

Psychological and neurophysiological mechanisms of the intergenerational transmission of dysfunctional parenting

Pietro De Carli

Advisor: Prof. Laura Parolin





UNIVERSITY OF MILANO-BICOCCA

DEPARTMENT OF PSYCHOLOGY

DOTTORATO IN PSICOLOGIA SOCIALE, COGNITIVA E CLINICA
CICLO XXVII

Psychological and neurophysiological mechanisms of the intergenerational transmission of dysfunctional parenting

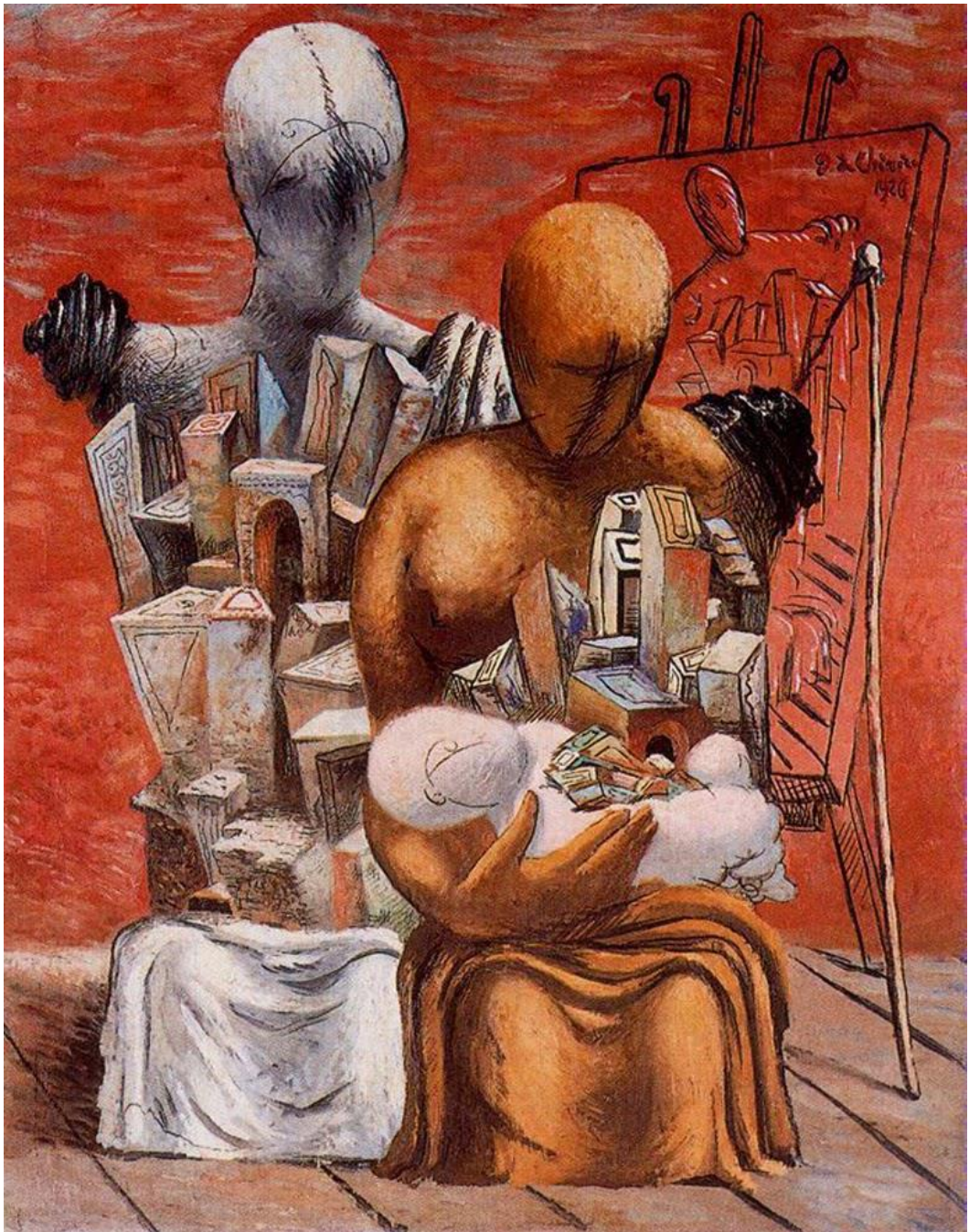
Candidate

Pietro De Carli

Advisor

Prof. Laura Parolin

Academic year 2015-2016



Giorgio de Chirico, *La Famille du peintre*, 1926, oil paint on canvas, 163 x 132 cm, Tate Gallery, London

Front Cover: Giovanni Segantini, *Le cattive madri*, 1894, oil paint on canvas, 105 x 200 cm, Kunsthistorisches Museum Vienna

a smile to remember

we had goldfish and they circled around and around
in the bowl on the table near the heavy drapes
covering the picture window and
my mother, always smiling, wanting us all
to be happy, told me, "be happy Henry!"
and she was right: it's better to be happy if you
can
but my father continued to beat her and me several times a week
while
raging inside his 6-foot-two frame because he couldn't
understand what was attacking him from within.

my mother, poor fish,
wanting to be happy, beaten two or three times a
week, telling me to be happy: "Henry, smile!
why don't you ever smile?"

and then she would smile, to show me how, and it was the
saddest smile I ever saw

one day the goldfish died, all five of them,
they floated on the water, on their sides, their
eyes still open,
and when my father got home he threw them to the cat
there on the kitchen floor and we watched as my mother
smiled

(Charles Bukowski, The Night Torn Mad With Footsteps, 2001)

Lasciami qui
Lasciami stare
Lasciami così
Non dire una parola che
Non sia d'amore

(Annarella, Epica Etica Etnica Pathos, CCCP, 1990)

Abstract

Intergenerational transmission of parenting is a well-documented phenomenon with high clinical relevance, especially for the continuity of dysfunctional processes across generations. To the extreme consequences, maltreated parents seem to be more likely to be abusive than non-maltreated ones (Widom et al., 2015). However, the mechanisms that mediate the association between childhood experience and adult parenting abilities remain unclear, influencing the effectiveness of preventive interventions (Euser et al., 2015). This thesis focuses on adults' low-level processes connected to parenting behavior and the moderating role of attachment and early care. The aim is to inform clinical interventions of the disrupted mechanisms to target in order to break the intergenerational cycle of abuse. Moving from a traditional correlational approach, we propose different quasi-experimental designs to combine the complexity of human experience with the rigorous laboratory methodology. The first part focuses on linking implicit processes implicated in parenting behaviors to individuals' experience. In the study presented in chapter one we found that individuals form more positive attitudes toward specific parenting styles, depending on their romantic attachment styles. This confirms a role of attachment on the transmission of parenting. Chapter two builds on the known effect that maltreated adults show augmented threat detection seeing adults' faces. The study extends these results to infants' face processing. These two chapters confirm the role of cognitive schemata, influenced by interpersonal experiences, in mediating the continuity of parenting. The second part describes the effects on adult brain of two children characteristics considered triggers of abuse: infant negative temperament and crying. In chapter three, we developed an fMRI paradigm to assess brain activation during the view of difficult or easy babies. We found that, compared to individuals with no emotional maltreatment experiences, individuals with

experiences of emotional maltreatment in childhood had reduced amygdala-middle frontal gyrus connectivity during the perception of an easy infant. We did not find effects of emotional maltreatment on neural processing of a difficult infant. Our findings show that experimental temperament manipulation can change brain responses to infant signals and constitute a risk factor for transmission of maltreatment. In chapter four, Transcranial Magnetic Stimulation has been used in a pilot study to show the roles of Inferior Frontal Gyrus and maltreatment in modulating the expression of physical force in response to infant crying. In both fMRI and TMS studies, we found that different brain susceptibility to infant stimuli represents a mechanism for parenting continuity. The last part aims at rejoining the empirical approaches of the first chapters within a broader literature review on the neurophysiological mechanisms of transmission of parenting. In chapter five the effects of early stress and attachment representations on parenting processes are discussed in light of the modern evolutionary framework. An original perspective on adult emotion regulation as the primary mechanism of parenting transmission is proposed. Consequences on interventions aimed at reducing risk of maltreatment are discussed.

Summary

Abstract	1
Summary	3
Introduction:	7
The intergenerational transmission of parenting	7
Why do we study parenting?	8
Are we turning into our parents?	12
Empirical evidences of intergenerational transmission of parenting	14
Moderators of transmission: in search of discontinuities	16
Does abuse beget abuse? Intergenerational transmission of maltreatment	19
An attachment perspective: the caregiving system	24
The intergenerational transmission of attachment	28
Breaking the cycle: interventions to prevent harsh parenting	31
Step back to move forward: a focus on the processes	34
Section One:	39
Implicit processes of parenting: the role of attachment styles and early experience	39
Introduction to the section	39
Chapter 1	43
Linking attachment and caregiving systems: anxiety and avoidance effects on implicit attitudes towards parenting styles	43
Introduction	44
Attachment theory	46
Social cognition of attachment	46
Implicit activation of attachment representations	48
Attachment and caregiving systems	50
The present study	52
Material and methods	54

Results.....	59
Discussion.....	63
Conclusion	65
Chapter 2	69
Approach-Avoidance Motor Responses to Emotional Infants' faces: the role of childhood maltreatment.....	69
Introduction	70
Study One: Approach and Avoidant behaviors in response to infants faces	73
Method.....	74
Study Two: emotional context and behavioral response to infant faces	80
Method.....	81
Results and discussion:	82
Study Three: right Inferior Frontal Gyrus in moderates the bias to threat effect towards infants' emotional faces	85
Method.....	85
Results and discussion:	87
General Discussion	90
Section 2	93
“He did not stop crying”: brain effects of triggers of child abuse in maltreated and non-maltreated adults	93
Introduction to the section	93
Chapter 3	95
Experimental manipulation of infant temperament affects amygdala-prefrontal functional connectivity	95
Introduction	96
Method.....	99
Participants	99
Procedure.....	100
Stimuli	103
fMRI paradigm and data acquisition	104
fMRI data analysis	105
Results.....	107

Behavioral Results.....	107
fMRI Results	110
Childhood emotional maltreatment	113
Functional connectivity.....	114
Discussion.....	118
Chapter 4	123
From brain to behavior: a pilot study on the role of Inferior Frontal Gyrus and childhood maltreatment in shaping the behavioral response to infant crying.....	123
Introduction	124
Method.....	128
Results.....	131
Discussion.....	133
Section 3	137
Toward an emotion regulation model of intergenerational transmission of parenting	137
Introduction to the section	137
Chapter 5	140
“A chip of the old block”: an evolutionary perspective on the neurophysiological mechanisms responsible for intergenerational transmission of dysfunctional parenting	140
Life History Theory.....	142
Intergenerational transmission of parenting	145
Intergenerational transmission of abuse and neglect.....	147
Dysfunctional parenting and neurocognitive mechanisms	147
Emotion Regulation	148
Role of childhood experiences in moderating parenting related processes during adulthood	150
Early childhood effects on parenting related neurophysiological processes	151
Early stress	151
Moderating effects of childhood experiences on brain correlates of parenting related tasks	152
Emotional processes	153

Reward processes	157
Early adversity as moderator of oxytocin effects on parenting related tasks	159
Stress Response and executive functions	164
Adult attachment as moderator of parenting related neurocognitive processes	167
Discussion.....	178
Resilience.....	183
Interventions	184
Limitations	185
Conclusion	186
Conclusion	189
And future directions	189
Bibliography	199
Acknowledgments.....	265

Introduction:

**The intergenerational
transmission of parenting**

This introduction provides a framework for the thesis's next chapters. We firstly define Parenting concept. The Intergenerational transmission of parenting is described from theoretical, clinical and empirical perspectives, and a lack of the comprehension regarding the implicated mechanisms is proposed. Then, a hypothesis on the intergenerational transmission of maltreatment is discussed. The Attachment Theory perspective on intergenerational stability is described that considers the partial mediational role of observed parenting behavior. A call for new research on the implicated factors is highlighted. The role of intervention programs in breaking the intergenerational cycle of maltreatment is briefly described and their unsatisfying effectiveness is proposed as a result of the lack of dysfunctional processes to target. Then the fruitful field of experimental research on basic psychological and neurophysiological processes implicated in parenting stability is presented. Methodological issues and limitations are discussed. Finally a brief summary of the thesis is provided.

Why do we study parenting?

During the last three decades, there has been growing agreement among developmental scholars on considering child's early intersubjective experience with caregivers and transactional development as the keys for building infants' psychic organization and relational abilities. Since the seminal works of Stern (1985), Trevarthen (1979), Schaffer (1977), Sameroff and Emde (1989) and Tronick (Cohn & Tronick, 1983), children's early abilities of communication and social interaction have been recognized and their role emphasized in the development of affect regulation and the broader concept of self (Schorer, 1994, 2003; Schorer & Schorer, 2007). In the first year of life, child's expression of primary emotions seems to be organized into coherent affective configurations with different communicative features depending on environmental events (Weinberg & Tronick, 1994). Child's manifestation of joy involves facial expression as well as gaze toward his/her mother. Similarly, a sad look for mother's temporary absence is associated to negative vocalizations and stress indicators (e.g. sucking his/her

tongue). Functions of these behaviors are both self-regulation and communication toward the mother. This simple form of communication is primarily “emotional, not just representational or referential (Trevarthen, 1994). It is fundamentally “self-with-other-referred” (Trevarthen & Aitken, 2001, p. 16). Therefore, from these very first moments of their life children can experiment and share their own affective states in a safe environment. Emde (1991, 1999) identifies in positive emotions shared with the mother the key for the development of personality. He proposes that this process builds an affective core of self “because our affective core gives meaning and consistency to what we feel deeply about as individuals, it comes to give us a sense of the uniqueness of our experience” (Emde, 1999, p. 324). In this perspective, mother’s role consists in validating infant’s positive emotions, enabling the development of a sense of identity and subjectivity. Stern (1993, 2010) proposes that during mother-child interactions, affective manifestations arise and take forms of vitality, a *gestalt* of emotion expressions, movements, directionality, sharing that come together all at once. The “maternal affect attunement” enables the “interpersonal communion [...] will play an important role in the infant’s coming to recognize that internal feeling states are forms of human experience that are shareable with other humans” (Stern, 1985, pp. 151–152). Tronick microanalytically studied mother child interactions and found that the balance of self and other regulation of the children was a deeply dynamic process. In fact, only a small portion of the time spent in interaction shows matching behavioral states, approximately about 30 % (Tronick & Gianino, 1986). It seems that an adaptive mother child interaction relies on the process of rupture and reparation of the contingency between mother and child. Moreover, Beebe and Lachman (Beebe & Lachmann, 2002; Beebe et al., 2010) showed that even a too contingent interaction would inhibit the opportunity for the child to learn how to develop an adaptive form of self-regulation, whereas a mother not contingent at all would lead to an exaggerated self-regulation of the child: in both cases psychic development would be affected. When reparation succeeds, in that moment the interplay of child and mother regulatory systems becomes a creative process able to expand both participants’ awareness of the other’s mental state. This perspective on the balance between self and mutual regulation echoes Bion’s

psychoanalytic perspective on *reverie*, the maternal function that allows child's emotional development. "Normal development follows if the relationship between infant and breast permits the infant to project a feeling, say, that it is dying, into the mother and to reintroject it after its sojourn in the breast has made it tolerable to the infant psyche. If the projection is not accepted by the mother the infant feels that its feeling that it is dying is stripped of such meaning as it has. It therefore reintrojects, not a fear of dying made tolerable, but a nameless dread" (Bion, 2013, p. 307). In the normative process, the tolerable affect becomes a step in the meaning making process of building child's psychic organization.

Fonagy and Target (2002) proposed that the reason why studies on attachment representations do not achieve great predictive power on developmental trajectories is because the effect of attachment security on the subsequent development is not at a representational level, but on the brain's major self-regulatory mechanism. In fact, they propose social intelligence and meaning making as a major selective advantage provided by attachment in humans. An *Interpersonal Interpretative Mechanisms* (Fonagy, Gergely, Jurist, & Target, 2002) is the neural mechanism that evaluates environment, allows individuals in sharing experiences, information and affects and create hypotheses on others' functioning. "We argue that in "loss", what is lost is not the bond but the opportunity to generate a higher order regulatory mechanism: the mechanism for appraisal and reorganization of mental contents. We suggest that the function of attachment is to bring complex mental life into being from a complex and adaptable behavioral system" (Fonagy & Target, 2002, p. 325). Modern neurophysiological models support this view of psychic development based on interpersonal exchange with significant others (Ammaniti & Gallese, 2014; Belsky & de Haan, 2011a; Narváez, Panksepp, Schore, & Gleason, 2012; Schore, 2012; Schore & Schore, 2007; Siegel, 2012; Siegel, 1999). In particular, the mirror neurons perspective (Frith & Frith, 2006; Gallese, 1998; Kohler, 2002; Rizzolatti & Sinigaglia, 2010), even if still studied at an early stage in children development, shed light on how perceiving another individual can shape your own mental states and your emotional self. Embodied simulation (Gallese & Sinigaglia, 2011; Gallese, 2014), driven by mirror

system, shapes a basic type of mentalization, that does not require a propositional level, but it is based on bodily representations (e.g. somatic effects of emotions). This does not mean that individuals feel what others feel, but that they experience that others have similar experiences as they do.

This brief and partial mini review of the last decades of research on social and affective child development, has the role to demonstrate how research is picturing development in a relational and transactional perspective (Sameroff & Fiese, 2000). So far, we could summarize all the previous paragraph with the famous Winnicott's words: "If maternal care is not good enough then the infant does not really come into existence, since there is no continuity of being; instead the personality becomes built on the basis of reactions to environmental impingement" (Winnicott, 1965, p. 54). This means that children are so deeply inserted in a social context and so much of their development depends on caregiving responsiveness that it would be partial consider them in a different context. In this perspective, parenting constitutes an all-encompassing ecology for development (Bornstein, 2001, 2002). Therefore, to answer the question of the title of the paragraph, we study parenting to understand the parents' role in the process that turns children into subjective individuals by means of building their psychic organization. Even more important, to propose enhanced models of intervention able to prevent or to treat dysfunctional parenting and negative children outcomes (Cicchetti, 2013a). Therefore, psychologists are strongly interested in understanding why parents behave the way they do, especially considering the high impact they have on children's development.

To comprehend and to make predictions on parenting functioning, the traditional Belsky's (1984) model is still valid and it is probably the most valuable effort to encompass all the determinants of parenting. The model is presented in *Figure a*. Even if it was based on a literature review of the early '80s is still relevant, complete and able to generate new predictions to be tested by empirical research. It describes parenting processes and behaviors as the dynamic result of macro and micro domains. Moreover it incorporates child's characteristics and development into the factors able to influence (and not only being influenced by)

parenting behaviors. Family support and other social networks seem to play a fundamental mediation role. Parent's personality is presented as the core of the model: this seems consistent with the modern importance of early relationships in shaping individual self. In this thesis we are interested in understanding the connection between parental developmental history and parenting via the mediation of regulatory abilities. Therefore, we start reviewing evidences that support the well known hypothesis of an intergenerational transmission of parenting abilities. In light of the aforementioned importance of caregivers in shaping emotional and psychic structures we can hypothesize that the development of self-regulation could be mediated by the cohesion and coherence of parents self. If social and affective development is a two person process, regulatory system of the parents directly affects regulatory system of the child and subsequently his/her psychic organization.

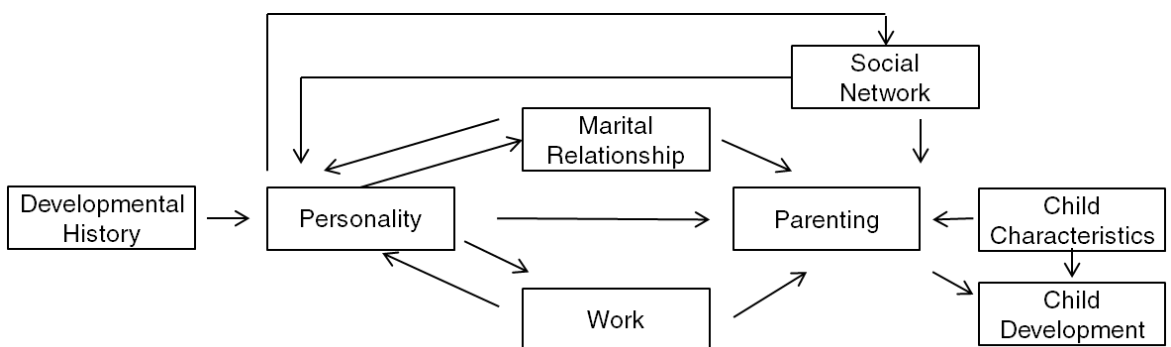


Figure a. A process model of parenting (from Belsky, 1984, p. 84)

Are we turning into our parents?

An enduring and accredited hypothesis in the developmental literature is so-called “intergenerational transmission”: parents behave in similar ways to the quality of the care they were exposed to during childhood. In fact, many theoretical models of human development predicted the stability of child-rearing strategies across generations, even if from different perspectives. Belsky and colleagues (Belsky, Conger, & Capaldi, 2009) notably argued that life course (Elder, Johnson,

& Crosnoe, 2003), attachment (Bowlby, 1969) and social learning theories (Bandura, 1977) all agree on behavioral continuity, even if they differ in defining the mechanisms that enable the process. More specifically attachment theory (Bowlby, 1969) proposes that a mother's ability to provide security during first early interactions will shape adults' cognitive schemata toward attachment relevant domains. Social learning (Bandura, 1977, 1986) proposes that learning is a cognitive process that takes place in a social context through observation: a child could develop a set of rules or a normative understanding of the necessity of a specific parenting behavior. For instance, exposure to physical discipline may be transmitted to the next generation through a set of parenting beliefs that consider harsh parenting as the only option or through little awareness of other options. Life-course Theory (Simons, Whitbeck, Conger, & Wu, 1991) suggests that the first generation's parenting behaviors will affect the personality traits and interaction styles of the second generation, which in turn will make the development of similar parenting strategies more likely. The continuity of parenting is not only consistent with these three theoretical models, but it is actually specifically expected. For the purposes of this thesis, attachment theory will be explained more in detail, but is important to note that the three mediational models are not mutually exclusive. Thus, unless changes in the environment happen, the next generation could benefit from the same parenting strategies. Also, from an evolutionary standpoint, intergenerational transmission denotes a clear advantage: if individuals reach the opportunity to parent their own offspring, it is very likely that the characteristics of the care they received will show a sufficient level of adaptation in that specific environment (Chapter 1, 5). Finally, from a clinical perspective, many practitioners and researchers, who deal with maltreating parents have noticed that they reported childhood histories of disruptive care and abusive behaviors. This has also led to clinically derived models being developed, such as Ferenczi's (Bonomi, 2002; Ferenczi, Dupont, Balint, & Jackson, 1995) concept of "identification with the aggressor", which the author describes as the process when the victim's psyche has become split, so that a part of the self has become automatically imitative of the former aggressor's behavior.

Empirical evidences of intergenerational transmission of parenting

The first empirical approaches to test the intergenerational transmission hypothesis were from the '1950s and mainly focused on the transmission of maltreatment. More specifically, they represented the first attempts to study maltreating parents and to comprehend the reasons for their behavior. Researchers unanimously reported expected findings on the etiology of abusing behaviors: abusive parents had been abused or maltreated as children (for review see: Spinetta & Rigler, 1972). For instance, Steele and Pollock (1968) showed that maltreating parents reported histories of families with the same styles that they had recreated in the patterns of rearing their own children. During childhood, all of the parents lacked the basic requirements of care and sensitivity from their own parents. More specifically, Gibbens and Walker (1956) identified the families of maltreating parents as rejecting, indifferent and hostile. Fontana (1968) proposed that the emotional dysregulation of parents originated from their histories of loneliness, lack of protection, and lack of love. Komisaruk (1966a) found the most striking statistic in his abusive parents' sample to be the high percentage of individuals who had lost a significant parental figure during childhood. Many other studies reported similar results (Bleiberg, 1965; Blue, 1965; Melnick & Hurley, 1969; Tuteur & Glotzer, 1966). Unfortunately, these studies cannot be considered strong evidence of the intergenerational transmission of parenting. First of all, the retrospective measures of childhood abuse lack sufficient validity to draw certain inferences (Hardt & Rutter, 2004; Kaufman & Zigler, 1987; van IJzendoorn, 1992). Even more importantly, the methodological procedure of selection for the maltreating sample cannot be used to infer an intergenerational transmission of parenting, due to the possible confounding effects of many variables and because it tends to bias the probability of finding dysfunctional processes in the target sample (Widom et al., 2015).

The first prospective studies on parenting transmission were from the '1980s; since then, much evidence has supported the claimed evidence of stable continuity across generations. Quinton and colleagues (Dowdney, Skuse, Rutter, Quinton, & Mrazek, 1985; Quinton, Rutter, & Liddle, 1984) focused on the parenting abilities of females reared in institutions because their families of origin could not cope with childrearing. Compared with an ad hoc control sample, institutionally reared mothers were less sensitive to their children's cues and, in response to their opposition, exercised control using confrontation and physical punishment. The quality of the inferences that can be drawn from this study is much better because the direction of the effect is clear and there are much fewer confounding effects due to the ability of the participants to remember the quality of care they received.

Caspi and Elder (1988) designed one of the first prospective studies to directly assess the quality of the care of the first generation (G1) and then the behavior of the second generation (G2) while interacting with their own children (G3). In a risky sample, they found an indirect but clear stability of parenting across the generations, mediated by aggressive behavior. In fact, G1 harsh parenting predicted aggressive behavior in G2 children. Consequently, higher levels of aggressive behavior during childhood predicted higher levels of G2 hostile parenting when G2 parenting behavior was assessed in interactions with G3 children, 30 years later. Huesmann and colleagues (Huesmann, Eron, Lefkowitz, & Walder, 1984a) focused on the stability of aggression across time and generations: in a 22-year span study, they found that G1 aggression scores measured during G2 childhood were able to predict the same variable in G2 while parenting G3 and, indirectly, also the children's scores. Many studies confirmed these results in the next years. In a small sample (N = 75) but with different and highly reliable measures, found a direct association between aggressive and angry parenting from G1 to G2. Also, in the studies by Bailey and colleagues (2009) and Neppl and colleagues (2009), harsh parenting in G1 predicted the same variables in G2. Other studies found a mediating role of antisocial behaviors (Capaldi, Pears, Patterson, & Owen, 2003; Thornberry, Freeman-Gallant, Lizotte, Krohn, &

Smith, 2003). On the contrary, Smith and Farrington (2004) showed that parenting practices play a partial role in the development of primary conduct problems.

More recently, research has broadened the perspective on the intergenerational transmission of parenting, showing that constructive and sensitive parenting behaviors are also stable across generations. Chen and Kaplan (2001) measured a large sample at different time points to show the role of experiencing good parenting on the expression of constructive parenting, both directly and via the mediations of interpersonal relations and social participation in G2. Within the Dunedin study (Arseneault, Moffitt, Caspi, Taylor, & Silva, 2000; Melchior, Moffitt, Milne, Poulton, & Caspi, 2007), Belsky and colleagues (Belsky, Jaffee, Sligo, Woodward, & Silva, 2005) found that childrearing and family climate, as measured at three different time points, predicted observed warm-sensitive-stimulating parenting but only for mothers of G3. Kovan and colleagues (Kovan, Chung, & Sroufe, 2009) analyzed data from the Minnesota Longitudinal Study of Risk and Adaptation (Sroufe, Egeland, Carlson, & Collins, 2009) and found a moderate stability ($r = .43$) of observed parenting composite scores across generations. The small size of the sample ($N = 61$) was compensated for by the quality of the measures from 12 months to 32 years old as well as powerful control over confounding variables like SES or cognitive development. To replicate the same findings in a broader sample from the same study using an interview-based measure of parenting, Raby and colleagues (Raby, Lawler, et al., 2015) confirmed the association across generations, but the intergenerational transmission was fully mediated by later competence in relationships with peers and romantic partners. Shaffer and colleagues (Shaffer, Burt, Obradović, Herbers, & Masten, 2009) replicated Chen and Kaplan's (2001) results on the mediating role of social competence but did not find an direct association between parents in G1 and G2.

Moderators of transmission: in search of discontinuities

The number and quality of the aforementioned prospective studies defectively support the evidence for intergenerational transmission of parenting.

Still, it remains unquestionable that the continuity across generations is not an univocal association, since all studies tend to be consistent: childhood rearing history accounts for approximately 15% of the variance in parenting (Belsky et al., 2005; Capaldi et al., 2003; Conger, Neppl, Kim, & Scaramella, 2003). Thus, research interest has moved from testing the hypothesis of continuity to answering why certain parents repeat their childhood experiences while others do not..” We have already mentioned some of the numerous mediators (Capaldi et al., 2003; Caspi & Elder, 1988; Huesmann et al., 1984a; Raby, Lawler, et al., 2015; Thornberry et al., 2003) that help to comprehend this complex—even if quite stable—phenomenon. Unfortunately, mediation models do not directly address the characteristics of the parents whose childrearing histories do not affect their parenting style. Introducing a rich special issue on *Developmental Psychology* focused on the intergenerational transmission of parenting, Belsky and colleagues (Belsky, Conger, et al., 2009) pointed out that research should focus more, despite the failures, on the “lawful discontinuities,” which means “the ability to predict and explain why usual expectations do not obtain” (p. 1202). Only a few studies have reported interesting results on this topic. Egeland and colleagues (Egeland, Jacobvitz, & Papatola, 1987) showed that maltreated children who experienced a supportive, close relationship during their life did not abuse their own children. A good and supportive romantic relationship or a fruitful therapy could change developmental trajectories and worked as a powerful protective factor. Also, Quinton and Rutter (Quinton et al., 1984; Quinton & Rutter, 1984) found a moderating role of good romantic relationships in breaking the cycle of maltreatment in institution-reared females. The authors explained this effect via the mediating role of school experience: school achievements lead to more self-efficacy and, in turn, more careful mate selection and, finally, better support and parenting. However, this hypothesis still has to be proved and other explanations have been formulated (Belsky, Youngblade, Rovine, & Volling, 1991). Conger and colleagues (Conger, Schofield, & Neppl, 2012) found the transmission of harsh parenting from one generation to the next, but when a mother or father co-parented with a partner who showed sensitive caregiving, the across-generations effect disappeared. A protective effect of warmth and positive communication with

a romantic partner was found in a subsequent study by the same group (Conger, Schofield, Neppl, & Merrick, 2013).

Belsky and colleagues (Belsky, Hancox, Sligo, & Poulton, 2012) made a notable, but failed, attempt to answer the question. They hypothesized that parental age could decrease the effect of childrearing history, as a proxy for increased psychological maturation (B. W. Roberts, Caspi, & Moffitt, 2001). They tested this claim on a group of parents from the Dunedin study (which is broader than Belsky et al.'s (2005) sample because of the time spent in between); but as mentioned, they failed to moderate the transmission effect. Beaver and Belsky (2012) conducted probably the most interesting and complete study on the effects that can moderate intergenerational transmission. They used data from the Longitudinal Study of Adolescent Health to test the differential susceptibility hypothesis (Bakermans-Kranenburg & van IJzendoorn, 2015; Belsky & Pluess, 2013) in the transmission of parenting. The results showed that the more plasticity alleles that were carried by participants, the more their parenting experience in adolescence predicted their future parenting experience. As expected, the participants who carried the most plasticity alleles were more affected by the quality of maternal parenting compared to those carrying the fewest plasticity alleles, for better and for worse.

In sum, just six studies found moderator effects, and most of them have not undergone any replication attempts. Belsky et al. (Belsky, Conger, et al., 2009) and Conger et al. (Conger, Belsky, & Capaldi, 2009) commented that the lack of moderator effects in the aforementioned special issue of *Developmental Psychology* was a lack of comprehension of the implicated mechanisms. Research has found a small continuity of parenting across generations, and it is not able to explain why the magnitude of the effect is so small. In other words, we are not able to predict why some individuals present strong discontinuities in transmission. Moreover, we lack even a theoretical model with which to make hypotheses on discontinuities, except for a GxE effect that seems promising but is difficult to test because of the sample size required. However, mechanisms of intergenerational transmission can also be addressed from basic research on the implicated

psychological and neurophysiological processes. Fruitful research advances can come from pursuing this shift from macro to micro processes, at least by proposing hypotheses to be tested in naturalistic prospective designs. This call for advances in basic research would also be useful for designing interventions to reduce the intergenerational effects of harsh parenting that focus on the key domains. The work by Lomanowska and colleagues (Lomanowska, Boivin, Hertzman, & Fleming, 2015) is a first and notable effort to review the effects of dysfunctional parenting on adult neurophysiological and the psychological processes that are, in turn, implicated in parenting.

Does abuse beget abuse? Intergenerational transmission of maltreatment

Besides the undoubted association of parenting across generations, a related question is about the intergenerational transmission of parents' child abuse and neglect. In fact, the research findings reviewed so far do not directly assess the perpetration of maltreatment, but when discussing dysfunctional parenting, they mainly report having observed harsh parenting behavior. There is obviously a positive correlation between harsh parenting and abusive behaviors, but the majority of harsh parenting does not fulfill the criteria for being considered abuse (Cicchetti & Toth, 1995). Then, the question addressed in this paragraph is different from the previous one on the transmission of parenting, and probably related to the literature on the so-called "cycle of violence" (Caspi et al., 2002; Dodge, Bates, & Pettit, 1990; Widom, 1989).

Kaufman and Zigler (1987) reviewed early studies on the intergenerational transmission of child abuse. Despite the belief in stability across generations being widely accepted among professionals, they showed a scarcity of empirical evidence to support it. In particular, they showed how a majority of the findings rely on case history studies (Fontana, 1968; Galdston, 1965a; Kempe, 1973; Steele & Pollock, 1968) and self-report studies (Conger, Burgess, & Barrett, 1979; Gaines, Sandgrund, Green, & Power, 1978; Herrenkohl, Herrenkohl, Toedter, & Finkelhor,

1983; Hunter & Kilstrom, 1979; Olmsted et al., 1982). However, the authors confirmed a small support for the intergenerational hypothesis, but claimed that researchers and clinicians had to realize how the vast majority of abused parents did not abuse their children. Unqualified acceptance of the intergenerational hypothesis had many negative consequences, in terms of prejudice toward individuals and misdirection in researching the real causes of maltreatment. They proposed changing the research question from “Do abused children become abusive parents?” to “Under what conditions is the transmission of abuse most likely to occur?” (Kaufman & Zigler, 1987, p. 191). A good example of this enriched approach is Egeland and colleagues’ work (Egeland, Jacobvitz, & Sroufe, 1988) work, in which they confronted abused mothers who perpetrated an abusive behavior toward their children with abused mothers who did not and broke the so-called “cycle of abuse.” First, the results showed a prevalence of perpetrators (continuity group, N = 18) compared to non-perpetrators (exception group, N = 12). Second, the exception group was more likely to have received emotional support from a non-abusive caregiver during childhood, joined therapy at any age, and had a supportive romantic relationship. Finally, the continuity group was more stressed, anxious, depressed, and immature. Ertem and colleagues (Ertem, Leventhal, & Dobbs, 2000) identified this study as the only one able to satisfy all eight methodological standards proposed on the quality of the measures collected and the intervening variables considered. They computed the relative risk for the abusive mothers to perpetrate the abuse and obtained a risk ratio of 12.6 (95% CI 1.82, 87.2).

More recently, other studies have generally supported the intergenerational hypothesis (Berlin, Appleyard, & Dodge, 2011; Dixon, Browne, & Hamilton-Giachritsis, 2005; Schofield, Lee, & Merrick, 2013; Thompson, 2006; Thornberry, 2009), but some others found no evidence (Renner & Slack, 2006; Sidebotham & Golding, 2001). Just recently, Widom and colleagues (Widom et al., 2015) published a study that can be considered outstanding for the size of the sample (N = 1147), the prospective 30-year longitudinal design, and the evaluation of outcomes using multiple sources of information (parent and non-parent self-

reports, offspring reports, and child protection agency records). The results show that the magnitude of the intergenerational transmission effect depended in large part on the source of information used. In particular, child protective services reports are likely to be problematic because of the high rate of detection or surveillance bias. However, the offspring of abused parents are more likely to report sexual abuse and neglect (but surprisingly, not physical abuse) and also that child protective services were concerned about them at some point.

Just a few studies focused on the mediators of the intergenerational stability of maltreatment. In particular, Dixon and colleagues (2005) found a mediating role of poor parenting styles and three significant risk factors: parents under 21 years old, mental illness or depression, and residing with a violent adult. Berlin and colleagues (2011) showed the mediating role of abused mothers' social isolation and aggressive responses. However, more research is needed to comprehend the underlying mechanism of the intergenerational association. Finally, several studies addressed the moderating role of safe, stable, and nurturing relationships (SSNRs) and their results were aggregated by means of a meta-analytical procedure (Schofield et al., 2013). Studies with different designs and measures were included in the meta-analysis, and studies with especially large samples were based on self-report measures and interviews (A. S. Masten, 2001; Mercy, 2009). However, meta-analytic results support the hypothesis of a protective role of SSNRs on the intergenerational continuity of abuse. Thus, a romantic partner, a co-parent, or any form of adult social support may play a key role in decreasing maltreatment continuity.

Psychodynamic notes on intergenerational transmission

The idea of a transmission of expectations and desires from parents to children is a fundamental idea in the history of psychoanalysis. Freud (1914/1958) first described the parental narcissistic investment toward the child, defined as "his majesty the baby" (p. 90). In Ferenczi's (Ferenczi et al., 1995; Ferenczi, 1931) exploration of early trauma consequences, the loss of the feeling that the world

can be a safe place annihilates the child's subjectivity: "The weak and undeveloped personality reacts to sudden unpleasure not by defence, but by anxiety-ridden identification and by introjection of the menacing person or aggressor" (Ferenczi, 1933 cited in Frankel, 2002). Even if Ferenczi does not directly discuss the effects of early trauma on parenting the next generation, the identification process is substantially connected to the caregiving modalities experienced by the child and, even more, the affects and thoughts connected to them. Frankel (Frankel, 2002) identifies three steps in Ferenczi's process of identification with the aggressor: first, the child is mentally subordinated to the aggressor; then, he/she "divines" the aggressor's desires and enters his/her own mind in order to anticipate frightening behaviors and increase the adaptation. Finally, the child annihilates him/herself through submission and attuned compliance. Anna Freud (1936) identifies the consequences of this transition from victim to victimizer, but Ferenczi's reflection is broader because it refers to the loss of inner authenticity and selfhood, describing an effect in some way similar to Winnicott's (1960) concept of false self-organization. In Winnicott's approach, the mother's lack of 'ability to mirror the child's affects and emotions leads to denying authenticity and building a sort of "mask," in order to adequate him/herself to the parent's characteristics. From a modern point of view, Fonagy (Fonagy et al., 2002) describes the mother's mirroring attitude as the process by which children learn how to regulate their own emotions. In both Ferenczi's and Winnicott's perspectives, the consequences on child's development are not only the denial of the real self, but also that "one may come reflexively to place oneself in the mind of everyone around him, scanning, checking out everyone as a possible threat, feeling that a repetition of one's trauma is just around each corner" (Frankel, 2002). In other words, abusive parents will drive their own children's development to become simultaneously very careful and very insensitive to others' needs and feelings. Victims of abusive parents can develop a strong fear of everyone who is different from them because they are perceived as being potentially dangerous; then, they will try to influence others in ways that can become aggressive (Ferenczi, 1933). Extending this perspective onto the next generation, parents who did not work through their abused childhoods can be extremely frightening (Lyons–

Ruth, Bronfman, & Atwood, 2000; Main & Hesse, 1990) because they will force their own mental states into their children, leaving no space for subjectivity or authenticity. In this way, the intergenerational pathway of harsh or abusive parenting seems completed.

The description of the consequences of identifying with the aggressor impressively resembles the philosophical concept called *epistemic vigilance* (Opposite to “Epistemic Trust”, Grasswick, 2010; Koenig & Harris, 2007; Shafto, Eaves, Navarro, & Perfors, 2012; Sperber et al., 2010), the “trust in the authenticity and personal relevance of interpersonally transmitted information” (Fonagy & Allison, 2014). Building upon the empirical evidence of the association between mothers’ attachment security and the development of children’ epistemic trust (Corriveau et al., 2009), Fonagy (Fonagy & Allison, 2014; Fonagy, Luyten, & Allison, 2015) proposed that an exaggerated vigilance toward communication with others is implicated in the development of personality disorders. From a clinical perspective, Jurist (Fonagy et al., 2002) defined the hostility expressed by a traumatized mother in psychotherapy as a “traumatic reenactment” (p. 446). The lack of authenticity is described in terms of deficits in emotion recognition and regulation: “Her rage flared up and automatically poured out; it loomed ominously in her psychic functioning. Teresa must have felt tremendous fear in the situation of having to defend herself as a mother, yet her rage contaminated the experience of this or any other affects” (p. 447). Once again, the association between fear and aggression was established, and the incapability of accessing the real emotional experience enabled the intergenerational transmission.

In the psychodynamic perspective, Selma Fraiberg directly addressed the question of parenting transmission. by referring to the history of the mothers with the evocative expression of “ghosts in the nursery” (Selma Fraiberg, Adelson, & Shapiro, 1975). Powerfully described as “the uninvited guests at the christening [that] conduct the rehearsal of the family tragedy from a tattered script” (p. 387-388), the ghosts represent repetitions of the past into the present: parents’ unremembered, early experiences of fear during childhood that unintentionally strike into the new child’s caregiving. The parent’s visceral reactions are driven by

the unrecognized past experience, and he/she fails to properly recognize or respond to the child's signals asking for security. The child's distress signals are either ignored or interpreted as expressions of hostility, therefore inducing an 'angry reaction from the parent (Lieberman, Padrón, Van Horn, & Harris, 2005; Lieberman, 2007). More specifically, Fraiberg (1980) describes the ghosts in the nursery not as the direct effects of the real events of harsh/abusive parenting, but the repression of the affects associated with the real frightening experience. In this sense, negative childhood events do not automatically imply that the same experiences will be actualized with the parents' children. Fonagy (Fonagy, Steele, Moran, Steele, & Higgitt, 1993) claim that even if not explicitly stated by Fraiberg, her clinical work implies that "the quality of the mental representation of the object and the representation of the self's relationship to it may be a further important determinant " (p. 959) to elicit (or not) the intergenerational transmission of maltreatment. Lieberman and colleagues (2005) proposed the concept of "angels in the nursery" to describe the experience of intense shared affect between a parent and a child, "in which the child feels nearly perfectly understood, accepted, and loved" (p. 504). The authors claim that this kind of experience can represent a buffer from overwhelming trauma and interrupt the re-actualization of maltreatment. Finally, a parallel is made between the angels in the nursery and the work in psychotherapy with traumatized parents, in which fostering the "reemergence" of representations of these figures can elicit a positive transformative stance.

An attachment perspective: the caregiving system

Bowlby (1969) defined attachment in terms of the ethological concept of the behavioral system, a biologically evolved program that organizes behaviors to increase survival and reproduction. The goal of attachment is to obtain protection from an attachment figure in case of real or perceived danger (Cassidy, 2008). Bowlby claimed that the behavioral system played a central role during an individual's entire life: the goal remains the same, but the behavior to reach it

depends on the current developmental task in an individual's life span. The complementary behavioral system is the caregiving one: at some point an individual is asked to shift from seeking protection to providing it (George & Solomon, 2008). Both systems share the same behavioral goal -the protection of the child- and therefore the same adaptive function: an increase of individual's reproductive fitness (Belsky, 1997; Simpson & Belsky, 2008). In fact, caregiving system is activated by situations that are perceived by the parent as dangerous, fear provoking or upsetting for the child. The cues that usually activate caregiving behaviors in adults are separations, dangers, and children's signals like crying (Soltis, 2004). Consistently with the strong feeling aroused by attachment, caregiving is also associated with strong emotions. Parents who are separated from their children will feel sad and will try to rejoin them. When children are in danger or distressed, especially when parents are not able to comfort their children, anxiety and despair will encourage parents to increase their protection efforts. On the contrary, great satisfaction comes from comforting and providing security for their children (Bowlby, 1969; George & Solomon, 2008).

Bowlby (1969, 1980) proposed that children's first experiences in interactions with their mother lead to the development of expectations regarding their feeling of security. Later, these expectations become organized representations—or internal working models—of the self, significant others, and the relationship between the two (Bretherton & Munholland, 2008; Pietromonaco & Barrett, 2000). A child engaged in interactions with a rejecting mother will depict her as emotionally unavailable and him/herself as ineffective and not worthy of help and comfort. On the contrary, an infant raised by a responsive and emotionally available mother will represent him/herself as love deserving and able to communicate emotional states and needs. Moreover self–other relationship representations are considered organizers of emotion (Cassidy, 1994; Eagle, 1990; Fonagy, Gergely, & Target, 2008; Holmes, 2000; Mikulincer & Shaver, 2007, 2008): emotion regulation processes develop in a relational context and will condition all future relationships in a dynamic interplay. The parent child affective communication provides the context where the child can experiment, understand

and organize affective experience (Cassidy, 1994). A secure child is engaged in a relationship with a sensitive parent who is able to decode and properly respond to infant's signals. Therefore the expression of emotional states is perceived as useful by the infant in order to be understood and to obtain a parental response that is attuned to him/feeling, even during distress. Parent's sensitive response will in turn enhance the child's sense of efficacy in modulating his/her feeling states (Bell & Ainsworth, 1972). The expectation of a supportive parent during the experience of negative affects helps learning that negative states can be temporarily tolerated and co-regulated (Beebe et al., 2010). The parent of an insecure avoidant child who chronically rejects his/her attachment needs will pass to the child a strategy to handle emotions based on minimizing them. The child will decrease the time spent in trying to activate adult's caregiving system. Although this is probably the most adaptive strategy in that specific environment in order to increase the chances to get support when actual dangers occur (Bowlby, 1969; Del Giudice & Belsky, 2007; Simpson & Belsky, 2016), the child learns that emotion communication is not associated to parental support. The child has to rely on his/her self-regulatory ability to minimize, but not regulate, emotional states. Minimization strategies are also necessary because the lack of supportive care experienced arouses an angry reaction that has to be muted into something else in order not to disrupt attachment bond. The child ends in denying emotional states and building a sort of mask of him/herself, very close to Winnicott's perspective of false self (Winnicott, 1960). Finally, insecure ambivalent children who experience parents providing cares in an unpredictable way, develop strategies aimed at maximizing the activation of parental caregiving behaviors. Their parents are characterized by high emotional arousal that can drive them towards attuned responses as well as very disruptive interactions. Children communication of emotions is heightened and functional in order to elicit attachment behaviors in parents. Parents' fear of losing the child encourages the expression of heightened anger and fearfulness as a reassurance that the child is involved with her. "They reassure the parent that she will continue to be needed and that the child will remain close to her; in other words, they reassure the parent that the child "will not become an adult and leave" (Bacciagaluppi, 1985, p. 371)""

(Cassidy, 1994, p. 244). This perspective is consistent with Main's definition of working defensive strategies (Main, 1995) that highlights how different patterns of attachment are well explained in terms of defensive mechanisms or coping strategies developed to face mother's emotional availability since the first months of life.

