.46	0.08	0.77	0.13
Income							-0.34	-0.19	-0.34	-0.20	-0.37	-0.21
Pregnancy Complications									-0.31	-0.04	-0.36	-0.04
Audio MPS											-0.63	-0.12
Happy Block Visual MPS											-0.45	-0.11
Sad Block Visual MPS											0.17	0.03

Note. $N = 100$. ** Significance is at the 0.01 level (2-tailed), * significance is at the 0.05 level (2-tailed).

Table 30 (continued). Hierarchical Multiple Regression Predicting Depression at T2 from Sociodemographics and MPS at T1: Changes in Models

	Depression at 6-Weeks Postpartum					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
R^2	.053	.063	.123	.159	.161	.183
F	5.48*	2.17	2.65*	2.49*	2.18*	1.79
ΔR^2	.053	.010	.060	.036	.001	.022
ΔF	5.48*	0.53	3.22*	1.97	0.14	0.81

Note. N = 100. * Significance is at the 0.05 level (2-tailed).

Hierarchical multiple regression for sociodemographic items, MPS, and depression at T2

For the hierarchical multiple regression analysis calculated with respect to depression scores at T2 as well as sociodemographic factors and MPS as measured at T2, the dependent factor was the EPDS score at T2 and the independent factors were:

Table 31. Variables in the Multiple Regression by Block and Level

Level	Block	Variables
1	Life events	• miscarriage
2	Social support	• Satisfaction with partner support • Satisfaction with family support
3	Previous mental illness	• Previous MDE • Previous other
4	Socioeconomic status (SES)	• Education • Income
5	Obstetric factors	• Birth complications • Nursing
6	MPS in *d'*	• Audio • Visual happy • Visual sad

Note. All listed items as measured at T2.

Independence of residuals was proven via a Durbin-Watson test, 2.03. As with the multiple regression calculations discussed above, the assumption of linearity and homoscedasticity by visually investigating scatterplots could not be confirmed between the depression scores and any of the independent factors entered into the linear regression model here. No transformations were attempted. High tolerance levels, the lowest tolerance level here was 0.829, and low correlation levels were present proving a lack of multicollinearity. There were no outliers. Ten data cases had leverage points above 0.2 and two cases were above 0.5. Cook's Distance values were investigated, revealing that the same data case that was above 1 in the previous model calculations here too contained presumably an error in data entry. This

case was removed. By inspecting a histogram as well as P-P and Q-Q plots, it was determined that the distribution was approximately linear.

Table 32 below shows a summary of the full model. As with the previous models, miscarriage remained a significant coefficient in all models. The models changed significantly from model 1 to 2, with the addition of social support to miscarriage leading to an R^2 increase of .056, $F(2, 94) = 8.100$, $p < .001$. Family support also was a significant coefficient in all five of the models in which it was entered, support from the spouse only, on the other hand, was not significant. There was also a significant change with the addition of birth complications and nursing in model 5, with an increase over model 4 of $R^2 = .071$, $F(2, 88) = 4.676$, $p < .001$, of which breastfeeding was the significant factor. The full model was not significant, $R^2 = .183$, $F(3, 88) = 1.80$, $p = .067$; adjusted $R^2 = .081$, but did show a better fit than the model in which the independent variables were measured at T1.

Table 32. Hierarchical Multiple Regression Predicting Depression at T2 from Sociodemographics and MPS at T2

Depression at 6-Weeks Postpartum												
	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Variable	B	β	B	β	B	β	B	β	B	β	B	β
Constant	3.68**		-4.12		-4.11		-4.69		-0.50		-1.92	
Miscarriage	4.32**	0.39	5.12**	0.46	5.11**	0.46	5.32**	0.48	4.89**	0.44	5.05**	0.45
Partner Support			-0.82	-0.06	-0.79	-0.05	-0.52	-0.04	-0.83	-0.06	-0.65	-0.04
Family Support			-8.59*	-0.27	-8.29*	-0.26	-8.36*	-0.26	-7.97*	-0.25	-8.67*	-0.27
Previous MDE					0.43	0.05	0.42	0.05	0.34	0.04	0.28	0.04
Previous Other Mental Disorder					0.74	0.10	0.44	0.06	0.31	0.04	0.16	0.02
Education					.		0.71	0.12	1.10*	0.20	1.31*	0.23
Income							-0.26	-0.17	-0.27	-0.17	-0.31*	-0.20
Birth Complications									-0.28	-0.04	-0.32	-0.05
Nursing									-4.55*	-0.28	-4.73*	-0.29
Audio MPS											0.34	0.07
Happy Block Visual MPS											-0.47	-0.11
Sad Block Visual MPS											0.34	0.08

Note. $N = 98$. ** Significance is at the 0.01 level (2-tailed), * significance is at the 0.05 level (2-tailed).

Table 32 (continued). Hierarchical Multiple Regression Predicting Depression at T2 from Sociodemographics and MPS at T2: Changes in Models

	Depression at 6-Weeks Postpartum					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
R^2	.149	.205	.216	.253	.324	.343
F	16.81**	8.10**	5.07**	4.35**	4.68**	3.70**
ΔR^2	.149	.056	.011	.037	.071	.019
ΔF	16.81**	3.34*	0.62	2.21	.4.61*	0.83

Note. ** Significance is at the 0.01 level (2-tailed), * Significance is at the 0.05 level (2-tailed).

Hierarchical multiple regression for sociodemographic items and MPS at T2 and depression at T3

The sociodemographic information used here was the same as was used in the previous calculation, as shown in Table 31 above. Independence of residuals was proven via a Durbin-Watson test, 2.24. The assumption of linearity and homoscedasticity by visually investigating scatterplots could not be confirmed. There was no multicollinearity. Two outliers with standard residuals slightly above 3 were present due to their high scores on the depression scale. They were not removed. Two cases had leverages values of over 0.5 and one over 0.2. Cook's Distance values were investigated, revealing once case to have values above 1, which was removed. By inspecting a histogram as well as P-P and Q-Q plots, it was determined that the distribution was approximately linear.

Table 33 shows a summary of the full model. As with the previous models, miscarriage remained a significant coefficient in all models. The addition of further factors never produced a significant change. The full model was not significant, $R^2 = .170$, $F(3, 83) = 1.42$, $p = .175$; adjusted $R^2 = .050$.

Table 33. Hierarchical Multiple Regression Predicting Depression at T3 from Sociodemographics and MPS at T2

Depression at 12-Weeks Postpartum												
	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Variable	B	β	B	β	B	β	B	β	B	β	B	β
Constant	3.13**		5.20		4.36		6.00		5.31		3.30	
Miscarriage	3.241**	0.30	3.22**	0.30	3.40**	0.31	3.27**	0.30	3.35**	0.30	3.30**	0.30
Partner Support			-1.60	-0.10	-1.68	-0.11	-1.87	-0.12	-1.91	-0.13	-2.09	-0.14
Family Support			-1.25	-1.35	-1.07	-0.12	-0.96	-0.10	-0.90	-0.10	-0.66	-0.07
Previous MDE					0.78	0.11	0.96	0.13	0.98	0.13	1.07	0.14
Previous Other Mental Disorder					0.24	0.03	0.42	0.61	0.46	0.06	0.42	0.06
Education					.		-0.80	-0.14	-0.85	-0.15	-0.90	-0.16
Income							-0.01	-0.12	-0.01	-0.12	-0.01	-0.12
Birth Complications									0.09	0.14	0.90	0.14
Nursing									0.60	0.04	0.41	0.03
Audio MPS											0.21	0.03
Happy Block Visual MPS											0.06	0.01
Sad Block Visual MPS											0.35	0.09

Note. $N = 96$. ** Significance is at the 0.01 level (2-tailed), * significance is at the 0.05 level (2-tailed).

Table 33 (continued). Hierarchical Multiple Regression Predicting Depression at T3 from Sociodemographics and MPS at T2: Changes in Models

	Depression at 12-Weeks Postpartum					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
R^2	.085	.117	.127	.157	.158	.170
F	8.77**	4.05**	2.62*	2.34*	1.80	1.42
ΔR^2	.085	.031	.010	.030	.001	.012
ΔF	8.77**	1.63	0.54	1.54	0.08	0.40

Note. ** Significance is at the 0.01 level (2-tailed), * significance is at the 0.05 level (2-tailed).

Hierarchical multiple regression for sociodemographic items at T3 and depression at T3

MPS scores were not measured at T3, thus only the sociodemographic information was included in the models for this linear regression. The sociodemographic items are the same as in Table 31, but as measured at T3. Independence of residuals was proven via a Durbin-Watson test, 1.77. The assumption of linearity and homoscedasticity by visually investigating scatterplots could not be confirmed for all of the variables. There was no multicollinearity. Two outliers with standard residuals above 3 were present due to their high scores on the depression scale. They were not removed. There were several cases with leverage points above 0.2, but none above 0.4. Cook's Distance values were investigated, revealing one case well above 1.0 and this was removed. By inspecting a histogram as well as P-P and Q-Q plots, it was determined that the distribution was approximately linear.

Table 33 shows a summary of the full model. Model 1 was significant, R^2 = .081, $F(1, 99)$ = 8.78, p = .004; adjusted R^2 = .072. The change from Model 1 to Model 2 with the addition of family support and partner support as measured at T3 in Model 2 led to a statistical increase in R^2 of .184, $F(2, 97)$ = 7.287, p = .003. The full model was R^2 = .172, $F(2, 91)$ = 3.30, p = .002; adjusted R^2 = .172. Within the final model miscarriage and family support, but not partner support are significant unique contributors to the model.

Table 34. Hierarchical Multiple Regression Predicting Depression at T3 from Sociodemographics at T3

Depression at 12-Weeks Postpartum										
Variable	Model 1		Model 2		Model 3		Model 4		Model 5	
	B	β	B	β	B	β	B	β	B	β
Constant	3.13**		9.66		9.70		11.69		11.08	
Miscarriage	3.09**	0.29	2.55*	0.24	2.81*	0.26	2.69*	0.25	2.85*	0.26
Partner Support			-2.78*	-0.20	-2.85*	-0.21	-2.67*	-0.19	-2.59	-0.18
Family Support			-3.97*	-0.22	-4.28*	-0.24	-4.21*	-0.23	-4.15*	-0.23
Previous MDE					1.45*	0.19	0.49*	0.20	0.47	0.06
Previous Other Mental Disorder					0.43	0.06	0.49	0.07	0.47	0.06
Education							-0.45	-0.08	-0.58	-0.11
Income							-0.19	-0.12	-0.19	-0.13
Birth Complications									-0.01	-0.00
Nursing									0.89	0.06

Note. $N = 101$. ** Significance is at the 0.01 level (2-tailed), * significance is at the 0.05 level (2-tailed).

Table 34 (continued). Hierarchical Multiple Regression Predicting Depression at T3 from Sociodemographics at T3: Changes in Models

	Depression at 6-Weeks Postpartum				
	Model 1	Model 2	Model 3	Model 4	Model 5
R^2	.081	.184	.220	.243	.246
F	8.78*	7.29**	5.35*	4.27**	3.30*
ΔR^2	.081	.102	.036	.024	.003
ΔF	8.78*	6.09*	2.17	1.45	0.18

Note. ** Significance is at the 0.01 level (2-tailed), * significance is at the 0.05 level (2-tailed).

H5 Summary

Antenatal factors that were shown to be associated with the onset of depression at T2 and T3 were a previous miscarriage and a previous mental disorder other than depression. Just to clarify by using the data from the first regression table for a miscarriage (*standardized* β = 0.26) and a previous mental disorder other than depression (*standardized* β = 0.24), if the other significant factors in the model are held constant, this indicates that for every single increase in standard deviation for miscarriage (*SD* = 0.30), there is an increase in the depression scores by 0.26 standard deviations. The standard deviation from depression scores was, *SD* = 3.57, which yields a change of 0.93 points on the EPDS depression scale. And for each increase in standard deviation in mental disorders other than depression there is an increase of 0.86 points on the EPDS. As the EPDS cutoff rate is ≥ 10, this represents a considerable change. A previous miscarriage predicted depression in all models (across as well as within measurement time). Nursing served as a protective factor within T2 (*standardized* β = -0.30) as did family support within both T2 and T3 (*standardized* β = -0.27; *standardized* β = -0.23). MPS did not predict depression in the postpartum period. Sociodemographic factors, including the history of a miscarriage, the history of mental disorders other than depression, predict depression within measurement times better than across them.

5 Discussion

The literature on maternal perceptual sensitivity presents a mixed picture, but observational studies show a clear difference between the mother-infant interactions in depressed and healthy populations, with even sub-clinically chronically depressed mothers being less emotionally available to their children (Cicchetti, Rogosch, & Toth, 1998; Field, 1998). We investigated if poor perception of emotion is one of the key factors in this relationship. This was not the case, at least in the way we had predicted. Our results show that mothers with higher levels of depression are just as capable as heathy mothers of perceiving various emotional cues from infants and are even better at perceiving low intensity negative emotion in infant facial expressions prior to the onset of depression. This points to high sensitivity, as according to our measurements, toward negative facial expressions as being a better predictor of depression rather than poor MPS per se. However, this is misleading and forces us to reconsider the measurement tools or definition of MPS used in this thesis. A heightened sensitivity toward low intensity negative expressions could be erroneously interpreted as very high sensitivity. It is, however, we consider it an error in sensitivity.

It is possible that due to this heightened focus on negative expressions, the mother then either misinterprets the signal or is overly responsiveness, or both. Thus, the data suggests that it is not simply poor perception of emotion, as we had hypothesized, but rather an exaggerated perception of weak negative emotions and involved overly sensitive interpretation skills and consequent inappropriate maternal responses to the baby's emotional signals that link PPD, maternal sensitivity, and poor child development. The literature has shown strong correlations between PPD and poor maternal behavioral or responsive sensitivity. Our data suggests that misinterpretation, that is an exaggerated perception toward negative stimuli, is the factor that leads to incongruent maternal behavior toward her infant's signals.

This novel finding forces us to reconsider the relationship between depression and maternal sensitivity and the definition of sensitivity itself. Thus far, we have discussed sensitivity only within positive terms. However, our results show that high sensitivity, in classical terms, is in fact a predictor for depression. Furthermore, we believe that this heightened awareness of negative facial expressions does not lead to better interceptive skills or behavior on the part of the mother. Rather, we have uncovered what is likely a more precise root, within the broader definition of maternal sensitivity, of why mothers with depression show lower maternal behavioral sensitivity: an error in sensitivity toward negative expressions in terms of being overly sensitive.

In the following sections we summarize all of our findings, briefly recount the methods used to come to these findings, and we related the findings to the current literature. We also expound on the implications thereof as well as give recommendations for future research. Next we discuss the limitations of the current study and how these limitations partially affected the interpretation of the findings. We continue thereafter with recommendations for professionals working with expecting women and with depressed mothers. The conclusion discusses larger implications of our findings.

Summary

The overarching goal of this study was to better understand the relationship between maternal perceptual sensitivity (MPS) and postpartum depression (PPD). In particular, we wanted to know if depression in the postpartum period could be predicted by MPS. In order to best understand this relationship, we also investigated if auditory and visual MPS were related to each other and if MPS was a stable trait or changed with the arrival of and interaction with a new baby. We also explored whether there were biases toward either negative or positive stimuli across groups (higher vs. lower severity of depressive symptoms). Finally, we looked at what if any antenatal and sociodemographic factors were correlated with depressive symptoms.

Expectant mothers were measured for MPS in the third trimester and again at 6-weeks postpartum. MPS was measured toward infant cries, happy infant faces, and sad infant faces using Signal Detection Theory (SDT) as well as accuracy. The audio MPS trials were a 2-alternative forced-choice (2AFC) test using Signal Detection Theory (SDT). The audio stimuli consisted of infant cries that were manipulated into varying pitches. The visual tests were of a yes/no design. Morphed pictures of infant expression of emotion were employed for the visual tests. Depression was measured during pregnancy, at 6-, and at 12-weeks postpartum. Diagnoses were given via the Structured Clinical Interview (SCID). Symptoms were measured with one subjective (EPDS) and one objective (IDS-C) measurement tool. Sociodemographic questionnaires were filled out by participants at all three measurement times.

Predicting PPD

The overriding question of this study was whether poor MPS during pregnancy predicts depression in the postpartum period. We hypothesized that poor MPS during pregnancy would predict depression in the postpartum period. To investigate this question, we assessed MPS with respect to the detection of differences in infant audio cries, as well as with respect

to identifying positive and negative infant facial expressions during and after pregnancy. This was measured via *d*' and accuracy. We looked at correlations within and across measurement times between MPS scores and depression. Linear regression models were run in order to assess if depression symptom levels during pregnancy predicted depression in the postpartum period. We additionally investigated the possible relationships between auditory and visual MPS to better address the above mentioned question by looking at correlations between the auditory, happy visual, and sad visual experiment blocks.

As expected, depression symptom levels at T2 and T3 were predicted by depression symptom levels at T1. The fact that changes in depression levels are predicted by baseline scores is in line with the literature. While a diagnosis for depression with the SCID excluded women from participating in the study, there were variations in levels of depression symptoms as measured by a subjective questionnaire (EPDS) at T1. Major and minor depression is the strongest predictor of depression in the postpartum period (Beck, 2001; Johnstone et al., 2001; Josefsson et al., 2002; Neter et al., 1995; O'Hara & Swain, 1996; Robertson et al., 2004). This is not a surprising pattern. Women who suffer from depressive symptoms during pregnancy may not have the coping skills or resiliency in the postpartum period that other women are able to tap into in this challenging period of life. When confronted with the myriad of life changes that occur after the birth of a child, women free of symptoms are better able to deal with, for example, weeks of disturbed or little sleep. For a woman already dealing with depressive symptoms, the compounding of new challenges with old depressive tendencies is likely to trigger a full blown depressive episode.

Concerning the ability of MPS to predict depression, our findings show that MPS as measured with *d'* at 6-weeks postpartum when identifying sad faces can predict depression at 12-weeks postpartum. This is not in line with our original model-driven hypothesis, in which poor MPS would predict depression. However, this finding is similar to findings in Bouhuys et al. (1999), where it was shown that a high perception of negative emotions predicted a relapse in a depressed population, indicating that a negativity bias is a more or less constant state that influences one's risk for depression and that is further amplified with the onset of symptoms. Our results show that higher sensitivity toward negative infant facial expressions at 6-weeks postpartum is a valid predictor of depression at 12-weeks postpartum. Is a pattern of negative cognition then a cause for the onset of depression? Possibly. Beck's cognitive theory of depression postulates that one's maladaptive or negative thoughts about oneself, one's experiences, and the future (the Negative Cognitive Triad) tend to lead to depression (Beck,

1979). Being hypervigilant toward negative facial expressions over positive ones could indeed lead to a perceived negative interaction with other humans and a believed lack of self-efficacy, thus paving the path towards depression.

Contrary to our hypothesis that lower MPS toward both happy and sad expressions would be correlated with and predict PPD, no further relationships were found between depression scores and MPS scores across or within measurement times. This finding mirrors previous studies in which no significant differences were found between depressed and non-depressed mothers' perceptual sensitivity (Balge & Milner, 2000; Broth et al., 2004; Stein et al., 2010). However, the results stand in contrast to studies that have shown correlations between poor maternal sensitivity and higher levels of depression (Donovan et al., 1997, 1998; Schuetze & Zeskind, 2001).