In adulthood, these representations of childhood attachment experiences affect also the caregiving system. A sort of confirmation of the similarities and overlaps for the two separate systems, attachment and caregiving, comes from the process of development of the adult attachment gold standard measure, the Adult Attachment Interview (AAI, George, Kaplan, & Main, 1985; Hesse, 2008; Main, Kaplan, & Cassidy, 1985). Main and colleagues (1985) noticed that the quality of the narratives on childhood attachment experiences was able to discriminate between mothers of children with different attachment patterns. Consequently, they offered a new definition of Internal Working Models in terms of the rules (conscious and unconscious) that organize information relevant to attachment. The focus is not on childhood experiences per se, but on the ability to reflect upon them in a coherent way. Internal working models can act in a way similar to defensive mechanisms (Fonagy et al., 2008; A. Freud, 1936; Mikulincer & Horesh, 1999; Perry & Henry, 2004) because can distort mental states to reduce anxiety, distress, or displeasure they can generate. These mental operations are thought to be considerably stable during life (Bakermans-Kranenburg & Van IJzendoorn, 1993; Bowlby, 1969; Fraley, 2002) and therefore to ensure continuity of the attachment system during the life span. Moreover, internal working models seem to affect also caregiving processes and to be passed in some way to the next generation. Bretherton proposed a process of identification: "individual may be using the internal model of the parent to guide his or her own parenting behavior" (Bretherton, 1985, p. 23). In other words, even if different systems, attachment and caregiving are in some way connected, at least because the reflection on mothers' attachment experiences is predictive of their own children development of attachment. Since Main's seminal study, research on the intergenerational transmission of attachment became a landmark of developmental psychology and

a powerful key of comprehension of reality (van IJzendoorn, 1995a; Verhage et al., 2015).

The intergenerational transmission of attachment

van IJzendoorn in 1992 describes the study of the association between mothers' state of mind with respect to attachment and children pattern of attachment as an approach to the intergenerational transmission of parenting. He could not find satisfying evidences of intergenerational transmission of parenting and proposes the transmission of attachment as a more sophisticated approach to the study of the continuity of representations between generations, more than just behavior. In 1995, he publishes the first meta-analytic work on the topic and confirms the existence of a stable continuity of attachment between parents and children (for secure autonomous transmission, $r = .47$). More intriguingly, he tested a mediation model to study the mechanisms through which attachment is transmitted. Ainsworth's seminal works (Ainsworth, Bell, & Stayton, 1974; Ainsworth, Blehar, Waters, & Wall, 1978) had claimed a primary role of caregiver sensitivity in mediating the association between mother's representation and child's attachment. In fact, sensitivity is defined as mother's ability to produce a response attuned to child's needs, to recognize child's emotions, to regulate them and not less important to establish physical contact with him/her. Unexpectedly, the mediating effect in the meta-analytic model was just partial. van IJzendoorn (1995; De Wolff & van IJzendoorn, 1997) called this lack of explanation of the mechanism implicated in the continuity of attachment across generations the "Transmission Gap". Since then, many efforts to explain and to bridge the transmission gap were devoted. George and Solomon (2006) interpret the gap as a cue of the relative independence of the attachment and caregiving systems. In partial support of this claim, some researchers have focused on parents' cognitive abilities to represent their children and their affective and mental states. More specifically, Slade and colleagues (Fonagy & Target, 2005; Grienemberger, Kelly, & Slade, 2005; Slade, Belsky, Aber, & Phelps, 1999; Slade, Grienemberger,

Bernbach, Levy, & Locker, 2005) introduced the mediational role of Reflective Functioning (Fonagy, Target, Steele, & Steele, 1998; Katznelson, 2014) “namely the mother's capacity to hold her baby and his mental states in mind” (Slade et al., 2005, p. 284). Thanks to their attachment experiences, secure mothers should be able to explore their own mental states and to extend this open stance to children's mental states as well. The awareness of their own mental states allows the mothers to understand their infants respecting the idea that children are separate human beings. In children, this maternal stance enables the formation of an authentic and open self. From an emotion regulation perspective, mothers high in reflective functioning are better in regulating children's fear: they can understand children's feelings, validate them and support their children without frightening them. Fonagy and Target (2005) suggest not only the closeness of this perspective to Bion's (1962/2013) idea of containment, but that mother's ability to understand her child mental states (mentalization) should be a fruitful target for interventions to prevent frightening parenting behaviors. A similar concept is Meins's mind-mindedness (Meins et al., 2012; Meins, Centifanti, Fernyhough, & Fishburn, 2013; Meins, Fernyhough, & Harris-Waller, 2014) defined as the ability to treat one's child as an individual. The partially mediating role of both variables confirm that intergenerational transmission can depend on different cognitive abilities beyond the behavioral level. Other studies focused on the ecological factors implicated in moderating the effect of caregiving sensitivity (Tarabulsky et al., 2005). Bernier and colleagues (Bernier, Matte-Gagné, Bélanger, & Whipple, 2014) expanded the behavioral measure of caregivers' parenting behavior, adding the construct of “autonomy support” to traditional maternal sensitivity.

Just recently, a new meta-analytic work (Verhage et al., 2015) revisited van IJzendoorn's 1995 previous findings, adding two decades of new research and updating effect sizes and research progress. In a much broader pooled sample ($N = 4,819$), analyses confirmed a significant association both for autonomous secure transmission and for unresolved transmission, even if with smaller effect sizes than before. Moreover, the parent-child association in attachment classifications is moderated by the risk status of the sample, the focus on adoptees' biologically

related children, and the children's age. If, on one hand, newer studies show smaller effect sizes in the across-generation stability, on the other hand, the transmission gap is still present but narrower than in the previous work. The existence of the transmission gap two decades later seems to confirm the presence of a missing link between caregivers and children's attachment classifications, and is not only the result of a measurement issue or a meta-analytical artifact from the previous study. Therefore, the authors articulated a theoretical model (*Figure b*) to account for the complexity of the intergenerational transmission of attachment. In particular, they claim that more research is needed in three domains that research has shown as fundamental in the mechanisms of transmission but that have not been fully explained yet. A strong moderator of the stability could be the effect of family characteristics, mainly in terms of the buffering effect of parental support and romantic relationships on stress. Another issue that is likely to play a key role but has no research available yet is differential susceptibility. Children's different sensitivities to the environment have to be addressed in order to understand its impact in deviating developmental trajectories, for better and for worse (Bakermans-Kranenburg & van IJzendoorn, 2015). Besides these factors, a deeper comprehension of caregivers' functioning is expected. Transmission between parent and child seems to lie on a more subtle level than both behavior (caregiving sensitivity) and the cognitive abilities of children's functioning (reflective functioning and mind mindedness). Thus, a focus is suggested on implicit and automatic processes that drive the effect of attachment representations in shaping children's attachment relationships. The primary candidate for this kind of exploration is caregivers' neurophysiological functioning. Research has been made on both the neural characteristics of parents (e.g. Lomanowska et al., 2015; Riem, Bakermans-Kranenburg, et al., 2011; James E. Swain, 2011) and brain correlates of attachment (e.g. Lenzi et al., 2013; Riem, Bakermans-Kranenburg, van IJzendoorn, Out, & Rombouts, 2012; Strathearn, Fonagy, Amico, & Montague, 2009). However, many steps are still required before these studies can provide reliable effects and methodologies that can be used to explore attachment transmission in depth.

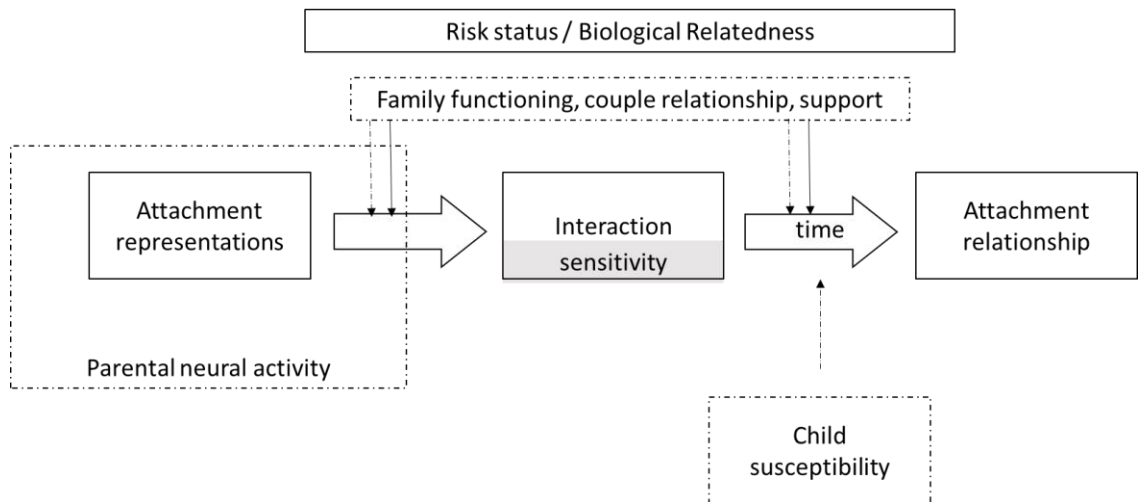


Figure b. Proposed theoretical model of the intergenerational transmission of attachment. Constructs in dashes remain to be investigated. In Verhage et al., 2015, p. 23.

Breaking the cycle: interventions to prevent harsh parenting

Many interventions have focused on improving the quality of parental behavior, particularly caregiving sensitivity (Bakermans-Kranenburg, van IJzendoorn, & Juffer, 2003). Some studies have focused on at-risk populations (e.g. Bakermans-Kranenburg, Juffer, & Van IJzendoorn, 1998; Black & Teti, 1997; Lyons-Ruth, Connell, Grunebaum, & Botein, 1990; Van Zeijl et al., 2006). The results from a meta-analytical approach show that interventions seem effective in enhancing parental sensitivity and infant attachment security (Bakermans-Kranenburg et al., 2003). More specifically, a moderate number of sessions seems to be more effective than many sessions as well as interventions that only focus on sensitivity. In turn, parental sensitivity promotes attachment security, confirming its causal role in attachment transmission (van IJzendoorn, 1995a; Verhage et al., 2015).

The small magnitude of the effects of the intergenerational transmission of parenting makes a direct test of the effect of interventions on the stability of harsh

parenting across generations very difficult. Usually, populations at risk of maltreatment are considered when many other risk factors are present, like low SES, early parenting, substance abuse, or even violent partners. Some studies have focused on samples of maltreating families and tested the efficacy of interventions in improving parenting abilities and decreasing the detrimental effects of child abuse and neglect. For instance, Swenson and colleagues (Swenson, Schaeffer, Henggeler, Faldowski, & Mayhew, 2010) conducted randomized controlled trials of multisystemic therapy for child abuse and neglect (MST-CAN) in a sample of abused pre-adolescents and adolescents as well as their families. MST-CAN significantly reduced youth mental health symptoms, parent distress, harsh parenting behavior connected to maltreatment, and changes in youth placements. Yet, even though the MST-CAN group had a slightly lower rate of reabuse situations, the overall incidence was extremely low and did not reach statistical significance.

Some meta-analytic studies were conducted to synthesize results on the effectiveness of intervention programs aimed at preventing or reducing child maltreatment. The only study that focused only on randomized clinical trial and measured the actual occurrence of child abuse and neglect has been recently conducted by Euser and colleagues (Euser et al., 2015). They tested the effectiveness of programs aimed at preventing child maltreatment (both in the population and in high-risk samples) and reducing the rate of child abuse and neglect in abusive families. Unfortunately, disappointing results emerged. A small but significant pooled effect on maltreatment ($d = 0.13$, $N = 4,883$) was found but disappeared when publication bias was taken into account. This, of course, does not mean that some interventions are not effective, such as, for instance, the previously mentioned MST-CAN or the parent child interaction therapy (Chaffin et al., 2004). In particular, moderator analyses showed that more recent studies have had larger effect sizes, as well as studies that had a parent training program and studies that targeted maltreating families.

Only one study (not present in the previous mentioned meta-analysis because it was not focused on child maltreatment) tested the effects of a

preventive parenting intervention on the transmission of a parenting-related domain. In fact, Mahrer and colleagues (Mahrer, Winslow, Wolchik, Tein, & Sandler, 2014) not only evaluated the effectiveness of the “New Beginnings Program” on G1 parenting quality and G2 wellbeing, but also on the intergenerational transmission of parenting attitudes from G1 to G2. Since parenting attitudes have been found to be predictors of later mother–infant relationships, parenting behavior, and child outcomes (Kiang, Moreno, & Robinson, 2004; Lounds, Borkowski, Whitman, Maxwell, & Weed, 2005; O’Callaghan, Borkowski, Whitman, Maxwell, & Keogh, 1999; Schatz, Smith, Borkowski, Whitman, & Keogh, 2008). These results suggest that the intergenerational transmission of poor parenting practices can be interrupted by a short parenting intervention. This is obviously is not direct proof of a break in the across-generation stability of parenting; however, this study is the first attempt to test the susceptibility of the association in a prospective way. The future direction of research should be considered to face a complete intergenerational transmission model, by means of an extension of the research design to G3 effects.

The aforementioned meta-analytic study and consistent recent reviews (Forman-Hoffman et al., 2013; MacMillan et al., 2009) contain a strong call for new research in two primary directions. First, more randomized clinical trials are needed to strengthen the effectiveness of interventions and to shed light on the characteristics of programs that are able to optimize the effectiveness. Second, more basic research is needed to better comprehend the disrupted processes that lie at the core of dysfunctional parenting and the intergenerational transmission of maltreatment. This could help in developing more specific and focused intervention programs as well as in maximizing their efficacy and cost-effectiveness. The disappointing meta-analytic results are an incentive for stronger efforts to understand better ways to approach the highly socially relevant issue of childhood abuse and neglect prevention.

Step back to move forward: a focus on the processes

Despite the many research advances on the intergenerational transmission of parenting and its high relevance to clinical and social domains, the field needs a paradigm shift produce new insights on the implicated mechanisms. After establishing the existence of the effect and its magnitude, researchers are now asked to answer more subtle questions on the processes that lie behind it. The study of basic neurophysiological and psychological processes affected by early parenting experiences, which are in turn responsible for parenting behaviors, seems to be a fruitful field of research. In particular, studies on the effects of early stress on childhood and adult neurophysiological functioning are now at the cutting edge of international research (e.g. Hackman & Farah, 2009; Pechtel & Pizzagalli, 2011; Pollak, 2008; Tost, Champagne, & Meyer-Lindenberg, 2015). This huge corpus of research does not entirely address the topic of parenting or, more specifically, the intergenerational transmission of attachment, but many relevant studies have been conducted in this direction (Atzil, Hendler, & Feldman, 2011; Kim et al., 2010a; Riem, Alink, Out, Van IJzendoorn, & Bakermans-Kranenburg, 2015; Riem, Bakermans-Kranenburg, Huffmeijer, & van IJzendoorn, 2013; Riem, Pieper, Out, Bakermans-Kranenburg, & van IJzendoorn, 2011; Strathearn et al., 2009; J E Swain et al., 2014; Weisman, Zagoory-Sharon, & Feldman, 2012). Moreover, many different effects (either directly relevant or not) have started to pile up, and the first attempts to review and synthesize them, can be made in order to propose new theoretical approaches (Crandall, Deater-Deckard, & Riley, 2015; Lomanowska et al., 2015; Rutherford, Wallace, Laurent, & Mayes, 2015). Comprehending the mechanisms implicated in the transmission of dysfunctional parenting can lead to the formulation of new hypotheses that can therefore be tested in more classic designs. An example from past research is the discovery of the representational level of attachment security, which led to new, interesting research on what is transmitted from mother to child and how this process works. Moreover, the apparent research failure in explaining the mediation effect of parental sensitivity on parent–child attachment association led to an interesting call for research, from which new hypotheses were tested and new constructs

were proposed. A similar shift is needed for the study of continuity of parenting because not only is research to comprehend the phenomenon lacking, but intervention programs also show disappointing results in preventing the most dangerous of harsh parenting behaviors, child abuse, and neglect (Euser et al., 2015). New insights on the mechanisms that connect early, negative experiences to the augmented risk of reenacting similar behavior would be helpful in building new interventions.

Considering the enormous advances of traditional research in the field, especially in terms of the methodological requirements to support its claims, experimental laboratory research seems to constitute a step back in the direction of a naturalistic ecological approach. This is undoubtedly true because the levels of inferences of laboratory effects applied to real life are problematic. However, a focus on the mechanisms implies a certain level of abstraction for the measured variables, but in exchange allows control many confounding effects to be controlled and specific hypotheses to be tested. An intriguing example is constituted by research on oxytocin's role in parenting processes. Oxytocin is a neuropeptide that has been highly implicated in parenting processes (Bakermans-Kranenburg & van I Jzendoorn, 2013), as suggested by its increase during breastfeeding and evidence from different research fields. It would be impossible to understand its role in parenting processes without a laboratory trial based on the exogenous administration and contextual manipulation of as many confounding variables as possible. In this way, oxytocin administration has been found to have many different behavioral consequences that can even be contradictory and highly dependent on participants' characteristics. Therefore, a high-level explanatory theoretical framework has been proposed (e.g. Social salience hypothesis, Shamay-Tsoory & Abu-Akel, 2015) and oxytocin's effects on psychological treatments have been considered.

Laboratory studies of intergenerational transmission rely on a quasi-experimental methodology: research designs imply the manipulation of the target variable but in interaction with childhood histories of parenting care. A problematic issue is the retrospective nature of most of the laboratory studies on the

neurophysiological correlates of parenting. In testing the role of early experiences, the use of retrospective instead of prospective studies constitutes a major limitation in interpreting the findings. Memory bias (Hardt & Rutter, 2004), especially in highly emotional childhood experiences, is well documented and decreases the power of a study to actually focus on that specific past experience. Prospective studies in this field are still rare because of the novelty of the approach and the often exploratory nature of the studies. This definitively makes prospective studies not cost effective. There are, in any case, some important exceptions (e.g. Zerach, Kanat-Maymon, Aloni, & Solomon, 2016). If this constitutes a serial limitation, then one way to decrease its detrimental effect on the study's power is to use well-validated and supported measures. A very good example of a retrospective measure of stress during childhood (i.e. emotional and physical abuse and emotional and physical neglect) is the Childhood Trauma Questionnaire (Bernstein et al., 1994, 2003a), a widely used self-report with high validity and good results in assessing histories of trauma in adults.

Concerning participant recruitment, several issues can be raised. First of all, gender often has an effect in parenting studies, essentially due to evolutionary differences in adaptation (Belsky, 1997; Del Giudice, 2009). Traditionally, the role of fathers has often been neglected, considering mothers' primary contribution in children's development. Now, research is extending to fathers (Kerr, Capaldi, Pears, & Owen, 2009; J E Swain et al., 2014; Weisman et al., 2012) but the amount of literature available for mother is overwhelming and allows for a better formulation of hypotheses and interpretations of the results. Moreover, the presence of gender effects is rarely understandable or predictable, leading to confounding effects. This is why a lot of research is still conducted on females. The last question is about testing hypotheses on parents versus males and females without children. It seems that adults process infant stimuli in specific ways as form of adaptation to the environment (Glocker, Langleben, Ruparel, Loughhead, Gur, et al., 2009; Glocker, Langleben, Ruparel, Loughhead, Valdez, et al., 2009; Kringelbach et al., 2008; Riem, Bakermans-Kranenburg, Voorthuis, & van IJzendoorn, 2014). This effect is consistent with the very idea that an

intergenerational transmission of parenting behaviors exists: exposure to specific forms of parenting during childhood will affect parenting behaviors many years later. Thus, childhood effects have to be “stored,” in some ways affecting psychological or neurophysiological processes. Moreover, parental brains have been shown to be characterized by specific processes and neurophysiological markers (Piallini, De Palo, & Simonelli, 2015; J E Swain et al., 2014; James E. Swain, 2011). Therefore, research is needed on adults with and without children: the firsts because can explain mothers’ and fathers’ behaviors and specificity; the second because, from the perspective of intergenerational transmission, confounding effects of parent experience can be avoided.

Section One:

Implicit processes of parenting: the role of attachment styles and early experience

Introduction to the section

Even if intergenerational transmission of parenting effect has been established (Belsky, Conger, et al., 2009; Conger et al., 2009), its predictive power remains low. A primary explanation for this evidence could be that the procedure to assess parenting relies too much on a behavioral domains that it is not probably

able to tap the complexity of the phenomenon. A similar issue pertains attachment transmission, because when a representational model is used the association between generations the effect is at least moderate to high. On the contrary when the association between representations across generations is thought to be mediated by a behavioral measure such as parental sensitivity, the mediation effect is small. Therefore, many scholars focused on studying which other psychological variables can intervene to predict the stability across generations. We propose here two different methodological approaches, adapted from the social cognition field, to test the predictive role of adult attachment styles and childhood history on the responses to two different parenting related types of stimuli. The interconnection with social cognition has already been proved to be particularly prolific. For instances, Westen (1991) proposed the social cognition approach to be a connection point with psychodynamic theory of object relationships. Then he presents the studies on the representational perspective on adult attachment as a fruitful form of integration (Main et al., 1985; Main, 1995). Others researchers studied attachment theory within a proper social cognition framework. Results created important insights on attachment theory basic foundations such as the definitions of internal working models (Baldwin, Fehr, Keedian, Seidel, & Thomson, 1993; Baldwin, Keelan, Fehr, Enns, & Koh-Rangarajoo, 1996). Moreover from social cognition comes one of the most useful approaches to the study of adult attachment, the emotion regulation perspective. In fact, Mikulincer and colleagues (Ein-Dor, Mikulincer, & Shaver, 2011; Gillath et al., 2006; Mikulincer & Shaver, 2007, 2008) repeatedly showed that individual differences in attachment styles rely on different ways to regulate emotions.

Therefore we propose two different ways to study implicit processes within the intergenerational transmission of parenting. In Chapter 1 we tested the hypothesis of an association between adult attachment styles and the formation of implicit attitudes toward caregiving. We are interested in establishing this association because we start from the theoretical hypothesis of caregiving and attachment as different motivational systems that share the same evolutionary goal: to increase security of the infant and to increase the chances of genes

transmission from one generation to the other. We propose that differences in adult attachment styles are associated to a preference for a caregiving style coherent with participants' own attachment styles and therefore experience.

In Chapter 2 we hypothesize that childhood maltreatment affect the behavioral approach avoidance response to infant stimuli with different emotional expressions. Our aim is to extend to infant processing the known effect of a bias to threat in adults with histories of maltreatment. We hypothesize that an augmented bias in processing emotionally negative infant stimuli could be responsible for a diminished parental sensitivity and, in turn, the intergenerational stability of attachment. For a better comprehension of the process implicated we added also two different manipulations of the laboratory conditions. In one case we manipulated mood of the participants to simulate parenting processes during enhanced positive or negative emotions. In the other case we used a Transcranic Magnetic Stimulation (TMS) to test the causal role of right Inferior Frontal Gyrus, a brain area strongly involved in empathy and mirroring processes, in determining the approach avoidance behavior.

Chapter 1

Linking attachment and caregiving systems: anxiety and avoidance effects on implicit attitudes towards parenting styles

De Carli, P., Tagini, A., Sarracino, D., Santona, A., & Parolin, L. (2016). Implicit Attitude Toward Caregiving: The Moderating Role of Adult Attachment Styles. *Frontiers in Psychology*, 6. doi:10.3389/fpsyg.2015.01906

Introduction

Even if intergenerational transmission of parenting effect has been established (Belsky, Conger, et al., 2009; Conger et al., 2009), its predictive power remains low. A primary explanation for this evidence could be that the procedure to assess parenting relies too much on a behavioral domains that it is not probably able to tap the complexity of the phenomenon. A similar issue pertains attachment transmission, because when a representational model is used the association between generations the effect is at least moderate to high. On the contrary when the association between representations across generations is thought to be mediated by a behavioral measure such as parental sensitivity, the mediation effect is small. Therefore, many scholars focused on studying which other psychological variables can intervene to predict the stability across generations. We propose here two different methodological approaches, adapted from the social cognition field, to test the predictive role of adult attachment styles and childhood history on the responses to two different parenting related types of stimuli. The interconnection with social cognition has already been proved to be particularly prolific. For instances, Westen (1991) proposed the social cognition approach to be a connection point with psychodynamic theory of object relationships. Then he presents the studies on the representational perspective on adult attachment as a fruitful form of integration (Main et al., 1985; Main, 1995). Others researchers studied attachment theory within a proper social cognition framework. Results created important insights on attachment theory basic foundations such as the definitions of internal working models (Baldwin et al., 1993, 1996). Moreover from social cognition comes one of the most useful approaches to the study of adult attachment, the emotion regulation perspective. In fact, Mikulincer and colleagues (Ein-Dor et al., 2011; Gillath et al., 2006; Mikulincer & Shaver, 2007, 2008) repeatedly showed that individual differences in attachment styles rely on different ways to regulate emotions.

Therefore we propose two different ways to study implicit processes within the intergenerational transmission of parenting. In Chapter 1 we tested the hypothesis of an association between adult attachment styles and the formation of

implicit attitudes toward caregiving. We are interested in establishing this association because we start from the theoretical hypothesis of caregiving and attachment as different motivational systems that share the same evolutionary goal: to increase security of the infant and to increase the chances of genes transmission from one generation to the other. We propose that differences in adult attachment styles are associated to a preference for a caregiving style coherent with participants' own attachment styles and therefore experience.

In Chapter 2 we hypothesize that childhood maltreatment affect the behavioral approach avoidance response to infant stimuli with different emotional expressions. Our aim is to extend to infant processing the known effect of a bias to threat in adults with histories of maltreatment. We hypothesize that an augmented bias in processing emotionally negative infant stimuli could be responsible for a diminished parental sensitivity and, in turn, the intergenerational stability of attachment. For a better comprehension of the process implicated we added also two different manipulations of the laboratory conditions. In one case we manipulated mood of the participants to simulate parenting processes during enhanced positive or negative emotions. In the other case we used a Transcranial Magnetic Stimulation (TMS) to test the causal role of right Inferior Frontal Gyrus, a brain area strongly involved in empathy and mirroring processes, in determining the approach avoidance behavior.

Attachment theory

In the first formulations of attachment theory, Bowlby (Bowlby, 1969, 1980) postulated that children's need of their caregivers, in terms of proximity seeking, was indispensable for evolutionary adaptation. Children rely on caregivers for safety and resources, but attachment bonds have far-reaching implications since they are involved in shaping development. As Bowlby (1969/82, p. 64) stated, "Not a single feature of a species' morphology, physiology, or behaviour can be understood or even discussed intelligently except in relation to that species' environment of evolutionary adaptiveness. (EEA)". This is consistent with the idea that less than optimal developments should be conceived as a sort of "over-adaptation" to a maladaptive environment rather than as mere failures in adaptation.

The evolutionary pressure that fosters mother-infant bonding lies at the core of adult social behaviors. Baumeister and Leary (1995) highlighted the benefits of forming and maintaining social bonds in terms of survival and reproduction, proposing that the need for interpersonal attachments constitutes a fundamental human motivation. Bowlby introduced the concept of Internal Working Models (IWM), whose function is "to simulate happenings in the real world, thereby enabling the individual to plan his behaviour with all the advantages of insight and foresight" (Bowlby, 1988). The IWMs are expectations aimed at the preservation of self-regulation and positive affect even in adverse environmental conditions (Schoore, 1994; Sroufe & Jacobvitz, 1989). Main and colleagues (Main et al., 1985) went beyond the behavioral perspective by introducing a representational framework, in which IWMs are considered to be "a set of conscious and/or unconscious rules", organizing attachment-related memories, emotions and thought processes. (p. 66).

Social cognition of attachment

Westen (1991) proposed that attachment studies are one of the most productive fields in which psychodynamic and cognitive studies can be integrated.

In his view, representations that underlie attachment-related processes constitute a key element in linking these two perspectives. In fact, Bowlby always underlined the primary role of beliefs and cognitive schemata in orienting attachment behaviors and expectations, but it is only after the reconceptualization of attachment theory in representational terms that social cognitive models and methods have effectively been implemented in this field (Bartholomew & Horowitz, 1991; Brennan, Clark, & Shaver, 1998; Brennan & Shaver, 2002; Mikulincer, Shaver, Gillath, & Nitzberg, 2005; Shaver & Mikulincer, 2013).

From a social cognition perspective, Baldwin and colleagues (Baldwin et al., 1996) found that accessible memories of satisfying or unsatisfying attachment experiences play a role in shaping the perception of relationships. Moreover, they showed that mental schemas of attachment can have different accessibility depending on different contexts, in a similar way to the majority of cognitive structures. In particular, they asked the participant to visualize different kinds of relationships and this led them to react in different ways to interpersonal information and to show increased attraction toward potential dating partners with the same attachment orientation. This helped to improve our understanding of the IWMs moving forward from a definition based on personality traits to a more complex perspective based on a hierarchical structure of relationship specific attachment orientations (Bretherton, 1987, 1999). In the same perspective Bartz and Lydon (2004) found the effect of manipulating close relationships on the working self-concept, in particular on agency and communion. Security priming of attachment leads to positive relationship expectations and affect (Carnelley & Rowe, 2007; Gillath, Selcuk, & Shaver, 2008; Rowe & Carnelley, 2003) and the effect seems stable across the life span and for different domains of social information processing (Dykas & Cassidy, 2011).

A social cognition perspective has been applied also to parenting behaviors. Atkinson and colleagues (2009) studied the interplay between emotional cognitive processes (selective attention in the Stroop task) and disorganized attachment in mothers and their children. They found an interesting interacting role of both attachment and loss of controlled attention that they

interpret as a process of “threat tags”. They conclude that IWMs role in risk for psychopathology can be fully appreciated only if research tries to explore different levels of analysis of attachment representations (cognitive and affective). In fact, Okagaki and Bingham (2005) had tried to drive the attention of researchers to the relevance of a better comprehension of the relation between social cognition and behavior in order to develop effective parent intervention programs. For instance, parental stress seems to be associated to both anxiety and avoidance of attachment, because of the difficulties they imply in coping with distress, but in different ways: more avoidant women attribute negative distress to a characteristic of the baby and not situational factors; more anxious women make more mistakes in recognizing fear and attribute distress to physical factors, then they could show an out of sync response to the babies’ distress signs (Leerkes & Siepak, 2006; for a complete review of a social cognition approach to parenting processes and behaviors, see: Jones, Cassidy, & Shaver, 2015a, 2015b).

Implicit activation of attachment representations

Attachment research studied the role of implicit activation of attachment representations (Gawronski & Payne, 2011), starting from Bowlby’s idea of the importance of automatic attachment schemata. For instance, there is evidence of individual differences in expressing avoidance or hypervigilance with respect to attachment threats: fearful avoidant individuals are in fact characterized by cognitive avoidance of all highly emotional stimuli (Dewitte, Koster, De Houwer, & Buysse, 2007). Baldwin and colleagues (Baldwin et al., 1993) as well as Mikulincer (1998) presented priming sentences like “If I trust my partner my partner will...” (this example manipulates the variable trust). Subsequently, a word non-word task with attachment related words (representing good or negative outcomes) as priming cues was administered. In general, insecure individuals were quicker in the negative outcome condition while secure were quicker in the good outcome condition. This result can be interpreted as insecure participants expecting less

supportive partners in stressful conditions: for them the negative outcome is more naturally consequent to angry feelings.

One of the most widely-used paradigms to study the automatic activation of representations is the Implicit Association Task (IAT, Greenwald, McGhee, & Schwartz, 1998; Greenwald, Nosek, & Banaji, 2003), which assesses implicit dimensions of psychological constructs such as attitudes and stereotypes (for a description see the Materials paragraph).

From the perspective of attachment research, Zayas and Shoda (2005) found a relation between Mother-IATs and Partner-IATs and an explicit measure of adult attachment (ECR). Low negative correlations were found between the Mother-IAT scores, defined as an association between the dichotomies “pleasant/unpleasant” and “supportive/rejecting” and the ECR-subscale Avoidance. For the Partner-IAT scores, participants were asked to indicate words that were highly related and highly unrelated to their partners. These words were then used as stimulus words to be classified according to a dichotomy “name of the partner/not-name of the partner”. In this case, the correlation with ECR-Avoidance was negative, but considerably higher. This last finding was consistent with Banse and Kowalick’s (2007) comparison between groups of women in different stressful conditions. It seems that positive representations of partners constitutes a resource for coping in stressful life situations. Dewitte and colleagues (Dewitte, De Houwer, & Buysse, 2008, p. 282) used the IAT “as an index of the implicit attachment self-concept” and found that self-esteem and relational anxiety on the IAT were, in fact, correlated with attachment style, and able to predict strategies for successfully managing attachment-related stressful circumstances. The aim of the present study is to extend this work on implicit processes related to attachment. We hypothesize an effect of attachment styles in shaping the implicit representations of caregiving related perceptions. Because of the centrality of attachment in affecting individual development, we propose a role of attachment dependent schemata in structuring the implicit activation determined by parenting behavior.

Attachment and caregiving systems

The fundamental role of the caregiver in influencing children's attachment behaviors and representations lead to the study of the caregiving behavioral system (George & Solomon, 2008). Bowlby (Bowlby, 1969, 1988) proposed the existence of a behavioral structure in caregivers which is reciprocal to the recipients' attachment behavior. Parenting entails moving from a position characterized by seeking protection and security to one which requires providing protection and care. The connection between the two systems is suggested by their shared evolutionary aim. In fact, Belsky and colleagues (1991, p. 172) proposed a definition of attachment as an evolved psychological mechanism, through which the parents' experiences during childhood and adolescence are transmitted "probabilistically" to their offspring, shaping their development and reproductive approaches. The strategies (in both behavioral domains and emotion regulation) learnt in infancy, constitute an adaptive advantage because they promote faster and more specific responses within the EEA. As a consequence, such strategies tend to remain relatively stable during the life-span, as confirmed by empirical research (Fraley, 2002; See also Raby, Steele, Carlson, & Sroufe, 2015 for the transmission of infant attachment). Numerous studies support the strong correspondence between mothers' states of the mind with respect to attachment and their children's attachment (van IJzendoorn, 1995a). This evidence seems stable and constant in different cultures (Grossmann, Fremmer-Bombik, Rudolph, & Grossmann, 1988; Hautamäki, Hautamäki, Neuvonen, & Maliniemi-Piispanen, 2010; Kazui, Endo, Tanaka, Sakagami, & Suganuma, 2000; Sagi et al., 1997) and in different risk populations (Bus & van IJzendoorn, 1997; McMahon, Barnett, Kowalenko, & Tennant, 2006; Shlafer, Raby, Lawler, Hesemeyer, & Roisman, 2015; Tarabulsky et al., 2005). In Bowlby's (1969) and Ainsworth's (Ainsworth et al., 1974, 1978) view, the mechanism responsible for this transmission should be the so called "maternal sensitivity", defined as the ability of being aware of infants' signals and to correctly respond to them. The effect they hypothesized was that an insecure mother's attachment lead to a poor

maternal sensitivity and in turn to the transmission of mother's attachment to the infant. Unexpectedly, research identified a "transmission gap" (van IJzendoorn & Bakermans-Kranenburg, 1997; van IJzendoorn, 1995a, 1995b) because the mediating role of maternal sensitivity was significant but modest. Fonagy and Target (2005) proposed the mediating function of mothers' ability to mentalize as a necessary factor for creating a secure base environment for their children, as empirical research confirmed. (Grienenberger et al., 2005; Slade et al., 2005). From a developmental perspective, Meins (Meins et al., 2012; Meins, Fernyhough, Fradley, & Tuckey, 2001) proposed that is mothers' mind-mindedness, i.e. the capacity to understand children's mental states, what enables them to respond to the children's needs adequately. More recently, Bernier and colleagues (Bernier et al., 2014) proposed to add the notion of "maternal autonomy support" to describe mothers' ability to enhance children's confidence in exploring the environment. This approach seems to take into account the problem of the transmission gap, although further studies are needed to explore underlying social cognition processes. Scharf and Mayseless (2011) followed 60 men from adolescence to early adulthood and found a continuity between their state of mind with respect to attachment in adolescence and the quality of parenting 9 years later. Other studies used self-reported attachment measures (Jones, Brett, Ehrlich, Lejuez, & Cassidy, 2014; Jones et al., 2015a, 2015b) and found that insecurity is associated with more negative attitudes toward parenting, which is considered more stressful (Nathanson & Manohar, 2012). Secure individuals consider themselves more competent and effective in parenting, compared to less secure ones (Caldwell, Shaver, Li, & Minzenberg, 2011; Howard, 2010; Kilmann, Vendemia, Parnell, & Urbaniak, 2009; Kohlhoff & Barnett, 2013). Anxiety was found to be associated to the perception of infants as interfering with parents' romantic relationship (Rholes et al., 2011) and jealousy toward the children (Wilson, Rholes, Simpson, & Tran, 2007). Parental avoidance is correlated with less optimistic expectations for child outcomes (Lench, Quas, & Edelstein, 2006).

From an evolutionary perspective, intergenerational transmission seems to foster the maintenance of strategies which are able to enhance the reproduction of

the species (Belsky, 2005), but the emotional and cognitive mediators remain unclear. In particular, literature focused primarily on correlational studies, with a less intense focus on experimental manipulations.

The present study

Although there is a growing theoretical interest about the attachment transmission gap, few studies focused on the cognitive processes that may affect the individual's relational patterns. The aim of this study was to explore the link between adult attachment styles and attitudes towards different caregiving behavioral modalities. In particular, we investigated if current adult attachment styles make individuals discriminate different ways of caregiving, and if they are associated with a preference for a specific caregiving modality. We hypothesize that the preference for proximity, avoidance, or resistance in adult relationships could predict the attitude toward the perception of a new specific relationship (Brumbaugh & Fraley, 2007), like a caregiving one.

From an evolutionary perspective, the intergenerational transmission should foster the maintenance of strategies able to lead to reproduction of the species (Belsky, 2005). Therefore, if these strategies experienced by an individual led to reproduction, there is no need to change them and they can be transmitted to next generations. Then we expect adult attachment styles to shape the adult perception of caregiving strategies.

In order to explore the association between attachment styles and the perception of different caregiving modalities, we designed a study to elicit a specific caregiving representation in the participants and, then, we assessed the attitude to the semantic category "mother". Our first hypothesis was that the activation of a caregiving representation in line with the participants' attachment style would entail a more positive attitude, implying a preference for a strategy that is coherent with one's own attachment style. For example, a participant who uses dismissing strategies in his/her adult relationships should show a more positive

attitude when he/she is watching a dismissing caregiver than when he/she is watching a preoccupied mother and her baby.

Second, a fundamental question relates to whether the transmission of attachment styles is an automatic or implicit process of identification with an experienced caregiving modality. Do individuals have “script-like representations of secure base experiences” (Waters & Waters, 2006, p. 185) and do they use them as basis for comparison in forming attitudes of different situations? In order to face this issue we used two different measures of attitude, an implicit one and an explicit one. We expect a stronger effect of attachment style on the more implicit measure, because of the importance of automatic processes in IWMs.

Third, in the light of the strong connection between attachment styles and emotion regulation strategies, we are interested in linking the perception of different caregiving styles to a measure of emotion arousal. The process of forming attitudes has also an affective component (Clore & Schnall, 2005; Malhotra, 2005; Petty, DeSteno, & Rucker, 2001) so we propose at an explorative level an influence of attachment styles on the emotional processes that contribute to define a specific attitude toward a caregiving style. More specifically, disgust seems to be involved in the process of formation of attitudes, for instance in political orientations (Hibbing, Smith, & Alford, 2014; Inbar & Pizarro, 2014). Disgust fosters avoidance not only of dangerous or unhealthy situations but also of unfair or not convenient conditions (Chapman & Anderson, 2013; Chapman, Kim, Susskind, & Anderson, 2009; Tybur, Lieberman, Kurzban, & DeScioli, 2013). The evolutionary purpose is to avoid unhealthy or unfamiliar behaviors, so it is possible that the same process takes place while an individual is selecting between different caregiving behaviors. Magai and colleagues found an effect of attachment “Preoccupation” on facial expression of disgust during an emotion elicitation task (Magai, Hunziker, Mesias, & Culver, 2000). For exploratory purposes, we want to test if this role of disgust can be extended during the perception of caregiving modalities. Then we tested whether the expression of disgust during the observation of a specific caregiving modality in adults depends on individual’s attachment style. A caregiving modality less coherent with participant’s attachment

style should elicit more disgust. We are interested in this effect as a first step toward a better understanding of the mechanisms to form this kind of attitudes. This effect could be part of the process that increases the chances of intergenerational transmission of attachment style, influencing the formation of attitudes and driving behaviors. Attachment style would be confirmed as crucial in the psychophysiological process of discerning between different caregiving behaviors and the prominence of low-level information processes in forming these attitudes. The attitudes towards caregiving modalities would directly shape the emotions expression and regulation: this would suggest an explanation of transmission gap in a sort of communication at an implicit level between mother and child.

Material and methods

Participants

Seventy-three Italian undergraduate students participated in exchange for course credits at the Psychology Department of the University of Milan-Bicocca. The only exclusion criteria was having children. Twenty-five participants (12 males) were assigned to a preliminary phase; 48 females were assigned to a second step of the present study.

Materials

Experiences in Close Relationship-Revised (ECR-R; Busonera, Martini, Zavattini, & Santona, 2014; Fraley, Waller, & Brennan, 2000). The ECR-R is a questionnaire used to assess adult romantic attachment style as resulting of two orthogonal dimensions: a subscale of anxiety and a subscale of avoidance. High scores on the first subscale indicate a tendency to preoccupation, jealousy and fear of abandonment, while high scores on the second scale suggest uneasiness

with intimacy. The questionnaire is largely used to measure individual differences in romantic adult attachment styles and shows good psychometric properties both for validity and reliability (Fairchild, 2006; Sibley, Fischer, & Liu, 2005).

Single Target-Implicit Association Task (ST-IAT; Wigboldus, Holland, & Van Knippenberg, 2004). The ST-IAT is a version of Implicit Association Task (IAT, Greenwald et al., 1998) that measures the level of association between two categories characterized by opposite polarities (e.g., pleasant/unpleasant) and a single target category (in the present study the category was “mother”). It is a computer task developed with Inquisit 4 (Millisecond Software, 2013): participants are asked to categorize the words that appear in the center of the screen depending on the category they belong to. By pressing different response keys, they associate these words to the categories presented on the top part of the screen: the left key for the left categories or the right key for the right categories. The words can refer to the a polarity (e.g., “wonderful” vs “awful”) or to a target category (e.g., “care” or “comfort”). In different trials target category can be presented on the right or on the left, that is can be associated with each of the opposite polarities (“good”, “bad”). The differences in reaction times between the conditions when the category is associated with each of the two polarities represent a measure of association between one side of the polarity and the target category. In our task the IAT algorithm (Greenwald et al., 2003) produced the score of the association between the category “good” and the category “mother”. IAT has been shown to have good predictive validity (Greenwald, Poehlman, Uhlmann, & Banaji, 2009) and validity of the scoring algorithm (Richetin, Costantini, Perugini, & Schönbrodt, 2015). It is one of the most used task to study implicit attitudes (Teige-Mocigemba, Klauer, & Sherman, 2010) and it has been used also in attachment research (Zayas & Shoda, 2005). The words used in the present task are the following. Positive: Marvelous, Superb, Pleasure, Beautiful, Joyful, Glorious, Lovely, Wonderful. Negative: Tragic, Horrible, Agony, Painful, Terrible, Awful, Humiliate, Nasty. Mother: Care, Attention, Consolation, Support, Help, Bond, Comfort.

Semantic Differential (SD; Osgood, Suci, & Tannenbaum, 1957). Semantic Differential is an explicit measure of attitude. The participant is asked to think to a category (in our study “mother”) and to rate 10 bipolar adjective on 7-point Likert scales (e.g. “strong/weak”, “good/bad”). It has been recently used to evaluate different kinds of parents (Weed & Nicholson, 2015), showing a good discriminant ability.

FaceReader software version 5.0 (FR, Noldus, 2013) automatically analyzed facial expressions to detect the six basic emotions described by Ekman (1992): happy, sad, angry, surprised, scared, disgusted and a neutral state. The software showed a good convergent validity (Den Uyl & Van Kuilenburg, 2005; Terzis, Moridis, & Economides, 2012) with the manually coded FACS ratings (Ekman & Rosenberg, 1997). FR reduces the time for behavioral coding without compromising accuracy and its use in psychological studies is increasing (Chentsova-Dutton & Tsai, 2010; He, Boesveldt, de Graaf, & de Wijk, 2014).

Stimulus materials. Three different videos of mother-infant interactions were employed to activate three different representations of caregiving. The videos were chosen based on mothers’ Adult Attachment Interview (AAI, George et al., 1985) classification, independently obtained. We selected the videos from a sample of mother infant free play (with standardized games) used in a previous study (Tagini et al., in prep.). The children in the selected videos were females of 23 months of age. Mothers’ AAI classification was previously assessed and the mothers were selected to be one secure, one preoccupied and one dismissing. In addition, a further selection criteria was that all ECR-R (which was assessed as well) scores of mothers were consistent with their AAI classification. The secure mother had low anxiety (less than a standard deviation from the mean) and low avoidant scores, the preoccupied one was high in anxiety (more than a standard deviation from the mean) and the dismissing one was high on avoidance. After watching the three videos, 18 attachment experts (researchers and clinicians) answered the following questions for each video: “How much do you consider the caregiving behavior of this mother prototypic of a secure/preoccupied/dismissing mother? One is not prototypic at all and 7 is very prototypic.” Results confirm that

our stimuli has been chosen to be actually able to represent different caregiving styles and this association seems to be empirically supported.

Procedure

This study was carried out in accordance with the recommendations of the Declaration on Helsinki and the approval of the Ethical Committee of University of Milano – Bicocca. All subjects gave written informed consent in order to participate.

The first phase of the experiment consisted in evaluating the association between measures of attitude and participants' attachment style. The implicit and explicit measures were assessed for a first sample of 25 participants (females = 14) and subsequently their attachment style was evaluated with the ECR-R. Because no significant correlations were found, the presence of an effect of attachment style on attitudes during the second phase, could be interpreted a consequence of the experimental manipulation. The second phase consisted in a new, larger sample of female participants ($N = 48$), who watched the videos of mother-child interactions. In each session, after viewing the mother-child interaction video, the participants' attitude toward the category "mother" was measured, by means of both implicit (ST-IAT) and explicit (SD) measures. Thus, differences in attitudes could be attributed to having watched the different videos. The order of the videos was randomly generated to control learning effects on the ST-IAT. Three days was the minimum interval between one condition and the subsequent one. The choice to select only female participants was due to the characteristics of the videos, that represent mothers playing with their daughters. This could make very difficult to interpret any possible gender difference in the data.

At the end of the first session, each participant was asked to fill out the ECR-R. The number of observations ($N = 138$) is slightly less than the maximum possible number ($N = 144$), because not all participants came three times to

perform the task in the three different conditions. Participants who came just once were excluded from the analysis ($N = 4$).

While participants were watching the videos, their faces were video recorded in order to analyze their emotional expressions.

Data-analysis

We used R software (R Development Core Team, 2013) to analyze data. Correlations between the attachment measure and the ST-IAT and SD in the condition when no caregiving representation was activated (no video watched) were calculated, in order to control the possibility that the attitude toward the category “mother” depended on attachment style.

The effects of the experimental manipulation on ST-IAT and SD was tested with Linear Mixed Models (LMMs). This allowed us to test within subjects experimental effects, considering attachment measures as covariates, and to perform repeated measure analyses, including those participants who were evaluated in only two conditions. The fixed effects were attachment style (anxiety and avoidance of attachment) and the type of condition (the vision of a video with a preoccupied/secure/dismissing mother). The outcome variable was the attitude toward the category “mother”, in one model it was the explicit measure (SD), and in the other model the implicit one (ST-IAT). We report all significant main effects and interactions (up to three way interactions).

The same predictors were used in a different model, with the Disgust measure of FaceReader Software as the outcome variable. Because of the very skewed distribution (skewness = 3.27 and kurtosis = 11.97) the outcome measure was recoded as a binomial variable (median split), in which 0 indicated a low Disgust mean and 1 a high Disgust mean. In this way, we could test a logistic mixed regression model, as part of the Generalized Linear Mixed Models (GLMMs).

LMMs and GLMM were performed in R by using the package “lme4” (D. Bates, Mächler, Bolker, & Walker, 2015) and bootstrapping all the confidence intervals. Degrees of freedom and p-values for the LMMs were computed via Kenward-Roger's approximations (F tests) and Satterthwate's approximations (t-tests) through the “lmerTest” package (Kuznetsova, Brockhoff, & Christensen, 2014). The GLMM p values and degrees of freedom for the Chi square tests were computed via the likelihood ratio tests through the package “afex” (Singmann et al., 2014). Plots were built using the package “ggplot2” (Wickham, 2009).