In our study there is not a correlation between depression and the ability to differentiate cry tones, which is contrary to some previous studies (Donovan et al., 1997, 1998; Schuetze & Zeskind, 2001). This came to us as a surprise as there was a correlation between performance in the sad block and depression, as well as between performances in the audio block at T1 and the sad block at T2. We thought because crying is an inherently negative signal, we would see similar patterns when looking at the sad visual blocks and the audio blocks to predict depression. However, there is indeed a key difference between the two. Sad facial expressions can turn into happy ones, whereby parents are rewarded for the efforts to alleviate the infant of whatever it is that is at the source of negative signals of emotion. Crying, on the other hand, is a one sided style of communication; the baby is either crying or not. While gradation of pitch communicates, for example, pain over mild boredom, there is not the full spectrum of positive and negative emotions within cry signals that is present in facial expressions of emotion. In retrospect, we realize that it is this lack of opposites within the cry signal paradigm that makes it impossible to investigate the role of a negative bias toward cries per se as a predictive measure for depression. Furthermore, many primiparous women in our society have very little contact with infants prior to bringing their own child into the world. Experienced mothers may have tapped into internalized negative reactions toward cry signals when participating in our study and the more sensitive ones would be better at differentiating cries in the "pain" versus "discomfort" register, but likely most of the primiparous women would not have yet learned these differences nor display the emotional or physical response that is learned after long interactions with crying infants. However, the correlation found between accuracy and *d*' in the sad visual at T2 and the audio block at T1, may indicate that

in part the skill set or neural pathway used to interpret negative expression of emotion do overlap across the sensory field. On the other hand, the statistical significance is admittedly odd, as it occurs across measurement times but not within them. It is not unlikely – despite efforts to control for such – that this correlation is merely a Type I error.

Future studies should focus on interpretation of infant signals and maternal behavior within the context of PPD. Attempts should be made to disentangle the two elements in order to hone in on the point of entry into the vicious intergenerational cycle of poor maternal sensitivity and depression as well as the advancement of recognition of and treatment for depression during pregnancy as a preventive tool for depression in the postpartum period with all the negative correlates it brings with it. Finally, investigations into higher sensitivity toward negative expressions should be made to see if the same results are present when using adult facial expressions. Moreover, it needs to be seen and if addressing this phenomenon proves beneficial in early diagnoses, or even prevention of PPD, as well as treatment methods.

The stability of MPS

Another of our questions was whether MPS is a stable or plastic trait. This is a particularly relevant question when considering prevention and intervention programs. If appropriately differentiated sensitivity toward infant signals can increase with experience, it can also likely be learned or improved upon before the arrival of a new baby thereby helping to prevent cases of neglect, abuse, and the consequential and unfortunate pattern of less optimal child development shown to be associated with low maternal sensitivity.

To answer this question, we compared scores across measurement times via Pearson's correlations and compared the scores of primiparous to multiparous participants. Our data shows that MPS is a stable trait when comparing scores during pregnancy to those after pregnancy. However, when comparing primiparous to multiparous women, we found that multiparous women had significantly lower mean scores in the happy visual block at T2 compared to T1. These findings indicate that sensitivity is not wholly consistent in the face of change. One explanation for this would be that experienced mothers during pregnancy have a positivity bias. Every new parent knows the joy of seeing their baby smile and hearing her coo for the first time and women expecting their 2nd+ child may perceive positive expressions where there are none, or be more able to identify low intensity happy baby expressions. This positivity bias may then drop away in the first few weeks after birth. Infants are first able to smile, starting at around 6-weeks of age and previously are only equipped with a negative expression of emotion, i.e. crying. Positive emotions may stagnate temporarily with a lack of

positive infant stimuli, explaining the drop in MPS toward positive facial expression in our T2 multiparous sample. This theory must unfortunately remain just that until further research is done, as we would have expected to see statistically significant differences in the happy block performance during pregnancy for the participants expecting their 2nd+ child compared to those expecting their first child, which we did not. Future long-term studies need to be conducted in order to observe the trend of parental sensitivity toward positive and negative stimuli as their child's repertoire gains more positive signals in order to be able to better understand what mechanisms underlie our findings.

Biases toward negative expressions or heightened sensitivity?

The literature discussing biases toward negative expressions within the depressed population or toward happy expressions within the healthy population presents a mixed picture. We explored the presence of biases across groups, as well as the possibility of differences in the ability to correctly identify low intensity expressions, by conducting an ANCOVA with depression as the covariate and intensity and valence of expression as the variables.

Spangler, Geserick, and von Wahlert (2005) found healthy parents to have a bias toward positive baby faces. We, on the other hand, did not see a positivity bias nor higher accuracy, within the happy block as compared to the sad block, nor did we see the attentional fixation toward negative emotions that Pearson et al. (2010) found in their healthy sample. Our findings also show no correlation between accuracy in differentiating cry tones and levels of depression symptoms, unlike findings from Donovan et al. (1997, 1998) and Schuetze and Zeskind (2001). Our data does show, however, as did Joormann and Gotlib (2006), that women with higher rates of depressive symptoms are more accurate in recognizing low intensity negative expressions compared to women with fewer symptoms. Several studies have identified the presence of a negativity bias in people with depression (Bouhuys et al., 1999; George et al., 1998; Gur et al., 1992; Pearson et al., 2010). Our study shows a correlation between depression and higher accuracy in low intensity negative expressions, but not a negativity bias. If it were a bias, we would expect higher levels of depressive symptoms to be correlated with lower accuracy levels (i.e. more false alarms) in the neutral trials, which was not the case in our study.

Our study shows that mothers with higher levels of depressive symptoms in the postpartum period are *more* sensitive toward low intensity negative facial expressions in babies than mothers with fewer symptoms. On the behavioral level this could have positive or negative implications for the mother-child dyad. We, however, believe that rather than being a

reflection of high sensitivity, i.e. a positive aspect, what we have uncovered is a *sensitivity error*. That is, high alertness toward negative expressions may alert a mother earlier that her child is becoming hungry or getting sleepy, or has some other unfulfilled need, thereby preventing the infant from escalating into a bout of pain-level crying. On the perceptual level, high sensitivity toward negative expressions may furthermore lead to a string of misinterpretations, whereby the mother personalizes the cause of the infant's negativity, leading to feelings of poor self-efficacy or self-blame, not to mention incorrect behavior toward the signal. Murray et al. (1996) found that depressed mothers responded more to negative emotions from their infants than to positive emotions and that the mothers showed fewer positive expressions, were less engaged, showed less eye-to-eye contact, and more negative behavior to signals of distress from their infant. In the absence of positive feedback, infants of depressed mothers are less likely to express positive emotions as frequently. This may in part be the beginning of the trajectory of increased negative emotions displayed by children of depressed mothers.

Risk and sociodemographic factors

Several large meta-analyses have been published discussing the risk factors associated with PPD based on the findings of a large number of international studies. The most predictive risk factor is maternal mental health, with depression during pregnancy having the largest effect size. While the design of our study prevented women with depression during pregnancy to participate in the study, we predicted that a history of depression, followed by a history of another mental illness would be the factors most strongly correlated with the onset of depression in the postpartum period. In order to identify which antenatal and postpartum factors were associated with the onset of depressive symptoms after birth, we looked at correlation tables and hierarchical multiple linear regression models.

The strongest antenatal predictive sociodemographic factor for the onset of depression in our study was not a history of depression, but rather a history of miscarriage, which predicts depression at both measurement times. As miscarriages are frequently followed by episodes of depression (Beutel, Deckardt, Von Rad, & Weiner, 1995; Thapar & Thapar, 1992) and can be extremely traumatic (Lee & Slade, 1996), it is surprising how rarely miscarriages appear in the literature on PPD. The three large meta-analyses conducted on risk factors for PPD (Beck, 2001; O'Hara & Swain, 1996; Robertson et al., 2004) do not mention miscarriage, indicating that it has rarely been assessed. However, two older studies (Jacobson, Kaij, & Nilsson, 1965; Playfair & Gowers, 1981) found miscarriage to be a significant predictor of PPD, as did

Cryan et al. (2001) in a low SES group of Irish women. 10.1% (N = 12) of our sample suffered a previous miscarriage. On the other hand, "life stress" has been shown to be associated with PPD, with moderate to strong effect sizes (Beck, 2001; Robertson et al., 2004). While generally studies have considered experiences such as job loss, moving, the death of a loved one etc. to be life stressors, many women consider pregnancy and birth stressors as well and certainly having had a miscarriage carries long-term psychological costs (Murray & Cooper, 1996; Robertson et al., 2004). It is therefore clear that miscarriage needs to be assessed as a risk factor in future studies.

Just like depression after the birth of a new child, miscarriage, and especially recurrent miscarriages, are very much a taboo topic that even professionals find difficult to discuss with patients (Van Den Boogaard et al., 2011). If a woman has had miscarriages but has not been able to successfully confront her grief and other associated emotions with the support of professionals or within her social circle, the successful birth of a new baby may result in the rise of complex and negative emotions but with no resources to turn to for help. This in turn makes her prone to depression.

Along with miscarriage, our findings show that having a history of a mental disorder other than depression was an additional antenatal predictor of depression at T2. The two most frequent lifetime disorders in our sample were eating disorders (13.6%, N = 16) and anxiety disorders (7.6%, N = 9). Antenatal anxiety, both as measured before and during pregnancy, has been well researched and has been shown to be a predictor of postpartum depression (Austin, Tully, & Parker, 2007; Beck, 2001; O'Hara & Swain, 1996; Robertson et al., 2004). Eating disorders have not been thoroughly investigated within the context of PPD, though one study has shown that both a history of bulimia and binge eating are associated with PPD (Mazzeo et al., 2006).

Of the postpartum factors measured, current subjective satisfaction with family support predicted depression most strongly at 6- and 12-weeks postpartum. Social support from one's partner, friends, and family has all been shown to be inversely correlated with PPD. Moreover, nursing was found to be inversely corrected with depression levels at 6-weeks postpartum both here and in another study (Hatton et al., 2005), but not at 12-weeks in our study. The relationship between nursing and PPD is a relatively new topic in the literature. The direction of causality remains unclear. It is unknown whether women who have a high

risk for depression more frequently choose not to breastfeed or if possibly positive feedback during nursing, such as hormones but also simply the feeling of self-efficacy, offers a protection against the onset of symptoms. Breastfeeding raises prolactin levels for as long as a women breastfeeds (Stallings, Worthman, Panter-Brick, & Coates, 1996) (though the levels do steadily decline), which is known to influence both anxiety and depression levels (Fava et al., 1983). However, it is still unclear if prolactin, or other hormones associated with breastfeeding, is indeed correlated with depression levels in the postpartum period. Studies have been published on both sides – with some showing lower prolactin levels in depressed nursing mothers (Harris et al., 1989) and others showing no correlations (O'Hara, Schlechte, Lewis, & Varner, 1991).

Surprisingly, a history of depression is not correlated with the onset of a depressive episode in the postpartum period in our study. Meta-analyses have shown prenatal depression to be a strong predictor of PPD and depression during pregnancy to be the strongest (Beck, 2001; Robertson et al., 2004). Major depression during the pregnancy was an exclusionary factor for our study, which likely in part explains our findings. Moreover, our sample is relatively well educated, high earning, and with little history of childhood abuse – as measured by the Questionnaire for Childhood Abuse and Care (CECA) (Bifulco, Bernazzani, Moran, & Jacobs, 2005). It is possible that even in the face of a history of depression our participants have more resources at hand, such as more money, a higher education, and the benefits of a relatively "normal" childhood lacking in abuse – all factors that can help them to better manage the stressors in the postpartum period and protect them from developing PPD.

The rolls that maternal mental health and social support play within the pathology of PPD have received a lot of attention in the scientific community. Miscarriage, strangely enough, is scarcely mentioned. Clearly, research needs to be done to understand to what degree a history of miscarriage is a risk factor for depression in other countries and cultures (our sample was relatively well-off, highly educated, and 93% German), in which miscarriage may be stigmatized differently than in Germany. Moreover, considerations should be made on how mental health and women's health professionals can more adequately address the issue with patients.

Breastfeeding within the context of PPD is receiving more attention from researchers, but a lot of questions remain. One question is that of causation. Do hormones offer protection over PPD? If so, can we supply women who are at high risk for depression and not able to nurse

their children with hormone therapy? Is it rather the frequent and close contact with the baby that is the key here? If so, can we help at-risk mothers with a sort of touch therapy for mother and child? Finally, preventive programs and classes that are designed to help expectant parents, such as Karl-Heinz Brisch's "SAFE" programs, should address the topic of PPD and possible risk and protective factors, including maternal mental health, miscarriage, social support, and breastfeeding.

Limitations

There are several weaknesses in the current study that are relevant when considering the statistical results as well underscoring the need for further research. Many of these limitations have to do with the sample. First, the sample was relatively small creating power limitations and thus creating difficulties in determining interactions within the linear regression models. Additionally, the sample was also quite homogenous. Despite efforts to recruit women from less affluent neighboring cities, the data from the sociodemographic items show a sample that in socioeconomic terms does not reflect the true distribution for Germany. Our sample was particularly well educated, with 61% of the sample having obtained a university degree. Moreover, while the mean monthly household income for Germany in 2016 after taxes was approximately 2,700 Euros. The median by our sample lay 2,400 – 2,999 Euros per month, reflecting a mostly financially stable sample (Statistisches Bundesamt, 2015). Furthermore, a large majority of our sample lived with their partners (92%), was satisfied with the support from their partner and family over two measurement times, and nursed their baby. These are all factors known to be negatively correlated with the onset of PPD, which brings us to our next point. Very few participants showed clinical levels of depression at T2 and T3. Unfortunately, heteroscedasticity increases the risk of a Type I error being made, so that particularly the multiple regression models discussed, which were used in order to identify sociodemographic factors associated with the onset of PPD, must be interpreted with caution.

There are several factors that could in part explain the low onset in our study. First, the strongest predictor of PPD is a depressive episode during pregnancy (Beck, 2001; O'Hara & Swain, 1996; Robertson et al., 2004). As we were interested in the possible role of non-mental health factors, current depression was an exclusion criterion in this study. Approximately 19% (N=23) of the study sample had at least one episode of major depressive episode prior to the study. This is within epidemiological estimates for lifetime risk for women, which is 10-25% (Kessler et al., 2003). As diagnosed with the SCID, 4.2% (N=5) and 3.4% (N=4) were diagnosed with major depression at T2 and T3, respectively. Of these, one participant that had

a diagnosis of MDE prior to the study received the same diagnosis at T2 and T3, respectively. These rates are much smaller than the most quoted 13% given by O'Hara and Swain (1996) as well as the studies within Europe revealing rates of around 9% (Banti et al., 2011; Navarro et al., 2008). The fact that more women had depression at T2 (6-weeks postpartum) than at T3 (12-weeks postpartum) as measured by the SCID, and symptom rates were higher at T2, as measured with the EPDS and IDS-C is consistent with previous studies showing a peak of onset at 6-weeks postpartum (Stowe et al., 2005). It is possible that we thereby inadvertently excluded the only significant population within the region that was at high risk for developing PPD. Future studies should include a group with depression and a control group without at the intake point of the study. Additionally, it could be that women with high-risk factors are not interested or able to participate in a scientific study, particularly one such as ours that required multiple several hour long sessions. Of the nine participants who chose not to return for the T2 and T3 testing appointments, four of them had a previous diagnosis for MDE, which does point to the risk of attrition bias within our data. The very low levels of depression present within the sample unfortunately make the results better understood as applied to relatively healthy new mothers rather than a clinical population.

The second considerable weakness lies in the question of the validity of our stimuli. The stimuli we used in our study have never been used in this exact manner elsewhere. The pictures came from the Oxford Infant Faces database from the University of Oxford (Kringelbach et al., 2008; Parsons et al., 2011) and have been used in previous studies in a different fashion. The original standard baby cries were also used in previous studies (Schuetze & Zeskind, 2001). The variations, while based on previous studies, were made uniquely for the purpose of this study. Future studies should consider making several changes to the stimuli used to measure maternal sensitivity and the experimental design. Our data show that the tasks in the MPS experiments were too easy overall. The high accuracy and hit rates make differentiations between highly sensitive and low sensitive groups difficult. It could be that the sensitivity paradigms were not stressful enough to reveal relationships between PPD and MPS. In situations that are of low stress and challenge, depressed mothers may not differ in their behavior from healthy mothers (Laurent, Ablow, & Measelle, 2011). Crockenberg and Leerkes (2003), for example, found a correlation between PPD and sensitivity only if mothers reported high rates of rejection as children. A different experimental design, in which maternal interpretation of infant emotions would be measured during a stressful situation, may reveal different results. Additionally, the cry samples were adjusted only in their fundamental frequencies, but not in other auditory factors known to

contribute to the perception of the cry, such as aspirations. Limitations in the technology available prevented us from making more complex and realistic changes to the audio files, but clearly it would have been desirable.

Another consideration is that participants did not hear cries or see expressions from their own infants. It is worth investigating if women show variances in sensitivity when signals come from their own infant versus from other infants. Finally, it is our belief that using even lower intensities of expressions of faces may have shown stronger patterns of bias and predictive associations within the context of PPD than the intensities we chose to employ.

Recommendations for Professionals

Recommendations for future research based on the findings gained in this study were given in the summary section above. Beyond the understanding gained from data collection and interpretation, we were able to obtain what we feel are important insights through the recruitment and data collection processes of this project. The data collection phase of this study took 26 months, during which we were privileged to be able to conduct extensive interviews with expectant and new mothers, as well as to be the beneficiaries of the support of many midwives in and around Tübingen. In addition, as compensation to participants, we designed and conducted training sessions for our participants on how to create and maintain a healthy mother-infant attachment within the first postpartum year. Over the months of contact with both professionals and our participants, certain factors came to our attention that we feel warrant consideration within the professional community. Through our exchanges with midwives, the stories and experiences our participants shared with us, and most particularly through the oral and written feedback we received from the participants in our training sessions we have gained considerable insights into several pressing and distinct issues, which are currently present in our society and culture. Below is a brief description of suggestions for both professionals and new mothers, based on these experiences. While we do recognize that our involvement was with a relatively small and privileged sample, we hope that at the very least, the suggestions given below will provide fodder for a larger discussion on possible prevention and treatment options for PPD within the larger community, as well as for expectant and new mothers.

Our connections revealed that PPD is, in Germany, very poorly understood by both the general and professional population. Most mothers we talked to were shocked to hear how high the prevalence rate for this disorder was and were unaware of the most common symptoms of PPD. Furthermore, the taboo status of depression in general, and of depression

amongst new mothers in particular, makes it very difficult to identify women experiencing problems as they are unaccustomed to talk about any negative aspects of motherhood openly. It is our belief that brief forms of education through public campaigns are absolutely necessary to more readily enable self-diagnosis. Providing family physicians, gynecologists, and pediatricians with something as simple as an informative poster to be hung in waiting rooms would be an inexpensive and convenient way of informing the general public about the basics of PPD. Perhaps being informed of the symptoms – and the commonality of such – would encourage more families to seek help when faced with symptoms, or at least to simply talk about it more openly with good friends and family.

Particularly unfortunate is the dearth of professionals – in this case gynecologists, midwives, and pediatricians – who seemed to be adequately informed about PPD, including what to look for in their patients, and how to address the topic of depression when society expects the very opposite. This is unfortunate, as the majority of German mothers have ample contact with medical professionals during the peri- and postpartum period, who could easily be trained to identify symptoms and women at risk before the disorder becomes full-blown. It would appear, however, that the apparent inhibition of healthcare workers to openly address depression in new mothers is prevalent in the current maternity healthcare circles. Evidence for this is that when we interviewed participants who were diagnosed in the study as having a mental illness at 6 or 12-weeks postpartum, few, if any, reported being asked by either their gynecologist or pediatrician about their symptoms or general mental wellbeing.

This is clearly an indication that more education is needed for medical professionals both to better acquaint them with the symptoms of PPD and how to best address this topic with patients. Simple courses explaining what to look for and how to approach the subject during check-ups (with the parents or infant) in the year after birth should suffice. This education should include training in the administration and scoring of the EPDS, which essentially is a quick and easy to score screening tool that could very well be administered by any medical professional. At the very least, it should be a standard part of the 6-week postpartum gynecological checkup recommended for all new mothers in Germany. Finally, professionals should be provided a guideline of what to do and to whom to refer patients if symptoms are present.

In addition to educational campaigns about the risk factors for and symptoms of PPD, we recommend expectant parents to attend a class *during pregnancy* and for a period of time thereafter that provides both information about infant development (e.g. what defines normal

sleep and nursing patterns), as well as common issues that may arise in the couples' relationship (e.g. changes in the sexual relationship, roles, and available time to spend together), and ways of addressing such issues. In today's world, many first time parents have had no previous experience with newborns, or small children, before the arrival of their own baby. Lack of basic knowledge about infant care, along with unrealistic expectations of life with a new infant, can add a dimension of difficulty to the already challenging adjustment period when a baby first comes home. These classes would also be the ideal platform for expectant parents to receive additional and more detailed information on PPD. Mothers and their partners could be told explicitly that mothers with depression are more hypervigilant toward negative facial expressions from infants and how a lack of positive feedback is thought to be one of the paths leading to depression, thus making PPD a more approachable problem that one is allowed to talk about.