Results

Correlation between attachment style and attitude measures without manipulation

The first step was to test the correlation between the two dimensions of attachment style (avoidance, anxiety) and the two measures of attitude (ST-IAT, and SD), when no representation of caregiving was activated. This analysis was performed on the first sample (N = 25) that did not watch any video. The results indicate that there was no significant association, both for the ST-IAT (avoidance: $r = .09$; anxiety: $r = -.06$) and for the SD (avoidance: $r = -.13$; anxiety: $r = -.16$). The non-significant correlations obtained allowed us to ignore the “baseline” condition (no experimental manipulation) in subsequent sample, in which it was therefore possible to consider the effect of attachment style as related to the experimental manipulation.

Effects of attachment style and conditions on IAT

The first LMM model (within-subjects factor: type of conditions; covariates: anxiety and avoidance of attachment, centered on the means) showed no effect of the predictors (neither main effects nor interaction effects), on the attitude measured in an explicit way. The random terms were both intercept (var = 0.11) and condition (var = 0.26), because the model with both effects showed a significant improvement of fit ($\Delta\text{BIC} = -44.48$, $\chi^2(5) = 54.48$, $p < .001$). The same

LMM model was performed with the ST-IAT scores as the outcome variable. The random term was just the intercept ($\text{var} = 0.04$), because the model with intercept and condition effects showed a not significant improvement of fit ($\Delta\text{BIC} = -17.89$, $\chi^2(5) = 6.71$, $p = .24$). IAT score was significantly affected by the type of Conditions ($F(2, 83.20) = 5.83$, $p < .01$) but not by Avoidance ($F(1, 42.90) = 0.06$, $p = .80$) and Anxiety ($F(1, 43.41) = 0.45$, $p = .51$). The three two-ways interaction terms were the following: Conditions x Avoidance, $F(2, 82.32) = 8.53$, $p < .001$; Conditions x Anxiety, $F(2, 82.82) = 7.86$, $p < .001$; Avoidance x Anxiety $F(1, 42.80) = 0.26$, $p = .61$. The three way interaction Condition x Anxiety x Avoidance was significant, $F(2, 82.22) = 3.85$, $p < .05$, suggesting that the effect of type of conditions (one of the three videos) was different for different levels of the two attachment style scales. To interpret this interaction we calculated the simple slope analysis: on the left panel of *Figure 1.1* the effects of Avoidance are shown (Anxiety centered on the mean), while on the right panel of *Figure 1.1* the effects of Anxiety are shown (Avoidance centered on the mean).

Effects of Attachment and Conditions on the Implicit Attitude

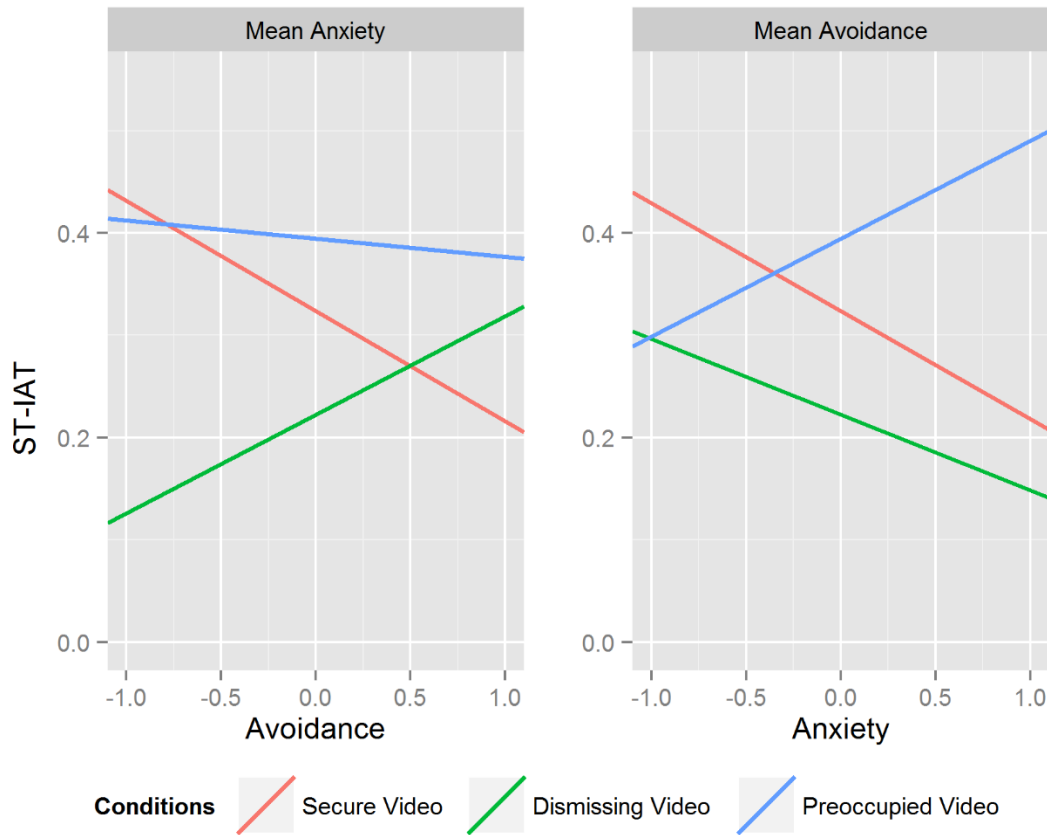


Figure 1.1 Results of the simple slope analysis of the ST-IAT model: effects of attachment styles and conditions. The left panel shows the effects of avoidance when Anxiety is centered on the mean, while the right panel refers to anxiety effects when Avoidance is centered on the mean.

When anxiety is centered on the mean, avoidance has a negative effect on implicit attitude after the Secure Video, $b = -0.11$, $SE = 0.05$, $t(89.83) = -2.26$, $p < .05$, 95% CI [-0.20, -0.004], a positive effect after the Dismissing Video, $b = 0.10$, $SE = 0.05$, $t(90.54) = 2.02$, $p < .05$, 95% CI [0.004, 0.189] and a negative not significant effect after the Preoccupied Video, $b = -0.02$, $SE = 0.05$, $t(90.48) = -0.37$, $p = .71$, 95% CI [-0.11, 0.81].

When avoidance is centered on the mean, anxiety has a negative effect on implicit attitude after the Secure Video, $b = -0.10$, $SE = 0.05$, $t(92.77) = -2.00$, $p = .05$, 95% CI [-0.21, -0.001], a negative not significant effect after the Dismissing

Video, $b = -0.07$, $SE = 0.05$, $t(90.85) = -1.42$, $p = .15$, 95% CI $[-0.17, 0.04]$ and a positive not significant effect after the Preoccupied Video, $b = 0.09$, $SE = 0.05$, $t(90.64) = 1.84$, $p = .06$, 95% CI $[-0.0009, 0.01988]$.

To sum up, we found a positive effect of avoidance on IAT after the dismissing video and negative effects of both anxiety and avoidance after the secure video.

Effects of attachment style and conditions on emotion expression

There was no significant association between Disgust variable and the explicit or implicit measures of attitude.

A third model with the same predictors and random effects was performed with the FaceReader measure of disgust as dichotomous outcome variable. The random term was just the intercept ($var = 0.00$) because the model with intercept and condition effects was not able to converge. The results showed a main effect of avoidance ($\chi^2(13) = 4.46$, $p = .03$) and no other significant main or interaction effect. The effect is positive, as it can be seen in *Figure 1.2* that represents the effect of the three different conditions even if no one of them is significant if taken singularly. Secure Video: $b = 0.43$, $SE = 0.36$, $z = 1.19$, $p = .23$, 95% CI $[-0.25, 1.20]$; Dismissing Video: $b = 0.33$, $SE = 0.31$, $z = 1.04$, $p = .30$, 95% CI $[-0.27, 0.99]$; Preoccupied Video: $b = 0.47$, $SE = 0.33$, $z = 1.42$, $p = .15$, 95% CI $[-0.14, 1.16]$.

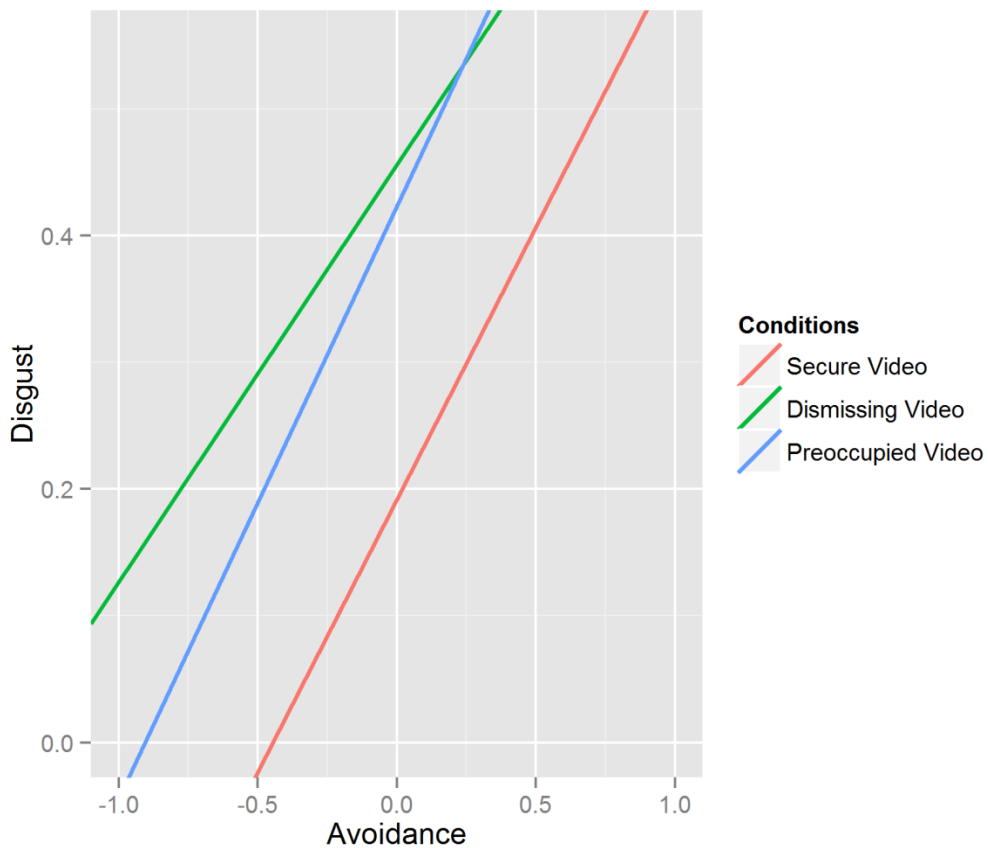


Figure 1.2 Results of the simple slope analysis of the Disgust model: effects of attachment styles and conditions.

Discussion

The results of this study confirmed the adequacy of the experimental paradigm in activating a specific caregiving representation, and measuring the process of forming an attitude. We found a role of adult attachment style in shaping the implicit attitude, but non the explicit one, toward the category “mother”. The explicit attitude seems not to be influenced neither by the manipulation neither by participants’ attachment style. This can be due to social desirability because the perception of the category “mother” is highly expected to be always good, or also to some kind of inability in being aware of a preference for a relational modality. On the contrary, the significance of the implicit attitude model could suggest the

importance of the automatic processes of the IWMs. Participants are able to compare their relational expectations with the behavior they see in the videos, but they process this information in a not conscious way.

The results of the implicit attitude model are consistent with our expectations. In fact both Avoidance and Anxiety have a negative effects on IAT scores after the Secure Video (when the other variable is centered on the mean). This means that the more insecure a participant, the more negative her attitude toward the secure mother. On the contrary, avoidance has a positive effect on IAT scores after the Dismissing Video, but no effect after the Preoccupied one. This seems consistent with our hypotheses: very avoidant participants tend to prefer the Dismissing Video, while we had no predictions of a role of Avoidance on implicit attitude after the Preoccupied Video. Anxiety plays a similar role because it has a positive marginally significant effect on attitude after the Preoccupied Video and a negative not significant effect after the Dismissing Video.

The link between adult attachment style and the perception of different ways of caregiving can contribute to a better understanding of the mechanisms underlying the transmission of attachment. Avoidance or seeking of proximity in adult attachment seem to impact implicit processes of evaluation of caregiving modalities. The continuity between representations of partners and responses in new social encounters (Brumbaugh & Fraley, 2007) has a specific feature for what concerns caregiving relationships. From an evolutionary perspective, attachment schemata are influenced by the caregiving style of the parents. Thus, if an individual reaches the goal of reproduction, it is implied that the caregiving strategies have succeeded in that specific environment. In this sense it seems inexpensive to maintain a continuity between generations. It is consistent with the definition of IWMs that they regulate the access to information relevant to attachment, and our findings underline that the information relevant for the caregiving system is also closely related to attachment styles.

The explorative hypothesis of the effect of the experimental manipulation and attachment style on the facial expression of disgust while participants were

watching the different videos was not confirmed. The only significant effect was a positive one of avoidance that was also unexpected because Magai and colleagues (Magai et al., 2000) found an association between facial expression of disgust and “Preoccupation” during an emotion elicitation task. Anyway it seems reasonable that a specific kind of human relationship like the mother infant one elicits more negative physiological reaction in participant with higher levels of avoidance, although this was not our hypothesis. Finally, we found no association between disgust and the two measures of attitude, so we can claim that the process of forming attitudes is not explained by the elicitation of this specific emotion.

Conclusion

Adult attachment styles seem to play a moderating role on high level implicit attitudes toward caregiving but not on explicit attitudes or on low level regulation and expression of emotion. These findings underline the fundamental role of adult attachment style in predicting attitudes related to the caregiving system. Our hypotheses are only partially confirmed because we found a correspondence only between attachment styles and the IAT. Anyway, this specific result is in line with Bowlby's statements on the complementarity of the caregiving and attachment motivational systems. Furthermore, our study confirms his belief in the complexity of the effects involved. In fact, Bowlby (1988) wrote: “Parenting behaviour, as I see it, has strong biological roots, which accounts for the very strong emotions associated with it; but the detailed form that the behaviour takes in each of us turns on our experiences -- experiences during childhood especially, experiences during adolescence, experiences before and during marriage, and experiences with each individual child.” (p. 5). From a clinical point of view, these issues are of great interest since they may contribute to the process of the intergenerational transmission of attachment, and the passing on of disorders, considering that an insecure attachment style can become a risk factor for psychopathology (Mikulincer & Shaver, 2012). It has in fact been associated to

internalizing and externalizing problems in adolescence (Sarracino, Presaghi, Degni, & Innamorati, 2011) clinical disorders such as depression (Cantazaro & Wei, 2010; Roberts, Gotlib, & Kassel, 1996; Santona et al., in press), anxiety disorders (Warren, Huston, Egeland, & Sroufe, 1997), and personality disorders (Crawford et al., 2007; Meyer & Pilkonis, 2005).

The limitations of this study must be acknowledged. In fact, research on adult attachment reports a “trivial to small” correspondence between adult attachment style questionnaires and state of mind with respect to attachment (Roisman et al., 2007a). Then a limitation of our study is the use of different models of measure between stimuli and participants’ assessment. AAI is indeed considered the “gold standard” for adult attachment assessment (Hesse, 2008) and differs from adult attachment styles questionnaires because of its implicit nature. AAI relies on different processes and measures coherence of mind with respect to attachment, which, by definition, differs from the explicit thoughts about attachment style. Finally the correspondence between an individual’s attachment style and his preference for the matching caregiving modality could however not be directly tested, because of the attachment model underlying the measurement used, which differed from the stimulus categorization. On one hand the continuous measure of attachment is more effective (Fraley, Hudson, Heffernan, & Segal, 2015), on the other hand led to a more difficult interpretation of the results because the videos had to be categorized.

A future perspective could explore the moderating role of gender in evaluating caregiving representations. Although differences in attachment style usually do not emerge from studies based on Adult Attachment Interview (Bakermans-Kranenburg & van IJzendoorn, 2009a), it seems reasonable that males and females could have different attitudes toward caregiving behaviors. In an evolutionary view, males tend to be more facultative investors (Del Giudice, 2009) than females, probably because a low parental investment can be more adaptive in order to save resources for additional mating. Thus, regardless of the effect of attachment style, we could expected higher levels of positive attitudes when representations were activated in females, due to evolutionary differences.

Approaching the transmission gap issue, the evidence of the non-linear effect of maternal sensitivity in shaping children attachment led to focusing on the role of other mediating constructs, such as Reflective Function (Fonagy & Target, 1997; Slade et al., 2005). This study attempted to investigate, at a more basic level, the link between attachment style and caregiving representations and we found an effect that may be a starting point for further research and for interventions on parenting skills in risk situations. Our results confirm that cognition and behavior linked to caregiving rely on automatic processes (Bos, Hermans, Montoya, Ramsey, & van Honk, 2010; Bowlby, 1969; Riem, Bakermans-Kranenburg, et al., 2011; Soltis, 2004; J E Swain et al., 2014). In this regard, a key research area may be the study of the maternal representations, in order to understand how this caregiving attitude emerge and develop in pregnancy and early motherhood (Innamorati, Sarracino, & Dazzi, 2010; Stern, 1995a). It seems that every kind of intervention should face these implicit processes that do not reach a conscious level of elaboration. Finally, the results may be relevant to psychotherapy, considering that the interconnection between representations and the perception of relational contexts is a key concept in those contexts that focus on pointing out specific non-adaptive representations and reflecting on which specific environment allowed its development.

Chapter 2

Approach-Avoidance Motor Responses to Emotional Infants' faces: the role of childhood maltreatment

De Carli, P., Lega, C., Zanardo, B., Cattaneo, Z., & Parolin, L. (in prep). Approach-Avoidance Motor Responses to Emotional Infants' faces: the role of childhood maltreatment.

Introduction

Adults' reaction to infants' stimuli are specific and different from adults' in the neurophysiological domain (Esposito, Valenzi, Islam, Mash, & Bornstein, 2015; Kringelbach et al., 2008; Pialiini et al., 2015; J E Swain et al., 2014; Young et al., 2015) and in the behavioral one (Bakermans-Kranenburg, van IJzendoorn, Riem, Tops, & Alink, 2012; Brosch, Sander, & Scherer, 2007; Frodi, Lamb, Leavitt, & Donovan, 1978; Out, Pieper, Bakermans-Kranenburg, & Van IJzendoorn, 2010). In facts, infants' signals are essential in communicating infants' needs and eliciting caregiving reactions in adults (Ainsworth et al., 1974; Bowlby, 1969; Soltis, 2004). In particular cry and facial expression represent the most powerful ways infants possess to communicate their states and interact with adults. Parents' ability to properly recognize and respond to these signals is crucial for infants' normal development (Bowlby, 1969; Klein Velderman, Bakermans-Kranenburg, Juffer, & van IJzendoorn, 2006; Van Zeijl et al., 2006), in particular for learning the ability to regulate emotions by themselves (Fonagy et al., 2002). In this paper we focus on the perception of different infants' emotional expression in nulliparous women and their effect on approach/avoidance behavior toward the stimulus. Aim of the study is to comprehend how infants expressions affect adults' reaction and behavioral response, in terms of predisposition to action. It is well known the aversive effect of infant cry that is associated to physiological arousal (Frodi et al., 1978; Groh & Roisman, 2009; Groh et al., 2015; Out et al., 2010) that elicits quicker responses (Del Vecchio, Walter, & O'Leary, 2009). In extreme cases, crying can also be considered a trigger of abuse and neglect (Barr, Trent, & Cross, 2006; Compier-de Block et al., 2015; Soltis, 2004). To our knowledge no study specifically focused on the role of infants' emotional expressions in shaping behavioral responses or predispositions to action, but fruitful hints can come especially from neurophysiological evidences. Brain activation during the perception of different expressions on baby faces has been studied both in parents and not parents. Strathearn and colleagues (Strathearn, Li, Fonagy, & Montague, 2008) found that only own-babies emotional expressions, and the happy one in particular, were associated to the activation of the dopaminergic circuits. This means that own

infant's smile is considered a reinforcement for mother's behavior and her caregiving ability as well. In nulliparous females Montoya and colleagues (Montoya et al., 2012) found that happy infants vs sad infants were more rewarding (activation of ventral striatum, caudate, ventromedial prefrontal and orbitofrontal cortices), while sad vs happy infants elicit more emphatic processes (precuneus, cuneus and posterior cingulate cortex). This could suggest that happy faces, because of the more rewarding features, can be considered a prompt to approach the infant, while the sad face, could be considered more aversive as infant cry. Actually, the aversive characteristic could be responsible for an avoidance predisposition that makes more urgent the caregiving behavior in order to stop the expression of infant distress.

Adults emotions have different functions because they are action dispositions and have a clear evolutionary function (Bradley, Codispoti, Cuthbert, & Lang, 2001; Lang, Bradley, & Cuthbert, 1998): when a stimulus is presented, different emotions can trigger approach or avoidance depending on the salience and the valence of the stimulus. Valence of the stimulus seems to be automatically evaluated, in order to provide a quick and adaptive response. Thus, the perception of emotion expression can be interpreted as a cue to understand motivation in others and elicit different behavioral response. This effect is often studied by means of manual approach-avoidance task: participants are asked to approach or distance emotional faces presented on the screen through pulling or pushing a lever (Marsh, Ambady, & Kleck, 2005; Roelofs, Elzinga, & Rotteveel, 2005; Seidel, Habel, Kirschner, Gur, & Derntl, 2010). Results consistently show that happiness, sadness and fear were associated with approach while anger was associated with avoidance. This confirms the role of anger expressions as a threat signal, while the other emotions as affiliative signals. In the case of infants' emotion expressions, smiles have a clear function of reinforcement of caregiving behaviors and bonding, while cry/sad faces have the role of enabling caregiving behaviors, through aversive signals of distress.

In addition, we test the role of participants' childhood experiences in moderating the effect of preference for approach or avoidance dispositions toward

different emotions. Adults with histories of maltreatment have deficits in recognizing certain emotions (Ardizzi et al., 2015) and childhood abuse is associated with bias to threat in children (Pine et al., 2005) and in adults (Fani, Bradley-Davino, Ressler, & McClure-Tone, 2011). In fact, striking evidences depict the role of experiences of care during childhood in shaping parenting related processes (Bakermans-Kranenburg et al., 2012; Bhandari, Bakermans-Kranenburg, et al., 2014; Bhandari, van der Veen, et al., 2014; Kim et al., 2010a; Kim, Ho, Evans, Liberzon, & Swain, 2015; Strathearn et al., 2009) and the intergenerational transmission of parenting (Conger et al., 2009; Lomanowska et al., 2015; Neppl et al., 2009; Scaramella, Neppl, Ontai, & Conger, 2008). More specifically, the effects of childhood experiences on infants' faces perception is reported by Bhandari and colleagues in two different studies: the first shows the higher rating of infant happy faces of participants with higher scores of maltreatment and how this association is explained by higher levels of endogenous oxytocin (Bhandari, Bakermans-Kranenburg, et al., 2014). The second study presents the moderating role of childhood maltreatment on the effect of oxytocin administration on memory for infant cues: only participants with higher scores of maltreatment showed a decrement in their ability of memorize child emotional characteristics after oxytocin administration (Bhandari, van der Veen, et al., 2014). In parents, Strathearn and colleagues (Strathearn et al., 2009) assessed participants' adult attachment representations and brain activation during the presentation of faces of their own or unfamiliar infants with different emotion expressions. Even if they did not directly assessed childhood experiences, adult state of mind with respect to attachment is clearly influenced by childhood rearing experiences (Main et al., 1985). Results show that secure mothers during the perception of their own infant's sad face continues to activate rewarding regions, while insecure/dismissing mothers' activation is associated with feeling of unfairness and pain. In secure mothers, infant cues are an important signal of "incentive salience" that reinforce maternal care. On the contrary, the greater activation of dorsolateral prefrontal cortex in insecure-dismissing mothers suggests the need of a cognitive control on the affective response and anterior insula is interpreted as the signal of a norm violation. Thus, insecure mothers are

probably more likely to perceive their own sad infant as a violation of an expected state and avoid or reject negative infant cues. Finally, Kim and colleagues (Kim, Fonagy, Allen, & Strathearn, 2014) found that mothers with unresolved traumas show a decreased amygdala response when they perceive their own infant in the sad versus happy condition, suggesting more disengagement from infant distress.

In sum, this study is aimed at studying the approach and avoidance dispositions to action in adults in response to different infant expressions. We hypothesize that for participants will be easier, because more coherent with their expectations, when they will be asked to approach infants with positive expression and avoid infants with negative expressions. Moreover we expect this association to be stronger in participants with higher scores of childhood maltreatment. In order to test this effects we developed a joystick task and we use it in three different studies. In study one we test our task and the main hypotheses, in study two and three we use the same task and we add different moderators: a mood manipulation and the inhibition of a specific neural process by means of Transcranial Magnetic Stimulation (TMS).

Study One: Approach and Avoidant behaviors in response to infants faces

In study One we developed the task and tested the fundamental hypothesis of approach or avoidance towards different emotions. The paradigm is adapted from Rinck and colleagues (Heuer, Rinck, & Becker, 2007; Rinck & Becker, 2007) and is based on the *Approach-Avoidance Task (AAT)*. Behavioral overt response to different stimuli has been found to be associated to arm movements since a long time (M. Chen & Bargh, 1999; Solarz, 1960) and it has been used with emotional faces firstly by Marsh and colleagues (Marsh et al., 2005). Approach was represented by pulling a joystick toward self and avoidance by pushing it away from self. Rinck and Becker (2007) found that this simple association can be biased because participants can consider that they move their hand toward the stimulus when they want to grab it. Thus, they proposed a zoom feature of the task

which means that when the joystick is pulled the face stimulus becomes bigger simulating it is coming closer to the participant and on the contrary becomes smaller when the lever is pushed simulating that it is moving away. Thus, our paradigm uses four different kinds of infant expressions: smiling, crying, neutral and sleepy. The sleepy infant is a specific infant characteristic because represents a non-positive expression but does not require the intervention of adults, meaning that there is no infant signal of need, contrary to the crying baby. We aimed at designing an implicit task, then we proposed to the participants two different conditions in randomized order: pulling or pushing when the infant face had a red mark on the forehead or not. Participants are asked to differentiate their answers depending on the presence of the red dot on stimuli: infants' expression are not even mentioned. Then we considered the reaction times in completing the movement of the joystick as an implicit measure of the congruency (or not) of the task for the participants: we expect RTs to be quicker when a participant is asked to approach (vs avoid) a happy face or to avoid (vs approach) a sad (crying) and sleepy face. No effect is expected for neutral faces. As previously mentioned a moderating role of childhood experience is expected. Bias to threat is characteristic of maltreated individuals and we hypothesize that this should lead to overestimations of the threat represented by sad infants. Therefore we hypothesize shorter reaction times in participants with higher scores of maltreatment.

Method

Participants

63 female undergraduate students from the Bicocca University of Milan participated in the study in exchange for credits. The study was carried out in accordance with the recommendations of the Declaration on Helsinki and the approval of the Ethical Committee of University of Milano – Bicocca. All subjects gave written informed consent in order to participate.

Materials and procedure:

In a preliminary phase the stimuli to build the task were validated. A pool of XX images were collected from the internet representing infants of four different categories: smiling, sad (crying), sleepy and neutral. Each face was put on a neutral grey wallpaper. Luminosity and size (50x50 pixels) of the pictures was controlled. Then this pool of pictures was presented to 30 students (18 females) and they were asked to categorize each of them in one of the four labels previously described. Then they were asked to evaluate each picture from one to seven answering these questions: "How much do you like this picture?", "How much do you think this infant needs help?" and "How difficult this picture is to perceive?". Finally they had to hypothesize if each infant was a male or a female and his age in months. Then we selected pictures that had at least 80% agreement on the emotion expressed between all the participants. Moreover the infants had not to be considered older than 24 months by at least 80% of the participants. We selected the first five pictures of each category with the highest agreement. Thus we obtained a pool of 20 pictures to be used in the task. As expected the happy faces were happier than all the others and the sad ones the least, while neutral and sleepy were in between. On the contrary the most needy of help were the sad ones and the happy ones the least. For the liking evaluation, no outliers were found in respect to the other pictures of the category. No picture was considered difficult to perceive (mean rating at least 2.5). All the pictures were duplicated and in one for each couple a red dot was added on infants' forehead.

We wrote our task in Matlab, using the Psychophysics Toolbox extensions (Brainard, 1997; Kleiner et al., 2007; Pelli, 1997). The participant was asked to sit comfortably in front of a computer with a joystick easy to grab with her dominant hand. The distance between the participant and the joystick ensured that the joystick motion was directed toward or away from the body. The task was initiated by the participant bending the joystick on her left. The task is made of two block in a randomized order between participants. In one block participants were instructed

to push the joystick away from themselves when they see a red dot on infants' forehead and to pull the joystick toward themselves when they did not see a red dot on infants' forehead. On the contrary in the other block participants were instructed to pull the joystick towards themselves when they see a red dot on infants' forehead and to push the joystick away from themselves when they did not see a red dot on infants' forehead. Before the real task a training phase was proposed in each block, so that participants could practice to be sure that the task was properly comprised. In this phase, made of 4 trials, participants were presented an adult face and feedback was given on each trial if the task was comprised or not. Between the two blocks a short break was presented and the participants could decide how long to wait before to start by herself the second block by moving the joystick on the left. The instructions asked participants to try to be as correct and as quick as possible in moving the joystick in one or the other direction. He was asked to watch the center of the screen all the time the pictures or a small black cross in between the pictures. After each joystick movement the participant had to take the joystick in the beginning position and the procedure was stopped until the joystick wasn't in the position. Each block was made of 40 trials. Each trial (*Figure 2.1*) was composed of a starting phase with the presentation of the cross in the center of the screen for 500 ms, then a picture of medium size apperared in a randomized order. At this point the participant can push or pull the joystick and consequently picture change in size, giving the impression that the picture is pulled toward self (i.e. becomes bigger) or pushed away (i.e. becomes smaller). When the image size reaches the screen size (when bigger) or became 20x20 pixels (when smaller) the picture stops changing size until the joystick movement is completed (approximately 30°) when the picture disappears. Then participants have to move back the joystick in the back upright position while on the screen appears the black cross. Until the starting position is not reached the subsequent image is not presented. The picture disappeared independently from the correct or wrong participants' answer. Reaction time are measured from the appearance of the picture on the screen to its disappearance.

Participants were recruited through announcements in the university and prior to participation was requested to fill online Italian version of the Childhood Trauma Questionnaire Short Form (Bernstein et al., 1994, 2003a). CTQ-SF is a measure of experiences of childhood abuse. Twenty-eight items were presented to assess experiences of physical abuse, emotional abuse, sexual abuse, physical neglect, and emotional neglect. Each item (e.g., “During my childhood I felt hated by family”) was rated on a 5-point Likert scale ranging from never true to very often true. In the current study we focused on the abuse subscales since they were expected to affect reactivity to infants with different temperaments. Therefore, an abuse scale was created ($\alpha = .78$) by averaging the items tapping into the physical abuse, emotional abuse, and sexual abuse dimensions.

After the online questionnaire participants were contacted and laboratory meeting was arranged to perform the Approach Avoidance Task.

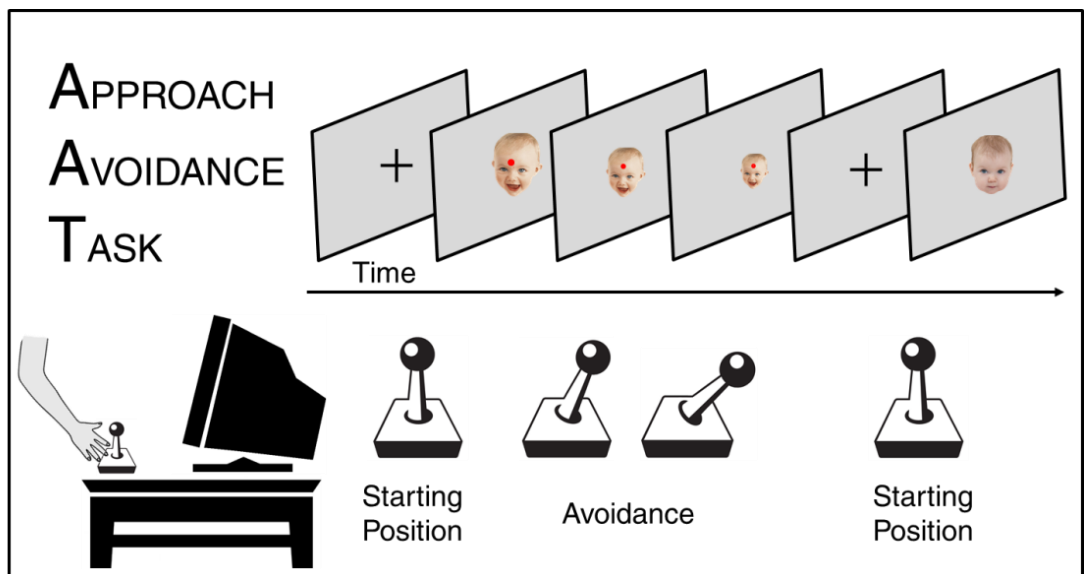


Figure 2.1. Schematic explanation of the Approach Avoidance Task as modified for the present study.

Results and discussion:

A linear mixed model was designed to test differences in reaction time when the task asked the participant to approach versus to avoidant the baby faces with or without the red dot on the forehead. The model was completely within subjects, and tested the fixed effects of the kind of infant expression of the stimuli and the condition, the request to approach or avoidance the joystick. The random term consisted in the intercept ($\text{var} = 0.23$) and the condition effects, because when the type of emotion was added to the model, it could not converge. Results showed the non-significant main effect of the type of infant expression ($F(3, 6605.3) = 1.21, p = .30$) and the significant main effect of the condition: approach or avoidance ($F(1, 63.9) = 10.62, p = .002$). The interaction effect was not significant as well ($F(3, 6425.6) = 1.14, p = .33$). In order to comprehend the main effect of condition we explored which of the infants' emotion showed a significant difference between the approaching and avoidance conditions. Therefore four linear mixed models were performed, one for each emotion. No effect was found for the happy face ($F(1, 1764.5) = 2.23, p = .13$) and the neutral face ($F(1, 1371.5) = 1.44, p = .23$). On the contrary, a significant difference in reaction time was found for tired ($F(1, 1764.5) = 4.09, p = .04$) and upset/sad pictures ($F(1, 1621.9) = 3.85, p < .001$): participants were slower when they were asked to approach these pictures compared to the avoidance behavior. Results are shown in *Figure 2.2*. This effect seems to confirm the hypothesis of a bias to threat emerging during the perception of negative emotions also in children. The Tired face is something in between and we found an effect but not strong. However, it is important to show that the bias in behavioral response depends probably on the level of negativity of the stimulus.

To test the association between childhood maltreatment and current bias to threat in adulthood towards infant faces, we tested the correlations between a CTQ derived scale of abuse and RT differences (approach minus avoidance) for each infants' expression. As expected, we found a significant correlation between abuse measure and the differences in RTs (approach-avoidance) for the upset/sad infants' faces, $r = .33, p = .008$. The others correlations between abuse and

differences in latency for the other expressions were not significant (upset/sad face, $r = .01$, $p = .90$, happy, $r = .09$, $p = .46$, neutral, $r = .11$, $p = .44$). These results strongly support the evidence of a role of childhood maltreatment in affecting the behavioral response to infants' negative emotions. The more severe the maltreatment received, the more sad infants are perceived as something not to approach.

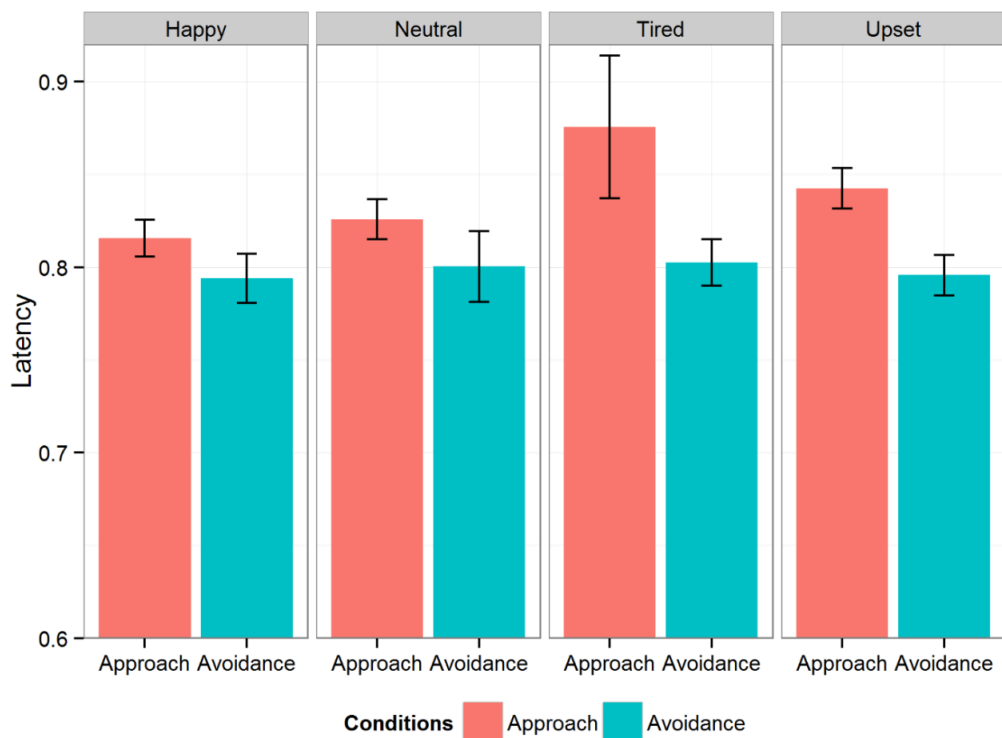


Figure 2.2. Reaction times for approach and avoidance behaviors in response to different infants' emotions. Error-bars represent standard error of the means.

Study Two: emotional context and behavioral response to infant faces

Mood dysregulation has a negative effect on parenting as showed by the studies on the disruptive effects of postpartum depression on maternal sensitivity and parenting behaviors (Field, 2010; Forman et al., 2007; Paulson, Dauber, & Leiferman, 2006; Santona et al., 2015). Far from the clinical complexity of these conditions, this study aims at exploring the effects of a mood manipulation on the approach avoidance disposition to action towards positive or negative infants' emotions. Literature shows the presence of biased memory processes favoring negative information recall in sad mood and favoring positive information in happy mood (Matt, Vázquez, & Campbell, 1992). This kind of memory bias is characteristic of depression and biases are (Mathews & MacLeod, 2005) more pronounced as consequence of a negative priming (Jeanne, Gross, Persons, & Hahn, 1998). In our knowledge no study assessed the effects of mood manipulation on approach avoidance using infants faces stimuli, and only one used adult emotional faces. Vrijssen and colleagues (Vrijssen, van Oostrom, Speckens, Becker, & Rinck, 2013) used video fragments to induce the mood manipulation and found no effects on the Approach Avoidance Task on the overall population but just on a subsample with highest depressive symptomatology scores. In these participants authors found mood-congruent and mood-incongruent behavioral tendencies and suggest that depression scores seem more relevant than mood manipulation.

We designed a within subject study with two laboratory visits in subsequent weeks on the same weekday. Participants were asked to think to one of the most sad/happy event in their lives and to write it on a paper. Then a simpler version of the AAT describe in study one was performed. We hypothesize a pejorative effect of negative manipulation meaning that participants in the negative mood condition are even quicker in avoiding the sad infant. On the contrary, we expect an ameliorative protective effect of positive manipulation both on the approach of happy and sad infant stimuli. Finally, we expect childhood maltreatment scores to

be associated to a more pronounced negative effect of the negative mood induction.

Method

Participants

In a preliminary stage, 220 students (173 females) filled out the CTQ-SF during lecture time. Then a subsample of 42 females were contacted and participated in the study in exchange for credits. Participants selection was semi-randomized in order to obtain a distribution of maltreatment scores less skewed than the overall sample one. The study was carried out in accordance with the recommendations of the Declaration of Helsinki and the approval of the Ethical Committee of University of Milano – Bicocca. All subjects gave written informed consent in order to participate.

Materials and procedure:

Participants were contacted and two appointments were arranged in two consecutive weeks in the same weekday approximately at the same time. The order of the mood manipulation was randomized between subjects. After participant arrived in the laboratory, she was asked to sit comfortably at the table and to wait for a moment for the experimenter. After one or two minutes, the consent form was given to the participants to read and sign it. Then participants were instructed on the procedure and the paper with the instruction for the manipulation was given to her. The instructions were: "Dear Student, this research aims at studying the ability to remember past events. We ask you to try to remember an episode of your recent life when you felt particularly HAPPY/SAD. It has not to be an "important" event and it has not to be a long episode. The only important thing is that you felt HAPPY/SAD. In the blank space below we ask you

to briefly describe the situation, what happened and what you felt.” Participants were told they could take all the time they needed and to tell the experimenter when they thought they finished. After that a quicker version of the AAT presented in the previous study was performed. The only difference was that in this task only happy and sad infants’ faces were presented for a total of 25 trials for each of the two blocks. After a questionnaire on the emotional state was given to the participant (Positive And Negative Affective Scale (PANAS) Watson, Clark, & Tellegen, 1988). Finally the experimenter check with the participant the next appointment or debrief her depending if the current session was the first or the second. PANAS was used as a manipulation check and after all the procedure two judges blind to the study rated each episode described by the participant on a Likert scale from 1 (poor emotional episode) to 7 (highly emotional episode).

Results and discussion:

To test the effect of the mood manipulation on the behavioral response to emotional infants’ expressions we calculated the mean latency of approach and avoidance for each condition. Then we subtracted the avoidance latency from the approach latency and we used this composite score as dependent variable in our model. We computed this new variable in order to decrease the number of factors in the model and offer an easies interpretation of the effects. A score above 0 means that the avoidance latency was lower than the approach latency, and vice versa a score below 0 meant a quicker approach compared to avoidance. We built a linear mixed model with random intercept and mood manipulation and infants’ emotion expression as fixed factors. Results (presented in *Figure 2.3*) show not significant main effects of emotion expression ($F(1, 129.35) = 1.16, p = .28$) and of manipulation ($F(1, 133.73) = 0.002, p = .96$), but a significant interaction effect of the two factors, $F(1, 129.35) = 4.62, p = .03$. This means that the effect of mood manipulation is different across the face expressions of emotions. Then we tested the differences between pair of conditions. We found significant differences between RT in response to the Upset/sad face following the sad mood manipulation and the response to the same face in the happy mood manipulation,

$b = 0.04$, $SE = 0.02$, $t(42.91) = 2.51$, $p = .02$. The difference between the response to the upset/sad face and the happy face, both in the happy mood manipulation is not significant but show an interesting tendency, $b = 0.07$, $SE = 0.04$, $t(86.00) = 1.85$, $p = .067$. No other level showed significant differences. We have also tested the each condition for a statistical difference from zero, which is the cut-off to discriminated between the preference for the avoidance or the approach behavior. The happy expression was easier to approach in the happy mood manipulation ($M = 0.03$, $t(44) = 2.38$, $p = .02$), as well as the upset/sad face in the sad mood manipulation ($M = 0.06$, $t(42) = 4.09$, $p < .001$). The others conditions showed no preferences between approach and avoidance (all $ps > .45$). These results show that bias to threat is susceptible to manipulation of the emotional context. The happy mood buffers the bias toward the upset/sad face that seems augmented by the sad mood manipulation. An unexpected result is the positive score of the happy face in the happy mood manipulation. This effect can be better understood in light of the abuse effect we tested through correlations with the RTs. In fact, correlations show that there is a positive association between the response to the happy face in the happy mood manipulation and the abuse scores, $r = .29$, $p = .05$. No one of the others RTs scores is associated with the abuse measure (all $ps > .35$). Therefore the effects can be probably explained with the high presence of maltreatment scores in the selected sample that drives the effect. It seems that the more maltreated you are, the more a positive mood manipulation has a non-intuitive effect of avoidance of happy faces. This support a perspective of maltreatment associated to emotion dysregulation in adulthood and consequently also higher risk of mental disorder. Happy emotions cannot be tolerated and are avoided, probably because of a strong fear of being overwhelmed by emotions itself.

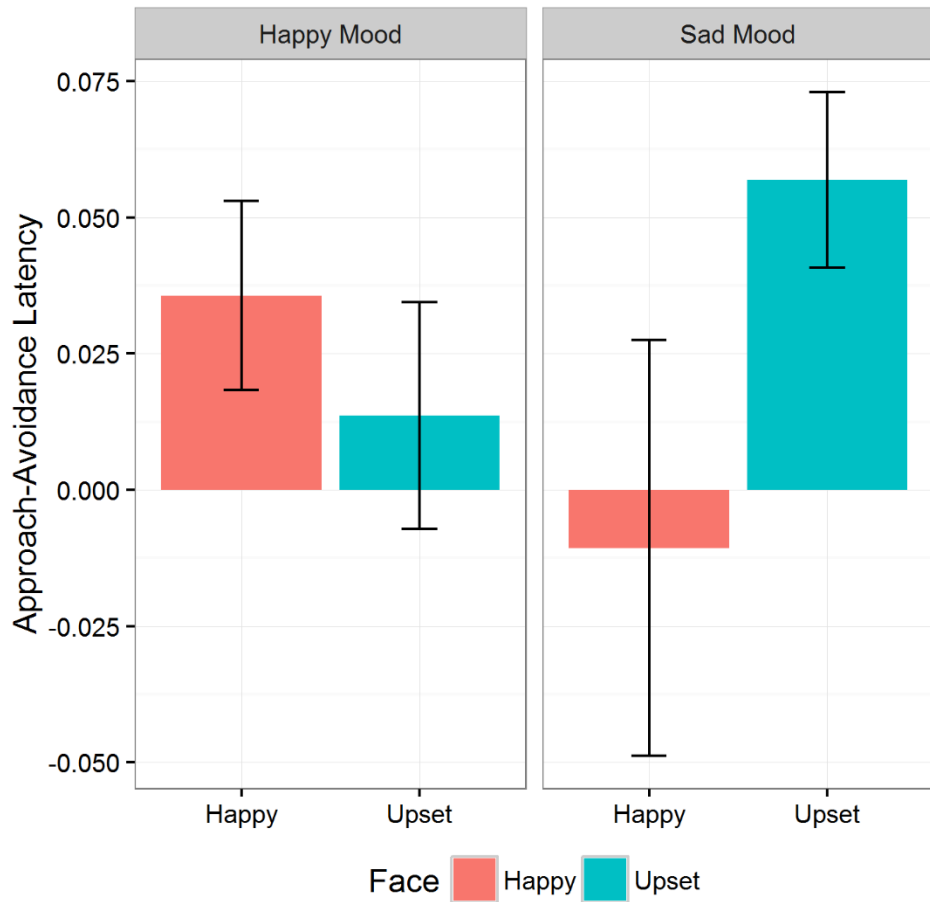


Figure 2.3. Differences in average reaction times (Approach Latency minus Avoidance Latency) for the Happy and Upset/Sad Faces. Left panel shows the effects of happy mood manipulation, while the right panel represents the sad mood manipulation. Error-bars represent standard errors of the mean.

Study Three: right Inferior Frontal Gyrus in moderates the bias to threat effect towards infants' emotional faces

In study three we aimed at studying the underlying process of the association between perception of infants' emotion and abuse. To do this, we designed a study to test the specific causal role of right Inferior Frontal Gyrus (rIFG) in determining the association between sad infant and avoidance arm movement. Montoya and colleagues (2012) found rIFG to be activated by infants' sad faces (both versus neutral face and versus happy face) and they interpret it as part of an empathic network. In fact, rIFG is associated in literature with emotional (and not "cognitive") empathy circuits in the brain (Shamay-Tsoory, Aharon-Peretz, & Perry, 2009). This area seems to play a role in mirror like processes (Kilner, Neal, Weiskopf, Friston, & Frith, 2009; Rizzolatti & Sinigaglia, 2010) that support the embodied simulation hypothesis (Gallese & Sinigaglia, 2011). We hypothesize that this empathic process is responsible for the bias in avoiding sad faces because allows a quicker process of these negative stimuli. Then we used Transcranial Magnetic Stimulation (TMS) to inhibit the functioning of rIFG and we expect it to have an effect on decreasing the bias in avoiding sad faces found in Study One and Two. Moreover we know that maltreatment experiences have a role in moderating the neurophysiological correlates of parenting (for reviews see Chapter 5 or Lomanowska et al., 2015). We do not have sufficient previous evidences to make a specific hypothesis on this specific area, but in an explorative way we suggest that IFG could be more relevant in participants with lower scores of childhood maltreatment. This study is part of a bigger project (cfr Chapter 4) on the role of rIFG in the perception of infants signals, in particular infant crying.

Method

Participants

From the same preliminary sample of Study Two a subsample of 12 females was contacted and participated in the study in exchange for credits. Participants selection was not randomized in order to obtain a not too skewed

distribution of abuse scores. This because the low number of participants required the selection of two groups with high (more than a standard deviation above the mean) and low (less than a standard deviation below the mean) scores. Moreover all participants were screened for TMS eligibility with these exclusion criteria: no left-handed as assessed by a standard test (Oldfield 1971); no neurological problems and history of seizures as assessed by a specific questionnaire (Rossi et al., 2011) to evaluate compatibility with TMS; no medications that could interfere with neuronal excitability. The study was carried out in accordance with the recommendations of the Declaration of Helsinki and the approval of the Ethical Committee of University of Milano – Bicocca. All subjects gave written informed consent in order to participate.

Materials and procedure:

We designed a mixed design based on two laboratory visits of the participants. In each session, participants are firstly screened for TMS contraindications. Then she's asked to sit comfortably on the chair and neuronavigation and stimulation are performed (the stimulation site is randomly assigned, rIFG (target area) or Vertex (control)). After the stimulation the participant performs the same version of the AAT used in Study Two. In the second visit the second stimulation (rIFG or Vertex) is performed followed by the same task.

Repetitive Transcranic Magnetic Stimulation (rTMS)

rTMS was administered over the right Inferior Frontal Gyrus by means of a Magstim Rapid machine (Magstim Co Ltd, Whitland, UK) with a 70 mm butterfly coil. A fixed intensity of 60% of the maximum stimulator output was used, in line with prior studies (Campana, Cowey, Casco, Oudsen, & Walsh, 2007a; Ferrari et al., 2014). The right Inferior Frontal Gyrus was targeted in light of previous evidence pointing to a right lateralized processing of emotional infant faces

(Montoya et al., 2012). rIFG was localized by means of stereotaxic navigation on individual estimated magnetic resonance images (MRI) obtained through a 3D warping procedure fitting a high-resolution MRI template with the participant's scalp model and craniometric points (Softaxic, EMS, Bologna, Italy). Talairach coordinates for this site ($x = 46$, $y = 14$, $z = 1$) were obtained from a previous fMRI study investigating neural correlates of processing of infant cry in Riem et al., 2011. The Vertex, corresponding to the median point of the nasion–inion line, was used as a control area. For each of the sites stimulated, 900 pulses were applied at a frequency of 1 Hz (train duration 15 min). Previous studies have shown that rTMS at 1 Hz temporarily reduces the excitability of the stimulated cortex for a time window that outlasts the period of stimulation (R. Chen et al., 1997a; Oliveri, Koch, Torriero, & Caltagirone, 2005a)

Results and discussion:

To test the effects of TMS stimulation on the approach avoidance behavior in response to different emotional infants faces we used a procedure similar to the second study one. Differences in latencies were computed and confronted between them and against zero. We built a linear mixed model with random intercept and mood manipulation and infants' emotion expression as fixed factors. Results (presented in *Figure 2.4*) show not significant main effects of emotion expression ($F(2, 55) = 0.48$, $p = .62$) and of tms stimulation ($F(1, 44) = 0.36$, $p = .54$), but a significant interaction effect of the two factors, $F(1, 44) = 6.62$, $p = .01$. This means that the effect of mood manipulation is different across the face expressions of emotions. Then we tested the differences between pair of conditions. We found significant differences between RT in response to the Upset/sad and the happy face response following the vertex stimulation, $b = 0.06$, $SE = 0.03$, $t(22) = 2.14$, $p = .04$. Moreover a slightly significant effect of TMS on the response to the happy faces is found, $b = -0.06$, $SE = 0.03$, $t(22) = -1.93$, $p = .067$. We have also tested the each condition for a statistical difference from zero, which is the cut-off to discriminated between the preference for the avoidance or the approach behavior. The happy expression was easier to approach after the

rIFG stimulation ($M = 0.06$, $t(11) = 4.35$, $p = .001$), but not after the vertex stimulation ($M = 0.06$, $t(11) = 4.35$, $p = .001$). face in the sad mood manipulation ($M = -0.002$, $t(11) = -0.06$, $p = .93$). The sad expression was easier to approach after the vertex stimulation ($M = 0.06$, $t(11) = 5.33$, $p < .001$), but not after the rIFG stimulation ($M = 0.03$, $t(11) = 1.50$, $p = .16$). Finally, a strong negative correlation between the effect of rIFG stimulation on the response to the happy faces and the abuse score was found, $r = -.67$, $p = .02$. All the others latency scores were not associated to abuse.

These results confirm the causal role of rIFG in determining the behavioral response to emotional infant faces. In particular, TMS seems to buffer the bias to threat effect on responding to sad infants' faces. This is probably due to the inhibition of an empathic process that allows a quicker processing of the emotional stimuli during the approach behavior. The effect of the TMS induced bias in avoiding happy faces was unexpected, but we can hypothesize that the inhibition of emotional empathy can disrupt the rewarding value of happy children faces. This is intriguing in particular because highlights the primary role of empathy and mirror system in selecting the behavior in response to stimuli connected to the parenting functioning. Moreover, this bias in responding to happy faces is strongly negatively correlated to abuse scores. This effect is partially consistent with our hypothesis of a diminished role of rIFG in processing emotional stimuli for maltreated individuals. The rIFG stimulation is less effective in enabling this bias in more abused individuals, suggesting that they rely less on processing positively valenced stimuli compared to non-maltreated adults. We can also interpret this happy face bias effect as a form of emotional dysregulation caused by the TMS stimulation. In fact, the effect of favoring a bias in happy faces responses is similar to the one found in study two and caused by the positive mood manipulation. Consistently, the correlations with abuse scores were differing: positive for the mood manipulation and negative for the TMS effect. The same dysregulated behavioral response was caused by different processes. In study two, a dysfunctional emotional processing was probably due to higher emotion dysregulation in abused participants. In study three, the inhibition of an area

involved in empathy processing led to emotional dysregulation, stronger in non-maltreated adults because they probably rely more on empathy process of positive children stimuli.

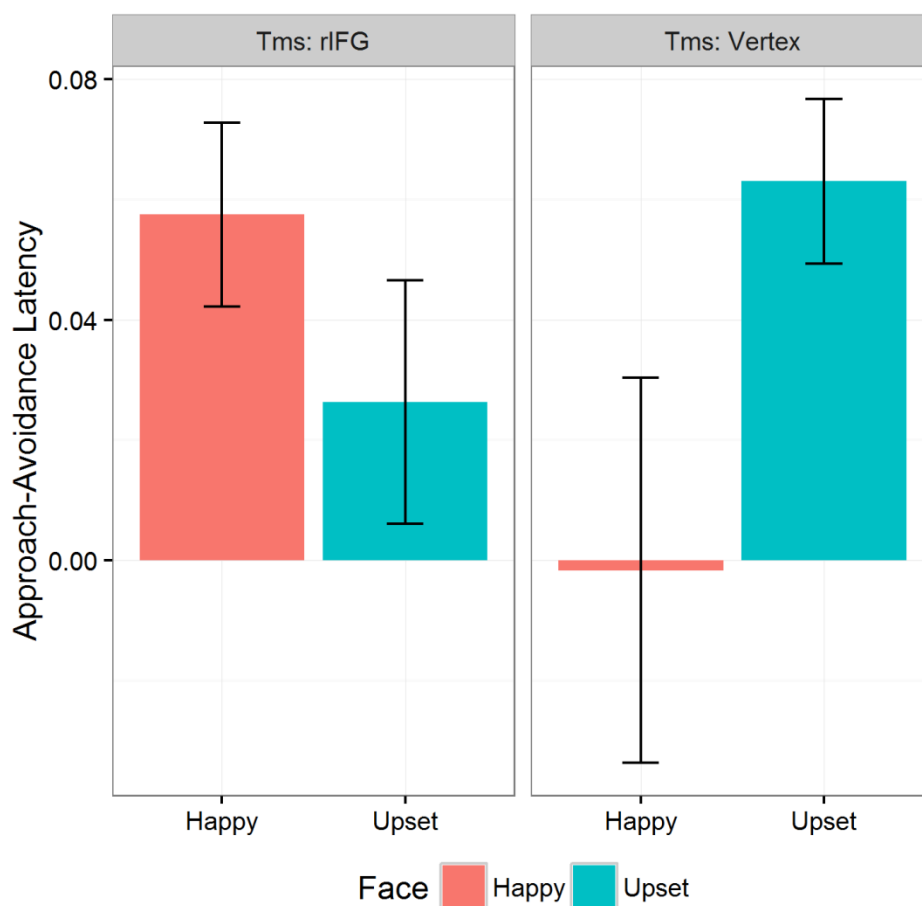


Figure 2.4. Differences in average reaction times (Approach Latency minus Avoidance Latency) for the Happy and Upset/Sad Faces. Left panel shows the effects of the target stimulation of rIFG, while the right panel represents vertex stimulation. Error-bars represent standard errors of the mean.

General Discussion

In this paper we studied the perception of different infants' emotional expression in nulliparous women and their effect on approach/avoidance behavior. Aim of the study was to comprehend how infants expressions affect adults' reaction and behavioral response, in terms of predisposition to action. Moreover we hypothesized an association between behavioral responses and individuals' history of abuse during childhood. In the first study, we present the joystick task and we show the bias to threat effect of sad faces perception, heightened in maltreated adults. In the second study, we took into account the emotional context of the task: the negative mood manipulation was consistent with the bias to threat effect of sad faces, while the positive manipulation buffered the sad faces bias, but unexpectedly determined a bias in responding to happy faces. The latter bias was correlated with participants' abuse scores, suggesting that abused adults could be dysregulated when experiencing exaggerated positive emotions. The last study confirmed the hypothesis of the role of rIFG in causing the sad faces bias. In fact TMS stimulation buffered the bias effect on sad faces but produced a new one in response to happy faces. The size of this bias was associated to participants' abuse score. We proposed that rIFG inhibition was responsible of a form of dysregulation of the response to positive emotions, but smaller in maltreated participants, because they rely less on empathy when processing happy stimuli.

In sum, approach avoidance behavior in response to infant emotional faces seem a valid way to study predispositions to act. Moreover our manipulations of the mood and brain functioning were effective, suggesting a good susceptibility of the process from external stimuli.

The effects reported so far can impact parenting research. First of all this study extended to children faces the effect of approach or avoidance behaviors in response to emotional adult faces. Even more important in the perspective of intergenerational transmission of parenting is the association between magnitude of the bias and abuse scores. The more an individual experienced a harsh environment and negative parenting cares, the more he/she will tend to avoid

infants with negative emotions. Moreover, abused adults are affected by positive emotions probably because they are not able to regulate their own emotions. A better comprehension of the process comes from the third study where the sad face bias was inhibited by TMS stimulation of rIFG. This means that empathy and mirror networks are essential in determining the bias. A new bias in responding to happy faces emerged after rIFG stimulation, negatively associated to participants' history of abuse. We interpret this result as a diminished role of rIFG in processing happy faces. In terms of parenting research, this data suggest that abused individuals are less able to use empathy when they have to deal with infants' emotions. They are probably not able to attune their emotions to children ones, or, as proposed by Fonagy and colleagues "mentalizing the baby" (Allen & Fonagy, 2006; Fonagy et al., 2002; Markin, 2013; Midgley & Vrouva, 2013).

Several limitations of this study must be acknowledged. First, we only selected nulliparous women, but it is known that mothers have different processes associated with responses to infants. It is consistent with the concept of intergenerational transmission that also non parents carry the "imprinting" of parenting style, but of course implications for the caregiving processes could be better understood in a sample of parents. In addition, a gender effect could be hypothesized, because males could be more biased than females in processing sad infants' faces, consistently with their less parental investment. Finally, the abuse measure was used to test correlations with single latency measure, but not inserted in the models to test moderations effects. This mainly because of power issues, but also to promote an easier interpretation of models and effects. Unfortunately this lowers the level of inference that can be drawn from the data. In particular we did not test if abuse was able to directly affect the role of the other factors.

In conclusion, approach avoidance in response to infants' faces seem to be a cost effective to study parenting and intergenerational transmission. The sad faces bias to threat can be buffered both stimulating the brain and eliciting a good or bad emotional situation. Abuse role seems important in driving some aspects of the process. In particular the diminished role of rIFG and empathy in abused

adults is intriguing but needs more attention and to be tested with different methodologies.

Section 2

“He did not stop crying”: brain effects of triggers of child abuse in maltreated and non-maltreated adults

Introduction to the section

We have already discussed the phenomenon of the transmission of maltreatment across generations. Considering the difficulty in determining the existence of the phenomenon, it is understandable that the mechanisms implicated remain largely unknown. However, the triggers of abuse are well known and studied. In particular crying seems the principal cause of episodes of child

abuse and neglect (Barr et al., 2006; Compier-de Block et al., 2015; Soltis, 2004). In this section, we use different methods to study brain responses to stimuli considered risk factors for maltreatment, and we test the hypothesis that individual differences in brain correlates depend on childhood experiences of maltreatment.

The role of infant crying as trigger of abuse is quite known, but also children with difficult temperament are more likely to be maltreated by adults (Brayden, Altemeier, Tucker, Dietrich, & Vietze, 1992; Dixon, Browne, et al., 2005; Famularo, Fenton, & Kinscherff, 1992; Friedrich & Boriskin, 1976; Friedrich & Einbender, 1983; Osborne, Hinz, Rappaport, Williams, & Tuma, 1988; Parke & Collmer, 1975; Sidebotham & Heron, 2003). The effects are actually overlapping because infants with difficult temperament have by definition higher rate of infant cry (Reijneveld, van der Wal, Brugman, Sing, & Verloove-Vanhorick, 2004; Soltis, 2004) and result inconsolable.

The primary novelties of the studies are essentially two. In Chapter 3, we tested by means of fMRI brain activation and connectivity during the perception of infants faces whose temperament had been experimentally manipulated. During the scan session neutral pictures were presented to the participants, but via a previous computer task participants had learnt infant's temperament. Therefore, the contrasting brain activation during the perception of faces with temperament manipulation vs faces without temperament manipulation, addressed the issue of infants' attributions. This is a step forward toward a slightly more naturalistic approach to the study of brain role in parenting behaviors. In Chapter 4, the novelty was represented by the use of Transcranic Magnetic Stimulation (TMS) that allows inhibiting the functioning of specific brain areas in order to test its causal role in a specific process. While fMRI relies on a correlational approach, TMS directly tests causal effects of brain areas on behaviors. If TMS has a disruptive effect on a behavioral task, it means that the target area is responsible for that specific process. Therefore TMS allows to test very specific hypotheses on brain mediators of behavioral responses.

Chapter 3

Experimental manipulation of infant temperament affects amygdala-prefrontal functional connectivity

Riem, M. M. E., van IJzendoorn, M. H., Parsons, C. E., Young, K. S., De Carli, P., Kringelbach, M. L., & Bakermans-Kranenburg, M. J. (submitted).
Experimental manipulation of infant temperament affects amygdala-prefrontal functional connectivity.

Introduction

Child temperament plays a key role in development, for example influencing how infants respond to the environment or how individuals in the environment react to the infants (J. E. Bates, Schermerhorn, & Petersen, 2012). Bidirectional effects between infant temperament and caregiving sensitivity have been found (J. E. Bates et al., 2012; Kiff, Lengua, & Zalewski, 2011), showing that child's temperament play an important role in influencing parents' behavior (Karreman, van Tuijl, van Aken, & Deković, 2006; Schermerhorn, Cummings, & Kail, 2008). Experimental manipulation of temperament and its influence on parenting has rarely been studied because in natural contexts it would require rather forceful interventions. Here we examine the effects of computerized manipulation of infant temperamental features on adults' neural processing of infant faces as assessed with functional magnetic resonance imaging (fMRI).

Kringelbach and colleagues (Bhandari, van der Veen, et al., 2014; Parsons, Young, Bhandari, et al., 2014) developed a paradigm called the Baby Social Reward Task (BSRT), which is a probabilistic learning task where child temperament is derived from learning the facial and vocal features indicative of a more or less happy (easy) or sad (difficult) baby. The BSRT consists of three parts: the first phase is a baseline measure of perceived temperament and cuteness. In addition, participants indicate their motivation to see the infant faces by key pressing to control the length of time the faces are onscreen. The second phase is training where, over a series of trials, participants learn to differentiate more often sad and more often happy infants by observing the infants' facial expressions and vocalizations. After the training phase, participants evaluate the infants again in terms of easy or difficult temperament, cuteness, and motivation to see the infant. The BSRT has been used to show that the perception of infant temperament and cuteness is not based on physical facial features alone, but is modifiable through experience (Parsons et al., 2014; Bhandari et al., 2014). The aim of the present study is to examine the neural responses in nulliparous women to infant faces with manipulated temperamental features, using the BSRT. Brain activity during the perception of faces of infants with difficult or easy temperaments

is compared to the activity during the perception of neutral infant faces without temperamental cues. This experimental procedure is a unique window to study variations in brain activity triggered by infants with different temperaments under controlled experimental conditions.

Children with difficult temperaments are more likely to be maltreated because of their higher rates of persistent crying (Reijneveld et al., 2004; Soltis, 2004). Crying elicits strong emotional and physiological reactions and is an important trigger for child abuse, especially in parents at risk for maltreatment (Soltis, 2004). Childhood maltreatment seems to play a role in heightening neural reactivity during the processing of negative emotional stimuli such as crying (Curtis & Cicchetti, 2011; C. L. Masten et al., 2008). The neural mechanism implied in this process might be related to enhanced reactivity of the amygdala, an important brain region in the processing of arousal or fear (LeDoux, 2012). Amygdala activity in response to emotional stimuli has more often been found to be moderated by childhood maltreatment (Fan et al., 2014; Pechtel, Lyons-Ruth, Anderson, & Teicher, 2014). One of the neural mechanisms responsible for the intergenerational transmission of childhood abuse (Pears & Capaldi, 2001; Widom et al., 2015) might therefore be an augmented amygdala reactivity to difficult temperament in individuals who experienced childhood abuse. In particular childhood emotional maltreatment has been linked to amygdala hyperreactivity (Dannlowski et al., 2012). Although emotional maltreatment has received less attention in research compared to other types of abuse, it is a widespread phenomenon (Stoltenborgh, Bakermans-Kranenburg, Alink, & van IJzendoorn, 2012a) with deleterious effects of children's social, emotional, and neurobiological development (Iwaniec, Larkin, & Higgins, 2006; van Harmelen et al., 2010, 2012). The self-reported prevalence has been estimated to be 363 per 1000 children (Stoltenborgh, Bakermans-Kranenburg, Alink, & van IJzendoorn, 2012b). One explanation for the strong effects of emotional maltreatment is that children who experience emotional abuse are exposed to prolonged maladaptive interactions with the parent, whereas other types of maltreatment such as physical or sexual abuse might be limited to a single incident (Glaser, 2002).

In addition to amygdala hyperreactivity, maltreated individuals might also show abnormalities in amygdala functional connectivity. Whereas previous studies point to an association between childhood abuse and functional activity in the amygdala, less is known about disruptions of amygdala functional connectivity in individuals with experiences of childhood abuse. The amygdala is one of the most highly connected regions of the brain and has been suggested to be a strong candidate for the integration of emotional and cognitive information because of its widespread connections to cortical and subcortical regions (Pessoa, 2008). For example, the amygdala has strong reciprocal connections to the visual cortex and these connectivities facilitate the perceptual tuning in the visual sensory cortex based on stimulus evaluation and significance. Visual cortex responses to emotionally salient stimuli depend on inputs received from the amygdala and this process might serve the upregulation of processing emotionally significant stimuli (Pessoa & Adolphs, 2010; Pessoa, 2008; Vuilleumier & Pourtois, 2007). In contrast, amygdala connectivities with frontal regions have been shown to be important for emotional regulation and downregulating of negative emotions (K. Ochsner & Gross, 2005; K. N. Ochsner, Silvers, & Buhle, 2012). Interestingly, resting-state fMRI studies have shown that individuals with experiences of childhood abuse have altered amygdala-frontal connectivity (Herrington et al., 2013; S J A van der Werff, Pannekoek, et al., 2013a).

In the current study we experimentally manipulated infant temperamental features and used fMRI to examine neural processing of infant faces associated with mostly easy or mostly difficult temperament. We expected the amygdala to show elevated reactivity to (Vuilleumier & Pourtois, 2007) faces of difficult infants compared to easy infants. Furthermore, this enhanced amygdala reactivity was hypothesized to be more pronounced in participants with childhood emotional maltreatment experiences. In addition, we examined amygdala connectivity during the perception of infants with different temperaments. We expected that individuals with childhood emotional maltreatment experiences would have altered amygdala connectivity with frontal regions. Lastly, the relation between amygdala connectivity and perceived temperament, cuteness and desire to view the infant

was examined. We hypothesized that amygdala connectivity is related to ratings of infant temperament and involved in explaining individual differences in the perception of infants with different temperaments. The current study is the first to examine the effect of experimentally manipulated infant temperament on amygdala reactivity and connectivity, taking into account experiences of childhood emotional maltreatment.

Method

Participants

A total of 121 female undergraduate students from the Department of Child and Family Studies, Leiden University, participated in the first phase of the study. In this phase, participants completed questionnaires on childhood experiences and demographic details. Ninety-seven participants who met inclusion criteria and with scores ranging from low to high on a questionnaire measuring experiences of emotional abuse and neglect were randomly selected and contacted for participation. Participants were screened for MRI contraindications, psychiatric or neurological disorders, hearing problems, pregnancy, alcohol and drug abuse, and did not have children of their own. More than 95% of the participants were born in the Netherlands. Fifty-four female participants completed the second phase of the study, consisting of the fMRI session. Two participants were excluded due to excessive head movement and two participants were excluded because fMRI scanning could not be completed due to technical or health problems during the session. Three participants were excluded from the analysis because they did not learn to discriminate between the sad and happy infants and showed more than two standard deviations below the mean accuracy score for selecting the correct infant in the final part of the learning phase of the BSRT. This resulted in a total sample size of 47 participants for the current study. The mean age of the participants was 19.62 (SD = 2.12). Written informed consent was obtained from all participants. Permission for this study was obtained from the Institute's Ethics Committee and from the Leiden University Medical Centre Ethics Committee.

Childhood emotional maltreatment The Childhood Trauma Questionnaire Short Form (CTQ-SF; Bernstein et al., 2003b) was administered to measure experiences of childhood abuse. Twenty-eight items were presented to assess experiences of physical abuse, emotional abuse, sexual abuse, physical neglect, and emotional neglect. Each item (e.g., “During my childhood I felt hated by family”) was rated on a 5-point Likert scale ranging from never true to very often true. In the current study we focused on the emotional abuse and emotional neglect subscales since they were expected to affect reactivity to infants with different temperaments. Therefore, an emotional maltreatment scale was created by averaging the ten items tapping into emotional abuse and emotional neglect dimensions.

Procedure

Participants were invited for a lab session at the Leiden University Medical Center. They first signed the consent form and were screened for MRI contraindications. Afterwards, the Baby Social Reward Task (BSRT) was administered. The Baby Social Reward Task was used to manipulate and measure participants’ perception of the temperament of six babies (see Parsons et al., 2014, for a detailed explanation of the paradigm). The task consists of three different phases: baseline measures of participants’ responses to the infant faces, the experimental manipulation of infant temperament, and post-manipulation measures of participants’ responses to the infant faces.

The first phase consists of two tasks: the Rating task and the Wanting task (Parsons et al. 2014). In both tasks each baby’s face is presented on the middle of the screen with a neutral expression. In the Rating task the participant is asked to evaluate the babies on three different dimensions (cuteness, difficultness and easiness) pressing the “up” or “down” arrow on the keyboard to change the level of a vertical visual analogue scale (VAS). Similar to Parsons et al. (2014) the ratings of difficultness and easiness were then combined (the difficultness values were

reversed) to produce a global measure of temperamental easiness of the baby. Each stimulus was presented for 5 seconds and each participant rated each face once. The Wanting task is a measure of motivation to see each baby's face. The participants are asked to press the "up" or "down" arrow to change the time they want to see the baby. A vertical VAS with a descending level represented the passing of time and the participant's key pressing changed the speed of the descending level (pressing the "up" arrow decreased the speed of the descending level, extending the amount of time the face was onscreen while pressing the "down" arrow increased its speed, reducing the amount of time the face was onscreen).

The second part of the BSRT consisted of the manipulation of the temperament: in each trial the participants were presented one of three pairs of baby faces and they were asked to identify, by trial and error, the happy baby or the sad baby of the pair. Participants selected one of the two babies and received feedback, in the form of a change of facial expression and an equivalent vocalization (either 'happy' or 'sad'). By means of repeated trials, participants could infer how often the baby cried or laughed and decide which one was the happier or the sadder of the two. Similar to Parsons et al. (2014), participants were instructed that "In each pair of faces, there is one happy and one sad baby. Like in real life the happy baby will not always be happy and the sad baby will not always be sad. In each set your task is to find the happier baby, the one who smiles most often, and continue to always select this baby even if this baby may sometimes appear sad." The three pairs of babies varied in the probability of each infant of being happy or sad. In the easy pair, the easy-to-learn happy infant laughed in 80% of trials and cried in the remaining 20% of trials. The easy-to-learn sad infant laughed in 20% of trials and cried in the other 80% of trials. In the difficult to learn pair the difficult-to-learn happy infant laughed 60% of the time while the difficult-to-learn sad infant laughed 40% of the time. As a variation to the BSRT task used in previous works (Parsons et al., 2014), we adapted the procedure to the fMRI requirements by eliminating a third pair (with 70% of probability for the "happy

baby” to be happy) and instead introduced a “neutral pair” where no feedback was given. See *Table 3.1* for an explanation of the labels that are used for each infant in the current study. Participants received feedback just for the selected baby, but they could infer that the infant not selected would show the opposite emotion on each trial. In each trial, neutral faces were presented onscreen until participants made a response. After participants made a response, visual feedback was presented immediately for 1.5 sec accompanied by a 1.5 sec vocalization. There was a 500 ms gap between the end of the feedback and the beginning of the next trial during which a red fixation cross was presented in the centre of the screen. The temperament of these babies was not manipulated.

The training consisted of two blocks of 60 trials each, so that each pair was presented 40 times in total (20 times per block). In one of the two blocks the participant was asked to select the happy baby, while in the other to select the sad baby. The order of the trials was randomized within session and the order of the blocks was randomized between participants. The identity of the babies (happy, sad or neutral) was randomized between participants.

After the training phase participants were ready to start the fMRI procedure. Participants were asked to change clothes and were given instructions about the fMRI paradigm (see fMRI paradigm and data acquisition). The third phase of the BSRT, consisting of the post-manipulation evaluation of the babies, was administered after the fMRI paradigm. During this phase participants were asked to perform the Rating and Wanting tasks again. Participants rated the cuteness, easiness, and difficultness of the babies and indicated through button-press how long they wanted to see the babies. Comparisons of the pre- and post-manipulation ratings and wanting data showed that the manipulation of temperament was effective. The BSRT was programmed and performed using Presentation software (Version 14.4 Neurobehavioral Systems, Inc., www.neurobs.com).

Table 3.1. Labels and explanations for the 80%, 60%, 40%, 20% happy babies and the neutral babies.

Label	Explanation	Rate of happiness
Easy to-learn <i>happy</i> Baby	The happy baby in the easy pair	80 %
Easy-to-learn <i>sad</i> Baby	The sad baby in the easy pair	20 %
Difficult-to-learn <i>happy</i> Baby	The happy baby in the difficult pair	60 %
Difficult to-learn <i>sad</i> Baby	The sad baby in the difficult pair	40 %
Neutral	No cues about temperament	--

Stimuli

All infant faces images and vocalizations were the same as used in Parsons et al. (2014) and Bhandari et al. (2014). The pictures represented smiling, crying and neutral faces for each of the six babies of the set. In order to reduce any confounding effects of stimulus gender, we had an independent sample of adult females ($n = 40$) rate faces from a larger set of 13 (Kringelbach et al., 2008) as 'male', 'female', or 'cannot tell'. These ratings were then used to select six faces such that there were two faces clearly perceived as female, two as male, and two with ambiguous ratings (Parsons et al., 2014). Images were in greyscale and equal in size (300x300 pixels) and luminosity. Vocalizations were 6 laughing babies and 6 crying babies, as unambiguously evaluated by adults (Young, Parsons, Stein, & Kringelbach, 2012), and sampled from the larger Oxford Vocal (OxVoc) Sounds Database which is a validated set of non-acted affective sounds from human infants, adults and domestic animals (Parsons, Young, Craske, Stein, & Kringelbach, 2014). The vocalisations were 1.5 seconds long, free from background noise and matched for the characteristics of the sounds. Vocalizations were presented to the participants through headphones.

fMRI paradigm and data acquisition

Inside the MRI scanner, participants were presented with six infant faces (with neutral facial expressions), one at a time. Each infant face was presented in the centre of the screen and accompanied by the words “sad” and “happy”. Participants were asked to indicate if the infant was happy or sad by using button presses with the right hand, based on what they had learned during the training phase of the BSRT. Infant faces were presented 20 times for maximum 2.6 seconds, in random order, resulting in a total of 120 infant presentations. The task was self-paced, meaning that the task continued to the next trial after a button press. Interstimulus intervals were jittered and calculated using Optseq (<https://surfer.nmr.mgh.harvard.edu/optseq/>). The mean number of errors during the fMRI paradigm were calculated, excluding the trials with the neutral infants because there was no correct answer for these infants. The percentage of incorrect trials was 26.3% ($M = 21.04$, $SD = 17.58$). The number of errors was negatively related to the mean post-manipulation rating of the happy infants (easiness and difficultness rating (reversed) combined) ($r = -.40$, $p < .01$). Individuals who rated the happy infants as more positive made fewer errors during the fMRI paradigm, indicating that individuals were accurate during fMRI when the temperament manipulation was effective. The number of errors was not significantly related to the mean post-manipulation rating of the sad infants (cuteness, easiness, and difficultness rating (reversed) combined) ($r = .19$, $p = .20$). The fMRI paradigm was programmed and administered using E-Prime software (version 2.0).

Scanning was performed with a standard whole-head coil on a 3-T Philips Achieva TX MRI system (Philips Medical Systems, Best, The Netherlands) in the Leiden University Medical Center. For fMRI, a total of 298 T2*-weighted whole-brain echoplanar images were acquired (repetition time=2.2 s; echo time = 30 ms, flip angle = 80°, 38 transverse slices, voxel size 2.75 × 2.75 × 2.75 mm (+ 10% interslice gap)). Following the fMRI scan, a T1-weighted anatomical scan was acquired (flip angle = 8°, 140 slices, voxel size .875 × .875 × 1.2 mm).

fMRI data analysis

Data analysis was carried out using FEAT (fMRI Expert Analysis Tool) version 6.00, part of FSL (S. M. Smith et al., 2004). The following pre-statistics processing was applied: motion correction (MCFLIRT, Jenkinson et al., 2002), non-brain removal (Smith, 2002), spatial smoothing using a Gaussian kernel of full-width-at-half-maximum 8.0 mm, and highpass temporal filtering (highpass filter cutoff = 90.0 s). Functional scans were registered to the high-resolution EPI-images (high-resolution functional scans), which were registered to the T1-weighted images, which were registered to standard space (Jenkinson, Bannister, Brady, & Smith, 2002).

In native space, functional activity was examined using general linear model analysis. Each infant (easy-to-learn happy, difficult-to-learn happy, easy-to-learn sad, difficult-to-learn sad, neutral 1, neutral 2) was modeled separately as a square-wave function. Each predictor was then convolved with a double gamma hemodynamic response function and its temporal derivative was added to the model, giving six regressors. To examine brain regions involved in the perception of infants with different temperaments we contrasted the easy-to-learn happy, the difficult-to-learn happy, the easy-to-learn sad, and the difficult-to-learn sad infant with one of the neutral infants (easy-to-learn happy > neutral, difficult-to-learn happy > neutral, easy-to-learn sad > neutral, difficult-to-learn sad > neutral).

In addition, we examined psychophysiological interactions (PPI), that is, condition-dependent changes in the covariation of the response between a seed region and other brain regions (Friston et al., 1997). We used the left and right amygdala as seed regions because we were interested in the influence of emotional maltreatment on amygdala connectivity during the perception of infants with different temperaments. We extracted the mean time series for each participant from the left and the right amygdala, defined using the Harvard–Oxford subcortical atlas. These time series were then used as a physiological regressor in the model. We applied two separate models: one to analyze left amygdala connectivity, and one to study right amygdala connectivity. Contrasts for the easy-to-learn sad, easy-to-learn happy, the difficult-to-learn sad, difficult-to-learn happy

infant and the neutral infant (all conditions versus baseline) were created. These regressors were convolved with a double gamma hemodynamic response function and their temporal derivatives were added to the model. The easy-to-learn sad, easy-to-learn happy, and the neutral infant contrasts were used as psychological regressors. Finally, the interaction between the psychological regressors and the time series from the left or right amygdala were modeled. We assessed the positive and negative contrast of the interaction in order to examine condition-dependent changes in functional connectivity.

All first-level contrast images and the corresponding variance images were transformed to standard space and submitted to second level mixed-effects group whole brain analyses. The group mean was tested using one-sample t-tests on these contrasts and the reverse contrasts (neutral > easy-to-learn happy, neutral > difficult-to-learn happy, neutral > easy-to-learn sad, neutral > difficult-to-learn sad). For PPI analysis, we tested the group means using one-sample t-tests on the positive and negative contrasts of the psychophysiological interaction. We included the number of errors of the last ten trials of the training phase of the BSRT as a confound regressor in the functional activity analysis and PPI analysis. The statistical images were thresholded using clusters determined by $Z > 2.3$ and a cluster corrected significance threshold of $p < .05$.

A whole brain analysis was conducted to examine brain activity during the perception of infants with different temperaments. In addition, a Region of Interest (ROI) analysis was conducted to examine functional activity in the bilateral amygdala, anatomically defined using the Harvard–Oxford subcortical atlas (<http://fsl.fmrib.ox.ac.uk/fsl/fslwiki/Atlases>). For amygdala activity, the contrasts easy-to-learn sad > neutral and difficult-to-learn sad > neutral were assessed.

Mean Z-values for amygdala activity for the contrasts easy-to-learn and difficult-to-learn sad > neutral were calculated for each participant with Featquery in order to examine the relation between amygdala activity and childhood emotional maltreatment. Hierarchical regression analyses were conducted to predict amygdala activity during the perception of the easy-to-learn or difficult-to-

learn sad infant compared to the neutral infant. The number of errors that were made during the fMRI task was entered in the first step and emotional maltreatment in the second step. Furthermore, mean Z-values were calculated (using Featquery) for brain regions that were significantly connected to the amygdala, the bilateral occipital fusiform gyrus and the left middle frontal gyrus (anatomically defined using the Harvard–Oxford cortical atlas), in order to examine the relation between amygdala connectivity, emotional maltreatment and the post manipulation ratings of the infants. Again, hierarchical regression analysis was used to examine the relation between amygdala connectivity, emotional maltreatment, and the post manipulation ratings, controlling for the number of errors that were made during the fMRI task.

Results

Behavioral Results

Cuteness. We tested the effect of the manipulated temperament on the perception of cuteness of the babies using a 2x2 repeated measure ANOVA. The two factors were Time (pre- and post-manipulation) and Valence (sad and happy babies). For the factor Valence, the mean of the ratings for the 20% happy and 40% happy babies who laughed 20% and 40% of the time were combined (easy-to-learn sad and difficult-to-learn sad) and the mean of the 60% happy and 80% happy babies were combined. There was a main effect of Valence ($F(1,46) = 20.38, p < .001$): the ratings of the happy babies ($M = 1.53, SD = 1.11$) were higher than the sad ones ($M = 0.42, SD = 1.39$). In addition, the interaction effect Time x Valence was significant ($F(1,51) = 10.62, p = .002$): the ratings of the sad babies decreased from before the manipulation ($M = 0.54, SD = 1.56$) to after ($M = 0.31, SD = 1.78$), while the ratings of the happy babies increased (Before: $M = 1.10, SD = 1.41$; After: $M = 1.97, SD = 1.16$). Paired t-tests (see *Figure 3.1*) showed the increase of cuteness rating from before to after the manipulation for the 80 % happy baby ($t(46) = -2.46, p = .02$) and the 60 % happy baby ($t(46) = -3.59, p < .001$).

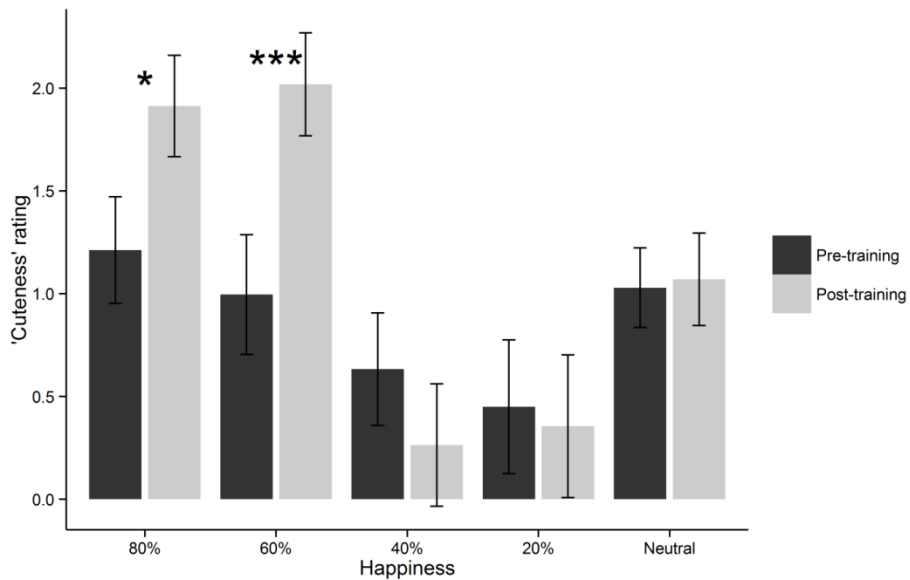


Figure 3.1. Cuteness ratings before and after training. Error bars represent the standard errors of the means. * $p < .05$, * $p < .001$**

Temperament. The same 2x2 repeated measure model was used to test the impact of manipulated temperament on the perceived temperament of the babies, using the aggregated score of the easiness and difficultness ratings. There was a significant main effect of Valence ($F(1,46) = 5.31$, $p = .03$): the happy babies ($M = 0.65$, $SD = 1.24$) were rated as easier than the sad babies ($M = 0.06$, $SD = 0.99$). In addition, the interaction effect Time x Valence was significant ($F(1,46) = 10.48$, $p = .002$): the temperament ratings of the sad babies decreased from before the manipulation ($M = 0.21$, $SD = 0.90$) to after ($M = -0.10$, $SD = 1.68$), meaning that the sad babies were perceived as less easy/more difficult after the manipulation. In contrast, the temperament ratings of the happy babies increased after the manipulation (Before: $M = 0.23$, $SD = 1.42$; After: $M = 1.07$, $SD = 1.50$), meaning that they were perceived as easier/less difficult. Paired t-tests (Figure 3.2) showed the increase of the easiness/difficultness ratings from before to after

the manipulation for the 80 % happy baby ($t(46) = -2.84, p = .007$) and the 60 % happy baby ($t(46) = -2.91, p = .006$).

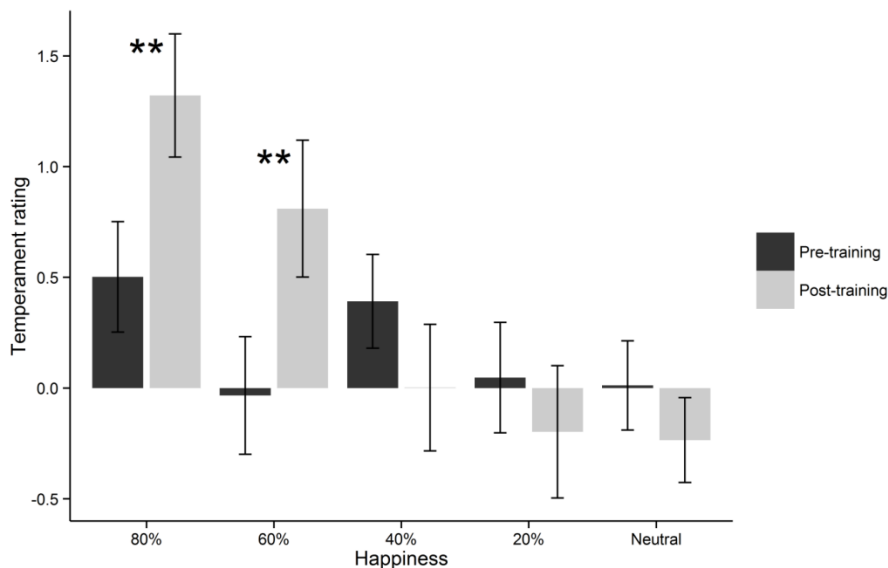


Figure 3.2. Temperament ratings before and after training. Error bars represent the standard errors of the means. ** $p < .01$

Wanting. The effect of the temperament manipulation on Wanting was tested with the same repeated measure ANOVA model, using as dependent variable the total time the participant spent watching the baby faces. We found no significant main effects of Time ($F(1, 46) = 0.51, p = .48$) or Valence ($F(1,46) = 3.23, p = .08$). The interaction effect Time x Valence was significant ($F(1,46) = 15.68, p < .001$): the time spent watching the sad babies decreased from before the manipulation ($M = 5985.11$ ms, $SD = 1567.76$) to after ($M = 5689.36$ ms, $SD = 1794.54$), while the time spent watching the happy babies increased (Before: $M = 6000.00$ ms, $SD = 1435.84$; After: $M = 6530.21$ ms, $SD = 1936.99$). Paired t-tests (*Figure 3.3*) showed the increase of time spent watching the baby from before to after the manipulation for the 80% happy baby ($t(46) = -3.127, p = .003$) and the decrease of the time for the neutral babies ($t(46) = 4.36, p < .001$).

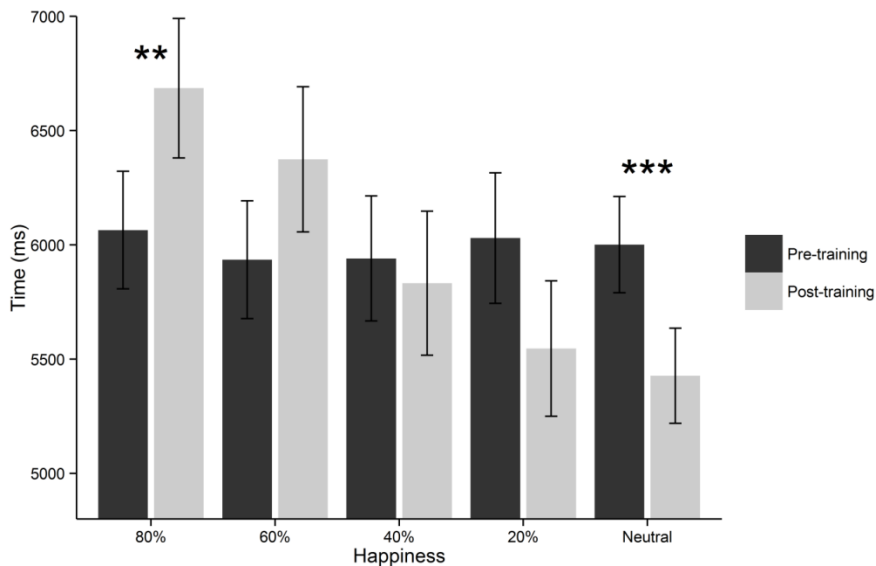


Figure 3.3. Time the participants decided to watch baby faces during the wanting task. Error bars represent the standard errors of the means. ** $p < .01$, * $p < .001$.**

fMRI Results

A whole brain analysis was conducted to examine brain activity for the contrasts (i) 'easy-to-learn happy infant' versus 'neutral infant,' (ii) difficult-to-learn happy infant versus neutral infant, (iv) easy-to-learn sad infant versus neutral infant (v) difficult-to-learn sad infant versus neutral infant, and the reverse contrasts. The contrast difficult-to-learn happy infant versus neutral infant showed significant activity in the cuneal cortex, but no significant activity was found during the perception of the easy-to-learn happy infant, the easy-to-learn sad infant, and the difficult-to-learn sad infant compared to neutral infants. However, the reverse contrasts comparing activity during neutral infants with easy-to-learn sad or easy-to-learn happy infants revealed significant activity in several brain regions (see *Table 3.2* and *Figure 3.4*). We found significant activity during the perception of the neutral infant compared to easy-to-learn happy infant in the middle frontal gyrus,

orbitofrontal cortex, the frontal pole, the angular gyrus, the putamen, the anterior cingulate cortex, precuneus, the middle and superior temporal gyrus, the insula and the paracingulate gyrus. In addition, during the perception of the neutral infant compared to the easy-to-learn sad infant significantly more activity was found in the postcentral gyrus, the precuneus, the frontal pole, the orbitofrontal cortex, the anterior cingulate cortex, the paracingulate gyrus, the thalamus, the nucleus accumbens, and the putamen (see *Table 3.2* and *Figure 3.4*). The Region of Interest analysis with the amygdala did not show significant activity during the perception of the easy-to-learn or difficult-to-learn sad infant compared to the neutral infant.

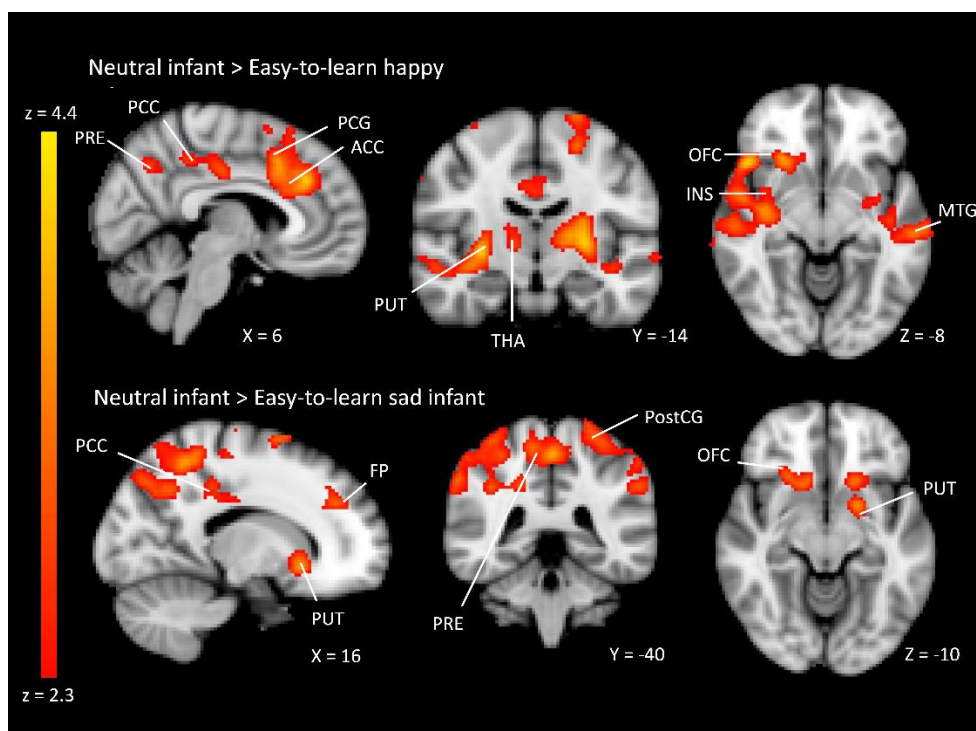


Figure 3.4 Top panel: significant activation during the perception of the neutral infant compared to the easy-to-learn happy infant. Lower panel: significant activation during the perception of the neutral infant compared to the easy-to-learn sad infant. ACC = anterior cingulate cortex, PCG = paracingulate gyrus, THA = thalamus, MTG = middle temporal gyrus, PostCG = postcentral gyrus, PRE = precuneus, PCC = posterior cingulate cortex, PUT = putamen, FP = frontal pole, OFC = orbitofrontal cortex, INS = insula. The right side of the brain corresponds with the left hemisphere and vice versa. Statistical images were thresholded with clusters determined by $Z > 2.3$ and a cluster-corrected significance threshold of $p < 0.05$.