Conclusion

Postpartum depression (PPD) is a devastating disorder that causes collateral damage to generations of the sufferer's family. The rapidness with which it negatively impacts child development is alarming and emphasizes the need to identify risk factors for the disorder. Additionally, while the topic of PPD has been well researched, findings are often contradictory or deviate to such a degree that there are still many aspects that are little understood. Thus, the need for further research on the subject remains. Ultimately, a better understanding of the disorder will enable healthcare workers to create more effective preventive and treatment programs.

Women with depression show low maternal sensitivity toward their babies. It has been shown that their processing of infant emotions deviates from healthy mothers (Pearson et al., 2010), that they perceive their child's behavior as more negative than neutral observers (Field et al., 1993), and infant distress cries as less urgent sounding (Schuetze & Zeskind, 2001). What's more, depressed mothers respond more to negative emotions from their infants, show fewer positive expressions, are less engaged, and show less eye-to-eye contact and more negative behavior to signals of distress from their infant. Finally, women with severe depression were the least likely to choose social behavioral responses to high pitched crying, such as picking up and cuddling, preferring the options of feeding and cleaning the baby (Schuetze & Zeskind, 2001).

Due to the negative impact low-sensitive parenting and in particular poor attachment can have on developing children, effective interventions are vital. Interventions aimed at increasing

sensitivity and the parent-child attachment do show some promise. Bakermans-Kranenburg, Van Ijzendoorn, and Juffer (2003) conducted a meta-analysis investigating the effectiveness of 88 different intervention programs. Methods included trying to directly change maternal behavior (e.g. via video feedback), changing representations (i.e. the internal working model of the parent-child relationship or of one's past), changing environmental factors (e.g. social support), and a combination of two or more of these factors. The analyses revealed that interventions can improve maternal sensitivity, but are less able to mend insecure mother-child attachments. Furthermore, interventions aimed at maternal sensitivity within samples of depressed or anxious mothers had a greater effect. Encouraging is that in particular interventions aimed at teaching parents how to better understand their infant's signals show improvement in parental sensitivity (van den Boom, 1994).

The overriding goal of the present study was to better understand the relationship between maternal perceptual sensitivity (MPS) and postpartum depression. We had originally hypothesized that poor perception of infant signals may be the key link between poor maternal sensitivity and depression and that poor MPS could predict the onset of depression in the postpartum period. In our original model we postulated that a poor perception of infant signals from the mother would result in maladaptive interactions in the mother-infant dyad. Not being able to properly perceive her infant's signals, she would experience feelings of low self-efficacy and would be less adequate in meeting her infant's needs, thereby triggering more negative affect in the infant. She then would withdraw even further from her baby and depression would build. Our findings refute this model. Poor perception of infant signals did not predict depression. Rather, a higher, not lower, sensitivity toward negative infant expressions predicted depression within the postpartum period. This is a novel finding. Moreover, women with higher levels of depression symptoms were better at identifying low intensity level negative expressions than were women with fewer symptoms – a pattern we dubbed a *sensitivity error*. Notably, however, this pattern was not a bias, in that neutral expressions were not more frequently identified as negative. Poor perception is thus not the primary difficulty that leads to poor maternal sensitivity in depressed mothers, but rather an exaggerated ability to detect negative expressions may be. This indicates that poor interpretation of very mild negative facial expression and consequent incongruent behavioral responses to that signal may be the key element in the relationship between poor maternal behavioral sensitivity and depression.

Additional findings from this study show other mental health disorders put women at risk for developing PPD. Furthermore, a history of miscarriage appears to put women at risk, which is a topic that is not well addressed in the current research. Social support, especially from family and friends, provides protection against onset of depression in the postpartum period. Finally, breastfeeding lowers the risk for depression, although the mechanisms thereof are still unknown and deserve more attention.

In the light of our findings and also our personal conversations with midwives as well as with the young mothers we have studied, we are convinced that mental health professionals, midwives, as well as women's health professionals must be more open about discussing PPD with expectant mothers. Informing patients and their partners about the symptoms of PPD and where the line is between baby blues and depression – for which one should seek professional help – should be standard in prenatal check-ups. Inquiring about maternal mental health history and being open about discussing previous miscarriages may help professionals red-flag women at high risk.

While we hope that these recommendations will be followed up upon, scientifically our study asks for more research on the identified *sensitivity error* to be conducted. Our proposed interpretation needs to be evaluated further. Can the identified over-sensitivity to subtle negative cues be indeed the key causal factor that fosters the development of PPD? Can it be replicated, also for other negative cues – such as mild wining versus actual crying of the baby? Also, it is difficult to conclude from this study whether or not negative auditory and visual signals are perceived in a similar manner, seeing that some, but not all, of the data investigating the question of correlations across the audio and visual senses were significant. This is a question that needs to be further addressed. Moreover, considering potential treatment options, it needs to be answered if the identified *sensitivity error* can be ameliorated? And if so, could it lower the risk for PPD? We are certain that further research addressing these questions will lead not only to a better understanding of why depressed mothers so frequently are less able to provide the warm, empathetic, sensitive care that we would wish all infants to receive, but also to the development of effective courses of actions that prevent – or at least ameliorate – PPD and the negative effects it has on mother and child.

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Appendix A

Table A1. Measurement Tools Used for the Main Study

T1: 27th – 40th Week of Pregnancy

In-Lab with mother

- Structured Clinical Interview for DSM Disorders (SCID)
- Structured Clinical Interview for DSM Disorders Axis II Personality Disorders (SCID - II)
- Inventory of Depression Symptomology – Clinician rated (IDS-C)
- Edinburgh Postnatal Depression Scale (EPDS)
- Center for Epidemiologic Studies *Depression* Scale (CES-D)
- Audio maternal perceptual sensitivity (MPS)
- Visual MPS
- Respiratory sinus arrhythmia (RSA)(mother)

Questionnaires

- T1 Sociodemographic Questionnaire (mother)
- Childhood Experience of Care and Abuse Questionnaire (CECA)
- Emotion Regulation Questionnaire (ERQ)
- Cognitive Emotion Regulation Questionnaire (CERQ)
- EPDS (father)

Table A1 (continued).

T2: 5 – 8 Weeks Postpartum

Questionnaires

- T2 Sociodemographic Questionnaire (mother)
- EPDS (father)
- Fragebogen zum Schreien, Füttern und Schlafen (SFS) (mother and father each)
- Infant Behavior Questionnaire – Revised (IBQ-R) (mother and father each)

T3: 11-14 Weeks Postpartum

In-Lab with mother and baby

- SCID
- HRSD
- IDS-C
- EPDS
- CES-D
- Visual Point of Subjective Equality (PSE)
- Stillface Paradigm
- RSA (baby)

Questionnaires

- T3 Sociodemographic Questionnaire (mother)
- EPDS (father)
- SFS (mother and father each)
- IBQ-R (mother and father each)

Table A2. Descriptive Statistics for MPS d' at T1 and T2: Full Visual Data Set

	N	*M*	*SD*
Audio T1	**117**	**1.80**	**0.64**
Happy Visual T1	**117**	**2.84**	**0.73**
Sad Visual T1	**117**	**2.82**	**0.60**
Audio T2	**113**	**1.94**	**0.70**
Happy Visual T2	**110**	**2.80**	**0.71**
Sad Visual T2	**110**	**3.00**	**0.72**

Note. *M* = mean, *SD* = standard deviation.

Table A3. Descriptive Statistics for MPS d' at T1 and T2: Reduced Visual Data Set

	N	*M*	*SD*
Happy Visual T1	**117**	**2.21**	**0.86**
Sad Visual T1	**117**	**2.30**	**0.63**
Happy Visual T2	**110**	**2.14**	**0.79**
Sad Visual T2	**110**	**2.50**	**0.80**

Note. *M* = mean, *SD* = standard deviation.

Table A4. Descriptive Statistics for MPS Accuracy at T1 and T2: Full Visual Data Set

	N	*M*	*SD*
Audio T1	**117**	**0.74**	**0.11**
Happy Visual T1	**117**	**0.85**	**0.10**
Sad Visual T1	**117**	**0.85**	**0.08**
Audio T2	**113**	**0.75**	**0.13**
Happy Visual T2	**110**	**0.83**	**0.11**
Sad Visual T2	**110**	**0.88**	**0.09**

Note. *M* = mean, *SD* = standard deviation.

Table A5. Descriptive Statistics for MPS Accuracy at T1 and T2: Reduced Visual Data Set

	N	*M*	*SD*
Happy Visual T1	**117**	**0.74**	**0.18**
Sad Visual T1	**117**	**0.77**	**0.14**
Happy Visual T2	**110**	**0.72**	**0.19**
Sad Visual T2	**110**	**2.50**	**0.15**

Note. *M* = mean, *SD* = standard deviation.

Table A6. Two-tailed Correlations between Sensitivity d' and Sociodemographic Items at T1

Variables		Audio T1	Happy block T1	Sad block T1
Age	r =	**-.141**	**.160**	**.039**
	p =	**.134**	**.088**	**.679**
Parity	r_{pb} =	**-.031**	**.101**	**.030**
	p =	**.740**	**.279**	**.751**
Cohabitation	r_{pb} =	**.162**	**-.001**	**-.015**
	p =	**.088**	**.988**	**.876**
Income	r =	**.023**	**-.089**	**.145**
	p =	**.809**	**.360**	**.133**
Education	r_s =	**.121**	**.271****	**.093**
	p =	**.205**	**.004**	**.331**
Music lessons (in years)	r =	**.283****	-	-
	p =	**.001**		
Previous MDE	r_{pb} =	**-.045**	**-.091**	**.010**
	p =	**.627**	**.328**	**.913**
Other mental illness	r_{pb} =	**.282****	**-.018**	**.016**
	p =	**.002**	**.848**	**.862**
Pregnancy complications	r_{pb} =	**-.007**	**-.021**	**.087**
	p =	**.939**	**.827**	**.359**
Spouse support	r_{pb} =	**.093**	**.027**	**-.058**
	p =	**.317**	**.773**	**.537**
Family support	r_{pb} =	**-.125**	**.081**	**.013**
	p =	**.179**	**.386**	**.890**
Miscarriage	r_{pb} =	**.076**	**.058**	**-.115**
	p =	**.415**	**.535**	**.217**

Note. ** Correlation is significant at the 0.01 level;

Table A7. Two-tailed Correlations between MPS d' and Sociodemographic Items at T2

Variables		Audio T2	Happy Block T2	Sad Block T2
Age	r =	**-.067**	**.041**	**.058**
	p =	**.488**	**.669**	**.550**
Parity	r_{pb} =	**-.068**	**-.057**	**.075**
	p =	**.472**	**.556**	**.438**
Cohabitation	r_{pb} =	**.103**	**.094**	**.150**
	p =	**.292**	**.343**	**.128**
Income	r =	**-.223***	**.076**	**.054**
	p =	**.022**	**.448**	**.586**
Education	r_s =	**.123**	**.248***	**.022**
	p =	**.206**	**.011**	**.822**
Music lessons (in years)	r =	**.253****	**-**	**-**
	p =	**.007**		
Previous MDE	r_{pb} =	**-.122**	**-.111**	**.022**
	p =	**.199**	**.246**	**.823**
Other mental illness	r_{pb} =	**.235***	**.041**	**-.045**
	p =	**.012**	**.673**	**.643**
Pregnancy complications	r_{pb} =	**-.142**	**-.055**	**-.084**
	p =	**.141**	**.573**	**.392**
Birth complications	r_{pb} =	**-.011**	**-.042**	**-.086**
	p =	**.906**	**.668**	**.374**
Nursing	r_{pb} =	**.209***	**.122**	**.032**
	p =	**.027**	**.205**	**.741**
Spouse support	r_{pb} =	**-.048**	**.050**	**-.087**
	p =	**.614**	**.603**	**.369**
Family support	r_{pb} =	**.052**	**.103**	**-.081**
	p =	**.585**	**.285**	**.401**
Miscarriage	r_{pb} =	**.147**	**.130**	**-.020**
	p =	**.121**	**.174**	**.836**

Note. ** Correlation is significant at the 0.01 level, * Correlation is significant at the 0.05 level.

Table A8. Two-tailed Correlations between Depression and Sociodemographic items

Variables		EPDS T2	IDS-C T2	EPDS T3	IDS-C T3
Age	r =	**.034**	**.017**	**-.019**	**.029**
	p =	**.714**	**.860**	**.840**	**.760**
Income	r =	**.010**	**-.029**	**-.087**	**-.019**
	p =	**.915**	**.761**	**.367**	**.846**
Education	r_s =	**.033**	**.099**	**-.143**	**-.095**
	p =	**.730**	**.298**	**.134**	**.319**
Previous MDE	r_{pb} =	**.022**	**.074**	**.093**	**.096**
	p =	**.048**	**.429**	**.317**	**.303**
Other mental illness	r_{pb} =	**.181***	**.124**	**.090**	**.025**
	p =	**.048**	**.181**	**.335**	**.787**
Pregnancy complications	r_{pb} =	**.053**	**.021**	**.114**	**.002**
	p =	**.575**	**.821**	**.230**	**.983**
Birth complications	r_{pb} =	**-.074**	**-.043**	**-.004**	**-.014**
	p =	**.433**	**.648**	**.969**	**.886**
Nursing	r_{pb} =	**-.237***	**-.112**	**-.031**	**-.048**
	p =	**.011**	**.237**	**.746**	**.610**
Spouse support	r_{pb} =	**-.044**	**-.032**	**-.244****	**-.093**
	p =	**.634**	**.734**	**.008**	**.319**
Family support	r_{pb} =	**-.165**	**-.113**	**-.275***	**-.140**
	p =	**.073**	**.226**	**.003**	**.134**
Miscarriage	r_{pb} =	**.219***	**.121**	**.199***	**.196***
	p =	**.017**	**.195**	**.031**	**.034**

Note. ** Correlation is significant at the 0.01 level, * correlation is significant at the 0.05 level. The items nursing, spouse support and family support were measured at T2 and T3. Correlations were calculated within measurement times, i.e. nursing as measured at T2 and the depression symptoms as measured at T2.

Appendix B

Wir bitten Sie um allgemeine Angaben zu Ihrer Person. Kreuzen Sie Zutreffendes bitte jeweils an oder ergänzen Sie wenn nötig schriftlich.

Heutiges Datum:_____

1. Schwangerschaftswoche:	
2. Voraussichtlicher Geburtstermin des Babys:	
3. Eigenes Geburtsdatum:	
4. Familienstand:	○ Ledig ○ Verheiratet ○ Eingetragene Partnerschaft ○ Geschieden ○ Verwitwet ○ Trennung
5. Lebenssituation: Wie leben Sie aktuell?	○ Kein Partner/-in, allein lebend ○ Zusammenzug während Schwangerschaft ○ Bereits zuvor Zusammenlebend ○ Getrennt lebend ○ Anders, nämlich: _____ _____ _____
6. Höchster Bildungsabschluss:	○ Kein Schulabschluss ○ Hauptschulabschluss ○ Realschule (Mittlere Reife) ○ Fachhochschulreife ○ Gymnasium (Abitur) ○ Hochschulstudium ○ Anderer Schulabschluss, nämlich _____

7. Sind Sie berufstätig?
   - Wenn **ja** welcher Berufsgruppe ordnen Sie sich zu?
     - Inhaberin, Geschäftsführerin eines großen Unternehmens
     - Freier Beruf
     - Mittlere und kleinere selbstständige Geschäftsleute
     - Selbstständige Handwerkerin
     - Leitende Angestellte
     - Landwirtin
     - Fachbearbeiterin
     - Sonstige Arbeiterin
     - Beamtin- mittlerer Dienst & gehobener Dienst
   - Wenn **nein**, welcher Gruppe ordnen Sie sich zu?
     - Schülerin
     - Studentin
     - Auszubildende
     - Hausfrau
     - Arbeitslos
     - Ohne Beruf

8. Aktuell/Zuletzt ausgeführte Berufsbezeichnung:

9. Falls Sie berufstätig sind, inwieweit sind Sie mit ihrer Arbeitssituation zufrieden?
   - Sehr unzufrieden
   - Unzufrieden
   - Eher unzufrieden
   - Weder/noch
   - Eher zufrieden
   - Zufrieden
   - Sehr zufrieden

10. Falls Sie berufstätig sind, ab welcher Schwangerschaftswoche werden oder haben Sie mit dem Mutterschutzurlaub angefangen?

11. Nationalität der Mutter:
    - Deutsch
    - Eine andere, nämlich

    _____

    _____

12. Nationalität des Vaters
    - Deutsch
    - Eine andere, nämlich

    _____

    _____

13. Muttersprache:
    - o Deutsch
    - o Eine andere, nämlich _____

14. Haben Sie bereits Kinder?
    - o Nein
    - o Ja

15. **Falls Sie bereits Kinder haben:** Wie viele haben Sie? Und wie alt sind diese?
    - o Wenn **ja**, wie viele haben Sie? _____ _____
    - o Wie alt sind diese? _____ _____

16. **Falls Sie noch keine Kinder haben:**
    - Haben Sie jüngere Geschwister mit einem Altersabstand von mindestens 5 Jahren?
        - o Nein
        - o Ja
    - Hatten Sie seit Ihrem 6. Lebensjahr über mindestens ein halbes Jahr regelmäßig Kontakt zu einem Baby/Babys (0-18 Monate)?
        - o Nein
        - o Ja
    - Wie intensiv war/ist dieser Kontakt zu einem Baby/Babys (0-18 Monate)?
        - o Sehr intensiv
        - o Intensiv
        - o Mittelmäßig
        - o Wenig intensiv
        - o Sehr gering

17. **Falls Sie bereits Kinder haben:**
Sind Sie mit der Betreuungssituation Ihrer Kinder zufrieden? (z.B. mit den Betreuungszeiten)

- o Ich habe keine Kinder
- o Nein
- o Ja
- o Wenn **nein**, weshalb

_____

_____

_____

_____

18. Haben oder hatten Sie irgendwelche körperlichen Krankheiten?

- o Nein
- o Ja
- o Falls ja, welche?

_____

_____

_____

_____

_____

_____

_____

19. Nehmen Sie aktuell oder haben Sie über einen längeren Zeitraum Medikamente eingenommen?

- o Nein
- o Ja
- o Wenn ja, welche und welche Dosierung?

_____

_____

_____

_____

_____

_____

20. Haben Sie eine Sehbeeinträchtigung?

- o Nein
- o Ja
  - o Falls **ja**, haben Sie eine Sehhilfe (Brille, Kontaktlinsen etc.)?
    - o Ja
    - o Nein
  - o Falls **ja**, ist Ihre Beeinträchtigung aktuell ausreichend korrigiert?
    - o Ja
    - o Nein

21. Haben Sie eine Hörbeeinträchtigung?

- o Nein
- o Ja
  - o Falls **ja**, ist Ihre Beeinträchtigung aktuell ausreichend korrigiert?
    - o Ja
    - o Nein

22. Sind in der aktuellen Schwangerschaft bislang irgendwelche Komplikationen aufgetreten?

Falls **ja**, welche?

- o _____
  _____
  _____
  _____
  _____
  _____

23. Wie zufrieden sind Sie mit der Betreuung durch Ihre Hebamme?

- o Ich habe keine Hebamme

- o Sehr unzufrieden
- o Unzufrieden
- o Eher unzufrieden
- o Weder/ noch
- o Eher zufrieden
- o Zufrieden
- o Sehr zufrieden

24. Wie zufrieden sind Sie mit der Betreuung durch Ihren Frauenarzt/Ihre Frauenärztin?

- o Sehr unzufrieden
- o Unzufrieden
- o Eher unzufrieden
- o Weder/ noch
- o Eher zufrieden
- o Zufrieden
- o Sehr zufrieden

25. Wie zufrieden sind Sie mit der Unterstützung durch Ihren Familien- & Freundeskreis?

- o Sehr unzufrieden
- o Unzufrieden
- o Eher unzufrieden
- o Weder/ noch
- o Eher zufrieden
- o Zufrieden
- o Sehr zufrieden

26. Wie zufrieden sind Sie mit der Unterstützung durch Ihren Partner/Ihre Partnerin?
   - o Sehr unzufrieden
   - o Unzufrieden
   - o Eher unzufrieden
   - o Weder/ noch
   - o Eher zufrieden
   - o Zufrieden
   - o Sehr zufrieden

27. Haben Sie jemals professionellen Musikunterricht erhalten? (z.B. in einer Musikschule oder bei einem Musiklehrer)
   - o Nein
   - o Ja
   - o Falls **ja**, über wie viele Jahre wurden Sie unterrichtet?