Table 3.2. MNI coordinates, cluster size, and Z-max values for significantly activated clusters.

Contrast	Brain region	N Voxels	Z max	MNI coordinates Z max		
				x	y	z
Neutral > Easy-to-learn <i>Happy</i>	L Middle Frontal Gyrus	7305	4.20	-32	24	28
	R Angular Gyrus	7296	4.50	54	-48	40
	R Putamen	3381	4.08	32	-16	0
	L Putamen	1533	4.01	-26	-14	4
Difficult-to-learn <i>Happy</i> > Neutral	R Cuneal Cortex	2165	3.50	8	-80	34
Neutral > Easy-to-learn <i>Sad</i>	R Postcentral Gyrus	8787	3.87	52	-28	56
	R Frontal Pole	1980	4.00	26	46	24
	R Nucleus Accumbens	1189	3.58	14	18	-6

Childhood emotional maltreatment

Mean Z-values for amygdala activity were extracted in order to examine the relation between amygdala activity and emotional maltreatment. There was no significant correlation (two-tailed) between maltreatment and amygdala activity for the contrast easy-to-learn sad versus neutral ($r = -.10$, $p = .49$). Neither was there a significant correlation between maltreatment and amygdala activity for the contrast difficult-to-learn sad versus neutral ($r = .16$, $p = .30$). Two hierarchical regression analyses were conducted to examine whether emotional maltreatment significantly affected amygdala activity for the easy-to-learn sad and difficult-to-learn sad versus neutral contrasts, controlling for the number of errors that were made during the fMRI task. The model for the contrast difficult-to-learn sad infant versus neutral infant ($F(2,44) = 2.13$, $p = .13$, $R^2 = .09$), and the model for the contrast easy-to-learn sad infant versus neutral infant were not significant ($F(2,44) = 1.48$, $p = .24$, $R^2 = .06$).

Furthermore, correlations between emotional maltreatment and the post manipulation ratings were inspected in order to examine whether maltreatment affected the perception of infant temperament after the manipulation. There were no significant correlations between maltreatment and the post-manipulation cuteness rating (happy: $r = -.14$, $p = .36$, sad: $r = -.04$, $p = .82$) or temperament rating (happy: $r = -.10$, $p = .50$, sad: $r = .02$, $p = .88$) and no significant correlation between maltreatment and time wanting to view the infant (happy: $r = -.18$, $p = .22$ sad: $r = .09$, $p = .57$) (easy-to-learn sad and difficult-to-learn sad combined, easy-to-learn happy and difficult-to-learn happy combined). Furthermore, there was no significant correlation between emotional maltreatment and the number of errors that were made during the fMRI task ($r = .02$, $p = .90$).

Functional connectivity

We performed PPI analyses to examine amygdala connectivity during the perception of infants with different temperaments. When participants were presented with the easy-to-learn happy infant (versus baseline), there was significant connectivity between the right amygdala and the bilateral occipital fusiform gyrus, the lateral occipital cortex, the occipital pole, the postcentral gyrus, inferior temporal gyrus, and the lingual gyrus and between the left amygdala and the left middle frontal gyrus (MFG), the frontal pole, the inferior frontal gyrus, the postcentral gyrus, and the lateral occipital cortex (see *Table 3.3* and *Figure 3.5* for the clusters of activation and *Table S1* for the local maxima in the activation clusters). In addition, we found significant functional connectivity between the left amygdala and the left superior frontal gyrus during the presentation of the neutral infant (versus baseline). Amygdala-frontal connectivity during the presentation of the easy-to-learn happy infant was negative, whereas amygdala-frontal connectivity during the presentation of the neutral infant was positive. There was no significant amygdala connectivity during the presentation of the easy-to-learn sad infant.

Mean Z-values were extracted from the left MFG in order to examine the relation between amygdala-MFG connectivity, emotional maltreatment and the post manipulation ratings of the infants. We found a significant negative correlation between emotional maltreatment and amygdala-MFG connectivity during the presentation of the easy-to-learn happy infant ($r = -.29$, $p < .05$). Hierarchical regression analysis was performed to examine the effect of emotional maltreatment when the number of errors that were made during the fMRI task was entered in the first step of the regression model. When we controlled for the number of errors, emotional maltreatment remained a significant predictor of amygdala-MFG connectivity ($\beta = -.29$, $p < .05$). A contrast Z-value was calculated by subtracting the mean Zvalue for the left MFG during the presentation of the neutral infant from the mean Z-

value for the left MFG during the presentation of the easy-to-learn happy infant. The correlation between the contrast Z-value (easy-to-learn happy infant versus neutral infant) and emotional maltreatment was marginally significant ($r = -.28$, $p = .05$). There was no significant correlation between amygdala-MFG connectivity during the presentation of the easy-to-learn happy infant and the post-manipulation temperament rating of the happy infants ($r = .10$, $p = .52$). Neither was there a significant correlation with the post-manipulation cuteness rating ($r = -.06$, $p = .69$) or time wanting to view the happy infants ($r = -.21$, $p = .17$).

Furthermore, mean Z-values were extracted from the occipital fusiform gyrus (OFG) in order to examine the relation between amygdala-OFG connectivity, emotional maltreatment and the post manipulation ratings of the infants. There was no significant correlation between emotional maltreatment and mean Z-values extracted from the OFG during the presentation of the easy-to-learn happy infant ($r = -.15$, $p = .31$). However, there was a significant positive correlation between amygdala- OFG connectivity and the post-manipulation temperament rating of the happy infants ($r = .31$, $p = .03$). Individuals with high levels of amygdala-OFG connectivity during the presentation of the easy-to-learn happy infant rated the happy infants as more positive than individuals showing low levels of functional connectivity. Hierarchical regression analysis showed that when we controlled for the number of errors that were made during the fMRI task, the temperament rating of the happy infants did not significantly predict amygdala-OFG connectivity ($\beta = .27$, $p < .09$). Again, a contrast Z-value was calculated by subtracting the mean Z-value for the OFG during the presentation of the neutral infant from the mean Z-value for the OFG during the presentation of the easy-to-learn happy infant. The correlation between the contrast Z-value (easy-to-learn happy infant versus neutral infant) and the post-manipulation temperament rating of the happy infants was significant ($r = .30$, $p = .04$). There was no significant correlation between

amygdala-OFG connectivity and the post-manipulation cuteness ratings of the happy infants ($r = -.06$, $p = .71$) or time wanting to view the happy infants ($r = -.04$, $p = .81$).

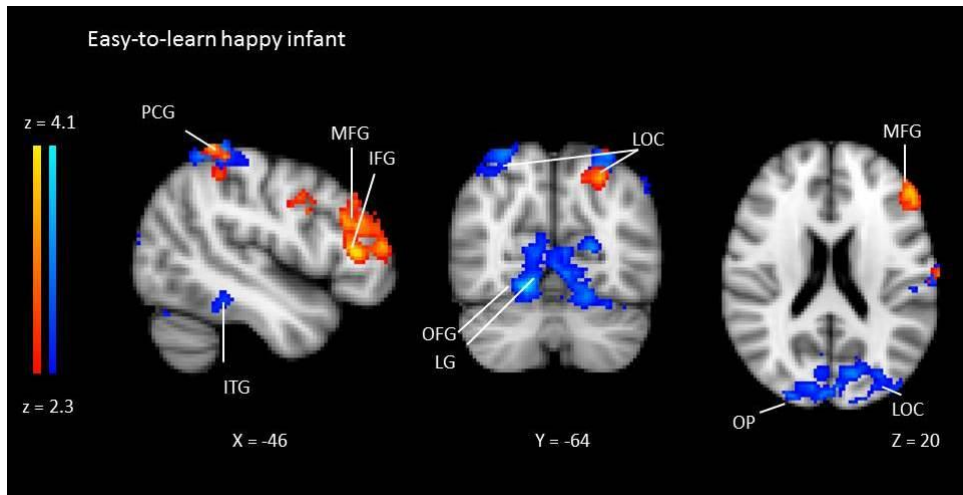


Figure 3.5. Significant functional connectivity with the left (red) and right (blue) amygdala during the presentation of the easy-to-learn happy infant. ITG = inferior temporal gyrus, PCG = postcentral gyrus, MFG = middle frontal gyrus, IFG = inferior frontal gyrus, LG = lingual gyrus, LOC = lateral occipital cortex, OFG = occipital fusiform gyrus, OP = occipital pole. The right side of the brain corresponds with the left hemisphere and vice versa. Statistical images were thresholded with clusters determined by $Z > 2.3$ and a cluster-corrected significance threshold of $p < 0.05$.

Table 3.3. Overview of functional amygdala connectivity: MNI coordinates, cluster size, and Z-max values for significant clusters of functional connectivity

Contrast	Direction	Seed region	Functional connectivity		N Voxels	Z max	MNI coordinates Z max		
							x	y	z
Easy-to-learn <i>Happy</i>	-	Right Amygdala	Lingual Gyrus		8363	4.12	16	-64	-12
	-	Left Amygdala	Middle Frontal Gyrus		1092	3.68	-52	32	24
			Lateral Occipital Cortex		927	3.32	-26	-62	50
Neutral	+	Left Amygdala	Superior Gyrus	Frontal	1089	3.32	-8	0	72

Discussion

The current fMRI study is the first to experimentally manipulate perception of infant temperament and examine subsequent neural processing of infant faces. We employed a computerized probabilistic learning task that manipulated infant temperamental features, the BSRT, to create a sense of the temperament of previously unfamiliar infants and examined its effects on neural processing. Our study is the first to demonstrate how a simple temperament manipulation can change brain activity to a basic social reward, namely infants with a neutral facial expression. Our results indicate that individuals with experiences of emotional maltreatment in childhood have reduced amygdala-middle frontal gyrus functional connectivity while viewing images of infants with a neutral facial expression and a difficult temperament, suggesting that emotional maltreatment has long-lasting effects on the neural level. In addition, we found that amygdala-occipital fusiform gyrus (OFG) connectivity is involved in explaining individual differences in the perception of infant temperament. Our findings are in line with previous studies indicating that the amygdala plays an important role in the perception of infant signals (Barrett et al., 2012; Feldman, Gordon, & Zagoory-Sharon, 2011; Kim et al., 2011; Riem et al., 2012; Riem, Bakermans-Kranenburg, et al., 2011) and indicate that the amygdala may be involved in the mechanism responsible for the intergenerational transmission of childhood abuse. Individuals with experiences of childhood emotional maltreatment showed reduced functional connectivity between the amygdala and the middle frontal gyrus when they saw faces of infants that they come to know as mostly happy. Whereas many previous studies have shown that maltreated individuals show amygdala hyperreactivity to various emotional stimuli (Dannlowski et al., 2012; van Harmelen et al., 2012), data on childhood maltreatment and amygdala connectivity during emotional tasks are scarce. Jedd et al. (2015) examined the relation between maltreatment and amygdala connectivity during an emotional face matching task. In line with our findings, they found that maltreated individuals showed altered functional connectivity between the amygdala and medial frontal gyrus and other frontal regions compared to a control group. Frontal regions exert inhibitory influence on

the amygdala and regulate emotional responses mediated by the amygdala (Hariri, Mattay, Tessitore, Fera, & Weinberger, 2003; Kim, Gee, Loucks, Davis, & Whalen, 2011; Phillips, Ladouceur, & Drevets, 2008). Aberrant fronto-amygdala development has been observed in children with a history of early deprivation in a study by Gee and colleagues (2013). Specifically, children who experienced maternal deprivation displayed accelerated development of amygdalafrontal connectivity, which may reflect an adaptation in response to early adversity, but may be associated with later costs and enhanced risk for psychopathology. Indeed, reduced amygdala-frontal connectivity has been observed in a range of psychiatric disorders (Almeida et al., 2009; Gilboa et al., 2004; Makovac et al., 2015) and might reflect hyperreactivity to negative emotions and problems with emotional regulation. In parents, emotional and physiological hyperreactivity to infant emotions may lead to less optimal or even harsh caregiving (Crouch, Skowronski, Milner, & Harris, 2008; Out, Bakermans-Kranenburg, van Pelt, & Van IJzendoorn, 2012). Our findings suggest that disruptions in amygdala connectivity might be involved in the mechanism underlying the intergenerational transmission of childhood maltreatment.

In contrast to our expectations, we did not find amygdala hyperreactivity in response to infants with a difficult temperament in individuals with experiences of childhood emotional abuse. One reason for the absence of amygdala hyperreactivity could be that we contrasted amygdala activity during the perception of sad or happy infants with activity during neutral infants. Individuals with experiences of emotional maltreatment might also be more reactive and make more negative attributions to neutral child stimuli (Farc, Crouch, Skowronski, & Milner, 2008; Leerkes & Siepak, 2006). Indeed, Van Harmelen et al. (2012) showed that maltreated individuals display heightened amygdala reactivity to happy, sad, and neutral faces, indicating that maltreatment affects the perception of facial expressions in general. Moreover, the amygdala also responds to neutral faces (Pessoa, 2010), which might explain why the sad versus neutral contrast did not reveal significant amygdala activity. Another explanation would be that it is in particular amygdala connectivity that is affected by emotional maltreatment. In line

with our findings, Gee et al. (2014) showed that amygdala connectivity, but not reactivity, was associated with separation anxiety in children with experiences of maternal deprivation. To our surprise, significant amygdala connectivity was found during the perception of the happy infant but not when individuals were presented the sad infant. The comparison of the pre- and post-manipulation temperament and cuteness ratings of the infants showed that the experimental manipulation was most effective for the happy infants. Therefore, the happy infants might have been more emotionally salient and resulted in more amygdala connectivity than the sad infants. An alternative explanation for the absence of maltreatment effects during the perception of the difficult infant is that emotional maltreatment leads to an altered capacity to integrate positive information. A similar mechanism has been observed in depressed patients who have difficulty using positive and rewarding stimuli to regulate negative mood and show aberrant processing of positive information, possibly because of their bias for negative emotions (Gotlib & Joormann, 2010). Although individuals with more experiences of emotional maltreatment did not make more mistakes during the identification of the easy and difficult infant during the fMRI paradigm, they might fail to update previously learned rewarding information about the easy infant. In line with this explanation, previous studies have shown that experiences of maltreatment or being at risk for maltreatment results in differential perception of negative infant signals, but also more positive infant signals, such as infant laughter (Bhandari, Bakermans-Kranenburg, et al., 2014; Compier-de Block et al., 2015), suggesting that it is essential to include responses to positive infant stimuli when studying effects of maltreatment. Furthermore, our study showed that amygdala-occipital fusiform gyrus connectivity during the perception of the happy infants was related to the post-manipulation temperament rating of the happy infants, although this was not significant when we controlled for the number of errors that were made during the fMRI task. Individuals with high levels of amygdala- OFG connectivity tended to rate the happy infants as more positive than individuals showing low levels functional connectivity. Although the amygdala is traditionally seen as a crucial brain region for fear conditioning (LeDoux, 2012), research shows that it is important for emotion processing in general and for the detection of biological

relevance (Pessoa & Adolphs, 2010; Pessoa, 2008; Sander, Grafman, & Zalla, 2003). The amygdala is functionally and anatomically connected to the regions of the visual cortex, including the fusiform gyrus, and exerts a modulatory influence on visual cortex responses based on the biological and affective relevance of the stimulus. In this way, the amygdala prioritizes the processing of emotional stimuli over others and separates significant from less significant stimuli (Pessoa, 2010). As a result, emotional stimuli evoke stronger responses in the visual cortex than neutral stimuli (Vuilleumier, Armony, Driver, & Dolan, 2001). The fusiform gyrus is particularly important for face processing and receives amygdala projections that serve enhanced processing of emotional faces (Herrington, Taylor, Grupe, Curby, & Schultz, 2011; Vuilleumier, Richardson, Armony, Driver, & Dolan, 2004). Our finding that amygdala-occipital fusiform gyrus connectivity is related to the temperament ratings of the infants might indicate that the amygdala plays an important role in enhancing the processing of emotional infant stimuli and tagging infant stimuli as emotionally significant.

Our study has a few limitations. First, functional connectivity using fMRI is a correlational method that does not allow conclusions about (the direction of) any causal relation between the amygdala, occipital fusiform gyrus and middle frontal gyrus. Although we speculate that top-down inhibitory frontal cortex influences on the amygdala are disrupted in individuals with experiences of childhood maltreatment, studies using effective connectivity analysis are needed to examine influences of maltreatment on the direction of connectivities in brain networks. The development of new whole-brain computational modelling methods may in future allow for further investigations of the underlying causal mechanisms (Deco & Kringelbach, 2014; Deco, Tononi, Boly, & Kringelbach, 2015). Another limitation is the use of self-report questionnaires to measure childhood emotional maltreatment. Furthermore, since research has shown that experiences of maltreatment are related to problems in the recognition of emotions and facial expressions (da Silva Ferreira, de Sousa Crippa, & de Lima Osório, 2014), it cannot be ruled out that individuals with experiences of emotional maltreatment had problems with discriminating between the sad and happy infants during the

learning phase of the BSRT, which might have influenced their neural responses to the infant stimuli. However, this is unlikely because emotional maltreatment was unrelated to the number of errors that were made during the fMRI task and to the postmanipulation ratings of the infants. Moreover, a previous study using the BSRT to test the effect of oxytocin on memory for infant cues showed that maltreated individuals who were administered a placebo did not make more mistakes in distinguishing between the sad and the happy infant (Bhandari, van der Veen, et al., 2014). Lastly, our findings can only be generalized to women without children of their own. A study of amygdala hyperactivity and connectivity in maltreating parents and in parents with experiences of childhood maltreatment is needed in order to shed more light on the mechanism responsible for the intergenerational transmission of childhood maltreatment.

In sum, the current study is the first to examine computerized manipulation of infant temperamental features and its effects on neural processing as assessed with fMRI. To our knowledge, this is the first demonstration of how temperament manipulation can change brain responses to infant signals. Our findings indicate that individuals with experiences of emotional maltreatment in childhood have reduced amygdala-middle frontal gyrus connectivity, which might explain why these individuals have problems with emotional regulation, are at risk for psychopathology (Alink, Cicchetti, Kim, & Rogosch, 2012; Felitti, 2002; Norman et al., 2012), and have more difficulty responding in a sensitive way to infant signals (Fuchs, Möhler, Resch, & Kaess, 2015; Marysko et al., 2010). Our findings point to a crucial role of the amygdala in the perception of infant signals and indicate that amygdala connectivity may be involved in mechanisms of transmission of child maltreatment.

Chapter 4

From brain to behavior: a pilot study on the role of Inferior Frontal Gyrus and childhood maltreatment in shaping the behavioral response to infant crying

De Carli, P., Bakermans-Kranenburg, M. J., Parolin, L., Lega, C., Cattaneo, Z., & van IJzendoorn, M. H. (in prep). From brain to behavior: a pilot study on the role of Inferior Frontal Gyrus and childhood maltreatment in shaping the behavioral response to infant crying.

Introduction

The role of infant crying in fostering parental proximity and caregiving is well known and documented (Bowlby, 1969; LaGasse, Neal, & Lester, 2005; Soltis, 2004; Zeifman, 2001; Zeskind & Lester, 2001). From an evolutionary perspective, adult's ability in identification and recognition of this child's signals seems essential to enhance his own survival chances (Wells, 2003). Coherently infant crying is associated to a specific adult behavioral response defined by rapid, coordinated effortful movements (Parsons, Young, Parsons, Stein, & Kringelbach, 2012). A physiological response is common in all adults, both parents and non-parents as well as males and females (Frodi et al., 1978; Frodi & Lamb, 1980; Groh & Roisman, 2009), and the amplitude of the response is specific for infant crying in respect to non-crying sounds comparable for stress induction level (Murray, 1985; Tkaczyszyn et al., 2013). Research on brain correlates shows the role of interacting cortico-limbic networks in supporting parental responses to infants (Bos et al., 2010; Seifritz et al., 2003; J E Swain et al., 2014).

Differences in neural responses to infant crying seems associated to different individual characteristic connected to maternal behavior. For instance mothers who reported higher maternal care in their own infancy show greater response in emotion regulation areas like the middle and superior frontal gyrus (Kim et al., 2010a). Insecurely attached women have a decrease in activation of amygdala, compared to securely attached ones (Riem et al., 2012). Depressed mothers hearing their own babies crying show less activation in nucleus caudate and accumbens, and thalamus, relevant areas in determining processes of maternal motivation (Landi et al., 2011; Laurent, Stevens, & Ablow, 2011).

Unlike brain activation, differences in physiological reactivity to infant crying have been found to be directly associated to the quality of parenting behavior (Joosen et al., 2013). Greater HR reactivity to infant crying has also been related to quicker and more adequate maternal responses to negative infant signals (Del Vecchio et al., 2009), which is a crucial aspect of maternal sensitivity (Ainsworth et al., 1974). Finally, from a polyvagal perspective (Porges, 2007), the

association between physiological reactivity and caregiving quality is confirmed in light of the finding that highly sensitive mothers had a greater increase in HR and a stronger RSA withdrawal in reaction to infant crying than less sensitive mothers. Interestingly, the perception of urgency of crying does not differ between the two groups (Joosen et al., 2013). Again adult attachment plays a role in predicting the physiological reactivity to infant crying (Ablow, Marks, Feldman, & Huffman, 2013; Groh & Roisman, 2009; Leerkes et al., 2014).

Maternal differences in the perception of infant signals are crucial also because crying can elicit negative reactions in parents (Dix, Gershoff, Meunier, & Miller, 2004) and therefore represent a trigger of child abuse and neglect (Soltis, 2004). Maltreating mothers differ from controls in response to infant crying both from a physiological and behavioral perspective: mothers at risk of abuse show higher heart rate (McCanne & Hagstrom, 1996) and maltreating mothers use more excessive force during a handgrip dynamometer task (Compier-de Block et al., 2014) even if they do not report differences in the perception of crying.

An important role in modulating responses to infant crying seems to be played by oxytocin, a neuropeptide implicated in parenting (Carter & Altemus, 1997; Feldman, Weller, Zagoory-Sharon, & Levine, 2007; Insel, 1997; Strathearn et al., 2009) and also in the perception of infant crying (Riem, Pieper, et al., 2011). A randomized controlled trial showed the effects of intranasal administration of oxytocin on brain response to infant crying: reduced activation in the amygdala and increased activation in areas associated with empathy and mother–infant bonding like insula and inferior frontal gyrus (IFG) (Riem, Bakermans-Kranenburg, et al., 2011). The effect of oxytocin manipulation on a handgrip dynamometer task in response to infant crying was moderated by childhood experiences: only the participants who did not experienced harsh discipline in their childhood used less excessive force in the oxytocin condition (Bakermans-Kranenburg et al., 2012). This evidence points out the role of experiences in moderating the effects of oxytocin and confirms the complexity of the intersection between behavioral and psychophysiological factors (Bartz, Zaki, Bolger, et al., 2010; Bartz, Zaki, Ochsner,

et al., 2010; Huffmeijer, Tops, Alink, Bakermans-Kranenburg, & van IJzendoorn, 2011; van IJzendoorn, Huffmeijer, Alink, Bakermans-Kranenburg, & Tops, 2011).

Hence, the effects of oxytocin on adult brain during infant crying are known, as well as the effect on a behavioral level. A further question is about the direct link between the brain and behavioral processes. Does the mechanism that allows the behavioral change require specific brain activation? Is this brain modification responsible for the behavioral differences? In other words, the question refers to the possible role of brain functioning in the behavioral response to infant signals. Finally, can the moderating effect of harsh parenting be explained by differences in brain response? As Swain and colleagues (2014) specifically pointed out on their recent review on the biology of human parental attachment, more information on which neural mechanisms drive which behavioral outcomes is necessary to develop more effective and tailored interventions.

Bakermans-Kranenburg and colleagues (2012) suggest a role of the increased activation of empathy related brain areas that, in association with reduced anxiety and aversion, could prevent the use of excessive force in response to infant signals. This hypothesis seems supported by the effect of oxytocin in enhancing empathy (Bartz, Zaki, Bolger, et al., 2010) and mind reading ability (Domes, Heinrichs, Michel, Berger, & Herpertz, 2007; Riem et al., 2014). Understanding the experience of the other person is crucial for a more attuned response and indeed the association with parental caregiving is theoretically relevant and empirically established. Ainsworth (Ainsworth et al., 1978) defined empathy as prerequisite of sensitivity, necessary to perceive, interpret and respond to infant signals, and the empirical evidences clearly support their correlation (Feldman, 2007; Gondoli & Silverberg, 1997; Leerkes, 2010).

The brain area that could be implicated in this process is the inferior frontal gyrus, as highlighted by Riem and colleagues (2011), which is responsible for emotional (and not “cognitive”) empathy circuits in the brain (Shamay-Tsoory, Aharon-Peretz, et al., 2009) and for affective prosodic comprehension (Leitman et al., 2010). Moreover this area seems to play a role in mirror like processes (Kilner

et al., 2009; Rizzolatti & Sinigaglia, 2010) that support the embodied simulation hypothesis (Gallese & Sinigaglia, 2011). Keuken and colleagues (2011) found that disrupting Left Inferior Frontal Gyrus with TMS, but not vertex, decreased the performance in an emotion recognition task, and eliminated the suppression of the 8–12 Hz EEG μ rhythm, a supposed index of mirroring activity.

Mirroring system seems to play a relevant role in attachment theory because, since Bowlby's first formulations, the mechanism that allows continuity of the relationship models across life span and across generations (Internal Working Models; Bowlby, 1969), is supposed to “simulate happenings in the real world, thereby enabling the individual to plan his behaviour with all the advantages of insight and foresight.” (Bowlby, 1988). In fact, the capacity of understanding children's mental states is strongly related to children opportunity to develop a secure attachment (Koren-Karie, Oppenheim, Dolev, Sher, & Etzion-Carasso, 2002; Meins et al., 2002; Oppenheim, Koren-Karie, & Sagi, 2001; Slade et al., 2005). A focus on the role of mirror-like brain circuits implied in caregiving system could help to identify the link between mothers' experiences of attachment and parenting behavior in order to shed light into the mechanism of intergenerational transmission of attachment.

So far, no study has investigated the empathy hypothesis and specifically whether the IFG plays a selective causal role in the perception of infant crying. Brain stimulation may directly affect—in a controlled and reversible way—neural activity in a targeted region, shedding light on the causal role of that region in mediating a particular function/behavior. In this study, we want to use transcranial magnetic stimulation (TMS) to directly investigate whether the IFG plays a causal role in determining the force used by participants to squeeze a dynamometer during exposure to infant crying sounds. Moreover we want to test the effect of stimulation on a task to test the ability to implicitly discriminate between tired babies and crying babies (both auditory and visual stimuli), as indirect measure of mind reading inherent to the specific context of caregiving.

Hypotheses

1. We hypothesize a causal role of rIFG in mediating the force used in response to the perception of infant cry. Specifically we expect that after the stimulation the dynamometer task reveals an increased use of excessive force in consequence of a reduction of empathy in the participant.

2. We can hypothesize a role of caregiving experiences as a moderator in the previous effect: we propose that rIFG stimulation was less effective in participants who experienced harsh caregiving behavior during childhood. This could be probably due to a deficit in mind reading ability (Riem et al., 2014) that led to a compensatory effect of other cognitive abilities. However, this hypothesis is highly speculative therefore the hypothesis should be considered exploratory.

Method

Participants

From the same preliminary sample of Study Two presented in Chapter 2, a subsample of 12 females were contacted and participated in the study in exchange for credits. Participants were selected from the first and the fourth quartile of the abuse distribution in order to obtain two groups, a high maltreatment group and a low maltreatment group. Moreover all participants were screened for TMS eligibility with these exclusion criteria: no left-handed as assessed by a standard test (Oldfield, 1971); no neurological problems and history of seizures as assessed by a specific questionnaire (Rossi, Hallett, Rossini, & Pascual-Leone, 2011) to evaluate compatibility with TMS; no medications that could interfere with neuronal excitability. The study was carried out in accordance with the recommendations of the Declaration of Helsinki and the approval of the Ethical Committee of University of Milano – Bicocca. All subjects gave written informed consent in order to participate.

Handgrip-force task

To measure the force used in response to different auditory stimuli a hand dynamometer was used. The dynamometer (model TSD121C) weighed 315 g and was 185-mm long, 42-mm wide and 30-mm thick, with an isometric range from 0 to 100 kg. Squeeze intensities (in kg) were transferred directly from the dynamometer to the AcqKnowledge software program (version 3.8; Biopac Systems, 2004). Matlab (version 7.8.0, Mathworks, MA, USA) was used to identify peak intensities for each squeeze.

After arrival to the laboratory and the stimulation participants are asked to sit comfortably and to take the handgrip with their dominant hand. Then they are told that during the task they have to squeeze the handgrip as hard as they can and at 50% of their strength. Before the task they can practice as many times as they want with a feedback of the strength they use displayed on a monitor. When they think they are ready to start because they learnt to properly squeeze the handgrip, the monitor was directed away not to provide feedback anymore. Then the real task starts on a laptop with a Matlab script running (Brainard, 1997; Kleiner et al., 2007; Pelli, 1997). Participants had to wear headphones. Each trial was made of a brief presentation of the words “squeeze maximally” and subsequently “squeeze at half strength” after 2s. Between the trials participants were asked to stare a small cross in the middle of the screen. Two training trial were presented before the real experiment made of three different sound: cry sound, laugh sound and a control sound. The order of the blocks was randomized. Each block was made of four trials. The infant laughter sound (duration = 2 min, average fundamental frequency = 215.96 Hz, constant volume) and the infant crying sound (duration = 2 min, average fundamental frequency = 360.06, constant volume) from Groh and Roisman (2009) were used. The intervening time between full- and half-strength prompts was 2 s; the intervening time period between half-strength and the next full-strength prompt was 25 s. Neutral auditory control stimulus from Riem et al, 2011 was used. It was created identical to the original auditory stimuli in terms of duration, intensity, spectral content, and amplitude envelope but lacking an emotional meaning.

To obtain an absolute measure of the force used, the half strength was divided by the maximum strength in order to obtain a composite score ranging from 0 to 1. Scores above 0.5 were interpreted as excessive force. In previous studies the number of times a participant used excessive force was used as outcome variable (Bakermans-Kranenburg et al., 2012; Compier-de Block et al., 2014). In the present study, considered the small effect of TMS stimulation the raw scores of force used was considered, because thought as more sensitive.

Childhood Trauma Questionnaire Short Form

CTQ-SF (Bernstein et al., 1994, 2003a) is a measure of experiences of childhood abuse. Twenty-eight items were presented to assess experiences of physical abuse, emotional abuse, sexual abuse, physical neglect, and emotional neglect. Each item (e.g., "During my childhood I felt hated by family") was rated on a 5-point Likert scale ranging from never true to very often true. In the current study we focused on the abuse subscales since they were expected to affect reactivity to infants with different temperaments. Therefore, an abuse scale was created ($\alpha = .73$) by averaging the items tapping into the physical abuse, emotional abuse, and sexual abuse dimensions.

Repetitive Transcranial Magnetic Stimulation (rTMS)

rTMS was administered over the right Inferior Frontal Gyrus by means of a Magstim Rapid machine (Magstim Co Ltd, Whitland, UK) with a 70 mm butterfly coil. A fixed intensity of 60% of the maximum stimulator output was used, in line with prior studies (Campana, Cowey, Casco, Oudsen, & Walsh, 2007b; Ferrari et al., 2014). The right Inferior Frontal Gyrus was targeted in light of previous evidence pointing to a right lateralized processing of infant cry in Riem et al., 2011. rIFG was localized by means of stereotaxic navigation on individual estimated magnetic resonance images (MRI) obtained through a 3D warping procedure fitting a high-resolution MRI template with the participant's scalp model and

craniometric points (Softaxic, EMS, Bologna, Italy). Talairach coordinates for this site ($x = -46$, $y = 14$, $z = 1$) were obtained from a previous fMRI study investigating neural correlates of processing of infant cry in Riem et al., 2011. The Vertex, corresponding to the median point of the nasion–inion line, was used as a control area. For each of the sites stimulated, 900 pulses were applied at a frequency of 1 Hz (train duration 15 min). Previous studies have shown that rTMS at 1 Hz temporarily reduces the excitability of the stimulated cortex for a time window that outlasts the period of stimulation (R. Chen et al., 1997b; Oliveri, Koch, Torriero, & Caltagirone, 2005b)

Procedure

When a participant arrives in the laboratory, is firstly screened for TMS contraindications. Then she's asked to sit comfortably on the chair and the stimulation is performed (the stimulation site is randomly assigned, rIFG or Vertex). After the stimulation the participant performs the two tasks. The harsh discipline questionnaire is given to him to answer at home and to return it during the next visit to the lab. In the second visit the second stimulation (again IFG or Vertex) is performed and again the same tasks.

Results

To assess the effects of child abuse and maltreatment experiences we tested different two by two linear models, one for each type of sound: cry, laugh and control sound. This was due to the small sample size of this pilot study. Each model was made of the same random effects (intercept), fixed effects (stimulation site, rIFG or Vertex and group of high or low abuse), and outcome variable (Half Strength/Maximum Strength). Analyses were performed with R software (R Development Core Team, 2013) and more specifically lme4 package (D. Bates et al., 2015; D. Bates, Maechler, Bolker, & Walker, 2013) to test the linear mixed models, lmerTest package (Kuznetsova, Brockhoff, Haubo, & Christensen, 2014)

to compute standard errors and p values and ggplot2 package (Wickham, 2009) to draw the lots. In response to the control sound, no significant effect of stimulation site ($F(1, 80.02) = 1.21, p = .27$), maltreatment group ($F(1,10.02) = 0.42, p = .53$) or their interaction was found ($F(1, 80.02) = 2.43, p = .12$). In response to infant's laugh, no significant effect of stimulation site ($F(1, 80.02) = 0.96, p = .27$), maltreatment group ($F(1,10.02) = 0.37, p = .53$) or their interaction was found ($F(1, 80.02) = 0.23, p = .63$). On the contrary infant's cry model showed not significant main effects of stimulation site ($F(1,80.02) = 0.03, p = .86$) and maltreatment group ($F(1,10.02) = 0.09, p = .77$), but a significant interaction effect ($F(1,80.02) = 4.87, p = .03$). Then we tested the effect of stimulation site in the maltreatment groups, separately. Linear mixed models for this analysis had the same outcome variable and random effects of the previous models, but only stimulation site as fixed effect. In the low maltreatment group, rIFG stimulation scores were statistically different from Vertex stimulation scores, $b = -0.05, SE = 0.02, t(41) = -3.07, p = .004$. In the high maltreatment group no differences were found between the scores of the two stimulation sites, $b = -0.04, SE = 0.04, t(39.03) = 1.08, p = .28$. Results of the infant's cry condition are presented in *Figure 4.1*.

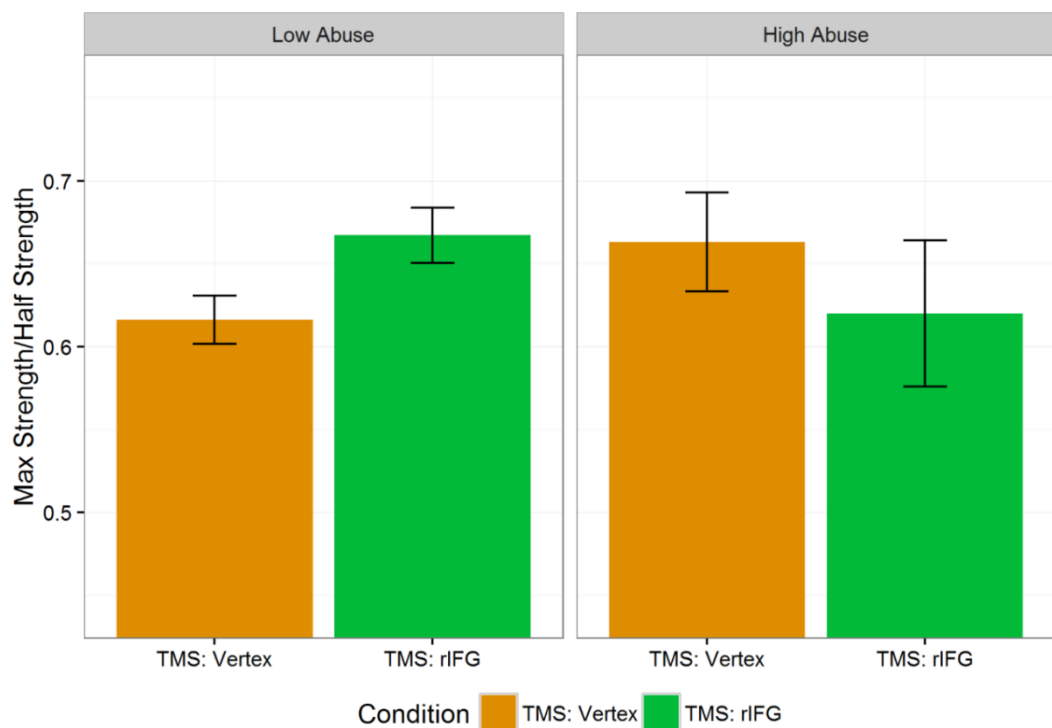


Figure 4.1. Strength used in squeezing the handgrip in response to infant crying. Strength variable is calculates as Max strength/Half strength. Error-bars represent the standard errors of the means.

Discussion

TMS stimulation of rIFG (compared to Vertex) yielded the expected effect of increasing the excessive force used in response to infant's cry, but only in non-maltreated participants. Even if we did not find a main effect of TMS in reaction to cry sound, results are consistent with our expectation of a smaller effect in maltreated participants. An important caveat is the preliminary stage of this research, to the point that we consider the present chapter only a pilot study. In fact, the sample size seems small to test a within/between model, even if the confirmation of the hypotheses is auspicious for the future results and confirms the solidity of the methodological approach.

Results confirm the causal role of rIFG in determining the behavioral response to infants crying in non-maltreated nulliparous females. Moreover, the pejorative effect of rIFG inhibition is specific for cry, compared with infant's laugh and a control sound. Infant's crying is an aversive stimulus with the specific evolutionary function of signaling infant's distress and eliciting a parental response to children needs. The aversive nature of cry makes it very stressful to listen to and this feature is highly adaptive in order to increase the chances of a parental intervention to provide security in a dangerous world. On the other hand, as consequence of the highly stressing effect, crying is also considered a powerful trigger of abuse (Soltis, 2004). The excessive force used in squeezing a hand dynamometer has been found to be able to discriminate between maltreating and non-maltreating mother in response to infant crying (Compier-de Block et al., 2014). Therefore, the present study shows that rIFG is able to buffer the negative consequences of listening to infant cry, even if only in individuals who have not experienced a harsh rearing environment during childhood. The psychological process associate to activation of rIFG is emotional (and not "cognitive") empathy (Shamay-Tsoory, Aharon-Peretz, et al., 2009). Therefore, we suggest that non-maltreated individuals are able to establish an empathic connection with the distressed infant and this process is probably responsible for the buffering of the excessive use of force. Intriguingly we did not find the same effect in maltreated females, suggesting that rIFG is not directly implicated in the cascade process that drives the brain processing to a behavioral response. At least not it is not implicated in a causal way. This is also an indirect confirmation of the role of rIFG in mediating the buffering effect of intranasal administration of oxytocin on the excessive force in response to infant cry (Bakermans-Kranenburg et al., 2012). An augmented effect of rIFG (Riem, Bakermans-Kranenburg, et al., 2011) could take part in the decrease of excessive force determined by oxytocin. Maltreated females seem not to be able to rely on rIFG to increase empathy toward the infant that is crying. Because their use of force is not significantly different from the non-maltreated one, we could hypothesize that they rely on different processes, like a cognitive and not emotional form of empathy. This speculation obviously requires further research. In the perspective of intergenerational transmission of parenting,

we propose that maltreated mothers could be less attuned to their children and less able to establish an empathic connection with them (Fonagy et al., 2002).

The relevance of rIFG in mirroring processes support another intriguing explanation based on the embodied simulation hypothesis proposed by Gallese (Gallese & Sinigaglia, 2011; Gallese, 2014). The buffering effect of IFG could rely, in fact, on the opportunity of “simulating other’s emotion” and therefore establish a connection. Gallese proposes that “internal representations of the body states associated with these actions, emotions, and sensations are evoked in the observer” (Gallese, 2009, p. 527). Since these processes are related to the born of intersubjectivity in children (Ammaniti & Gallese, 2014), childhood maltreatment could impair this ability, maintaining a sort of intergenerational stability of the deficit.

These results are different from the one presented in Chapter 2 of a positive effect of rIFG stimulation in buffering the bias in responding to negative infant facial expression. In Chapter 2 study, TMS stimulation buffered a bias process, while in the present study TMS has a pejorative effect on the behavioral performance. We explain these differences in terms of the huge differences between the two different measurements. In fact, the studies differ for the nature of the stimuli (auditory vs visual) and the behavioral task (handgrip force vs approach avoidance task) and the outcome variable (Relative strength vs reaction times). Moreover, in Chapter 2 we found that the bias in processing sad faces is adaptive, at least at some point. Therefore, also in that study we could consider TMS effects as pejorative of the performance. Beside these differences, both studies report a negative association between abuse scores and the effect of TMS stimulation. This confirms the difficulty of accessing empathy processes in maltreated females due to a diminished role of rIFG.

Limitations must be acknowledged. First, sample size seems inadequate in order to identify stable results because of the interaction effect between within and between effects. We consider this study as the pilot test before the real experiment. Then the retrospective measure of childhood abuse implies a

memory bias, especially in highly emotionally domains as abuse. The self-report measure used in this study, however, is largely used for its sensitivity and show good psychometric properties.

In sum, this study provides first empirical evidences of a buffering role of rIFG and empathy in the behavioral response to infant's cry. This effect seems to be limited to non-maltreated individuals, but more research is needed to study the different network implicated in a sort of compensatory process.

Section 3

Toward an emotion regulation model of intergenerational transmission of parenting

Introduction to the section

In this section, we present a review of the studies that focused on the effects of childhood early stress on adults' neurophysiological processes related to parenting behaviors. We believe that the amount of evidences presented in the last decade, allows proposing a synthesis of the mechanisms involved in the intergenerational transmission of dysfunctional parenting. The interpretative key we used to understand the effects of harsh environment is rooted in an evolutionary approach. We present the basic concepts of Life History Theory in order to demonstrate that the dysfunctional effects due to growing up in a harsh

early environment are essentially part of an adaptive process that affect primarily the type of reproductive strategies and rearing offspring of the individual. The reason of this choice is that this theoretical framework allows a fruitful integration between retrospective studies based on self-report measures of the care received during childhood and adult attachment representation studies. In fact, this perspective has been extensively used to explain attachment (Belsky, 1997; Del Giudice, 2009; Simpson & Belsky, 2008, 2016) and intergenerational transmission of attachment (Belsky, 2005). Within this unique theoretical framework, evidences from the two research lines can be integrated by means of the same interpretative mechanism. Moreover, this approach seems very consistent with Bowlby very foundations of Attachment Theory, especially because the primary evolutionary purposes of attachment systems is the adaptation to the environment and the search for proximity and security on an innate base. Another nice feature of this approach is the predictive power of the hypotheses that it is able to generate. Probably the most impressive is the existence of the differential susceptibility phenomenon (Belsky & van IJzendoorn, 2015). However, these predictions do not usually rely on the mediators of the phenomenon they explain or predict, leaving space for other theoretical approaches to make hypotheses to integrate. In the case of intergenerational transmission of parenting the basic principle is that a harsh environment promotes reproduction strategies based on large offspring but low parental investment. Low parental investment means low parental sensitivity and the presence of few caregiving oriented behaviors. Harsh parenting during childhood will shape individual's personality in order to determine a lower investment on parenting and enabling the transmission. Within this statement, each theory on human development can introduce its own specific interpretation on how this intergenerational continuity takes place. The hypothesis we are going to try to demonstrate in Chapter 5 is about the role of emotion regulation in bringing this strategy into reality. Therefore this perspective, even if deeply rooted into neuroscientific empirical evidences, does not close the door to more speculative interpretation of the phenomenon like the intersubjectivity approach (Ammaniti & Gallese, 2014; Stern, 1995b) or the a psychodynamic perspective on the mirroring maternal functioning (Fonagy et al., 2002; Winnicott, 1971). We are

not implying that Life History Theory represents a higher order theorization, but we think that its not applicative nature makes it flexible and usable in coordination with clinical approaches.

With his well know pioneering attitude, Bowlby had already caught these very basic ideas in 1984 when he wrote on the American Journal of Psychoanalysis the article titled "Violence in the family as a disorder of the attachment and caregiving systems". In this paper Bowlby present unregulated anger as the cause of family violence but also an adaptive behavior at some point, especially considering specific environment and situations. We report at the beginning of Chapter 5 a brief quotation from this paper that is particularly explanatory.

Chapter 5

“A chip of the old block”: an evolutionary perspective on the neurophysiological mechanisms responsible for intergenerational transmission of dysfunctional parenting

De Carli, P., & Parolin, L. (in prep). “A chip of the old block”: an evolutionary perspective on the neurophysiological mechanisms responsible for intergenerational transmission of dysfunctional parenting.

“It is within this evolutionary perspective that I believe we can understand how angry behavior between members of a family can often be functional. For, as I said earlier, in the right place, at the right time, and in the right degree, anger can serve to maintain these vitally important long-term relationships. But, as is very obvious, anger can be overdone. My thesis is simply that a great deal of the maladaptive violence met with in families can be understood as the distorted and exaggerated versions of behavior that is potentially functional, especially attachment behavior on the one hand and caregiving behavior on the other.”

(Bowlby, 1984, p. 12)

The early environment has a tremendous effect on children’s development and adults’ outcomes (Del Giudice, 2014; Ellis & Del Giudice, 2014; Franklin et al., 2010; Kaufman & Charney, 2001; Teicher et al., 2003). In particular, the “maternal effect” (Bjorklund, 2006; Maestripieri & Mateo, 2009) is one of the most important sources of phenotypic and genotypic plasticity (Belsky & Pluess, 2013; Belsky, Jonassaint, et al., 2009) and promotes better adaptation to a specific context. When conditions are harsh, the effects become awful and the cost of adaptation becomes elevated. Early stress greatly highly affects all domains of children’s functioning and their trajectories of development, as well as modulating many processes in adulthood, including their caregiving abilities. Childhood context and experiences have a central role in shaping reproduction choices as well as parenting strategies (Bowlby, 1969; George & Solomon, 2008; Lomanowska et al., 2015; Neppl et al., 2009; Simpson & Belsky, 2008). For instance, exposure to maltreatment or neglect is considered a risk factor for turning into maltreating parents (Dixon, Browne, et al., 2005; Widom et al., 2015; Zeanah & Zeanah, 1989). This paper is aimed at expanding the comprehension of the intergenerational effects of dysfunctional parenting by providing an evolutionary conceptual framework to understand the neurophysiological mechanisms implicated. We are specifically interested in the intergenerational transmission of

parenting strategies for two main reasons: first, because of the developmental and social effects of parenting behavior and the central role that parenting strategies play within an evolutionary framework; and second, because of the powerful opportunity opened up by this process, in terms of interventions to prevent negative developmental outcomes. Interventions aimed at improving parenting abilities represent a unique occasion to break the intergenerational transmission of negative parenting behavior. The focus on neurophysiological processes comes from the need once the intergenerational effect has been established to explore the mediators and moderators of transmission with different levels of analysis. In particular, the research lacks an articulated comprehension of the mechanisms responsible for the transmission effects (Belsky, Conger, et al., 2009; Conger et al., 2009). We claim that the difficulties in designing effective interventions to prevent childhood maltreatment (Euser et al., 2015) come from a lack of specific hypotheses on the disrupted processes implicated and the possible ways to intervene.