_____

_____

Es ist Ihnen freigestellt, ob Sie zu den nächsten Fragen Angaben machen möchten oder nicht.

28. Leiden Sie aktuell unter einer psychiatrischen Krankheit oder ist bei Ihnen jemals eine psychiatrische Krankheit diagnostiziert worden? (z.B. Depression, Essstörung, Schizophrenie, etc.)
   - o Nein
   - o Ja
   - o Falls **ja**, welche Diagnose?

_____

_____

_____

   - o und wann wurde sie festgestellt?

_____

_____

_____

29. Waren oder sind Sie selbst in psychologischer Behandlung?
   - o Nein
   - o Ja
   - o Wenn, **ja**, weshalb

_____

_____

_____

30. Leidet oder litt innerhalb ihrer Familie jemand an einer psychiatrischen Krankheit? (z.B. Depression, Essstörung, Schizophrenie)

- o Nein
- o Ja
- o Falls **ja**, was ist/war die Diagnose und wann wurde sie gestellt?

_____

_____

_____

_____

31. Derzeitiges zur Verfügung stehendes monatliches **Nettoeinkommen** – beinhaltet das eigene und ggf. auch das Einkommen des **Partners/der Partnerin** (nach Abzug der Steuern)

- o 0-399 Euro
- o 400-799
- o 800-1199
- o 1200-1799
- o 1800-2300
- o 2400-2999
- o 3000-3999
- o 4000-4999
- o 5000 Euro oder mehr

32. Ist die aktuelle Schwangerschaft gewollt?

- o Nein
- o Ja

33. Sind Sie während des bisherigen Schwangerschaftsverlaufes stressigen Ereignissen ausgesetzt gewesen?

- o Nein
- o Ja
- o Wenn, **ja**, welchen

_____

_____

_____

_____

_____

_____

34. Haben Sie seit Beginn der aktuellen Schwangerschaft Alkohol getrunken?

- o Nein, nie
- o Sehr selten (1-5) Gläser seit Beginn der Schwangerschaft)
- o Selten (6-9) Gläser seit Beginn der Schwangerschaft)
- o Oft (10-15) Gläser seit Beginn der Schwangerschaft)
- o 15 Gläser oder mehr seit Beginn der Schwangerschaft

35. Haben Sie seit Beginn der aktuellen Schwangerschaft geraucht?

- o Nein, nie
- o Ja, täglich weniger als 1 Zigarette pro Tag
- o 1-5 Zigaretten pro Tag
- o 6-10 Zigaretten pro Tag
- o 11-15 Zigaretten pro Tag
- o 16-20 Zigaretten pro Tag
- o 20 Zigaretten oder mehr pro Tag

36. Haben Sie während der aktuellen Schwangerschaft illegale Drogen konsumiert?

- o Nein
- o Ja
- o Wenn **ja**, welche

_____

_____

_____

_____

37. Haben Sie jemals ein Kind (während der Schwangerschaft) verloren?

- o Nein
- o Ja
- o Wenn **ja**, wie

_____

_____

_____

_____

_____

38. Haben Sie jemals einen Schwangerschaftsabbruch unternommen?

- o Nein
- o Ja

Questionnaire B2. Soziodemographischer Fragebogen zu T2

Wir bitten Sie um allgemeine Angaben zu Ihrer Person. Zutreffendes bitte jeweils ankreuzen oder schriftlich ergänzen.

Heutiges Datum:_____

Liebe Teilnehmerinnen,

bitte wundern Sie sich nicht über ähnliche Fragestellungen, es geht uns um die zeitliche Veränderung - alle Fragen beziehen sich auf den Zeitraum seit der letzten Sitzung.

1. Momentane Lebenswoche des Babys:	
2. Geburtstag des Kindes:	
3. Geschlecht des Kindes:	
4. Name des Kindes:	
5. Eigenes Geburtsdatum:	
6. Familienstand:	o Ledig o Verheiratet o Eingetragene Partnerschaft o Geschieden o Verwitwet o Trennung
7. Lebenssituation: Wie leben Sie aktuell?	o Kein Partner/-in, allein lebend o Zusammenzug während Schwangerschaft o Bereits zuvor Zusammenlebend o Getrenntlebend,seit:_____ _____ o Anders, nämlich: _____ _____

8. Sind Sie aktuell körperlich gesund?
   - o Nein
   - o Ja
   - o Wenn nein, **unter was leiden Sie**?

   _____

   _____

9. Nehmen Sie aktuell Medikamente ein?
   - o Nein
   - o Ja
   - o Wenn ja, welche und welche Dosierung?

   _____

   _____

10. Wo haben Sie entbunden?
    - o Klinik – welche?_____
    - o Geburtshaus
    - o Zu Hause
    - o Sonstiges:

    _____

    _____

11. Aufenthalt nach der Geburt:
    - o Ambulant
    - o Klinikaufenthalt (mehr als 24 h)
    - o Wenn Klinikaufenthalt, wie lange war dieser in Tagen?

    _____

12. Geburtsgewicht des Kindes in Gramm:

13. Größe des Kindes bei der Geburt in cm:

14. Kopfumfang des Kindes bei der Geburt in cm:

15. Wenn Sie eine/n (Ehe-) Partner/in haben, war dieser während der Geburt dabei?
    - o Nein
    - o Ja
    - o Ich habe keine(n) Partner(in)

16. Haben Sie sich während der Geburt geborgen gefühlt?
    - o Nein
    - o Ja

17. Sind während der Geburt Komplikationen aufgetreten?
- o Nein
- o Ja
- o Wenn ja, welche?

_____
_____
_____
_____

18. Sind nach der Geburt Komplikationen aufgetreten?
- o Nein
- o Ja
- o Wenn ja, welche?

_____
_____
_____
_____
_____
_____

19. Wie zufrieden sind/waren Sie mit der Betreuung durch Ihre Ärzte?
- o Sehr unzufrieden
- o Unzufrieden
- o Eher unzufrieden
- o Weder/ noch
- o Eher zufrieden
- o Zufrieden
- o Sehr zufrieden

20. Wie zufrieden sind/ waren Sie mit der Betreuung durch Ihre Hebamme?
- o Ich habe keine Hebamme
- o Sehr unzufrieden
- o Unzufrieden
- o Eher unzufrieden
- o Weder/ noch
- o Eher zufrieden
- o Zufrieden
- o Sehr zufrieden

21. Ist Ihr Kind gesund auf die Welt gekommen?
- o Nein
- o Ja
- o Wenn nein, was hat/te es?

_____
_____

_____

_____

22. Ist Ihr Kind aktuell gesund?

- o Nein
- o Ja
- o Wenn nein, was hat/te es?

_____

_____

_____

_____

_____

23. Haben Sie das Gefühl Ihr Kind ist besonders quengelig?

- o Nein
- o Ja
- o Wenn ja, was hat/te es?

_____

_____

_____

_____

_____

24. Stillen Sie Ihr Baby?

- o Nein
- o Ja
- o Wenn nein, aus welchen Gründen nicht?

_____

_____

_____

_____

_____

25. Falls Sie nicht stillen, haben Sie jemals dieses Baby gestillt?

- o Nein
- o Ja

26. Sind seit unserem letzten Termin irgendwelche Komplikationen während der Schwangerschaft aufgetreten?
    - o Nein
    - o Ja
    - o Falls **ja**, welche?

    _____
    _____
    _____
    _____
    _____

27. Wie viele Stunden Schlaf bekommen Sie pro Nacht im Durchschnitt?
    - o Sehr unzufrieden
    - o Unzufrieden
    - o Eher unzufrieden
    - o Weder/ noch
    - o Eher zufrieden
    - o Zufrieden
    - o Sehr zufrieden

28. Wie zufrieden sind Sie mit dem Schlafverhalten Ihres Kindes?
    - o Sehr unzufrieden
    - o Unzufrieden
    - o Eher unzufrieden
    - o Weder/ noch
    - o Eher zufrieden
    - o Zufrieden
    - o Sehr zufrieden

29. Wie zufrieden sind Sie mit dem Schreiverhalten Ihres Kindes?
    - o Sehr unzufrieden
    - o Unzufrieden
    - o Eher unzufrieden
    - o Weder/ noch
    - o Eher zufrieden
    - o Zufrieden
    - o Sehr zufrieden

30. Insofern Sie einen/e Partner-in haben, wie zufrieden sind Sie mit dessen/deren Unterstützung seit der Geburt Ihres Kindes?
    - o Sehr unzufrieden
    - o Unzufrieden
    - o Eher unzufrieden
    - o Weder/ noch
    - o Eher zufrieden
    - o Zufrieden
    - o Sehr zufrieden

31. Wie zufrieden sind Sie mit der Unterstützung durch Ihre Familie?
   - o Sehr unzufrieden
   - o Unzufrieden
   - o Eher unzufrieden
   - o Weder/ noch
   - o Eher zufrieden
   - o Zufrieden
   - o Sehr zufrieden

32. Wenn Sie normalerweise berufstätig sind, wie viel Zeit planen Sie insgesamt zu pausieren/oder haben Sie bereits pausiert, wenn Sie schon wieder in den Beruf eingestiegen sind?
   - _____
   - o Ich bin nicht berufstätig

33. Falls Sie bereits andere Kinder (nicht das Neugeborene) haben, wie schätzen Sie die Zufriedenheit Ihrer Kinder mit der neuen Situation ein?
   - o Sehr unzufrieden
   - o Unzufrieden
   - o Eher unzufrieden
   - o Weder/ noch
   - o Eher zufrieden
   - o Zufrieden
   - o Sehr zufrieden

34. Wer ist die Hauptbezugsperson Ihres Babys?
   - o Mutter
   - o Vater
   - o Andere_____

35. Wie viele **Stunden** pro Woche verbringt die Hauptbezugsperson mit dem Baby? (Gesamte verbrachte Zeit, auch schlafen)
   - _____

36. Wer ist die zweite Hauptbezugsperson des Babys?
   - o Vater
   - o Mutter
   - o Andere_____

37. Wie viele **Stunden** pro Woche verbringt Ihr Baby mit der zweiten Hauptbezugsperson (Bsp.: Vater, Gesamte verbrachte Zeit, auch schlafen)

_____

38. Wird Ihr Baby von anderen Personen/Einrichtungen betreut?

- o Nein
- o Ja
- o Wenn ja, welche

_____

_____

39. Falls Ihr Baby von weiteren anderen Personen/Einrichtungen betreut wird, wie zufrieden sind Sie mit der Betreuung?

- o Sehr unzufrieden
- o Unzufrieden
- o Eher unzufrieden
- o Weder/ noch
- o Eher zufrieden
- o Zufrieden
- o Sehr zufrieden

40. Falls Ihr Baby durch weitere andere Personen betreut wird, wie viele Stunden in der Woche verbringt es ca. mit den anderen Personen?