In sum, in this paper, we briefly present Life History theory (LH, Chisholm, 1993; Del Giudice, Gangestad, & Kaplan, 2015; Figueredo et al., 2006; Simpson & Belsky, 2008; Stearns, 1992) as a framework to understand how different environments affect childrearing strategies and parenting behaviors. Then we define the concepts of intergenerational transmission, early stress and dysfunctional parenting, in order to then review the effects of early stress on parenting-related processes. In this part, we synthesize the studies reviewed and propose a deficit of emotion regulation as the mechanism responsible for intergenerational transmission. Finally, we discuss how these research advances can inform interventions aimed at breaking the transmission of dysfunctional parenting.

Life History Theory

Life history theory is an evolutionary approach in biology that explains how organisms invest resources into different activities during their lifecycle. Every

organism lives in an environment with finite resources: time, food, and energy are all finite. Thus, every individual's choice is the result of a balance, or a tradeoff between different adaptation strategies. A classic example is the balance between bodily growth and reproduction: both are strategies to enhance evolutionary fitness, but producing offspring significantly decreases somatic growth. A better environmental adaptation consists of a good balance between the two polarities, in light of the contextual characteristics. In general, a definite strategy assures a better level of adaptation, compared to a non-definite one.

Life history theory states that the primary trade-offs in individuals' lives are current vs. future reproduction, quality vs. quantity of offspring, and mating vs. parenting effort. Delaying reproduction could allow individuals to be more prepared when offspring come and be more able to provide a safe environment. On the contrary, in a high-mortality environment, quicker reproduction should heighten the chances of gene transmission. Moreover, the choice between quality and quantity of offspring is based on the balance between high effort in raising a few descendants or low effort but many descendants. In a similar way, parental effort is considered adaptive: spending more resources on raising offspring should ensure more adaptation to the environment, but reduces individuals' mating effort. Different choices in how to face these balances drive different life history strategies and result in different efforts in approaching developmental tasks. Environments play a key role in promoting specific strategies and trade-offs, depending on two basic characteristics: harshness and unpredictability (Brumbach, Figueredo, & Ellis, 2009; Ellis, Figueredo, Brumbach, & Schlomer, 2009). In fact, short lifespan, high child mortality, and reduced parental investment are correlated with the early production of numerous offspring. These are called "fast" life history strategies. On the contrary, "slow" life history strategies are based on slow growth and late reproduction, and are correlated with long lifespan and high-quality but few offspring. In other words, slow strategies bet on a delayed reward in exchange for current effort and within a sufficiently safe and predictable environment, in order to reach the time to produce well-supported offspring. Fast strategies consider the advantages of short-term rewards and invest in numerous

offspring, in light of the high-risk context in which the effort to protect their descendants would be vain.

The most relevant empirical support for this perspective comes from the confirmation of three predictions based on this model (Simpson & Belsky, 2008): parent–child positivity predicts delayed pubertal development (Ellis, McFadyen-Ketchum, Dodge, Pettit, & Bates, 1999a; Graber, Brooks-Gunn, & Warren, 1995; Kim & Smith, 1998a; Steinberg, 1988), while parent–child conflict predicts earlier pubertal timing (Jorm, Christensen, Rodgers, Jacomb, & Easteal, 2004; Kim & Smith, 1998b; Mezzich, 1997; T. E. Moffitt, Caspi, Belsky, & Silva, 1992); finally stressful family relationships predict later pubertal maturation in girls (Ellis & Garber, 2000; Ellis, McFadyen-Ketchum, Dodge, Pettit, & Bates, 1999b).

The environment seems to have a primary role in promoting fast versus slow life history strategies: by focusing on the effects of early stress on parenting-related processes, we aimed to study the neurophysiological mediators of this evolutionary push.

Small parental investment represents per se a harsh environment that requires specific adaptive strategies (Ellis & Del Giudice, 2014; Erickson, Egeland, & Pianta, 1989) and affects infants' development. Because many of the next approaches will refer to the quality of the childhood experience as a moderator of parenting-related processes in adulthood, we have to specify the evolutionary perspective on childhood stress that we support, with some caveats. Starting from the assumption that a single behavioral strategy can be very adaptive to a specific environment and not to another one, it is unlikely that one single strategy will evolve because of natural selection. Then, a stressful environment can be considered as one of the possible contexts to which humans are programmed to respond. In this sense, development under stressful conditions must not be considered as a “simple” disruption of normal development, but as a strategy to face the context in which the development takes place (Del Giudice, Ellis, & Shirtcliff, 2011; Del Giudice, 2014; Ellis & Del Giudice, 2014). Empirical confirmations of this hypothesis include children's ability to estimate environmental

states (Frankenhuis, Gergely, & Watson, 2013) and the evidence of the role of early stress in enhancing some cognitive abilities like memory and memory in stress situations (Bagot et al., 2009; Buwalda, Stubbendorff, Zickert, & Koolhaas, 2013; Champagne et al., 2008; Frankenhuis & de Weerth, 2013). The important caveat is that, of course, a certain amount of early stress can lead to adaptive functioning, although this does not mean it has no consequences. Of course, children can have unspeakable experiences that can be very disruptive, leading to tragic consequences for their development.

Intergenerational transmission of parenting

The intergenerational transmission of parenting is a long-standing hypothesis within the developmental field. Many theoretical approaches have predicted it, such as attachment theory (Bowlby, 1969), social learning theory (Bandura, 1977, 1986), and life course theory (Elder et al., 2003). Different clinical approaches (Fontana, 1968; Selma Fraiberg et al., 1975; Galdston, 1965b; Kempe, 1973) have highlighted the intergenerational continuity of abusive behaviors, ever since the first seminal psychoanalytic work by Ferenczi (1933) on the “identification with the aggressor” and the effects of trauma on psychic development. The first empirical tests of the phenomenon were retrospective studies of maltreating adults who reported histories of abuse and neglect (Bleiberg, 1965; Blue, 1965; Fontana, 1968; Gibbens & Walker, 1956; Komisaruk, 1966b; Melnick & Hurley, 1969; Steele & Pollock, 1968). These studies were likely to be affected by memory bias (Hardt & Rutter, 2004; Kaufman & Zigler, 1987; van IJzendoorn, 1992) as well as detection bias (Widom et al., 2015). To overcome these limitations, the first prospective studies on parenting transmission were designed in the 1980s. Quinton and colleagues (Dowdney et al., 1985; Quinton et al., 1984) focused on the parenting abilities of women reared in institutions as a consequence of negative parenting. Caspi and Elder (1988) prospectively assessed three generations: they directly assessed the parenting abilities of the first generation (G1) and the second generation (G2). In a risky sample, they found

an indirect but clear stability of parenting across the generations, mediated by aggressive behavior. Many other studies have confirmed the association, either directly (Bailey et al., 2009; Conger et al., 2003; Huesmann, Eron, Lefkowitz, & Walder, 1984b; Neppl et al., 2009) or through the mediating effect of antisocial behaviors (Capaldi et al., 2003; C. A. Smith & Farrington, 2004; Thornberry et al., 2003). Chen and Kaplan (2001) also found warm parenting to be transmitted across generations, and the same results were confirmed by data from the Dunedin study (Belsky et al., 2005) and the Minnesota Longitudinal Study of Risk and Adaptation (Kovan et al., 2009).

In sum, parenting is transmitted across generations, but the implicated mechanisms still need to be comprehended. Moreover, childhood rearing history accounts for approximately 15% of the variance in parenting (Belsky et al., 2005; Capaldi et al., 2003; Conger et al., 2003). This means that if some parents repeat their childhood experiences, many others do not. Mediational approaches do not solve this problem; therefore, moderating effects have to be studied in order to identify “lawful discontinuities” (Belsky, Conger, et al., 2009) in the intergenerational association. Only a few studies have focused on this specific topic, and more research is needed. Potential candidates identified by empirical approaches that could switch trajectories include good and supportive romantic relationships (Conger et al., 2012, 2013; Egeland et al., 1987; Quinton et al., 1984; Quinton & Rutter, 1984) and the differential susceptibility hypothesis effect (Beaver & Belsky, 2012), where the participants who carried the most plasticity alleles were more highly affected by the quality of maternal parenting, for better and for worse.

We claim that the scarcity of moderating effects (Belsky, Conger, et al., 2009; Conger et al., 2009) that can scratch the surface of the intergenerational effect is due to a lack of comprehension of the implicated mechanisms. Moreover, we lack even a theoretical model with which to make hypotheses on discontinuities, except for a GxE effect that seems promising but is difficult to test because of the sample size required. We propose that the already impressive amount of neurophysiological effects (Lomanowska et al., 2015) can be used to propose new interpretative mechanisms able to generate new hypotheses. A shift

from macro to micro processes could also lead the intervention research toward up-to-date approaches to treat and prevent the transmission of harsh parenting.

Intergenerational transmission of abuse and neglect

The extreme consequences of the intergenerational transmission of parenting involve the transmission of maltreating behavior from one generation to the next. The association has been hypothesized for a long time, yet empirical investigations have not always been consistent. Many studies have found a significant effect of childhood experience (Berlin et al., 2011; Dixon, Browne, et al., 2005; Dixon, Hamilton-Giachritsis, & Browne, 2005; Pears & Capaldi, 2001), while others have not (Renner & Slack, 2006; Sidebotham & Golding, 2001). A fundamental issue that can be raised is the quality of the empirical approaches to the topic (Ertem et al., 2000; Widom et al., 2015). In fact, using longitudinal vs retrospective studies and self-reported reports versus reports from child protective services can produce very different results. A recent study by Widom, Czaja, and DuMont (2015) significantly represents an improvement in methodology. It considers two 30-year longitudinal samples using both children self-reports and child protective services measures. This study found a significant association between parents' maltreatment and risk of childhood neglect and abuse, but not physical abuse. However, it seems that a detection bias overestimates the continuity between generations when measured by child protective services: maltreated parents are more controlled than non-maltreated populations. This topic would benefit from a meta-analytic approach to try to resolve the situation.

Dysfunctional parenting and neurocognitive mechanisms

In this review, we do not directly report the effects of childhood experiences on dysfunctional parenting, but just on related processes. Starting from the evidence for the continuity of parenting behaviors across generations, we are more interested in lower-level processes that can shed light into the mediating and

moderating mechanisms. Thus, we could consider the target of the present review to be the mechanisms of dysfunctional parenting risk. The definition of dysfunctional parenting is also very broad: in every parenting-related task, it is the outcomes that seem to be less adaptive, negatively biased, or responsible for a negative effect on children.

Emotion Regulation

Emotions are highly adaptive mechanisms that allows us to interact with the environment. When individuals encounter a specific stimulus, they always determine (either implicitly or explicitly) its positive or negative valence, depending on the context and the individual's goals. The cognitive, physiological, and behavioral response that arises from this evaluation is an emotion. Emotion regulation, as defined by Gross (Gross, 1998, 2013b), refers "to shaping which emotions one has, when one has them, and how one experiences or expresses these emotions" (Gross, 2013a, p. 6). Thus, the centrality of the emotion regulation concept in psychological functioning can be understood. Emotions represent a "whole body" phenomenon, and emotion regulation allows some grade of control to be exerted on the emotion-generative process, either consciously or unconsciously and with good or bad outcomes. From an evolutionary standpoint, emotion regulation has not been studied extensively, but it appears to be one of the mechanisms able to modulate the allocation of cognitive and bodily resources, in response to the environment's demands (Worthman, 2009). Context characteristics direct individuals toward slower or faster LH strategies, through opportunities to invest resources into different tasks, which modulate their emotion regulation processes. Del Giudice (2015) described LH strategies in relations to self-regulation. Unpredictable environments incentivize patterns of impulsivity and inflexible feedforward control (e.g. fast strategies), while predictable environments request effortful control and a balance between feedforward and feedback regulation (slow strategies). Emotion regulation could work in a similar fashion: the attentional costs of monitoring an unpredictable environment imply fewer

resources available for the appraisal phase of emotion regulation (Gross, 2013a), which is underinvested in order to promote a faster response to the stimulus. If stimuli are likely to be threats, a quicker response is preferable, even independently from the response per se. A more predictable environment favors the investment of resources into the cognitive change during the appraisal phase of emotion regulation, allowing a greater modulation of the emotion response. This could be how emotion regulation represents a mechanism of differentiating individuals' LH strategies. In the parenting perspective, we could hypothesize that a parent who has experienced childhood maltreatment will be less attuned to an infant because the distressing feature of his/her signals will be perceived as a threat and there will be no efforts to appraise the negative effects of the stimulus. Then, the response will be quicker and unregulated, and not modulated by the infant's specificity. This, in turn, will lead to less involvement in the care process and less reward from it, or in other words, a fast LH strategy.

Neurophysiological evidence shows that parenting affects different domains of neurocognitive functioning in adulthood. More specifically, a recent review by Lomanowska and colleagues (2015) identified three different psychological domains that mediate the intergenerational transmission of parenting: perceptual responsiveness, executive functions, and emotional functioning. We hypothesize that each of these domains contributes to the broader concept of emotion regulation. In fact, perceptual responsiveness contributes to the attention stage when selecting relevant cues. The association between impulsive-inattention behaviors and dysfunctional parenting has been proven (Mandy Chen & Johnston, 2007; Johnston, Mash, Miller, & Ninowski, 2012; T. Moffitt, Poulton, & Caspi, 2013). Emotional processing and executive functions are involved in the emotional appraisal process, when the emotion is evaluated and a behavioral response is selected. If the study of executive functions in parenting is still at an early stage (Rutherford, Wallace, et al., 2015), the association with emotional functioning will be much more certain (Lupien, McEwen, Gunnar, & Heim, 2009; Morgan, Shaw, & Forbes, 2014a; Rutherford, Wallace, et al., 2015; Santona et al., 2015)

Role of childhood experiences in moderating parenting related processes during adulthood

In this section, we essentially review retrospective studies, because to our knowledge, just two prospective studies (Boecker et al., 2014a; Morgan, Shaw, & Forbes, 2014b) have assessed the association between early childhood experiences and basic processes, as presented here (Kim et al. (2015) relies on longitudinal data, but they assess childhood poverty and directly assess the quality of childhood experiences). In these studies, the subjects reported childhood experiences, essentially through self-reports and questionnaires. The limitations of this approach are discussed in detail later in this paper. Subsequently, we report studies that focus on attachment representations as moderators of parenting-related domains. Attachment categorization is not, per se, a measure of the quality of childhood experiences, because it does not directly assess the quality; rather, it focuses on the current representation toward attachment experiences. However, while insecure individuals have reported negative childhood experiences (Main et al., 1985; Stovall-McClough & Cloitre, 2006), it is not obvious that secure subjects had experienced good-quality care. The ability to coherently describe attachment-related situations discriminates between the security and insecurity of attachment representations (Bakermans-Kranenburg & Van IJzendoorn, 1993; Bakermans-Kranenburg & van IJzendoorn, 2009b; Hesse, 2008; Main et al., 1985; Roisman, Padron, Sroufe, & Egeland, 2002).

We are interested in papers implying tasks that directly refer to parenting abilities. More specifically, we selected studies that directly refer to parenting-related tasks (e.g. using infant stimuli like infants' faces or crying) or neurophysiological networks that are intrinsically connected to parenting behaviors (i.e. oxytocin system). Within these latter domains, studies with direct measures of parenting-related tasks are highlighted.

Early childhood effects on parenting related neurophysiological processes

In this section, we review the literature on the role of early childhood experience in shaping parenting related processes. Different paragraphs refer to different domains of effects, all directly connected to caregiving.

Early stress

In this review, we will basically refer to early stress experiences as every form of negative experience during childhood. We decided to reduce the selection of the paper based on this criterion in order to not lose precious information. These differences represent a limitation that we discuss later in detail, but the specific operationalization of the concept will be presented for each of the main papers we reviewed. Our primary interest is to study the role of the kind of parenting style experienced by subjects, but restricting the selection of the papers to only those on parental effects could be very incomplete, in terms of the current literature. We consider each possible indicator of a harsh environment, but the impact of the differing operationalization of the early stress variable on development is of course a primary source of incongruence between the studies. Finally, in line with this statement, we also consider poverty as an indicator of early stress because individuals growing up in poverty are more likely to experience harsh parenting, including maltreatment (Bradley & Corwyn, 2002; K. E. Grant et al., 2003; Hackman & Farah, 2009). In general, the effects of early life adversity on children's and adults' physical and emotional health are well known (for reviews see: Evans et al., 2015; Gee, Ro, Shariff-Marco, & Chae, 2009; Holz et al., 2015; Kida et al., 2013; Krugers & Joëls, 2014; Nusslock & Miller, 2015; Tost et al., 2015).

Moderating effects of childhood experiences on brain correlates of parenting related tasks

Early stress modulates both architecture and functionality of brain development in humans with long lasting effects in adulthood (e.g. Belsky & de Haan, 2011b; Evans et al., 2015; Krugers & Joëls, 2014; Pechtel & Pizzagalli, 2011), so it is likely to be one of the primary mediators of parenting intergenerational transmission. Just a limited number of studies directly focused on the role of childhood experiences in shaping brain activation during parenting related tasks. Kim and colleagues (2010b) studied the effects of reported quality of maternal care in childhood on brain structure and functionality in mothers during the first month of postpartum. Mothers with higher scores on the quality of their own childhood care showed greater grey matter volume in superior and middle frontal gyri, orbital gyrus, superior temporal gyrus and fusiform gyrus. Authors proposed an explanation of these differences based on the brain circuits involved in emotionally salient stimuli processing (i.e. middle temporal gyrus, superior temporal sulcus and middle frontal cortex). Then mothers who perceived a better quality of care in their childhood could be more attuned and able to respond sensitively to their children. Decreased volume of orbital gyrus could represent a difficulty in processing social and emotional information. Moreover, brain activation in response to infant crying was assessed. Mothers reporting higher scores of maternal care during childhood showed higher activation in the subsequent areas: middle frontal gyrus, superior temporal gyrus and fusiform gyrus, while the other group showed an enhanced hippocampal activation. This could mean that mothers who perceived a better quality of care could be more able to interpret others' mental states, while the hippocampal activation in the other group could be implicated in stress response because able to regulate the hypothalamo-pituitary-adrenocortical (HPA) axis. Thus, more adverse experiences during childhood could be related to heightened stress reactivity in hippocampus and then in the HPA axis, leading to a difficulty in showing adequate maternal sensitivity towards their children. The association between functional activation and structural changes in the parietal lobe could represent a cue of the enhanced negative

emotion regulation ability in the high quality care mothers. Contrary to expectations, no differences between groups in amygdala functionality or structure has been found.

Kim and colleagues (2015) studied the role of social inequalities in shaping neural processes during the perception of cry sounds in young adults. A prospective analysis of poverty was used to predict brain activation. While no main effects of poverty were found, a gender by childhood interaction was revealed. Females who grew up in poverty showed enhanced activity in areas involved in negative emotional information processing (posterior insula, striatum, calcarine sulcus, hippocampus and fusiform gyrus). On the contrary, males who grew up in poverty showed reduced neural activity in the same areas during infants cry. This suggests that social inequalities influence more negatively females than males in terms of neural responses to infants. A possible explanation based on an evolutionary perspective could be that females are more sensitive to changes in the environment for what concerns caregiving processes, in light of their greater investment on caregiving (Del Giudice, 2009).

Emotional processes

This paragraph does not describe effects of early stress on direct parenting related tasks, but the role of emotion in parental care is obviously primary and cannot be avoided. Thus here we review the brain based emotion processes moderated by early experience.

Effects of early stress on brain architecture are controversial. Compelling evidences support both an increasing and decreasing effect of early stress on amygdala volume. On one hand, it seems that animal models support a greater amygdala volume after early stress through an enhanced dendritic spine density in rodents (Bennur et al., 2007; A Vyas, Pillai, & Chattarji, 2004; Ajai Vyas, Bernal, & Chattarji, 2003). This is also confirmed by humans studies (Evans et al., 2015; Mehta et al., 2009; Pechtel et al., 2014; Tottenham et al., 2010). On the other hand, other researchers hypothesize the opposite effect, understandable in light of

apoptosis of amygdala cells (Ding, Han, & Shi, 2010) and found it in humans (Hanson, Nacewicz, et al., 2015; Hodel et al., 2015; Rifkin-Graboi et al., 2015). We do not discuss this debate here. On the contrary maltreatment is clearly associated with smaller hippocampal volume (Riem et al., 2015), confirming a dysfunctional stress reactivity because of the central role of hippocampus in modulating the Hypothalamic-Pituitary-Adrenal axis. This could be responsible in turn of a disrupted emotion regulation network. Moreover childhood emotional maltreatment is associated to smaller medial prefrontal cortex volume (Arnsten, 2009; Lupien et al., 2009; van Harmelen et al., 2010), confirming a decreased dimension of regulating areas. A smaller development of brain areas involved in downregulating emotions could play an adaptive role in harsh environment where emotions play an important role in providing quick responses to threats.

Moving to brain activation and functional connectivity, it is well established that facial expression presentation results in enhanced amygdala reactivity in children (Tottenham et al., 2011) and in adults (Dannlowski et al., 2012, 2013; Evans et al., 2015; McCrory et al., 2011, 2013; Redlich et al., 2015; Taylor, Eisenberger, Saxbe, Lehman, & Lieberman, 2006; van Harmelen et al., 2012) reporting high scores of early adversity. For what concerns amygdala-prefrontal cortex connectivity, one of the most important circuits for emotion regulation in the brain, early stress seems responsible for an earlier maturational process of the pathway (Gee et al., 2013; Tottenham, 2012, 2015), as a form of ontogenetic adaptation to adversity. For the same reason, children with early maternal deprivation have indiscriminate amygdala response to mothers and strangers (Olsavsky et al., 2013). Anyway also in this field more research is needed and theoretical models are required to assess the complexity of the findings reporting both increased and diminished connectivity (Cisler et al., 2013; Dean, Kohno, Hellemann, & London, 2014; Heringa et al., 2013; Jedd et al., 2015; Thomason et al., 2015; S J A van der Werff, Pannekoek, et al., 2013b). However, irrespectively of the direction of the effect, the common result of these studies is the disrupted functional connectivity samples with early stress, suggesting a specific deficit in emotional regulation that is the high level strategy to connect different parts of the

emotion processing network. In fact a study found hypoactive functioning of the medial prefrontal cortex, even controlling for volume differences, during higher order emotional stimuli processing like encoding and recognition of emotionally related words (van Harmelen et al., 2014).

Emotion regulation concept plays a well-established role in shaping maternal sensitivity. In fact maternal emotion regulation has been studied as a predictor of parenting ability (Crandall et al., 2015; Killeen & Teti, 2012; Lotzin, Schiborr, Barkmann, Romer, & Ramsauer, 2015; Mazursky-Horowitz et al., 2015; McCullough, Han, Morelen, & Shaffer, 2015; Morelen, Shaffer, & Suveg, 2014; Rutherford, Wallace, et al., 2015; Saritaş, Grusec, & Gençöz, 2013), but also as a direct predictor of children outcomes (Are & Shaffer, 2015; Bariola, Gullone, & Hughes, 2011; Han & Shaffer, 2013; Jones et al., 2014; Pat-Horenczyk et al., 2015; Samuelson, Krueger, & Wilson, 2012). Finally emotion regulation is associated with adult early stress experiences (Curtis & Cicchetti, 2011, 2013; Kim & Cicchetti, 2010; Pollak, 2008) and it has been found to be a predictor of the risk for mothers to engage in childhood maltreatment (Fontaine & Nolin, 2012; Skowron, Kozlowski, & Pincus, 2010). In order to study brain correlates and neural mechanism of early stress effects on emotion regulation, researchers focused on different paradigms to induce and measure emotion regulation processes. In the next review of papers differences between tasks has to be taken into account to explain and understand each portion of results.

Tottenham and colleagues (Tottenham et al., 2010) found an atypically greater amygdala volume and difficulties in emotion regulation measured with an emotional go/no go task in prolonged institutionalized children. They report a trend for the correlation between amygdala volume and number of errors in the blocks of the task where a negative face was the distractor during the recognition of positive faces. This suggests an interfering effect of potential threats probably due to the exaggerated amygdala functionality. A state of hypervigilance in stress situations (van Marle, Hermans, Qin, & Fernández, 2009) could be adaptive for maltreated children in order to detect environment threats but it could cost a lower investment on higher cognitive processing of emotionally relevant signals, like infants

emotional states. In fact, neglectful mothers show a brain failure in early discriminating infants' signs as pictures of infants' cries laughs and neutral faces (León et al., 2014; Rodrigo et al., 2011). In addition, the specific interference effect of negative stimuli is consistent with this speculation because a higher rate of false negative is more adaptive in a harsh environment.

Lee and colleagues (2015) used a gender identification task with emotional faces during fMRI scan to study the role of previous verbal abuse in shaping brain correlation of emotion regulation in adolescence. Subjects were instructed to identify if the face on the screen was a male or a female without focusing on emotion expression. During negative emotional faces were presentation, right amygdala activity and functional connectivity with the rostral anterior cingulate cortex were associated with verbal abuse experiences scores.

Marusak and colleagues (2015) asked 30 children and adolescents to perform a task during fMRI session based on the instruction of identifying the expression of the stimuli ignoring an overlying emotion word. Nearly half of the sample had been exposed to trauma and the other half was matched for IQ, age and sex. Trauma exposed children showed less activation of dorsolateral prefrontal activity and failure to engage amygdala pregenual cingulate inhibitory circuit, in addition to greater amygdala response to emotional conflict and reduced emotion regulation.

Other studies operationalized emotion regulation as the performance of slightly different version of a task based on emotional stimuli presentation while participants were requested to downregulate (or reappraisal) their arousal or not to do it. Kim and colleagues (2013) designed a perspective study to test the effect of poverty at 9 years old on emotion regulation processes at 24. Results showed a failure in suppressing amygdala activation and less activation of ventrolateral and dorsolateral prefrontal cortex in participants with low-income family at 9 and no effect of adult income. Moutsiana and colleagues (2014) showed the predictive power of attachment insecurity at 18 months of life on adult brain correlates of emotion regulation 20 years later. During the attempt to up-regulate positive

emotions, previously insecure attached children showed a greater activation in prefrontal regions and reduced co-activation of nucleus accumbens and prefrontal cortex, suggesting a lower ability in regulating positive emotions. In contrast with these studies Schweizer and colleagues (2015) found that the exposure to moderate childhood adversity can have an enhancing effects on regulation ability of negative and positive emotions. This was correlated to a reduced recruitment of emotion regulation brain areas during the regulation process, specifically prefrontal cortex and temporal gyrus. However, even if results are compelling, they actually confirm the importance of the environment where individual develop and face stimuli. Emotion regulation is enhanced in individuals who experiences a low level of negative emotions, but it is probably not so not useful in totally safe environments. On the contrary, in harsh environments emotion regulation is less adaptive because high negative arousal is useful to protect from threats and positive arousal means wasting resources.

Taken together these results are consistent with LH because harsh environments requires a fast lower levels of analysis of threats like the ones represented by angry faces, but can more safely afford to save resources during cognitive processing. This could be one of the brain mechanisms underlying the choice of fast LH strategies in rearing offspring: early adversity differences in processing emotional stimuli could be responsible for the less attunement between parent and children interactions.

Reward processes

Animal literature shows how one of the key processes in shaping and determining parenting behavior is a specific motivation circuit based on dopamine and oxytocin systems (Numan & Woodside, 2010; Robinson, Zitzman, & Williams, 2011) that allows the preference and the high responsivity toward infant stimuli (Kringelbach et al., 2008). Hedonic responses and approach motivation are parts of the reward system in humans (Berridge & Kringelbach, 2008). Reward processes involve frontostriatal areas, in particular the orbitofrontal cortex, nucleus

accumbens and basal ganglia (Born et al., 2011; Galvan et al., 2005; Knutson & Cooper, 2005). Many evidences show the central role of reward system in maternal behaviors and processing of infant stimuli (Kringelbach et al., 2008; J E Swain et al., 2014). More specifically, happy infant faces (but not sad) activate reward related areas (Strathearn et al., 2008) and the overall rewarding effect of infants' faces is moderated by cuteness of the baby (Glocker, Langleben, Ruparel, Loughhead, Valdez, et al., 2009) or small abnormalities of the baby (Parsons et al., 2013). These effects show the specificity of adult brain in processing infant stimuli. The sensitivity to changes in infants' faces could probably support an evolutionary interpretation: a process of natural selection could disfavor infants carrying anomalies because probably ill or sick. Parenting resources represent a better investment when directed to offspring more likely to survive.

Childhood negative experiences seem to alter the normative functionality of the brain reward system, especially in monetary incentive delay task (Boecker et al., 2014b; Dillon et al., 2009; Guyer et al., 2006; Hanson, Hariri, & Williamson, 2015; Mehta et al., 2010; Morgan et al., 2014b; Whittle et al., 2009). Besides, a study found that maternal parenting behavior measured when the children were 3 years old predicted children ERP reactivity during a monetary reward task during mid- to late childhood (Kujawa, Proudfit, Laptook, & Klein, 2015).

These studies do not directly approach the rewarding brain system in association with parenting related tasks, but it the hypothesis of a role of early childhood experiences in shaping caregiving rewarding processes seems consistent with the literature. Moreover, a blunted reward system could represent a powerful mechanism associated to the execution of fast strategies: considering infants less rewarding allows less parental investment on the offspring.

Recently an intriguing and challenging hypothesis was formulated, in order to explain the complexity of the childhood adversity effects on physical and emotional health across the lifespan. The proposed mechanism is a neuroimmune network, where early life adversity enhances the interplay between peripheral inflammation and neural circuits involved in threat, reward and executive control

processing (Nusslock & Miller, 2015). Authors effectively propose the combined role of enhanced amygdala threat sensitivity (through cytokines) and reduced basal-ganglia reward sensitivity (through risky behaviors) in increasing and maintaining low grade peripheral inflammation. Moreover, a role of prefrontal cortex is implicated in mediating early adversity and executive control deficit, which affect threat and reward sensitivity through voluntary emotion regulation (Gianaros, Marsland, Sheu, Erickson, & Verstynen, 2013; Hanson et al., 2012). This hypothesis is not directly related to maternal or parenting behaviors, but we argue that the depth of the investigation and the ability of integrating research and generating hypothesis makes it useful also within the field of our interest. In particular we believe that this highlights that the effects of early stress on individuals are not supposed to be considered domain specific but need a process of integration. Thus, in maltreated parents, the vicious circle of enhanced threat sensitivity and blunted reward sensitivity has to be considered to understand the complexity of the network.

Early adversity as moderator of oxytocin effects on parenting related tasks

Quality of childhood experiences is one of the multiple mediators of the complex OT effects on brain and behavior. In particular early experiences seem to moderate the well-known effect in attenuating cortisol and behavioral responses to psychosocial stress (Ditzen et al., 2009; Heinrichs, Baumgartner, Kirschbaum, & Ehlert, 2003; Linnen, Ellenbogen, Cardoso, & Jooper, 2012; Quirin, Kuhl, & Düsing, 2011). Adult men with early parental separation show a reduction of the suppressing effect of OT on cortisol levels (Flanagan, Baker, McRae-Clark, Brady, & Moran-Santa Maria, 2015; Meinschmidt & Heim, 2007), suggesting an altered OT sensitivity during exposure to acute psychosocial stress. The neural mechanism implicated seems to be an interaction between early life stress and OT administration to predict limbic system activation (Grimm et al., 2014). More specifically childhood negative experiences modulate the amygdala – anterior

cingulate cortex resting state functional connectivity and OT could mediate this effect only in adults with lower levels of early stress (Fan et al., 2014).

Taken together, all these evidences are absolutely consistent with the “social salience hypothesis” of OT (Bartz, Zaki, Bolger, & Ochsner, 2011; Shamay-Tsoory & Abu-Akel, 2015; Weisman & Feldman, 2013): OT regulates the salience of social cues through the interaction with the dopaminergic system, depending on both contextual and individual differences. Weisman and Feldman (2013) proposed the role of nucleus accumbens area in increasing the reward value of social stimuli together with their salience. In fact OT effects seems to be mediated by its influence on dopaminergic pathways, more specifically the mesolimbic ventral tegmental area (Groppe et al., 2013): OT effect on the ventral tegmental area leads to increased dopamine release in the nucleus accumbens (Skuse & Gallagher, 2009). The importance of reward area in parenting behavior is highlighted in the specific paragraph, with many references (e.g. Atzil et al., 2011; Atzil, Hendler, & Feldman, 2014; Glocker, Langleben, Ruparel, Loughhead, Valdez, et al., 2009; J E Swain et al., 2014).

Irrespective of the mechanism implicated in this process, a key role is played by childhood experience, since the consistent findings that many positive OT administration effects are substantially diminished or lacking in individuals who experienced early stress (Bakermans-Kranenburg & van I Jzendoorn, 2013; Bakermans-Kranenburg et al., 2012; Feeser et al., 2014; Riem, Bakermans-Kranenburg, et al., 2013; Riem et al., 2014; Riem, van IJzendoorn, et al., 2013; van IJzendoorn et al., 2011). This could be interpreted as an effect of early stress on functioning of OT system, probably at the level of OT receptors. Because of the central role of OT in determining the salience of social stimuli, this could be one of the mechanisms implied in shaping the attention bias to threat in maltreated children (Pine et al., 2005) and all the consequences in terms of adaptation to the environment. In fact, in an environment characterized by lack of resources, a prosocial effect of enhanced OT (e.g. during breastfeeding) could be dangerous, while an enhanced aggressive behavior could represent an advantage for adaptation (DeWall et al., 2014; Shamay-Tsoory, Fischer, et al., 2009).

To our knowledge, just two studies directly targeted the role of childhood experiences as moderator of OT administration on parenting related basic processes. The first one studied the effect of OT on the strength participants used to squeeze a handgrip dynamometer while listening an infant cry sound, an infant laugh sound. Handgrip force is considered associated to parenting behavior (Crouch et al., 2008) and infant crying is considered a trigger of violent shaking of the baby (Barr et al., 2006). In a sample of females, after a double blind OT administration, only participants with low scores of harsh parenting experiences decreased the force used during infant crying sounds. Moreover maltreating mother exert more excessive force than the control group while listening to infants' sounds (Compier-de Block et al., 2015). This confirms the predicting power of the handgrip measure in discriminating between potentially abusive mothers, but OT administration seems not to be able to affect this process. Clearly, OT is implicated in the epigenetic process that leads from an abusive environment during childhood to a potentially abusive behavior in adulthood, but its role requires more attention from the researchers.

The other double blind randomized (but between subject) trial focused on the effects of OT administration on the memory for infant cues (Bhandari, van der Veen, et al., 2014). After a procedure aimed at manipulating perceived temperament of a set of infants' pictures (Parsons, Young, Bhandari, et al., 2014), participants were asked to recognize the happier infant in a pair of infant faces. Results show that participants with higher scores of childhood emotional maltreatment are less accurate in selecting the happier baby after OT administration. Authors propose two different explanation of the underlying mechanism of this effect. One possibility is the increased amygdala activity elicited by emotional stimuli in maltreated individuals (van Harmelen et al., 2012) which could be counterbalanced by OT effect on amygdala activation when infant stimuli are presented (Riem, Bakermans-Kranenburg, et al., 2011). The other explanation is more consistent with the social salience hypothesis and relies on ability of OT of decreasing the cortisol responses to stressful cues, which in turn could change the reactivity to emotionally relevant infant faces and finally impair memory processes

(Smeets, Otgaar, Candel, & Wolf, 2008). This effect could suggest a role of OT in decreasing aversion toward distressed infant in potentially abusive adults, but the effects on parental sensitivity and brain mechanisms implicated remain largely unknown.

Studying endogenous levels of OT, the enhanced OT levels effect in facing stressful situation is quite controversial (Meyer-Lindenberg, Domes, Kirsch, & Heinrichs, 2011). It seems pretty clear in animal models (e.g. Neumann, Wigger, Torner, Holsboer, & Landgraf, 2001) while in humans results are less consistent. Some studies found increased levels of OT after stressful stimuli (G. Sanders, 1990; Seltzer, Ziegler, & Pollak, 2010; Tops, van Peer, & Korf, 2007) and also an association between OT levels and stress perceived in participants' relationships (Taylor, Gonzaga, et al., 2006). However, the principal disagreement between the studies is the effect on OT of the Trier Social Stress Test (Kirschbaum, Pirke, & Hellhammer, 1993). Many studies failed to find an increased OT response after a stress inducing task like the TSST (Altemus et al., 2001; Cyranowski et al., 2008; Taylor, Gonzaga, et al., 2006), while more recently some found the expected results (Jong et al., 2015; B Pierrehumbert et al., 2010).

Moreover, the moderating role of early stress experiences seems essential. General OT concentration appear to be lower in individuals who experienced early life stress (Crowley, Pedersen, Leserman, & Girdler, 2015; C Heim et al., 2009; Mohiyeddini, Opacka-Juffry, & Gross, 2014; Opacka-Juffry & Mohiyeddini, 2012). On the other hand strong early life threats predict enhanced plasma OT levels after a stressful situation in women (B Pierrehumbert et al., 2010), which could be interpreted as an emotional hyperregulation. Fries and colleagues (Fries, Ziegler, Kurian, Jacoris, & Pollak, 2005) found that adoptees with a history of institutionalization showed lower OT after interaction with their mothers. The same moderator effect of maltreatment on OT response to induced stress has been found also in girls (but not in boys) during middle childhood: they showed higher endogenous salivary OT levels (while cortisol levels were lower) after an experimentally induced stressor (Seltzer, Ziegler, Connolly, Prosofski, & Pollak, 2014). Finally early stress interact with genetic variables: adult emotional deficits

are predicted by the interaction of childhood abuse and OT receptor nucleotide polymorphism (rs53576) (Bradley et al., 2011) and the OXTR A-allele carriers interacts with early stress to predict heightened amygdala activation during the exposure to environmental cues (Marusak, Furman, et al., 2015).

Taken together, this complex summary of the role of endogenous OT on stress regulation directly refers to parenting processes: for instance, mothers (but not fathers) showing difficult interactions with their infants showed an association between urinary OT and relationship anxiety and parenting stress (Feldman et al., 2011). Moreover, all this evidences are consistent with the idea that the complex epigenetic pathway that connects early life stress to parenting strategies relies on the OT role in shaping stress regulation. The stress induced experimental manipulation is still far from the complexity of the emotion regulation processes that determines children's socio-emotional development, but this field of research seems promising, even if challenging. One study directly targeted the complex interplay of childhood experiences, OT and emotion regulation. Bhandari and colleagues (Bhandari, Bakermans-Kranenburg, et al., 2014) found a mediating role of endogenous (salivary) OT between childhood emotional maltreatment and the responses to emotional infant happy faces. Authors propose an intriguing explanation based on the anxiolytic role of OT (Ditzen et al., 2009; Neumann & Landgraf, 2012): this could be consistent with the evidence that individuals who experienced more early stress require more OT to face emotional situations, to the extension that OT can be implicated in resilience phenomena (DuMont, Widom, & Czaja, 2007; Feder, Nestler, & Charney, 2009).

Finally a key role is also played by gene environment analysis of parents in order to predict the quality of the relationship with their children: Mileva-Seitz and colleagues (2013) found a significant interaction between early experience and both rs2740210 and rs4813627 OXT polymorphisms, able to predict their caregiving behavior and post-partum feelings. Consistently with the differential susceptibility hypothesis, individuals with the previous polymorphism are more context dependent, showing an enhanced effect of the quality of their childhood

experiences, for better and for worse (Bakermans-Kranenburg & van IJzendoorn, 2015; Jonas et al., 2013).

Stress Response and executive functions

Early stress has undoubtedly long lasting effects on stress reactivity and diurnal levels of HPA function in childhood (Cicchetti & Rogosch, 2001; Saridjan et al., 2010; Tarullo & Gunnar, 2006) as well as in adulthood (Engert, Efanov, Dedovic, Dagher, & Pruessner, 2011; Gonzalez, Jenkins, Steiner, & Fleming, 2009; Hagan, Roubinov, Purdom Marreiro, & Luecken, 2014; Christine Heim, Shugart, Craighead, & Nemeroff, 2010; Luecken & Appelhans, 2006; Luecken, Hagan, Wolchik, Sandler, & Tein, 2015). In turn, HPA axis is implicated in caregiving behaviors (Fleming, Steiner, & Corter, 1997; Gonzalez, Atkinson, & Fleming, 2009; Gonzalez, Jenkins, Steiner, & Fleming, 2012; Krpan, Coombs, Zinga, Steiner, & Fleming, 2005; Stallings, Fleming, Corter, Worthman, & Steiner, 2001), probably through an executive functions deficit (Atkinson et al., 2009; Atkinson, Scott, Chisholm, & Blackwell, 1995; Deater-Deckard, Sewell, Petrill, & Thompson, 2010; Gonzalez et al., 2012). Juul and colleagues (2015) found that childhood trauma (but not maternal depression) is associated to more neutral affect and less cortisol in mothers at 6 months postpartum. Moreover, cortisol seems to be able to mediate the effect of childhood trauma and maternal affect. More interestingly, Gonzalez and colleagues (2012) tested the role of early life experiences of postpartum mothers in predicting maternal sensitivity. The effect was fully mediated by the effect of HPA function and the indirect effect of HPA function via spatial working memory score. This study sheds light on a complex association between psychophysiological processes combined with high levels cognitive functions in predicting a totally different behavioral system, the caregiving one.

In a psychopathology perspective Heim and colleagues (2004) showed that a hyperactive HPA function discriminates between abused women and abused women with current depression. This highlights the importance of considering the

interplay between early stress and current context to fully understand the role of cortisol as stress response. An intriguing way to study the brain correlates of changing in HPA axis is to administer cortisol to participants and assess their brain activation by means of functional magnetic resonance imaging. A brain circuitry highly involved in caregiving processes is the reward one (Lomanowska et al., 2015; Parsons et al., 2013; J E Swain et al., 2014), because it highly affects motivation processes. Montoya and colleagues (2014) administered cortisol to twenty male and combined it with a monetary incentive delay task to assess the brain activation during anticipation of potential reward, focusing on amygdala and striatum. Results showed that striatum and basolateral amygdala activation decreased in both rewarding and not rewarding conditions, coherently with participants subjective reports. Then it seems that cortisol in humans downregulate motivational processing in general, coherently with the negative effects of early stress in predicting cortisol endogenous levels and in turn maternal sensitivity. The same research group has studied the direct effect of cortisol administration in modifying caregiving related processes (Bos, Montoya, Terburg, & van Honk, 2014). Cortisol was administered to male participants and their brain activation during exposure to infant crying was assessed. Cortisol affected hippocampal activation, and more interestingly, the magnitude of this effect was predicted by the exposure to childhood neglect, even in this non-clinical sample. Hippocampal activation is correlate with maternal bonding (Musser, Kaiser-Laurent, & Ablow, 2012), but this altered cortisol-sensitivity of hippocampus in participants who experienced early stress represents an increased risk for psychopathology because it could lead to strong downregulation of the HPA axis.

Martinez-Torteya and colleagues (2014) extended this effects of early adversity to infants: they did not assess HPA axis in mothers, but they found that infant cortisol reactivity is indirectly predicted by maternal childhood maltreatment history, via maternal depressive symptoms which in turn predicts maternal positive parenting, which is directly associated to infants HPA.

As mentioned above, executive functions are correlated to maternal sensitivity (Chico, Gonzalez, Ali, Steiner, & Fleming, 2014; Cuevas et al., 2014)

and highly dependent on exposure to early adversity (Gould et al., 2012; Majer, Nater, Lin, Capuron, & Reeves, 2010; Pechtel & Pizzagalli, 2011), therefore very likely to be involved in the association between early experiences and parenting. Animal models are consistent with this evidence because for instance pups raised without the mother show attentional deficits (Lovic & Fleming, 2004). Artificially reared pups engage in maternal behaviors towards their offspring, showing an unaltered primary maternal motivation dynamics, but the quality of their maternal behavior is lacking (Lovic & Fleming, 2015). Moreover, they show compromised executive functions responsible for the inability of producing high quality maternal behavior. In humans, mothers slower in answering a modified version of the Stroop task with attachment related words, were also slower in responding to infants signals (Steinhauer, Villani, Pereira, Leung, & Atkinson, 2009). Mothers with disorganized attachment were slower in the Stroop task and their scores were also relate to their children attachment at one year (Atkinson et al., 2009). Teenager mothers are particularly subtle to executive functioning deficits (Chico et al., 2014), especially associate to brain reward circuitry (Geier, Terwilliger, Teslovich, Velanova, & Luna, 2010; Van Leijenhorst et al., 2010).

Finally, to our knowledge, only one paper address the topic of studying the interplay of executive functioning and emotion regulation in mothers (Rutherford, Booth, Crowley, & Mayes, 2015). The authors find a specific effect of visuospatial working memory in predicting emotional regulation, while verbal working memory seems to play a secondary role. More research is needed in this field, also to assess the relationship with some specific caregiving ability. The topic is definitely central, in order to study the complexity of the caregiving experience, without separating emotional and cognitive processes, losing complexity and adherence to reality.

Adult attachment as moderator of parenting related neurocognitive processes

Attachment and caregiving are defined by Bowlby (1969) with the ethological concept of behavioral system, a biologically evolved program that organize behaviors in order to increase survival and reproduction. The two systems share the same goal, eliciting (or providing) protection of the child in case of real or perceived danger to increase individual's reproductive fitness. Behavioral systems keep unaltered their functions during all individual's lifetime, changing the behaviors used to reach the goals depending on the phase of his/her life. Attachment and caregiving systems are complementary, to the point that the cues that usually activate caregiving behaviors in adult are the same who arouse attachment system in children: separations, dangers and child's signals like crying (Soltis, 2004). Consistently with the strong feeling aroused by attachment, also caregiving is associated with strong emotions. When a parent is separated from his/her child will feel sad and will try to rejoin him or her. When children are in danger or distressed, and especially when parents are not able to comfort them, anxiety and despair will encourage parents to increase the protection effort. On the contrary, great satisfaction comes from comforting and providing security for their children (Bowlby, 1969; George & Solomon, 2008). Because attachment system has an earlier development and is transmitted from caregiver to the child, it makes sense to consider it a fundamental variable connected to the transmission of parenting. Adult attachment styles resemble infant attachment and seems stable at some degree, so parenting related effects in adults moderated by attachment represent a way to study the interconnection between the two systems and also an indirect form of intergenerational transmission. It is clear that it is not a direct way to study the role of early experience and it is not even a reconstructive measure of childhood, however it is a very informative approach, also to face the complex theme of the transmission of attachment from parent to child (Madigan et al., 2006; van IJzendoorn, 1995b). A sort of confirmation of the similarities and overlaps for the two separate systems, attachment and caregiving, comes from the process of development of the adult attachment gold standard measure, the Adult Attachment

Interview (AAI, George et al., 1985; Hesse, 2008; Main et al., 1985). Main and colleagues (1985) noticed that the quality of the narratives on childhood attachment experiences was able to discriminate between mothers of children with different attachment patterns. The continuity of the attachment system during the life span was ensured by the capability to cognitively access and organize information relevant for attachment and that this affected next generation attachment behavior. In other words, even if different systems, attachment and caregiving were in some way connected, at least because the reflection on mothers' attachment experiences was predictive of their own children development of attachment. Since this seminal study, parent-child continuity of attachment (usually mother's adult attachment during pregnancy and infant attachment at 12 months) became one of the most stable and replicated effects within attachment theory framework (van IJzendoorn, 1995a; Verhage et al., 2015).