_____

Es ist Ihnen freigestellt, ob Sie zu den nächsten Fragen Angaben machen oder nicht.

41. Sind Sie seit der Geburt stressigen Ereignissen ausgesetzt gewesen?

- o Nein
- o Ja
- o Wenn ja, was für welchen?

_____

_____

_____

42. Haben Sie seit der Geburt Ihres Kindes Alkohol getrunken?
- o Nein, nie
- o ca. 1-5 Gläser pro Woche seit der Geburt
- o ca. 6-9 Gläser pro Woche seit der Geburt
- o ca. 10-15 Gläser pro Woche seit der Geburt
- 15 oder mehr Gläser pro Woche seit der Geburt

43. Haben Sie seit der Geburt Ihres Kindes geraucht?
- o Nein, nie
- o Ja, täglich weniger als 1 Zigarette pro Tag
- o 1-5 Zigaretten pro Tag
- o 6-10 Zigaretten pro Tag
- o 11-15 Zigaretten pro Tag
- o 16-20 Zigaretten pro Tag
- o 20 Zigaretten oder mehr pro Tag

44. Haben Sie seit der Geburt Ihres Kindes illegale Drogen konsumiert?
- o Nein
- o Ja
- o Wenn ja, welche?

_____

_____

45. Waren oder sind Sie selbst seit der Geburt in psychologischer Behandlung?
- o Nein
- o Ja
- o Wenn ja, weshalb?

_____

_____

_____

_____

_____

46. Was können wir verbessern?

_____

_____

_____

_____

_____

_____

_____

_____

-Vielen Dank für Ihre Teilnahme-

Questionnaire B3. Soziodemographischer Fragebogen zu T3

Wir bitten Sie um allgemeine Angaben zu Ihrer Person. Zutreffendes bitte jeweils ankreuzen oder schriftlich ergänzen.

Heutiges Datum:_____

Liebe Teilnehmerinnen,

bitte wundern Sie sich nicht über ähnliche Fragestellungen, es geht uns um die zeitliche Veränderung - alle Fragen beziehen sich auf den Zeitraum seit der letzten Sitzung.

1. Momentane Lebenswoche des Babys:	
2. Geburtstag des Kindes:	
3. Eigenes Geburtsdatum:	
4. Familienstand:	o Ledig o Verheiratet o Eingetragene Partnerschaft o Geschieden o Verwitwet o Trennung
5. Sind Sie aktuell gesund?	o Nein o Ja o Wenn nein, **unter was leiden Sie**? _____ _____
6. Nehmen Sie aktuell Medikamente ein?	o Nein o Ja o Wenn ja, welche und welche Dosierung? _____ _____

7. Lebenssituation: Wie leben Sie aktuell?

- o Kein Partner/-in, allein lebend
- o Aktueller Zusammenzug
- o Bereits zuvor Zusammenlebend
- o Getrenntlebend seit:

_____

- o Anders, nämlich:

_____

_____

_____

_____

8. Sind seit der letzten Sitzung Komplikationen aufgetreten?

- o Nein
- o Ja
- o Wenn ja, **wann** und **welche**?

_____

_____

9. Wie zufrieden sind/waren Sie mit der Betreuung durch Ihre Ärzte?

- o Sehr unzufrieden
- o Unzufrieden
- o Eher unzufrieden
- o Weder/ noch
- o Eher zufrieden
- o Zufrieden
- o Sehr zufrieden

10. Wie zufrieden sind/waren Sie mit der Betreuung durch Ihre Hebamme?

- o Ich habe keine Hebamme

- o Sehr unzufrieden
- o Unzufrieden
- o Eher unzufrieden
- o Weder/ noch
- o Eher zufrieden
- o Zufrieden
- o Sehr zufrieden

11. Ist Ihr Kind aktuell gesund?
    - o Nein
    - o Ja
    - o Wenn nein, was hat/te es?

    _____

    _____

    _____

    _____

    _____

12. Haben Sie das Gefühl Ihr Kind ist besonders quengelig?
    - o Nein
    - o Ja
    - o Wenn ja, was hat/te es?

    _____

    _____

    _____

    _____

    _____

13. Stillen Sie Ihr Baby?
    - o Nein
    - o Ja
    - o Falls nein, aus welchen Gründen nicht?

    _____

    _____

    _____

    _____

14. Falls Sie nicht stillen, haben Sie jemals dieses Baby gestillt?
    - o Nein
    - o Ja

15. Wie viele Stunden Schlaf bekommen Sie pro Nacht im Durchschnitt?

16. Wie zufrieden sind Sie mit dem Schlafverhalten Ihres Kindes?
    - o Sehr unzufrieden
    - o Unzufrieden
    - o Eher unzufrieden
    - o Weder/ noch
    - o Eher zufrieden
    - o Zufrieden
    - o Sehr zufrieden

17. Wie zufrieden sind Sie mit dem Schreiverhalten Ihres Kindes?
- o Sehr unzufrieden
- o Unzufrieden
- o Eher unzufrieden
- o Weder/ noch
- o Eher zufrieden
- o Zufrieden
- o Sehr zufrieden

18. Insofern Sie einen/e Partner-in haben, wie zufrieden sind Sie mit dessen/deren Unterstützung?
- o Sehr unzufrieden
- o Unzufrieden
- o Eher unzufrieden
- o Weder/ noch
- o Eher zufrieden
- o Zufrieden
- o Sehr zufrieden

19. Wie zufrieden sind Sie mit der Unterstützung durch Ihre Familie?
- o Sehr unzufrieden
- o Unzufrieden
- o Eher unzufrieden
- o Weder/ noch
- o Eher zufrieden
- o Zufrieden
- o Sehr zufrieden

20. Wenn Sie normalerweise berufstätig sind, wie viel Zeit planen Sie insgesamt seit der Geburt zu pausieren?
- o Ich bin nicht berufstätig

_____

21. Falls Sie bereits andere Kinder (nicht das Neugeborene) haben, wie schätzen Sie die Zufriedenheit Ihrer Kinder mit der neuen Situation ein?
- o Sehr unzufrieden
- o Unzufrieden
- o Eher unzufrieden
- o Weder/ noch
- o Eher zufrieden
- o Zufrieden
- o Sehr zufrieden

22. Wer ist die Hauptbezugsperson Ihres Babys?
- o Mutter
- o Vater
- o Andere_____

23. Wie viele **Stunden** pro Woche verbringt die Hauptbezugsperson mit dem Baby? (Gesamte verbrachte Zeit, auch schlafen)

_____

24. Wer ist die zweite Hauptbezugsperson Ihres Babys?

- o Vater
- o Mutter
- o Andere_____

25. Wie viele **Stunden** pro Woche verbringt Ihr Baby mit der zweiten Hauptbezugsperson (Bsp.: Vater, gesamte verbrachte Zeit, auch schlafen)?

_____

26. Wird Ihr Baby von anderen Personen/Einrichtungen betreut?

- o Nein
- o Ja
- o Wenn ja, welche

_____

27. Falls Ihr Baby von weiteren anderen Personen/Einrichtungen betreut wird, wie zufrieden sind Sie mit der Betreuung?

- o Sehr unzufrieden
- o Unzufrieden
- o Eher unzufrieden
- o Weder/ noch
- o Eher zufrieden
- o Zufrieden
- o Sehr zufrieden

28. Falls Ihr Baby durch weitere andere Personen betreut wird, wie viele Stunden in der Woche verbringt es ca. mit den anderen Personen?

Es ist Ihnen freigestellt, ob Sie zu den nächsten Fragen Angaben machen oder nicht.

29. Sind Sie seit der letzten Sitzung stressigen Ereignissen ausgesetzt gewesen?
- o Nein
- o Ja
- o Wenn ja, **wann** und **was für welchen**?

_____

_____

_____

30. Haben Sie seit der letzten Sitzung Alkohol getrunken?
- o Nein, nie
- o ca. 1-5 Gläser pro Woche seit der Geburt
- o ca. 6-9 Gläser pro Woche seit der Geburt
- o ca. 10-15 Gläser pro Woche seit der Geburt
- o 15 oder mehr Gläser pro Woche seit der Geburt

31. Haben Sie seit der letzten Sitzung geraucht?
- o Nein, nie
- o Ja, täglich weniger als 1 Zigarette pro Tag
- o 1-5 Zigaretten pro Tag
- o 6-10 Zigaretten pro Tag
- o 11-15 Zigaretten pro Tag
- o 16-20 Zigaretten pro Tag
- o 20 Zigaretten oder mehr pro Tag

32. Haben Sie seit der letzten Sitzung illegale Drogen konsumiert?
- o Nein
- o Ja
- o Wenn ja, welche?

_____

_____

33. Waren oder sind Sie selbst seit der letzten Sitzung in psychologischer Behandlung?
- o Nein
- o Ja
- o Wenn ja, weshalb?

_____

_____

_____

_____

34. Allgemeine Bemerkungen:

_____

_____

_____

_____,_____

-Vielen Dank für Ihre Teilnahme-