The mechanisms that mediate this transmission from adults to infants remain unclear, because maternal sensitivity, proposed by Ainsworth in her seminal work, seems to be just a partial mediator. van IJzendoorn called this phenomenon "Transmission gap" (van IJzendoorn, 1995b) and since then two different research lines have been conducting to solve the problem: on one hand better and more accurate measures of maternal sensitivity have been developed. First of all it seemed clear that longer home visiting sessions of evaluation worked better (Pederson & Moran, 1995), raising a reassuring issue of naturalistic validity. More interestingly, a very promising research consists in re-conceptualizing the way we operationalized maternal behavior: in particular Bernier and colleagues (2014) added maternal sensitivity also a focus on maternal support of child's autonomy. On the other hand, other researchers hypothesized different psychological processes that could take part in the mediational mechanism, together with maternal sensitivity. In particular Fonagy and Target (2005) proposed the concept of (Fonagy & Target, 2005) "Reflective Functioning" pointing out the ability of the parent of "mentalizing the baby" as function of adult attachment and as predictor of the infant one. In other words mothers' ability well described by Bowlby (Bowlby, 1969, 1988) of functioning as "secure base" and

“safe heaven” for children, requires a deep comprehension of children mental states. In this perspective, adult attachment could be considered a measure of this emotion regulation ability towards mother’s own attachment experience. This in turn could be responsible also for the transmission of the attachment style to the offspring. In an evolutionary perspective, we could say that the real difference in terms of accessibility of the resources is due exactly to this specific ability of the caregiver. Offspring choice between faster or slower strategies depends on the feeling of being safe: maternal feedbacks play a fundamental role. In a harsh environment, mother’s lack of mentalization toward se or her baby could be more adaptive because save cognitive resources and avoid empathy and pain in the likely case of child’s death. Some empirical findings confirm this approach (Grienenberger et al., 2005; Slade et al., 2005), in particular when the mentalizing ability of the caregiving is operationalized as “maternal mind-mindedness” (Laranjo, Bernier, Meins, & Carlson, 2014; Meins et al., 2002, 2012, 2013, 2001, 2014). Moreover this interpretation of an emotion regulation ability underlying attachment security is consistent (but not tested per se) with the recent findings of the predictive power of adult attachment security assessed at 19 years old in forecasting maternal sensitivity with the first child up to 15 years later (Shlafer et al., 2015).

Recently a new meta-analytic work showed that the transmission gap effect is narrowing (Verhage et al., 2015) but still clear. Focusing on a neurophysiological perspective can address the issue from a different approach. Breaking the complex concept of parenting in different small cognitive and affective processes can be useful to build a solid foundation for the association between attachment and caregiving.

In attachment theory field, one of the central issues is the assessment of adult attachment, because different instruments measurement are poorly correlated (Roisman et al., 2007b) and refer to different theoretical model. However we refer only to representational measures of attachment, based on the definitions on Main’s definition of attachment representations, or Internal Working Models: “a set of conscious and/or un conscious rules for the organization of

information relevant to attachment and for obtaining or limiting access to that information, that is, to information regarding attachment-related experiences, feelings, and ideations” (Main et al., 1985, pp. 66–67).

The Adult Attachment Interview (George et al., 1985) is universally considered the gold standard for the assessment of attachment representations in adulthood (Bakermans-Kranenburg & Van IJzendoorn, 1993; Bakermans-Kranenburg & van IJzendoorn, 2009b; van IJzendoorn, 1995a). It is a semi-structured interview: it can be scored with different systems all focusing on the coherence of participant’s discourse towards the childhood attachment experiences. Insecure individuals show a lack of ability in reporting in a complete and adequate manner their experiences.

When exposed to infant signals, insecure individuals are usually less able than secure ones in responding to infants’ need. Evolutionary these individuals experienced some kind of lack or inconsistency of parenting behavior during childhood: their caregivers strategy was closer to the fast polarity of LH theory. Especially if their environment has not been changed, they tend to take advantage of a similar strategy, where the lack of resources entails less involvement in parenting behavior in exchange for mating. In terms of AAI, the exposure to a “not optimal” parenting behavior during childhood was not enough to lead to insecure attachment, but the experience has not been adequately understood and reinterpreted. In evolutionary theory it is called “stability of a difficult environment”, while it is defined “lack of opportunities to reconsider individual’s experience” in Main’s attachment theory conceptualization.

Consistently with this hypothesis, insecure individuals show an enhanced amygdala activity compared to the secure individuals when exposed to infant crying (Riem et al., 2012). This could be in fact one of the mechanism leading to the negative emotionality experienced by these individuals during infants stress expression. This mechanism imply an avoidance behavior and it is confirmed by the use of excessive force measured with a hand dynamometer during infant cry. In term of maternal sensitivity, the effect could be obviously an incapability of

emphatically bonding the baby and regulating his mental state because of the parental hyperarousal.

Strathearn and Fonagy (Strathearn et al., 2009) showed to new mothers pictures of children with smiling or crying facial expressions, both their children or seen for the first time. AAI attachment security moderated the brain activation: pictures of their own children were more rewarding in secure mothers and activated more hypothalamus/pituitary regions compared to insecure mothers. Moreover, oxytocin level at 7 months was higher for secure individuals and correlated with brain activation. Interestingly insecure mothers showed greater activation of dorsolateral prefrontal cortex and anterior insula when exposed to their own children sad faces: this could be interpreted as the presence of a cognitive control of a negative affective response, the need of a cognitive effort to balance the unexpected emotional state. This could be a mediator of an avoidance strategy, a strategy contrary to the secure one based on rewarding because probably based on anticipation of loss. Again, the fast strategy of LH theory is mediated by a brain process aimed at diminishing the emotional engagement in bonding with the child. The presence of a double level of functioning based on a sort of disconnection between emotional and cognitive response to infant cues result even more clear from the results of Lenzi work (Lenzi et al., 2013) focused on the differences between nulliparous females securely attached or categorized as dismissing in empathic processes toward infants stimuli. They had hypothesized a lower empathic activation in dismissing individuals suggested by a behavioral strategy of avoidance of emotional stimuli. Surprisingly they found an enhanced activity in motor, mirror, and limbic related areas and a decreased activation in the medial orbitofrontal cortex and the perigenual anterior cingulate cortex for dismissing adults compared to secure ones. These apparently contradictory results highlighted the disconnection between two neural systems in dismissing individuals when exposed to empathy related tasks. As theoretically proposed by Main (1991), the implicit levels of functioning is a deep emotional dysregulation when the individual resembles his rejection experiences during childhood, while the overt behavioral strategy is a

deactivation of the attachment system to balance the emotional dysregulation. Of course this second level of functioning has a cognitive cost in terms of resources to build a sort of “false sense of security” (Lenzi et al., 2013, p. 1410). A similar interpretation comes from Mikulincer and Shaver’s work (2008): in avoidant individuals (but measured with a self-report for romantic attachment then not a representational measure of attachment) a stressor does not affect their performance in an implicit task, unless a cognitive load is not requested (Mikulincer, Dolev, & Shaver, 2004a). The evolutionary interpretation is consistent, but in the latter study the cost of the adaptation process is much more clear. The transmission of a fast LH strategy is useful and increase the chance to pass by individual’s own genes in specific contexts but the emotional dysregulation is not without consequences and requires a cognitive effort to be silenced.

The studies reviewed until here consider a dichotomy between secure and insecure individuals or a score of coherence of mind toward attachment, but AAI has a specific classification for unresolved trauma or loss, that has to be considered something different. In fact, this classification can be added to the secure/dismissing/preoccupied one even if it remains primary. It refers to a strongly insecure classification that relies on individual’s signs of absorption in a past trauma or loss experience. AAI discourse is not coherent because this experience invades individual’s thoughts and breaks his control over the speech. This attachment classification is considered very risky in term of intergenerational transmission of attachment because strongly associated with disorganized attachment in infancy (Hesse & Main, 1999; Madigan et al., 2006). The caregiving behavior of these mothers is defined frightened and alarmed (Lyons–Ruth, Yellin, Melnik, & Atwood, 2005). Kim and colleagues (S. Kim et al., 2014) studied the effect of unresolved loss as defined by AAI when participants were presented picture of their own infants (compared to strangers) with sad or happy expressions. Results show a diminished amygdala response in unresolved participants when presented pictures of their own infants with sad expressions compared to happy faces. Secure individuals, as expected showed more amygdala response in the contrast sad versus happy. This seems deeply in

contrast with previously presented research, but unresolved mothers cannot be considered as the others insecure classifications: their caregiving ability seems severely impaired and this specific amygdala deactivation toward their own sad infants seems useful in not to resemble their painful past experience of trauma or loss. Otherwise like during the AAI their behavior would be completely disorganized losing any coherence. The disruption of the normal process associated with their own infants' sad stimuli could be at the base of an inability of emotional attunement with their children and in particular when they are distressed. Authors claim that this process could also be related to the intergenerational transmission of trauma, because show how children remains "psychically alone" basically because their mothers deny their psychological needs. When traumatic representations are triggered, mothers' behavior becomes totally unpredictable for their children: the only acceptable strategy becomes the freezing of any behavior (Simpson & Belsky, 2008). In fact during the standardized observation of mother child interactions, these infants just lack of any coherent strategy to approach the mother.

Even if not directly connected to parenting processes Galynker and colleagues (2012) considered the moderator effect of depression and attachment security on brain activation during an attachment related task in which they presented to females participants pictures of their mother, female friends and stranger. They found an association between attachment and medial thalamus and ventral caudate, related to reward and affectively motivated behavior and memory. Researchers then focused on the cortico-striato-thalamic circuits of affect regulation. For the contrast mother stranger (early attachment figure) overall brain analysis showed overlap and interactions effects between depression and insecure attachment in both cortical and subcortical parts of the circuits. For the friend stranger contrast (late attachment figure) only cortical effects were found. The interconnection between attachment and depression as predictor for the activation of the emotion regulation circuit is an evidence of the complex role of attachment in organizing the mental functioning of individuals. Moreover, the hint for the "hierarchical" representation of attachment, because older attachment

relationships are more deeply encoded into the brain, can also be informative for the relationship between attachment and caregiving. It seems that the representation of participant's first caregiving model is involved in emotion regulation processes at a very basic level. A further step of analysis following this methodology on maternal representation could consider whether females participants were mothers, and differences between primiparous and nulliparous women. It would be very interesting to understand if early attachment stimuli have different effects on affect regulation circuits when the new developmental task requires shifting from being the target of caregiving behaviors to being a new caregiver per se.

Physiological differences in coping with stressor due to attachment representations measured with AAI have been studied by Pierrehumbert and colleagues (2012). Autonomous participants showed a low reported subjective stress, moderate HPA axis activity (ACTH and cortisol) and high levels of OT. Dismissing participants reported a moderated level of subjective stress, elevated HPA axis activity and moderate OT levels. Preoccupied participants showed moderate levels of subjective stress, moderate HPA axis activity and low OT. Finally, unresolved participants reported elevated subjective stress, low HPA axis activity and moderate levels of OT. These fruitful results confirm a role of adult attachment representations in shaping the stress response (but see Rifkin-Graboi, 2008 for inconsistent results) and confirm the double function of OT in regulating both attachment and stress systems. In fact, autonomous mothers (vs dismissing) showed a greater plasma OT increase after an interaction with their children (Strathearn et al., 2009).

Another instrument to evaluate adult attachment in an implicit way is the Attachment Script Assessment (ASA; Waters & Rodrigues-Doolabh, 2004). Adults are asked to produce stories using some word prompts, chosen to elicit attachment-oriented narratives. Their stories are then coded for "secure base script knowledge" (Waters & Waters, 2006), a strategy for problem solving related to attachment relevant events based on the detection of the problem, a help request and the solution of the problem. Because attachment security is

considered to reflect cognitive and affective organizations of previous experiences that in turn structure expectations and emotional responding to environmental stimuli, ASA secure base script knowledge score has been used as moderator to study the effects of infant crying in non parents adults (Groh & Roisman, 2009). In particular it has been found that less secure individuals showed greater electrodermal reactivity from rest listening to infant crying, conceptualized as a measure of inhibition. The effects was not found for infant laugh stimuli. In other words, secure individuals show more productive emotional responses to attachment-related challenges and the emotion regulation ability during the exposure to attachment stimuli seems supported by attachment security. The emotion and cognition organizing function of attachment seems confirmed. The same effect has been replicated also in a sample of expectant mothers (Ablow et al., 2013). The evolutionary perspective of a continuity between fast or slow LH strategy across two generations seems respected: inhibited reaction to a negative emotion stimuli leads to less involvement in caregiving behaviors and allows saving resources. Less emotional involvement protects parent from the pain of an eventual loss in a difficult environment. Groh and colleagues (2015) extended this research using EEG alpha asymmetry, considered a measure of mothers' emotional response useful to explain their sensitive-responsiveness in interaction with their infants (Killeen & Teti, 2012). They found that mothers lower on secure base script showed smaller right versus left shifts in EEG activation while listening to infant crying but not during the resting condition. This means that their ability of facing the baby crying stimuli relies on a limited emotion regulation and produce a rigid and uncoordinated response. In addition, subjective and observed response to infant crying confirms this neurophysiological finding, suggesting that emotion regulation in caregiving stressful situation could be one of the most important mediators of the intergenerational transmission of attachment. The underlying idea and intriguing hypothesis could be that mothers built an ability of emotion regulation in their primary attachment relationships and then this process could be implicated in defining their parenting and caregiving ability.

The Adult Attachment Projective Picture System (AAP, George & West, 2001, 2012) is a free-response psychological assessment of adult attachment based on a projective approach. Attachment representations are inferred from subjects' description of some pictures representing situation that activate the attachment system (e.g., illness, separation, solitude, death, and abuse). A ERP study with AAP attachment classification confirms that insecure individuals allocate less resources in analyzing and interpreting infants signals (Fraedrich, Lakatos, & Spangler, 2010). In this case participants were presented pictures of babies' faces with different emotions expressions: the ERP analysis showed that secure mothers are better in face perceptions (N170) and use more resources to focus on social stimuli (N200, P300). This means that they actively invest more cognitive resources and will be more able to detect infant emotional state and to use this information in order to interact in a more attuned way with the infants.

A few studies focused on the effects of intranasal OT administration and tested the moderator effect of attachment representations. Waller and colleagues (2015) studied the OT effect on 24 healthy fathers involved in a double blind, placebo controlled, within subject experimental design. While event related potential were assessed, participants were presented pictures of their own children, and familiar and unfamiliar infants' pictures. In the placebo condition, the familiarity of their own children resulted in a broad negativity at occipital and temporo-parietal electrodes before 400 ms after the stimulus presentation. This familiarity effect has not been found in the OT condition, suggesting that OT could increase approach tendencies and reduce responses to social cues to allow new social bonds. This OT reduction of neural activity was more pronounced in secure vs insecure individuals, where attachment representations were measured by AAP. This could suggest that OT has to rely on secure attachment in order to be more effective. The early stress effect on OT administration mentioned above seems coherent with this finding of a complex interplay between subject history and OT administration.

Buchheim and colleagues (2009) developed an experimental procedure to directly test the effect of OT on attachment representation. In a double blind

randomized clinical trial 26 healthy male participants classified with an insecure attachment pattern were administered OT or placebo. Then their adult attachment representations were assessed by a task based on the AAP. 32 AAP picture were presented and for each of them participants had to choose between four different sentences that referred to secure or insecure attachment classifications. From placebo to OT condition, participants significantly shifted towards more secure phrases, demonstrating a security enhancing effect of OT in insecure participants. This study is brilliant and fruitful, but the results do not converge with evidence of OT effects on insecure subjects, even if the lack of a group of secure participants makes difficult to speculate if this boosting security effect is limited to insecure individuals.

Many other studies used adult attachment questionnaires as moderators in parenting related processes, but we do not present them here because of they do not assess in any way early experiences. However, a complete review of these studies has been presented by Jones, Cassidy and Shaver (Jones et al., 2015b). For what concerns the interplay of OT and attachment, we point out a review (Gander & Buchheim, 2015) and we present a study that represent one of the strongest evidence of OT effects on attachment system. In a double blind, placebo controlled, crossover designed study, Bartz and colleagues (Bartz, Zaki, Ochsner, et al., 2010) studied memories of childhood maternal care and closeness. Less anxiously attached individuals (measured with the Experiences in Close Relationship questionnaire) showed more memories of their mother as caring and close, after OT administration. More anxiously attached participants showed the opposite effect they remembered their mother as less caring and close after in OT condition. These results seem consistent with the complex interaction between OT and individual differences, where more secure individuals take advantage of OT while insecure individuals do not.

Discussion

Taken together all these studies show the complexity and the quantity of research on neurophysiological mechanisms of intergenerational transmission so far. We propose that these evidences can be used not only to test existing approaches but also to build new theoretical models to comprehend the intergenerational transmission process and generate new hypotheses to drive new research. In the present review, we focused on the processes associated to parenting abilities that have been shown to be affected by early care experiences. We used a life history approach to interpret how the effects reviewed could represent an adaptive evolutionary pathway to enact fast strategies in real life. The evolutionary explanation is actually quite simple: early stress experiences shape individuals' developmental strategies in order to deal with a harsh environment, favoring a preference for fast strategies of rearing offspring in adulthood. Thus, a decreased brain reward system, altered emotion and stress regulation networks appear to activate behavioral strategies of parenting that favor the quantity of offspring versus the quality of the parental investment. We consider emotion regulation as the primary domain responsible for organizing a fast evolutionary strategy. Parenting is a highly emotional phenomenon and emotions are considered the mechanism that promote quick and attuned responses to children's needs (Belsky, 1984; Bowlby, 1969; Gander & Buchheim, 2015). Therefore, this emotional network has to be blunted in order to enable a low parental investment strategy. The intergenerational transmission hypothesis seems consistent with this process: if an individual was born in a harsh environment, it is highly probable that also his/her children will face a similar environment: then the quality of care he/she experienced during childhood is likely to be still adaptive. The stability across generations seems to be ensured by different systems. We reviewed the early stress effects on oxytocin network, stress response HPA axis, reward systems and emotional functioning. Each of these systems is strongly affected by early experience, confirming the predictive power of the intergenerational hypothesis.

We consider stability of parenting behavior across generations as a stable and reliable effect, but as already mentioned only a small portion of the variance of

parenting behavior can be explained in this way. Neurophysiological evidences could play a role in explaining not only continuities but also discontinuities in parenting. The lack of perspective studies in this topic of research leaves no space in direct tests of the neurophysiological mechanisms that can switch developmental trajectories and enable moderation effects. In other words, there are no studies testing if when early stress does not affect specific neurophysiological mechanisms intergenerational transmission is avoided. We propose adult attachment representations as an intriguing step forward toward the comprehension of the across generations transmission. In fact, adult attachment is of course affected by childhood experiences but its measure assesses even if eventual adverse experiences have been (or not) worked through. We are not implying that a secure adult attachment remove traces of negative past experiences, but it can be surely considered a buffer against them. Moreover, because of the strong connection between attachment and caregiving systems, the ability to put a distance between an individual and his/her past, in a way that does not deny negative experiences but recognize them and their consequences, surely play a role in reenacting rearing strategies. Within Life History perspective, attachment stability from infancy to adulthood is the process that enables coherent strategies all through the life course (Simpson & Belsky, 2008, 2016). As hypothesized by Cassidy (1994) emotion regulation is strongly influenced by attachment relationships and different patterns of attachment (in childhood and in adulthood) rely on different strategies of emotion regulation. Children of secure parents learn that emotion are important and that they can regulate them through the parent (Fonagy et al., 2002), therefore it is likely they will be adults characterized by the flexible ability to accept and integrate both positive and negative emotions. On the contrary, children of insecure mothers are more likely to develop more limited or heightened negative affect. Empirical confirmation of this models comes from Mikulincer and Shaver's work (Mikulincer, Birnbaum, Woddis, & Nachmias, 2000; Mikulincer, Dolev, & Shaver, 2004b; Mikulincer & Shaver, 2007, 2008). Moreover all the studies reviewed in this paper where attachment classification was used as predictor of brain activity in relation to caregiving activation stimuli, were interpreted as differences in emotion regulation (Kim et al.,

2014; Lenzi et al., 2013; Riem et al., 2012; Strathearn et al., 2009; Vrtička & Vuilleumier, 2012). We interpret these effects as central for the intergenerational transmission of attachment (van IJzendoorn, 1995a; Verhage et al., 2015). Parental emotion regulation seems necessary to properly perceive infants' signals and adequately respond to them, as confirmed also by Musser and colleagues (Musser et al., 2012) who studied the association between observed maternal sensitivity and brain activation during the perception of mothers' own children cry. Correlation between the maternal intrusiveness and the left insular cortex and temporal pole, regions implicated in the integration of sensory-emotional information, emotion recognition, empathy and making meaning of stimuli. In other words, it seems that more attuned mothers need to be able to establish a connection with the children's emotional states and to realize their children as individuals with their own mental states and emotions (Fonagy & Target, 1997; Katznelson, 2014).

We propose a model to integrate early stress and attachment effects in order to explain the intergenerational transmission of parenting phenomenon, where the key role is played by emotion regulation. The model is presented in *Figure 5.1*. We claim that early stress affects the four domains of neurophysiological mechanisms already mentioned: oxytocin network, stress regulation, reward processes and emotional functioning. We propose that each of these systems is associated with adult attachment representations and contributes to explain and predict them. In fact, adult attachment patterns have different endogenous oxytocin levels (Blaise Pierrehumbert et al., 2012; Strathearn et al., 2009) and moderate the effect of exogenous oxytocin administration (Waller et al., 2015). Also HPA axis activity seems to be different in participants with different adult attachment representations (Blaise Pierrehumbert et al., 2012), as well as the rewarding value of children's faces (Strathearn et al., 2009). Finally, the emotional functioning is deeply rooted into the very definition of attachment representation and we have already explained the interplay between emotions and attachment strategy. It is important to note that in *Figure 1* we present a directional effect of the four domains on adult attachment representation. This is because we have

strong evidences of these domains strictly depending on the quality of cares received and childhood environment, while we know that attachment is not simply a function of rearing experiences. Beside this, the interplay between adult attachment representations and neurophysiological functioning is not so simplistic. Another possible explanation is that attachment representations, which derive from childhood expectations on caregivers' provision of security, drive neurophysiological mechanisms toward an adaptation to the characteristics of the environment. Then, we depict attachment representations and emotion regulation as domains almost overlapping, for the already mentioned reasons and directly affecting parenting behaviors. In this model, we highlight two main sources of discontinuities: in infancy attachment security and in adulthood current life experiences. In fact, attachment security can be a protective factor able to switch developmental trajectories even in harsh environments (Sung et al., 2016), while the effect of a stable and secure relationship with a romantic partners is probably the only proved moderator of intergenerational transmission of parenting.

This perspective of the primary role of emotion regulation does not try to explain everything but offers an interpretative mechanism to approach the complexity of the studies on the intergenerational transmission of parenting. Moreover, if there are many evidences of the association between early stress and the four domains we presented, much weaker effects (especially in terms of number of publications) support the association between attachment and the effects of early stress. Therefore, more research is needed. The model we presented highlights the primary role of emotion regulation in enabling intergenerational transmission. This hypothesis could be experimentally tested by means of a randomized clinical trial where a specific emotion regulation training could be used to try to improve the quality of observed parental sensitivity. In this way, the predictive power of the synthesis of the effects reviewed in this paper can be shown and evaluated. Finally, emotion regulation is also deeply involved in resilience phenomena and it is studied in order to foster resilience in highly stressful situations.

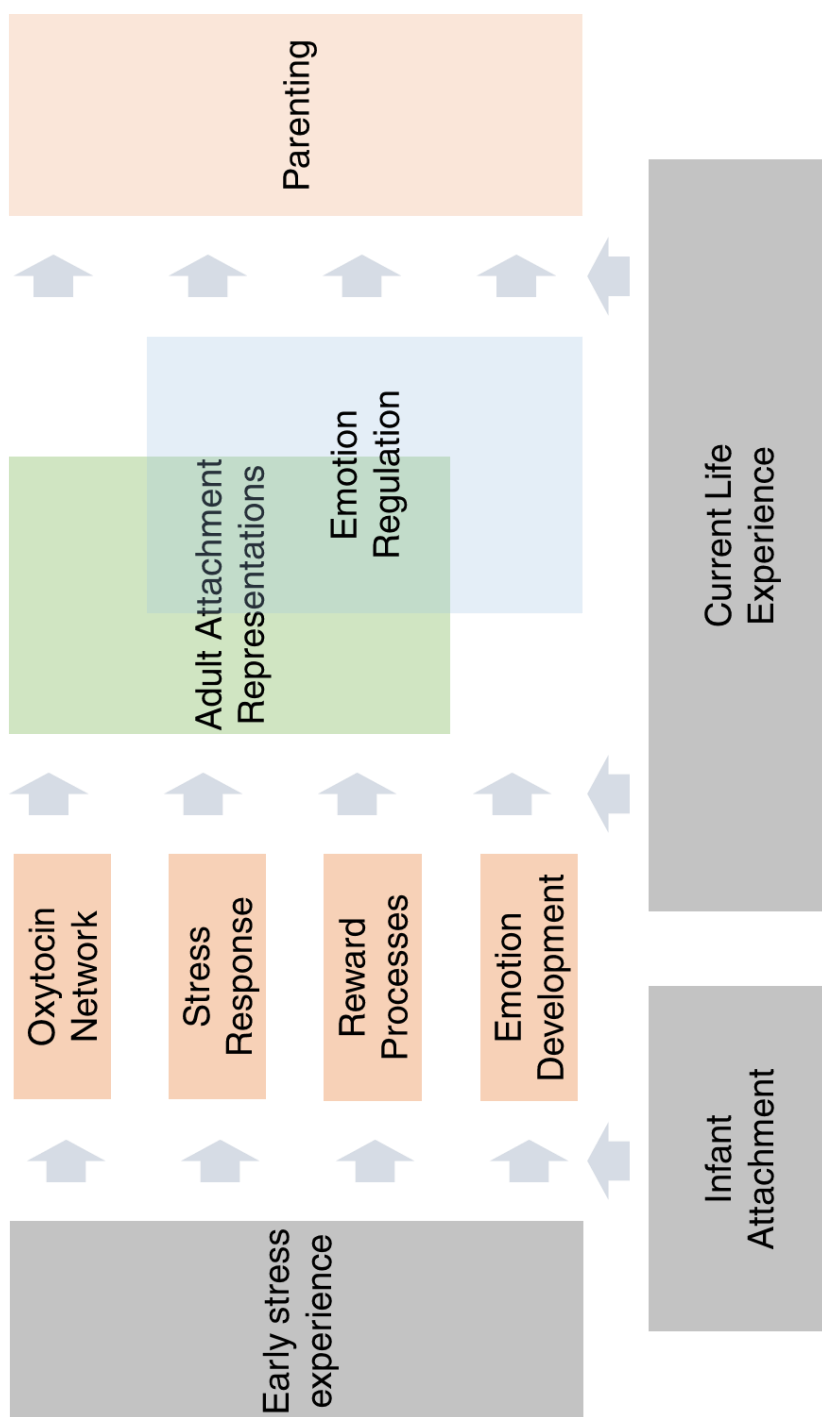


Figure 5.1. A model on the neurophysiological mechanism on intergenerational transmission of parenting.

Resilience

Resilience construct is highly debated in psychology and no general consensus is found for a cross contextual operationalization. Here we refer to the broad definition proposed by Masten and Coatsworth (1995): “achieving desirable outcome in spite of significant challenges to adaptation or development” (p. 737, cited in Buckner, Mezzacappa, & Beardslee, 2003). Early stress is one of the most evident, and therefore studied, examples of challenge to adaptation (for reviews see: Cicchetti, 2013b; Klika & Herrenkohl, 2013; MacPhee, Lunkenheimer, & Riggs, 2015; S J A van der Werff, van den Berg, Pannekoek, Elzinga, & van der Wee, 2013). Moreover, the association between resilience and emotion regulation is so deep and established that the two constructs are considered almost the same. Seminal studies showed that maltreated children with better current adaptation to the environment, were also more able to have emotion responses consistent with the situation and to modulate their feelings (Cicchetti & Rogosch, 1997; A. M. Shields, Cicchetti, & Ryan, 1994; A. Shields, Ryan, & Cicchetti, 2001). Both behavioral and brain measures of emotion regulation independently predict resilience scores in a sample of maltreated school age children, suggesting different levels of analysis in the association between the two domains (Curtis & Cicchetti, 2007). Also fMRI studies on adults with histories of early stress report the role of emotion regulation circuits moderates the detrimental stress effect and highlight emotion regulation as a specific target in intervention following early adversity (M. M. Grant et al., 2015; Johnson & Tottenham, 2015; Steven J.A. van der Werff et al., 2013). Recently, an intriguing resilience-as-regulation perspective has been proposed by MacPhee and colleagues (MacPhee et al., 2015), where resilience processes are described as the interplay of regulation processes in two different levels of analysis, an individual one and a familiar one, in order to consider co-regulation (Sanchez, McCormack, & Howell, 2015) along with self-regulation (Bridgett, Burt, Edwards, & Deater-Deckard, 2015). Taken together all this evidences are consistent with the idea that emotion regulation could be a process to target in parents in order to elicit their own resilience processes. Enhancing parents’ own resilience could represent a key to address the

complexity of the interplay of different generations' risk factors and prevent offspring from entering the circle of intergenerational transmission of abuse. However, in our knowledge the effects of parents' resilience on their parenting abilities has not been studied so far.

Interventions

A recent meta-analysis found a combined not significant effect of parent programs to prevent or reduce child maltreatment in randomized controlled trials (Euser et al., 2015). Even if a subset of studies show interesting and promising results, the global picture is disappointing. We propose that the difficulties in designing effective interventions are probably due to the lack of comprehension of the mechanisms responsible for negative parenting behaviors (i.e. Sandler, Schoenfelder, Wolchik, & MacKinnon, 2011). Thus, we think that the neurocognitive processes highlighted in this review could represent a unique window to understand the underlying targets and modalities of interventions. More specifically, we propose that a shift towards a more effective emotion regulation ability in parents could represent a valuable and fruitful access key to break the vicious circle of intergenerational transmission maltreatment. Even when existing interventions for parents at risk of maltreating their children do not explicitly focus on emotion regulation construct, they target it anyway, referring to the training towards a nurturing, synchronous and not frightening care (Dozier, Meade, & Bernard, 2014; M. R. Sanders, 2012; Urquiza & Timmer, 2014) or more directly to "experiential methods of learning" (Webster-Stratton, 2014). Anyway these interesting evidence based approaches (see: Timmer & Urquiza, 2014) even if considering the importance of parents' ability in recognizing and appropriately responding to children states and behavior, do are not aimed at improving emotion regulation functioning per se. We propose that a parent training on emotion regulation could be an intriguing way to propose stable and durable parenting interventions. The dysregulated parenting behaviors could be paradoxical adaptive in a highly unpredictable environments where a fast strategy for reproduction

offers better chances to succeed. Thus moving against evolutionary push could be not easy and even less worthwhile. This review showed the neurophysiological mechanisms underlying fast strategies choices, so directly targeting these processes could, in turn, help in redirecting parental pathways toward qualitatively better care. Emotion regulation seems to be the most comprehensive and effective predictor of the effects review so far. Of course, there are other specific mediators as the reward system or the OT effects, but we think they are less effective and less central in determining the risk of maltreatment outcomes. In sum, more research is needed to test the central role of emotion regulation, through the development of specific interventions. Many programs have been proposed to directly enhance emotion regulation (Berking, Ebert, Cuijpers, & Hofmann, 2013; Berking & Schwarz, 2013; Farb, Anderson, Irving, & Segal, 2013; Grafton & MacLeod, 2013; Schuppert et al., 2009), but no one of these is has been specifically applied to parents at risk for maltreatment.

Limitations

The primary and most relevant limitation of this review is the retrospective nature of almost all the studies reviewed. No prospective studies on the effects of childhood maltreatment on adult functioning has been reported and just a few considered the longitudinal effects of poverty. Moreover, these did not directly addressed neurophysiological mechanism implicated in parenting behaviors. Then this limitation seems to be unavoidable considering the current state of the art. We understand the cost effectiveness of this kind of studies and the relative novelty of the psychophysiological approach. We trust that prospective longitudinal approaches are going to represent one of the future directions of the field. Another limitation consists in our broad definition of early stress, because we reviewed papers targeting very different populations, from participant with early-institutionalized rearing histories to participants who reported higher scores of verbal abuse on a questionnaire. This led to a not specific approach where each effect is not fully comparable to the others. However, we think that the scarce level

of selection of the papers based on the operationalization of the early stress measure allowed us to a deeper exploration of the complexity of the phenomenon and the state of the art of research done so far.

Another limitation is the choice not to review papers that propose an epigenetic pathway for the effects of maltreatment in adulthood. This represents actually a new perspective to the study of parenting (see: Mileva-Seitz, Bakermans-Kranenburg, & van IJzendoorn, 2015) that offers a more complete view of the picture and opens new reflection on the topic. Moreover the only GxE study on intergenerational transmission seem to indicate this as a promising direction for research (Beaver & Belsky, 2012). We decided not to include these studies in this review only for a reason of paper length.

In the present review, we did not specify difference between studies on males of females as well as fathers or mothers. This is to be considered a limitation, in light of the evidences of gender effect in processing parenting relates stimuli (e.g. Proverbio, Brignone, Matarazzo, Del Zotto, & Zani, 2006). Unfortunately, research on early stress effects on parenting related processes is still in an early stage and do not allow to take into account the differences raised by the parental condition.

Conclusion

In this chapter, we reviewed the studies that addressed the issue of the early stress effects on neurophysiological domains. In addition we considered adult attachment as a measure related to early care but able to express also individual's ability to reflect upon his/her experiences. We claim that at this point some interpretative hypotheses can be formulated to expand our comprehension of the phenomenon of intergenerational transmission of parenting. In fact, we propose a synthesis of the effects by means of a model that highlights the key role of emotion regulation as moderator and as possible factor of discontinuity to be targeted by interventions. Finally, we propose three directions for future research. First, prospective studies on the neurophysiological effects are required to test the

effects of early stress and to draw causal models. Second, as we have already mentioned, the role of emotion regulation in parenting can be directly assessed through randomized clinical trials to test the causal effect of an emotion regulation training. This approach not only can inform research but could also help to develop more focused and effective intervention to prevent or reduce the effect of child abuse and neglect. The last point is about a completely avoided question in this paper and in this field: the effects on the children. Many studies on intergenerational transmission of parenting used articulated methodologies based on the assessment of three generations. We understand the complexity of moving this methodology to study the neurophysiological effects, but no final comprehension of the stability of the mechanism across generations will be reached until children will be incorporated in the model, because their wellbeing is the real objective of all this reflection.

Conclusion

And future directions

The present thesis was aimed at investigating the psychological and neurophysiological mechanisms that enable the phenomenon of the intergenerational transmission of parenting behaviors. We firstly reviewed the empirical and clinical evidences of the continuity of parenting across generations. We concluded that researchers agree on the transmission of both harsh and warm parenting behaviors. However, even if the quality of the studies to assess intergenerational stability is remarkably high and still improving, childhood experiences predict future parenting behaviors only in a limited way. Even more important, research findings lack variables able to moderate the transmission (Belsky, Conger, et al., 2009; Conger et al., 2009), in order to comprehend when the intergenerational cycle breaks. Promising results come from the differential susceptibility hypothesis (Bakermans-Kranenburg & van IJzendoorn, 2015), but the application to parenting transmission is still at the beginning since only one study tested it (Beaver & Belsky, 2012). However, the processes that enable the transmission remain largely not comprehended. We think this is one of the causes of the disappointing results obtained by programs aimed at preventing children abuse and neglect in at risk parents (Euser et al., 2015). We propose that a focus on basic psychological and neurophysiological processes could lead the way toward a deeper comprehension of the phenomenon. Moreover, we claim that the amount of research conducted in the last 10 years on the effects of early environment on the neurophysiological correlates of parenting processes enables the opportunity to synthesize the evidences, to propose interpretative explanations and to generate new hypotheses. Therefore, the thesis was articulated to test specific hypotheses in the first four chapters (effects of childhood history and attachment styles on implicit processes and brain correlates of parenting) and finally propose a unifying perspective in the fifth chapter in order to generate new hypotheses to test in future research directions. In this conclusion paragraph, we review the empirical findings in light of the emotion regulation hypothesis presented in chapter five.

In the first section, we focused on the implicit processes implicated in parenting related tasks. We confirmed the hypothesis that both early childhood

experiences and attachment styles moderate automatic processing of parenting related stimuli. We proposed that attachment style was more related to high-level processes implicated in forming attitudes, while childhood history was predictive of lower level approach avoidance dispositions toward infant stimuli. This seems consistent with the model presented in chapter five, where adult attachment (but measured in a representational perspective) is associated to emotion regulation processes (e.g. prefrontal cortex activation) while early stress childhood experience directly affect amygdala network of emotion processing. More specifically, in Chapter 1 we found that adult attachment styles predicted implicit attitudes towards different patterns of mother child interaction. This highlights an association between caregiving and attachment systems based on automatic activation of implicit processes. Within the framework of the intergenerational transmission of attachment, the continuity between attachment and caregiving seems to be mediated by social cognition processes. Therefore, these results support those approaches that try to bridge the transmission gap (van IJzendoorn, 1995a; Verhage et al., 2015) focusing on mother's ability to mentalize about his/her own child (Meins et al., 2012, 2001; Slade et al., 1999, 2005). In fact, they confirm that there is more than representation in transmission, because attachment stability relies on an automatic process of interpretation of the others (Fonagy & Target, 1997, 2002, 2005). Chapter 2 presents a task to measure the implicit disposition to approach or avoidance infants' faces with different emotions. Results show that participants automatically tend to avoid (or actually not to approach) sad infants faces, confirming the same bias previously found with adult stimuli. Interestingly the size of the bias was associated to a measure of childhood maltreatment. This effect is consistent with the primary role of emotion regulation in intergenerational transmission of parenting processes, extending the evidences based on brain activation to the behavioral domain. If the bias in processing sad infants' face is not problematic per se, it could affect parental ability of parenting at some point, as confirmed by its augmented effect in maltreated adults. When an abused individual has to deal with infants' emotions is biased, probably because of his/her difficulty in regulating his/her own negative emotions. This, in turn, will make him/her less engaged in the interaction with the child. In addition, maltreated

adults and children have difficulties in emotion recognition of sadness, (Ardizzi et al., 2015; da Silva Ferreira et al., 2014; Umiltà, Wood, Loffredo, Ravera, & Gallese, 2013). In terms of intergenerational transmission of parenting, these results confirm the difficulty of individuals who experienced harsh caregiving environments in attuning with negative emotions of their own children. In a psychodynamic perspective the inability to deal with negative infants' emotions would not enable the parents to use the mirroring feature to help children in developing their own real selves (Fonagy et al., 2002; Winnicott, 1960, 1971). The chapter is made of two other studies designed to explore the process underlying this effect. In one of them, a sad mood manipulation did not alter the bias for the sad face, while a happy mood manipulation buffered it. Moreover, a happy manipulation caused a bias toward happy faces, and the magnitude of the effect was correlated with childhood abuse scores. The emotion regulation explanation is absolutely consistent with it, because maltreated participants tend to be dysregulated by unexpected positive emotions, therefore the happy infants' face suddenly becomes something to avoid. The last study within Chapter 2 tested if the right Inferior Frontal Gyrus played a causal role in determining the bias toward sad faces. Results confirmed the hypothesis suggesting that sad infant bias is due to a slower empathic processing of the stimuli, probably based on mirroring circuit. This effect was not associated to maltreatment scores, then it seems not to be responsible for the bias transmission but confirms the emotional nature of the effect, since rIFG plays a role in emotional (and not cognitive) empathy. Interestingly rIFG inhibition caused a bias in processing happy faces and this effect was strongly negatively associated with maltreatment scores. We interpret this effect in light of the dysregulation produced by the disrupted empathic process in association with a lower involvement of rIFG in maltreated adults. As in the previous study the processing of the happy infant stimuli after the manipulation is associated with maltreatment scores. These results resemble Emde's (1991, 1999) perspective on sharing positive emotions between parent and child as the organizing principle of infants' personality. In his view, mother's validation of positive emotions during the first year is the primary process that structure and organize child's subjectivity. In maltreated adults, a disrupted processing of infant's

positive emotionality could be responsible for the continuity across generations of harsh parenting because of a disrupted validation of positive emotions.

In the second section, we studied the brain correlates of two risk factors of parent's abusive behaviors: infant crying and infant temperament. These two dimensions are associated because an infant with negative temperament is of course characterized by high rate of crying and inconsolability. Crying is considered a trigger of abuse (Soltis, 2004), or at least a trigger of harsh parenting, especially in maltreated individuals.

Both studies found differentiated brain effects depending on childhood maltreatment scores. Considering the highly emotional impact of the stimuli and their relevance in parenting processes, these studies are good ways to test the emotion regulation hypothesis in intergenerational transmission of parenting. In Chapter 3 we experimentally manipulated infant temperamental features using the Baby Social Reward Task. In this task, participants learned to differentiate between more often sad and more often happy infants by observing the facial expressions and vocalizations of previously unfamiliar infants. Afterwards, neural responses to infants with an easy (happy) or a difficult (sad) temperament were measured with fMRI. We found that individuals with experiences of emotional maltreatment in childhood had reduced amygdala-middle frontal gyrus connectivity during the perception of an easy temperament infant. Unexpectedly, we did not find differences in amygdala connectivity during the perception of the difficult temperament infant. However, the altered amygdala connectivity confirms the long lasting effects of childhood stress on emotional neural circuits and the relevance for emotion regulation. This study support the same intergenerational mechanism of transmission of parenting emerged in Chapter 2 for what concerns the role of positive emotions. Here we are not referring to a simple positive stimulus but to a neutral stimulus to which a positive attribution was associated by the participant by means of trials errors. Therefore, from a methodological point of view, this study is a step further in trying to study neurophysiological effects of parental attributions to children and point out the role of infant representations in driving brain activation. Chapter 4 describes the effects of rIFG stimulation on the behavioral response to

infant crying. The outcome measure is the use of excessive force in a handgrip task, a measure able to tap an automatic behavioral response that is very likely to be involved in maltreating behaviors (Compier-de Block et al., 2015). rIFG inhibition by means of TMS had a pejorative effect on the performance, but only in non maltreated participant. We have to acknowledge that this is just a pilot study and therefore the sample size is quite inappropriate to draw conclusions, but these results seems very promising. In fact, they show that rIFG plays a causal role in determining the amount of force used in response to sad faces by participants who did not experience a harsh early environment. Therefore, this suggests that non maltreated participants' neural process that determines the behavioral response does rely on empathic/mirroring processes that buffer the use of excessive force. On the contrary, maltreated individuals, are less depending on this brain area to determine a response. We could hypothesize that their response to infant crying is depending on more cognitive forms of empathy or cognitive control of the stimuli. Even if the stimulation site is the same of the third study of Chapter 2, the outcome variables are very different and rely on different neural circuits. This is why the effects are so different in the direction, because one buffers the bias (Chapter 2) while the other increase the bias (Chapter 4). However, we know that Chapter 2 bias is adaptive, at least at some point, then the direction could be less different than we thought. More important we have evidences from both studies that maltreated participants' behavioral responses to infant stimuli are less depending on rIFG performance. This result is consistent with our perspective of a deficit in emotion regulation, and specifically on the mutual features of emotion regulation. Moreover, this diminished mirroring activity during the perception of infant stimuli could be associated to a deficit of "maternal affect attunement" described by Stern (Stern, 1985). A difficulty in "putting oneself in infant's shoes" could decrease the ability to detect and properly respond to infant's emotion. The embodied simulation hypothesis (Gallese & Sinigaglia, 2011; Gallese, 2014) supports Bion's idea of *reverie*. Mother's capacity to sense (and make sense of) what is going on inside the infant works through projective identification. In other words, at some point, the mother has to feel the emotions of the child in order to be able to adequately return them in a form suitable for him/her.

Chapter 5 contains a synthesis of the literature on the neurophysiological mechanism underlying the intergenerational transmission effect. We reviewed all the studies that targeted the effects of childhood early experience on processes that could play a role in determining parenting abilities. In particular we extended the previous literature (Lomanowska et al., 2015) in two ways: firstly we use an evolutionary Life History approach (Belsky, 1997, 2005; Del Giudice, 2009; Simpson & Belsky, 2016) as interpretative key. This allows explaining the consequences of early stress experiences in terms of adaptation to a specific environment. Strategies of adaptation to maximize the chances to pass genes to the next generations are extremely different depending on the characteristics of the environment. Early stress environment will privilege early maturation and the production of large offspring with low parental investment. We propose that the neurophysiological effects of childhood adversities allow this process reducing the ability to regulate emotions when interacting with infants. This lack of emotion regulation is the cause of harsh parenting and by inhibiting child's regulatory process enables the stability of parenting behaviors across generations. Secondly, we extended previous literature by including in our review studies that used adult attachment representations in order to predict the neurophysiological response to infant stimuli. On one hand attachment representations are problematic as measure of early stress because do not directly rely on reported experiences. On the other hand, they are much more informative because they do not describe the perception of experiences, but more interestingly adult's ability to reflect upon them. Individual difference in adult attachment representations rely on adult ability to regulate emotions (Cassidy, 1994; Fonagy & Target, 2002; Mikulincer, Gillath, & Shaver, 2002; Mikulincer & Shaver, 2007, 2008; Schore, 1994). Therefore, attachment studies complete the perspective on intergenerational transmission of parenting by focusing on current functioning instead of reported experiences of harsh parenting. We proposed a model where childhood experience affects four domains of neurophysiological mechanisms: oxytocin network, stress regulation, reward processes and emotional functioning. Each of these systems is associated with adult attachment representations and contribute to explain and predict them. As said, emotional functioning is deeply rooted into the very definition of

attachment representation and therefore we depict attachment representations and emotion regulation as almost overlapping domains. In this model, we highlight two main sources of discontinuities: in infancy attachment security and in adulthood current life experiences. The most powerful prediction of this model is about the causal role of emotion regulation in determining the transmission of parenting. This is consistent with developmental research on mother child interaction, but it has never been directly tested. Therefore, a primary future direction is to design an intervention study targeting emotion regulation in parents at risk for harsh parenting. In a clinical randomized trial (Euser et al., 2015) the causal role of emotion regulation in determining parenting transmission can be tested. This could represent a response to Belsky and colleagues' (2009) call for investigating the moderators of intergenerational transmission. We pointed it out in the introduction of this thesis: a step back to move forward. A synthesis of experimental works on neurophysiological mechanisms is able to open up new directions in developmental longitudinal research and to propose clinical directions for new interventions.

Other future directions consist in ameliorating the methodological quality of the researches on the effects of early stress on parenting neurophysiological correlates by means of prospective studies. So far just a few studies (e.g. Zerach et al., 2016) used a longitudinal perspective. The methodological advantages are terrific. In fact, the problem of the memory bias in recollecting data from participants' childhood is avoided and actual predictions can be formulated testing causal models. In particular, individuals characterized by dismissing attachment have by definition a bias in reporting episodes of negative emotionality from the past. In an easy prospective study with self-report, the effect is detrimental and will tend to bias the final result. Studies on the intergenerational transmission of parenting reached a very high level of complexity focusing on three different generations, the challenge for the next years will be to add a neurophysiological perspective.

A neglected issue in this thesis is the genetic perspective on parenting (Mileva-Seitz et al., 2015). We report only the effort to explain the moderators of

stability across generations testing the differential susceptibility hypothesis (Beaver & Belsky, 2012). For years genetic effects have been considered not impacting attachment, but the concept of differential susceptibility changed this perspective, shedding light on the reason why some interventions seem very effective on some individuals and not effective at all on others (Bakermans-Kranenburg & van IJzendoorn, 2015; Belsky & Pluess, 2013; Belsky & van IJzendoorn, 2015; Belsky, Jonassaint, et al., 2009). In future perspectives genetic domains will be unavoidable.

Finally, another future direction for these studies is to enlarge the perspective studying also parents and not only nulliparous females participant but also males (and fathers). In fact, parental brain is known to work in a substantial different way compared to non-parents' one. Moreover, research is driving new attention onto fathers and their role in affecting children development. Fathers are not considered anymore only a support for mothers but they are described as directly involved in parenting and its transmission to the next generations.

In sum, the aim of this thesis was to study the psychological and neurophysiological mechanism of the intergenerational transmission of parenting. In four chapters we presented new empirical data to support the evidence that childhood experiences and adult attachment styles affect different domains implicated in parenting processes: attitudes towards caregiving, motor responses to emotional infants faces, perception of infants with different temperaments and behavioral response to infant crying. In the last chapter, we reviewed the empirical literature on the neurophysiological mechanisms of intergenerational transmission of parenting and proposed emotion regulation construct as key process in stability of across generations. Interestingly the journey of this thesis started with the role of parenting in shaping infant's intersubjectivity and finished with reviewing very different evidences but identifying at the core of intergenerational transmission parents' regulatory abilities. In other words, we have reason to think that it is the mutual regulatory ability that lies at the core of the self that is transmitted across the generations.

Bibliography

- Ablow, J. C., Marks, A. K., Feldman, S. S., & Huffman, L. C. (2013). Associations between first-time expectant women's representations of attachment and their physiological reactivity to infant cry. *Child Development, 84*(4), 1373–91. doi:10.1111/cdev.12135
- Ainsworth, M. D. S., Bell, S. M., & Stayton, D. (1974). Infant-mother attachment and social development. In M. P. Richards (Ed.), *The introduction of the child into a social world* (pp. 99–135). London: Cambridge University Press.
- Ainsworth, M. D. S., Blehar, M., Waters, E., & Wall, S. (1978). *Patterns of Attachment*. Hillsdale, NJ: Erlbaum.
- Alink, L. R. A., Cicchetti, D., Kim, J., & Rogosch, F. A. (2012). Longitudinal associations among child maltreatment, social functioning, and cortisol regulation. *Developmental Psychology, 48*(1), 224–236. doi:10.1037/a0024892
- Allen, J. G., & Fonagy, P. (2006). *The handbook of mentalization-based treatment*. New York: John Wiley & Sons.
- Almeida, J. R. C. de, Versace, A., Mechelli, A., Hassel, S., Quevedo, K., Kupfer, D. J., & Phillips, M. L. (2009). Abnormal Amygdala-Prefrontal Effective Connectivity to Happy Faces Differentiates Bipolar from Major Depression. *Biological Psychiatry, 66*(5), 451–459. doi:10.1016/j.biopsych.2009.03.024
- Altemus, M., Redwine, L. S., Leong, Y.-M., Frye, C. A., Porges, S. W., & Carter, C. S. (2001). Responses to laboratory psychosocial stress in postpartum women. *Psychosomatic Medicine, 63*(5), 814–821.
- Ammaniti, M., & Gallese, V. (2014). *The Birth of Intersubjectivity: Psychodynamics, Neurobiology, and the Self*. WW Norton & Company.
- Ardizzi, M., Martini, F., Umiltà, M. A., Evangelista, V., Ravera, R., & Gallese, V. (2015). Impact of Childhood Maltreatment on the Recognition of Facial Expressions of Emotions. *PLOS ONE, 10*(10), e0141732. doi:10.1371/journal.pone.0141732
- Are, F., & Shaffer, A. (2015). Family Emotion Expressiveness Mediates the Relations Between Maternal Emotion Regulation and Child Emotion Regulation. *Child Psychiatry and Human Development*. doi:10.1007/s10578-015-0605-4
- Arnsten, A. F. T. (2009). Stress signalling pathways that impair prefrontal cortex structure and function. *Nature Reviews. Neuroscience, 10*(6), 410–22. doi:10.1038/nrn2648

- Arseneault, L., Moffitt, T. E., Caspi, A., Taylor, P. J., & Silva, P. A. (2000). Mental Disorders and Violence in a Total Birth Cohort. *Archives of General Psychiatry*, 57(10), 979. doi:10.1001/archpsyc.57.10.979
- Atkinson, L., Leung, E., Goldberg, S., Benoit, D., Poulton, L., Myhal, N., ... Kerr, S. (2009). Attachment and selective attention: disorganization and emotional Stroop reaction time. *Development and Psychopathology*, 21(1), 99–126. doi:10.1017/S0954579409000078
- Atkinson, L., Scott, B., Chisholm, V., & Blackwell, J. (1995). Cognitive coping, affective distress, and maternal sensitivity: Mothers of children with Down syndrome. *Developmental Psychology*, 31(4), 668–676. doi:10.1037/0012-1649.31.4.668
- Atzil, S., Hendler, T., & Feldman, R. (2011). Specifying the Neurobiological Basis of Human Attachment: Brain, Hormones, and Behavior in Synchronous and Intrusive Mothers. *Neuropsychopharmacology*, 36(13), 2603–2615. doi:10.1038/npp.2011.172
- Atzil, S., Hendler, T., & Feldman, R. (2014). The brain basis of social synchrony. *Social Cognitive and Affective Neuroscience*, 9(8), 1193–202. doi:10.1093/scan/nst105
- Baccigaluppi, M. (1985). Inversion of parent-child relationships: A contribution to attachment theory. *British Journal of Medical Psychology*, 58(4), 369–373. doi:10.1111/j.2044-8341.1985.tb02655.x
- Bagot, R. C., van Hasselt, F. N., Champagne, D. L., Meaney, M. J., Krugers, H. J., & Joëls, M. (2009). Maternal care determines rapid effects of stress mediators on synaptic plasticity in adult rat hippocampal dentate gyrus. *Neurobiology of Learning and Memory*, 92(3), 292–300. doi:10.1016/j.nlm.2009.03.004
- Bailey, J. A., Hill, K. G., Oesterle, S., & Hawkins, J. D. (2009). Parenting practices and problem behavior across three generations: Monitoring, harsh discipline, and drug use in the intergenerational transmission of externalizing behavior. *Developmental Psychology*, 45(5), 1214–1226. doi:10.1037/a0016129
- Bakermans-Kranenburg, M. J., Juffer, F., & Van IJzendoorn, M. H. (1998). Interventions with video feedback and attachment discussions: Does type of maternal insecurity make a difference? *Infant Mental Health Journal*, 19(2), 202–219. doi:10.1002/(SICI)1097-0355(199822)19:2<202::AID-IMHJ8>3.0.CO;2-P
- Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2013). Sniffing around oxytocin: review and meta-analyses of trials in healthy and clinical groups with implications for pharmacotherapy. *Translational Psychiatry*, 3, e258. doi:10.1038/tp.2013.34
- Bakermans-Kranenburg, M. J., & Van IJzendoorn, M. H. (1993). A psychometric study of the Adult Attachment Interview: Reliability and discriminant validity.

Developmental Psychology, 29(5), 870–879. doi:10.1037/0012-1649.29.5.870

- Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2009a). No reliable gender differences in attachment across the lifespan. *Behavioral and Brain Sciences*, 32(01), 22–23. doi:10.1017/S0140525X0900003X
- Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2009b). The first 10,000 Adult Attachment Interviews: distributions of adult attachment representations in clinical and non-clinical groups. *Attachment & Human Development*, 11(3), 223–263. doi:10.1080/14616730902814762
- Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2015). The hidden efficacy of interventions: genexenvironment experiments from a differential susceptibility perspective. *Annual Review of Psychology*, 66, 381–409. doi:10.1146/annurev-psych-010814-015407
- Bakermans-Kranenburg, M. J., van IJzendoorn, M. H., & Juffer, F. (2003). Less is more: Meta-analyses of sensitivity and attachment interventions in early childhood. *Psychological Bulletin*, 129(2), 195–215. doi:10.1037/0033-2909.129.2.195
- Bakermans-Kranenburg, M. J., van IJzendoorn, M. H., Riem, M. M. E., Tops, M., & Alink, L. R. A. (2012). Oxytocin decreases handgrip force in reaction to infant crying in females without harsh parenting experiences. *Social Cognitive and Affective Neuroscience*, 7(8), 951–7. doi:10.1093/scan/nsr067
- Baldwin, M. W., Fehr, B., Keedian, E., Seidel, M., & Thomson, D. W. (1993). An exploration of the relational schemata underlying attachment styles: Self-report and lexical decision approaches. *Personality and Social Psychology Bulletin*, 19, 746.
- Baldwin, M. W., Keelan, J. P. R., Fehr, B., Enns, V., & Koh-Rangarajoo, E. (1996). Social-cognitive conceptualization of attachment working models: Availability and accessibility effects. *Journal of Personality and Social Psychology*, 71(1), 94.
- Bandura, A. (1977). *Social learning theory*. Englewood Cliff, NJ: Prentice-Hall.
- Bandura, A. (1986). *Social foundations of thought and action*. Englewood Cliff, NJ: Prentice-Hall.
- Banse, R., & Kowalick, C. (2007). Implicit attitudes towards romantic partners predict well-being in stressful life conditions: Evidence from the antenatal maternity ward. *International Journal of Psychology*, 42(3), 149–157. doi:10.1080/00207590601067037
- Bariola, E., Gullone, E., & Hughes, E. K. (2011). Child and adolescent emotion regulation: the role of parental emotion regulation and expression. *Clinical Child and Family Psychology Review*, 14(2), 198–212. doi:10.1007/s10567-011-0092-5

- Barr, R. G., Trent, R. B., & Cross, J. (2006). Age-related incidence curve of hospitalized Shaken Baby Syndrome cases: convergent evidence for crying as a trigger to shaking. *Child Abuse & Neglect*, 30(1), 7–16. doi:10.1016/j.chiabu.2005.06.009
- Barrett, J., Wonch, K. E., Gonzalez, A., Ali, N., Steiner, M., Hall, G. B., & Fleming, A. S. (2012). Maternal affect and quality of parenting experiences are related to amygdala response to infant faces. *Social Neuroscience*, 7(3), 252–268. doi:10.1080/17470919.2011.609907
- Bartholomew, K., & Horowitz, L. M. (1991). Attachment styles among young adults: a test of a four-category model. *Journal of Personality and Social Psychology*, 61(2), 226.
- Bartz, J. A., & Lydon, J. E. (2004). Close relationships and the working self-concept: Implicit and explicit effects of priming attachment on agency and communion. *Personality and Social Psychology Bulletin*, 30(11), 1389–1401.
- Bartz, J. A., Zaki, J., Bolger, N., Hollander, E., Ludwig, N. N., Klevzon, A., & Ochsner, K. N. (2010). Oxytocin selectively improves empathic accuracy. *Psychological Science*, 21(10), 1426–8. doi:10.1177/0956797610383439
- Bartz, J. A., Zaki, J., Bolger, N., & Ochsner, K. N. (2011). Social effects of oxytocin in humans: context and person matter. *Trends in Cognitive Sciences*, 15(7), 301–9. doi:10.1016/j.tics.2011.05.002
- Bartz, J. A., Zaki, J., Ochsner, K. N., Bolger, N., Klevzon, A., Ludwig, N. N., & Lydon, J. E. (2010). Effects of oxytocin on recollections of maternal care and closeness. *Proceedings of the National Academy of Sciences of the United States of America*, 107(50), 21371–5. doi:10.1073/pnas.1012669107
- Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, 67(1). doi:10.18637/jss.v067.i01
- Bates, D., Maechler, M., Bolker, B., & Walker, S. (2013). lme4: Linear mixed-effects models using Eigen and S4. R package version 1.0-5. Retrieved from <http://cran.r-project.org/package=lme4>
- Bates, J. E., Schermerhorn, A. C., & Petersen, I. T. (2012). Temperament and parenting in developmental perspective. In M. Zentner & R. L. Shiner (Eds.), *Handbook of temperament* (pp. 425–441). New York: Guilford.
- Baumeister, R. F., & Leary, M. R. (1995). The need to belong: desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, 117(3), 497.
- Beaver, K. M., & Belsky, J. (2012). Gene-Environment Interaction and the Intergenerational Transmission of Parenting: Testing the Differential-Susceptibility Hypothesis. *Psychiatric Quarterly*, 83(1), 29–40. doi:10.1007/s11126-011-9180-4

- Beebe, B., Jaffe, J., Markese, S., Buck, K., Chen, H., Cohen, P., ... Feldstein, S. (2010). The origins of 12-month attachment: a microanalysis of 4-month mother-infant interaction. *Attachment & Human Development*, 12(1-2), 3–141. doi:10.1080/14616730903338985
- Beebe, B., & Lachmann, F. (2002). *Infant Research and Adult Treatment: Co-Constructing Interactions*. Hillsdale, New Jersey: The Analytic Press.
- Bell, S. M., & Ainsworth, M. D. S. (1972). Infant Crying and Maternal Responsiveness. *Child Development*, 43(4), 1171. doi:10.2307/1127506
- Belsky, J. (1984). The Determinants of Parenting: A Process Model. *Child Development*, 55(1), 83. doi:10.2307/1129836
- Belsky, J. (1997). Attachment, mating, and parenting. *Human Nature*, 8(4), 361–381. doi:10.1007/BF02913039
- Belsky, J. (2005). The developmental and evolutionary psychology of intergenerational transmission of attachment. In C. S. Carter, L. Ahnert, K. E. Grossmann, S. B. Hrdy, M. E. Lamb, S. W. Porges, & N. Sachser (Eds.), *Attachment and bonding: A new synthesis* (pp. 169–198). Cambridge, MA: MIT Press.
- Belsky, J., Conger, R., & Capaldi, D. M. (2009). The intergenerational transmission of parenting: introduction to the special section. *Developmental Psychology*, 45(5), 1201–4. doi:10.1037/a0016245
- Belsky, J., & de Haan, M. (2011a). Annual Research Review: Parenting and children's brain development: the end of the beginning. *Journal of Child Psychology and Psychiatry*, 52(4), 409–428. doi:10.1111/j.1469-7610.2010.02281.x
- Belsky, J., & de Haan, M. (2011b). Annual Research Review: Parenting and children's brain development: the end of the beginning. *Journal of Child Psychology and Psychiatry*, 52(4), 409–428. doi:10.1111/j.1469-7610.2010.02281.x
- Belsky, J., Hancox, R. J., Sligo, J., & Poulton, R. (2012). Does being an older parent attenuate the intergenerational transmission of parenting? *Developmental Psychology*, 48(6), 1570–4. doi:10.1037/a0027599
- Belsky, J., Jaffee, S. R., Sligo, J., Woodward, L., & Silva, P. A. (2005). Intergenerational Transmission of Warm-Sensitive-Stimulating Parenting: A Prospective Study of Mothers and Fathers of 3-Year-Olds. *Child Development*, 76(2), 384–396. doi:10.1111/j.1467-8624.2005.00852.x
- Belsky, J., Jonassaint, C., Pluess, M., Stanton, M., Brummett, B., & Williams, R. (2009). Vulnerability genes or plasticity genes? *Molecular Psychiatry*, 14(8), 746–54. doi:10.1038/mp.2009.44
- Belsky, J., & Pluess, M. (2013). Beyond risk, resilience, and dysregulation:

- phenotypic plasticity and human development. *Development and Psychopathology*, 25(4 Pt 2), 1243–61. doi:10.1017/S095457941300059X
- Belsky, J., Steinberg, L., & Draper, P. (1991). Childhood experience, interpersonal development, and reproductive strategy: An evolutionary theory of socialization. *Child Development*, 62(4), 647–670.
- Belsky, J., & van IJzendoorn, M. H. (2015). What works for whom? Genetic moderation of intervention efficacy. *Development and Psychopathology*, 27(01), 1–6. doi:10.1017/S0954579414001254
- Belsky, J., Youngblade, L., Rovine, M., & Volling, B. (1991). Patterns of Marital Change and Parent-Child Interaction. *Journal of Marriage and the Family*, 53(2), 487. doi:10.2307/352914
- Bennur, S., Shankaranarayana Rao, B. S., Pawlak, R., Strickland, S., McEwen, B. S., & Chattarji, S. (2007). Stress-induced spine loss in the medial amygdala is mediated by tissue-plasminogen activator. *Neuroscience*, 144(1), 8–16. doi:10.1016/j.neuroscience.2006.08.075
- Berking, M., Ebert, D., Cuijpers, P., & Hofmann, S. G. (2013). Emotion Regulation Skills Training Enhances the Efficacy of Inpatient Cognitive Behavioral Therapy for Major Depressive Disorder: A Randomized Controlled Trial. *Psychotherapy and Psychosomatics*, 82(4), 234–245. doi:10.1159/000348448
- Berking, M., & Schwarz, J. (2013). Affect Regulation Training. In J. J. Gross (Ed.), *Handbook of Emotion Regulation Second Edition* (pp. 529–547). New York: Guilford Press.
- Berlin, L. J., Appleyard, K., & Dodge, K. A. (2011). Intergenerational Continuity in Child Maltreatment: Mediating Mechanisms and Implications for Prevention. *Child Development*, 82(1), 162–176. doi:10.1111/j.1467-8624.2010.01547.x
- Bernier, A., Matte-Gagné, C., Bélanger, M.-È., & Whipple, N. (2014). Taking stock of two decades of attachment transmission gap: broadening the assessment of maternal behavior. *Child Development*, 85(5), 1852–65. doi:10.1111/cdev.12236
- Bernstein, D. P., Fink, L., Handelsman, L., Foote, J., Lovejoy, M., Wenzel, K., ... Ruggiero, J. (1994). Initial Reliability and Validity of a New Retrospective Measure of Child-Abuse and Neglect. *American Journal of Psychiatry*, 151(8), 1132–1136. doi:10.1176/ajp.151.8.1132
- Bernstein, D. P., Stein, J. A., Newcomb, M. D., Walker, E., Pogge, D., Ahluvalia, T., ... Zule, W. (2003a). Development and validation of a brief screening version of the Childhood Trauma Questionnaire. *Child Abuse & Neglect*, 27(2), 169–190. doi:10.1016/S0145-2134(02)00541-0
- Bernstein, D. P., Stein, J. A., Newcomb, M. D., Walker, E., Pogge, D., Ahluvalia, T., ... Zule, W. (2003b). Development and validation of a brief screening

- version of the Childhood Trauma Questionnaire. *Child Abuse & Neglect*, 27(2), 169–190. doi:10.1016/S0145-2134(02)00541-0
- Berridge, K. C., & Kringelbach, M. L. (2008). Affective neuroscience of pleasure: reward in humans and animals. *Psychopharmacology*, 199(3), 457–80. doi:10.1007/s00213-008-1099-6
- Bhandari, R., Bakermans-Kranenburg, M. J., van der Veen, R., Parsons, C. E., Young, K. S., Grewen, K. M., ... van IJzendoorn, M. H. (2014). Salivary oxytocin mediates the association between emotional maltreatment and responses to emotional infant faces. *Physiology & Behavior*, 131, 123–8. doi:10.1016/j.physbeh.2014.04.028
- Bhandari, R., van der Veen, R., Parsons, C. E., Young, K. S., Voorthuis, A., Bakermans-Kranenburg, M. J., ... van IJzendoorn, M. H. (2014). Effects of intranasal oxytocin administration on memory for infant cues: moderation by childhood emotional maltreatment. *Social Neuroscience*, 9(5), 536–47. doi:10.1080/17470919.2014.932307
- Bion, W. (2013). The psycho-analytic study of thinking. *The Psychoanalytic Quarterly*, 82(2), 301–310. doi:10.1002/j.2167-4086.2013.00030.x
- Bjorklund, D. (2006). Mother knows best: Epigenetic inheritance, maternal effects, and the evolution of human intelligence. *Developmental Review*, 26(2), 213–242. doi:10.1016/j.dr.2006.02.007
- Black, M. M., & Teti, L. O. (1997). Promoting Mealtime Communication Between Adolescent Mothers and Their Infants Through Videotape. *Pediatrics*, 99(3), 432–437. doi:10.1542/peds.99.3.432
- Bleiberg, N. (1965). The neglected child and the child health conference. *New York State Journal of Medicine*, 65, 1880.
- Blue, M. T. (1965). The battered child syndrome from a social work viewpoint. *Canadian Journal of Public Health*, 56, 197.
- Boecker, R., Holz, N. E., Buchmann, A. F., Blomeyer, D., Plichta, M. M., Wolf, I., ... Laucht, M. (2014a). Impact of early life adversity on reward processing in young adults: EEG-fMRI results from a prospective study over 25 years. *PloS One*, 9(8), e104185. doi:10.1371/journal.pone.0104185
- Boecker, R., Holz, N. E., Buchmann, A. F., Blomeyer, D., Plichta, M. M., Wolf, I., ... Laucht, M. (2014b). Impact of early life adversity on reward processing in young adults: EEG-fMRI results from a prospective study over 25 years. *PloS One*, 9(8), e104185. doi:10.1371/journal.pone.0104185
- Bonomi, C. (2002). Identification with the Aggressor—An Interactive Tactic or an Intrapsychic Tomb?: Commentary on Paper by Jay Frankel. *Psychoanalytic Dialogues*, 12(1), 153–158. doi:10.1080/10481881209348659
- Born, J. M., Lemmens, S. G. T., Martens, M. J. I., Formisano, E., Goebel, R., &

- Westerterp-Plantenga, M. S. (2011). Differences between liking and wanting signals in the human brain and relations with cognitive dietary restraint and body mass index. *The American Journal of Clinical Nutrition*, 94(2), 392–403. doi:10.3945/ajcn.111.012161
- Bornstein, M. H. (2001). Parenting: Science and Practice. *Parenting*, 1(1-2), 1–4. doi:10.1080/15295192.2001.9681208
- Bornstein, M. H. (2002). Parenting infants. *Handbook of Parenting*, 1, 3–43.
- Bos, P. A., Hermans, E. J., Montoya, E. R., Ramsey, N. F., & van Honk, J. (2010). Testosterone administration modulates neural responses to crying infants in young females. *Psychoneuroendocrinology*, 35(1), 114–21. doi:10.1016/j.psyneuen.2009.09.013
- Bos, P. A., Montoya, E. R., Terburg, D., & van Honk, J. (2014). Cortisol administration increases hippocampal activation to infant crying in males depending on childhood neglect. *Human Brain Mapping*, 35(10), 5116–26. doi:10.1002/hbm.22537
- Bowlby, J. (1969). *Attachment and loss, Vol. 1: Attachment*. New York: Basic Books.
- Bowlby, J. (1980). *Attachment and loss, Vol. 3: Loss, sadness and depression*. New York: Basic Books.
- Bowlby, J. (1984). Violence in the family as a disorder of the attachment and caregiving systems. *The American Journal of Psychoanalysis*, 44(1), 9–27. doi:10.1007/BF01255416
- Bowlby, J. (1988). *A secure base: Clinical applications of attachment theory* (Vol. 393). London: Routledge.
- Bradley, B., Westen, D., Mercer, K. B., Binder, E. B., Jovanovic, T., Crain, D., ... Heim, C. (2011). Association between childhood maltreatment and adult emotional dysregulation in a low-income, urban, African American sample: moderation by oxytocin receptor gene. *Development and Psychopathology*, 23(2), 439–52. doi:10.1017/S0954579411000162
- Bradley, M. M., Codispoti, M., Cuthbert, B. N., & Lang, P. J. (2001). Emotion and motivation I: Defensive and appetitive reactions in picture processing. *Emotion*, 1(3), 276–298. doi:10.1037/1528-3542.1.3.276
- Bradley, R. H., & Corwyn, R. F. (2002). Socioeconomic status and child development. *Annual Review of Psychology*, 53, 371–99. doi:10.1146/annurev.psych.53.100901.135233
- Brainard, D. H. (1997). The Psychophysics Toolbox. *Spatial Vision*, 10(4), 433–436. doi:10.1163/156856897X00357
- Brayden, R. M., Altemeier, W. A., Tucker, D. D., Dietrich, M. S., & Vietze, P. (1992). Antecedents of child neglect in the first two years of life. *The Journal*

- of *Pediatrics*, 120(3), 426–429. doi:10.1016/S0022-3476(05)80912-6
- Brennan, K. A., Clark, C. L., & Shaver, P. R. (1998). Self-report measurement of adult attachment. *Attachment Theory and Close Relationships*, 46–76.
- Brennan, K. A., & Shaver, P. R. (2002). Attachment styles and personality disorders: Their connections to each other and to parental divorce, parental death, and perceptions of parental caregiving. *Journal of Personality*, 66(5), 835–878.
- Bretherton, I. (1985). Attachment Theory: Retrospect and Prospect. *Monographs of the Society for Research in Child Development*, 50(1/2), 3. doi:10.2307/3333824
- Bretherton, I. (1987). New perspectives on attachment relations: Security, communication, and internal working models. In I. Bretherton & J. D. Osofsky (Eds.), *Handbook of infant development (2nd ed.)* (pp. 1061–1100). Oxford, UK: John Wiley & Sons.
- Bretherton, I. (1999). Updating the “internal working model” construct: some reflections. *Attachment & Human Development*, 1(3), 343–57. doi:10.1080/14616739900134191
- Bretherton, I., & Munholland, K. A. (2008). Internal working models in attachment relationships: Elaborating a central construct in Attachment Theory. In J. Cassidy & P. R. Shaver (Eds.), *Handbook of Attachment* (pp. 103–129). New York: Guilford Press.
- Bridgett, D. J., Burt, N. M., Edwards, E. S., & Deater-Deckard, K. (2015). Intergenerational transmission of self-regulation: A multidisciplinary review and integrative conceptual framework. *Psychological Bulletin*, 141(3), 602–654. doi:10.1037/a0038662
- Brosch, T., Sander, D., & Scherer, K. R. (2007). That baby caught my eye... Attention capture by infant faces. *Emotion*, 7(3), 685–689. doi:10.1037/1528-3542.7.3.685
- Brumbach, B. H., Figueredo, A. J., & Ellis, B. J. (2009). Effects of Harsh and Unpredictable Environments in Adolescence on Development of Life History Strategies. *Human Nature*, 20(1), 25–51. doi:10.1007/s12110-009-9059-3
- Brumbaugh, C. C., & Fraley, R. C. (2007). Transference of attachment patterns: How important relationships influence feelings toward novel people. *Personal Relationships*, 14(4), 513–530. doi:10.1111/j.1475-6811.2007.00169.x
- Buchheim, A., Heinrichs, M., George, C., Pokorny, D., Koops, E., Henningsen, P., ... Gündel, H. (2009). Oxytocin enhances the experience of attachment security. *Psychoneuroendocrinology*, 34(9), 1417–22. doi:10.1016/j.psyneuen.2009.04.002
- Buckner, J. C., Mezzacappa, E., & Beardslee, W. R. (2003). Characteristics of

- resilient youths living in poverty: The role of self-regulatory processes. *Development and Psychopathology*, 15(1), 139–162. doi:10.1017/S0954579403000087
- Bus, A. G., & van IJzendoorn, M. H. (1997). Affective dimension of mother-infant picturebook reading. *Journal of School Psychology*, 35(1), 47–60.
- Busonera, A., Martini, P. S., Zavattini, G. C., & Santona, A. (2014). Psychometric properties of an italian version of the Experiences in Close Relationships–Revised (ECR–R) Scale. *Psychological Reports*, 140402143305007. doi:10.2466/03.21.PR0.114k23w9
- Buwalda, B., Stubbendorff, C., Zickert, N., & Koolhaas, J. M. (2013). Adolescent social stress does not necessarily lead to a compromised adaptive capacity during adulthood: a study on the consequences of social stress in rats. *Neuroscience*, 249, 258–70. doi:10.1016/j.neuroscience.2012.12.050
- Caldwell, J. G., Shaver, P. R., Li, C.-S., & Minzenberg, M. J. (2011). Childhood Maltreatment, Adult Attachment, and Depression as Predictors of Parental Self-Efficacy in At-Risk Mothers. *Journal of Aggression, Maltreatment & Trauma*, 20(6), 595–616. doi:10.1080/10926771.2011.595763
- Campana, G., Cowey, A., Casco, C., Oudsen, I., & Walsh, V. (2007a). Left frontal eye field remembers “where” but not “what.” *Neuropsychologia*, 45(10), 2340–2345. doi:10.1016/j.neuropsychologia.2007.02.009
- Campana, G., Cowey, A., Casco, C., Oudsen, I., & Walsh, V. (2007b). Left frontal eye field remembers “where” but not “what.” *Neuropsychologia*, 45(10), 2340–2345. doi:10.1016/j.neuropsychologia.2007.02.009
- Cantazaro, A., & Wei, M. (2010). Adult Attachment, Dependence, Self Criticism, and Depressive Symptoms: A Test of a Mediational Model. *Journal of Personality*, 78(4), 1135–1162.
- Capaldi, D. M., Pears, K. C., Patterson, G. R., & Owen, L. D. (2003). Continuity of Parenting Practices Across Generations in an At-Risk Sample: A Prospective Comparison of Direct and Mediated Associations. *Journal of Abnormal Child Psychology*, 31(2), 127–142. doi:10.1023/A:1022518123387
- Carnelley, K. B., & Rowe, A. (2007). Repeated priming of attachment security influences later views of self and relationships. *Personal Relationships*, 14(2), 307–320. doi:10.1111/j.1475-6811.2007.00156.x
- Carter, C. S., & Altemus, M. (1997). Integrative Functions of Lactational Hormones in Social Behavior and Stress Management. *Annals of the New York Academy of Sciences*, 807(1 Integrative N), 164–174. doi:10.1111/j.1749-6632.1997.tb51918.x
- Caspi, A., & Elder, G. H. (1988). Emergent family patterns: The intergenerational construction of problem behavior and relationships. In: In R. A. Hinde & J. Stevenson-Hinde (Eds.), *Relationships within families: Mutual influences* (pp.

- 218–240). Oxford: Clarendon Press.
- Caspi, A., McClay, J., Moffitt, T. E., Mill, J., Martin, J., Craig, I. W., ... Poulton, R. (2002). Role of Genotype in the Cycle of Violence in Maltreated Children. *Science*, 297(5582), 851–854. doi:10.1126/science.1072290
- Cassidy, J. (1994). Emotion regulation: influences of attachment relationships. *Monographs of the Society for Research in Child Development*, 59(2-3), 228–249. doi:10.1111/j.1540-5834.1994.tb01287.x
- Cassidy, J. (2008). The nature of the child's ties. In J. Cassidy & P. R. Shaver (Eds.), *Handbook of attachment: Theory, research, and clinical applications* (2nd ed.) (pp. 3–22). New York: Guilford Press.
- Chaffin, M., Silovsky, J. F., Funderburk, B., Valle, L. A., Brestan, E. V., Balachova, T., ... Bonner, B. L. (2004). Parent-Child Interaction Therapy With Physically Abusive Parents: Efficacy for Reducing Future Abuse Reports. *Journal of Consulting and Clinical Psychology*, 72(3), 500–510. doi:10.1037/0022-006X.72.3.500
- Champagne, D. L., Bagot, R. C., van Hasselt, F., Ramakers, G., Meaney, M. J., de Kloet, E. R., ... Krugers, H. (2008). Maternal care and hippocampal plasticity: evidence for experience-dependent structural plasticity, altered synaptic functioning, and differential responsiveness to glucocorticoids and stress. *The Journal of Neuroscience : The Official Journal of the Society for Neuroscience*, 28(23), 6037–45. doi:10.1523/JNEUROSCI.0526-08.2008
- Chapman, H. A., & Anderson, A. K. (2013). Things rank and gross in nature: a review and synthesis of moral disgust. *Psychological Bulletin*, 139(2), 300.
- Chapman, H. A., Kim, D. A., Susskind, J. M., & Anderson, A. K. (2009). In bad taste: Evidence for the oral origins of moral disgust. *Science*, 323(5918), 1222–1226.
- Chen, M., & Bargh, J. A. (1999). Consequences of Automatic Evaluation: Immediate Behavioral Predispositions to Approach or Avoid the Stimulus. *Personality and Social Psychology Bulletin*, 25(2), 215–224. doi:10.1177/0146167299025002007
- Chen, M., & Johnston, C. (2007). Maternal inattention and impulsivity and parenting behaviors. *Journal of Clinical Child and Adolescent Psychology : The Official Journal for the Society of Clinical Child and Adolescent Psychology, American Psychological Association, Division 53*, 36(3), 455–68. doi:10.1080/15374410701448570
- Chen, R., Classen, J., Gerloff, C., Celnik, P., Wassermann, E. M., Hallett, M., & Cohen, L. G. (1997a). Depression of motor cortex excitability by low-frequency transcranial magnetic stimulation. *Neurology*, 48(5), 1398–1403. doi:10.1212/WNL.48.5.1398
- Chen, R., Classen, J., Gerloff, C., Celnik, P., Wassermann, E. M., Hallett, M., &

- Cohen, L. G. (1997b). Depression of motor cortex excitability by low-frequency transcranial magnetic stimulation. *Neurology*, 48(5), 1398–1403. doi:10.1212/WNL.48.5.1398
- Chen, Z., & Kaplan, H. B. (2001). Intergenerational Transmission of Constructive Parenting. *Journal of Marriage and Family*, 63(1), 17–31. doi:10.1111/j.1741-3737.2001.00017.x
- Chentsova-Dutton, Y. E., & Tsai, J. L. (2010). Self-focused attention and emotional reactivity: the role of culture. *Journal of Personality and Social Psychology*, 98(3), 507–19. doi:10.1037/a0018534
- Chico, E., Gonzalez, A., Ali, N., Steiner, M., & Fleming, A. S. (2014). Executive function and mothering: challenges faced by teenage mothers. *Developmental Psychobiology*, 56(5), 1027–35. doi:10.1002/dev.21185
- Chisholm, J. S. (1993). Death, Hope, and Sex: Life-History Theory and the Development of Reproductive Strategies. *Current Anthropology*, 34(1), 1. doi:10.1086/204131
- Cicchetti, D. (2013a). Annual Research Review: Resilient functioning in maltreated children--past, present, and future perspectives. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, 54(4), 402–22. doi:10.1111/j.1469-7610.2012.02608.x
- Cicchetti, D. (2013b). Annual Research Review: Resilient functioning in maltreated children--past, present, and future perspectives. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, 54(4), 402–22. doi:10.1111/j.1469-7610.2012.02608.x
- Cicchetti, D., & Rogosch, F. A. (1997). The role of self-organization in the promotion of resilience in maltreated children. *Development and Psychopathology*, 9(04). doi:10.1017/S0954579497001442
- Cicchetti, D., & Rogosch, F. A. (2001). Diverse patterns of neuroendocrine activity in maltreated children. *Development and Psychopathology*, 13(3), 677–693. doi:10.1017/S0954579401003145
- Cicchetti, D., & Toth, S. L. (1995). A Developmental Psychopathology Perspective on Child Abuse and Neglect. *Journal of the American Academy of Child & Adolescent Psychiatry*, 34(5), 541–565. doi:10.1097/00004583-199505000-00008
- Cisler, J. M., James, G. A., Tripathi, S., Mletzko, T., Heim, C., Hu, X. P., ... Kilts, C. D. (2013). Differential functional connectivity within an emotion regulation neural network among individuals resilient and susceptible to the depressogenic effects of early life stress. *Psychological Medicine*, 43(3), 507–18. doi:10.1017/S0033291712001390
- Clore, G. L., & Schnall, S. (2005). The influence of affect on attitude. *The Handbook of Attitudes*, 437–489.

- Cohn, J. F., & Tronick, E. Z. (1983). Three-month-old infants' reaction to simulated maternal depression. *Child Development*, 54(1), 185–193. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/6831986>
- Compier-de Block, L. H. C. G., Alink, L. R. A., Reijman, S., Werner, C. D., Maras, A., Rijnberk, C., ... Bakermans-Kranenburg, M. J. (2014). Handgrip force of maltreating mothers in reaction to infant signals. *Child Abuse & Neglect*. doi:10.1016/j.chiabu.2014.03.006
- Compier-de Block, L. H. C. G., Alink, L. R. A., Reijman, S., Werner, C. D., Maras, A., Rijnberk, C., ... Bakermans-Kranenburg, M. J. (2015). Handgrip force of maltreating mothers in reaction to infant signals. *Child Abuse & Neglect*, 40, 124–31. doi:10.1016/j.chiabu.2014.03.006
- Conger, R. D., Belsky, J., & Capaldi, D. M. (2009). The intergenerational transmission of parenting: closing comments for the special section. *Developmental Psychology*, 45(5), 1276–83. doi:10.1037/a0016911
- Conger, R. D., Burgess, R. L., & Barrett, C. (1979). Child Abuse Related to Life Change and Perceptions of Illness: Some Preliminary Findings. *The Family Coordinator*, 28(1), 73. doi:10.2307/583271
- Conger, R. D., Neppl, T., Kim, K. J., & Scaramella, L. (2003). Angry and Aggressive Behavior Across Three Generations: A Prospective, Longitudinal Study of Parents and Children. *Journal of Abnormal Child Psychology*, 31(2), 143–160. doi:10.1023/A:1022570107457
- Conger, R. D., Schofield, T. J., & Neppl, T. K. (2012). Intergenerational Continuity and Discontinuity in Harsh Parenting. *Parenting*, 12(2-3), 222–231. doi:10.1080/15295192.2012.683360
- Conger, R. D., Schofield, T. J., Neppl, T. K., & Merrick, M. T. (2013). Disrupting Intergenerational Continuity in Harsh and Abusive Parenting: The Importance of a Nurturing Relationship With a Romantic Partner. *Journal of Adolescent Health*, 53(4), S11–S17. doi:10.1016/j.jadohealth.2013.03.014
- Corriveau, K. H., Harris, P. L., Meins, E., Fernyhough, C., Arnott, B., Elliott, L., ... de Rosnay, M. (2009). Young Children's Trust in Their Mother's Claims: Longitudinal Links With Attachment Security in Infancy. *Child Development*, 80(3), 750–761. doi:10.1111/j.1467-8624.2009.01295.x
- Crandall, A., Deater-Deckard, K., & Riley, A. W. (2015). Maternal emotion and cognitive control capacities and parenting: A conceptual framework. *Developmental Review*, 36, 105–126. doi:10.1016/j.dr.2015.01.004
- Crawford, T. N., Livesley, W. J., Jang, K. L., Shaver, P. R., Cohen, P., & Ganiban, J. (2007). Insecure Attachment and Personality Disorder : A Twin Study of Adults, 208(December 2005), 191–208. doi:10.1002/per
- Crouch, J. L., Skowronski, J. J., Milner, J. S., & Harris, B. (2008). Parental responses to infant crying: the influence of child physical abuse risk and

hostile priming. *Child Abuse & Neglect*, 32(7), 702–10.
doi:10.1016/j.chiabu.2007.11.002

Crowley, S. K., Pedersen, C. A., Leserman, J., & Girdler, S. S. (2015). The influence of early life sexual abuse on oxytocin concentrations and premenstrual symptomatology in women with a menstrually related mood disorder. *Biological Psychology*, 109, 1–9.
doi:10.1016/j.biopsycho.2015.04.003

Cuevas, K., Deater-Deckard, K., Kim-Spoon, J., Watson, A. J., Morasch, K. C., & Bell, M. A. (2014). What's mom got to do with it? Contributions of maternal executive function and caregiving to the development of executive function across early childhood. *Developmental Science*, 17(2), 224–38.
doi:10.1111/desc.12073

Curtis, W. J., & Cicchetti, D. (2007). Emotion and resilience: A multilevel investigation of hemispheric electroencephalogram asymmetry and emotion regulation in maltreated and nonmaltreated children. *Development and Psychopathology*, 19(03), 811. doi:10.1017/S0954579407000405

Curtis, W. J., & Cicchetti, D. (2011). Affective facial expression processing in young children who have experienced maltreatment during the first year of life: an event-related potential study. *Development and Psychopathology*, 23(2), 373–95. doi:10.1017/S0954579411000125

Curtis, W. J., & Cicchetti, D. (2013). Affective facial expression processing in 15-month-old infants who have experienced maltreatment: an event-related potential study. *Child Maltreatment*, 18(3), 140–54.
doi:10.1177/1077559513487944

Cyranowski, J. M., Hofkens, T. L., Frank, E., Seltman, H., Cai, H.-M., & Amico, J. A. (2008). Evidence of dysregulated peripheral oxytocin release among depressed women. *Psychosomatic Medicine*, 70(9), 967–75.
doi:10.1097/PSY.0b013e318188ade4

da Silva Ferreira, G. C., de Sousa Crippa, J. A., & de Lima Osório, F. (2014). Facial emotion processing and recognition among maltreated children: a systematic literature review. *Frontiers in Psychology*, 5.
doi:10.3389/fpsyg.2014.01460

Dannlowski, U., Kugel, H., Huber, F., Stuhrmann, A., Redlich, R., Grotegerd, D., ... Suslow, T. (2013). Childhood maltreatment is associated with an automatic negative emotion processing bias in the amygdala. *Human Brain Mapping*, 34(11), 2899–909. doi:10.1002/hbm.22112

Dannlowski, U., Stuhrmann, A., Beutelmann, V., Zwanzger, P., Lenzen, T., Grotegerd, D., ... Kugel, H. (2012). Limbic scars: long-term consequences of childhood maltreatment revealed by functional and structural magnetic resonance imaging. *Biological Psychiatry*, 71(4), 286–93.
doi:10.1016/j.biopsych.2011.10.021

- De Wolff, M. S., & van IJzendoorn, M. H. (1997, August). Sensitivity and attachment: a meta-analysis on parental antecedents of infant attachment. *Child Development*. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/9306636>
- Dean, A. C., Kohno, M., Hellemann, G., & London, E. D. (2014). Childhood maltreatment and amygdala connectivity in methamphetamine dependence: a pilot study. *Brain and Behavior*, 4(6), 867–76. doi:10.1002/brb3.289
- Deater-Deckard, K., Sewell, M. D., Petrill, S. A., & Thompson, L. A. (2010). Maternal working memory and reactive negativity in parenting. *Psychological Science*, 21(1), 75–9. doi:10.1177/0956797609354073
- Deco, G., & Kringelbach, M. L. (2014). Great Expectations: Using Whole-Brain Computational Connectomics for Understanding Neuropsychiatric Disorders. *Neuron*, 84(5), 892–905. doi:10.1016/j.neuron.2014.08.034
- Deco, G., Tononi, G., Boly, M., & Kringelbach, M. L. (2015). Rethinking segregation and integration: contributions of whole-brain modelling. *Nature Reviews Neuroscience*, 16(7), 430–439. doi:10.1038/nrn3963
- Del Giudice, M. (2009). Sex, attachment, and the development of reproductive strategies. *The Behavioral and Brain Sciences*, 32(1), 1–21; discussion 21–67. doi:10.1017/S0140525X09000016
- Del Giudice, M. (2014). Early stress and human behavioral development: emerging evolutionary perspectives. *Journal of Developmental Origins of Health and Disease*, 5(4), 270–80. doi:10.1017/S2040174414000257
- Del Giudice, M. (2015). Self-Regulation in an Evolutionary Perspective. In G. H. E. Gendolla, M. Tops, & S. L. Koole (Eds.), *Handbook of Biobehavioral Approaches to Self-Regulation* (pp. 25–41). New York, NY: Springer. doi:10.1007/978-1-4939-1236-0_3
- Del Giudice, M., & Belsky, J. (2007). Evolving Attachment Theory : Beyond Bowlby and Back to Darwin, 4(2), 112–113.
- Del Giudice, M., Ellis, B. J., & Shirtcliff, E. A. (2011). The Adaptive Calibration Model of stress responsivity. *Neuroscience and Biobehavioral Reviews*, 35(7), 1562–92. doi:10.1016/j.neubiorev.2010.11.007
- Del Giudice, M., Gangestad, S. W., & Kaplan, H. S. (2015). Life history theory and evolutionary psychology. In D. M. Buss (Ed.), *The handbook of evolutionary psychology* (2nd edit., pp. 88–114). New York: Wiley.
- Del Vecchio, T., Walter, A., & O’Leary, S. G. (2009). Affective and physiological factors predicting maternal response to infant crying. *Infant Behavior & Development*, 32(1), 117–22. doi:10.1016/j.infbeh.2008.10.005
- Den Uyl, M. J., & Van Kuilenburg, H. (2005). The FaceReader: Online facial expression recognition. In *Proceedings of Measuring Behavior* (Vol. 30).

- DeWall, C. N., Gillath, O., Pressman, S. D., Black, L. L., Bartz, J. A., Moskowitz, J., & Stetler, D. A. (2014). When the Love Hormone Leads to Violence: Oxytocin Increases Intimate Partner Violence Inclinations Among High Trait Aggressive People. *Social Psychological and Personality Science*, 5(6), 691–697. doi:10.1177/1948550613516876
- Dewitte, M., De Houwer, J., & Buysse, A. (2008). On the Role of the Implicit Self-Concept in Adult Attachment. *European Journal of Psychological Assessment*, 24(4), 282–289. doi:10.1027/1015-5759.24.4.282
- Dewitte, M., Koster, E. H. W., De Houwer, J., & Buysse, A. (2007). Attentive processing of threat and adult attachment: A dot-probe study. *Behaviour Research and Therapy*, 45(6), 1307–1317.
- Dillon, D. G., Holmes, A. J., Birk, J. L., Brooks, N., Lyons-Ruth, K., & Pizzagalli, D. A. (2009). Childhood adversity is associated with left basal ganglia dysfunction during reward anticipation in adulthood. *Biological Psychiatry*, 66(3), 206–13. doi:10.1016/j.biopsych.2009.02.019
- Ding, J., Han, F., & Shi, Y. (2010). Single-prolonged stress induces apoptosis in the amygdala in a rat model of post-traumatic stress disorder. *Journal of Psychiatric Research*, 44(1), 48–55. doi:10.1016/j.jpsychires.2009.06.001
- Ditzen, B., Schaer, M., Gabriel, B., Bodenmann, G., Ehler, U., & Heinrichs, M. (2009). Intranasal oxytocin increases positive communication and reduces cortisol levels during couple conflict. *Biological Psychiatry*, 65(9), 728–31. doi:10.1016/j.biopsych.2008.10.011
- Dix, T., Gershoff, E. T., Meunier, L. N., & Miller, P. C. (2004). The affective structure of supportive parenting: depressive symptoms, immediate emotions, and child-oriented motivation. *Developmental Psychology*, 40(6), 1212–27. doi:10.1037/0012-1649.40.6.1212
- Dixon, L., Browne, K., & Hamilton-Giachritsis, C. (2005). Risk factors of parents abused as children: a mediational analysis of the intergenerational continuity of child maltreatment (Part I). *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, 46(1), 47–57. doi:10.1111/j.1469-7610.2004.00339.x
- Dixon, L., Hamilton-Giachritsis, C., & Browne, K. (2005). Attributions and behaviours of parents abused as children: a mediational analysis of the intergenerational continuity of child maltreatment (Part II). *Journal of Child Psychology and Psychiatry*, 46(1), 58–68. doi:10.1111/j.1469-7610.2004.00340.x
- Dodge, K., Bates, J., & Pettit, G. (1990). Mechanisms in the cycle of violence. *Science*, 250(4988), 1678–1683. doi:10.1126/science.2270481
- Domes, G., Heinrichs, M., Michel, A., Berger, C., & Herpertz, S. C. (2007). Oxytocin improves “mind-reading” in humans. *Biological Psychiatry*, 61(6), 731–3. doi:10.1016/j.biopsych.2006.07.015

- Dowdney, L., Skuse, D., Rutter, M., Quinton, D., & Mrazek, D. (1985). The nature and qualities of parenting provided by women raised in institutions. *Journal of Child Psychology and Psychiatry*, 26(4), 599–625. doi:10.1111/j.1469-7610.1985.tb01644.x
- Dozier, M., Meade, E., & Bernard, K. (2014). Attachment and Biobehavioral Catch-Up: An Intervention for Parents at Risk of Maltreating Their Infants and Toddlers. In S. Timmer & A. Urquiza (Eds.), *Evidence-Based Approaches for the Treatment of Maltreated Children* (pp. 43–59). Dordrecht. doi:10.1007/978-94-007-7404-9_4
- DuMont, K. A., Widom, C. S., & Czaja, S. J. (2007). Predictors of resilience in abused and neglected children grown-up: The role of individual and neighborhood characteristics. *Child Abuse & Neglect*, 31(3), 255–274. doi:10.1016/j.chiabu.2005.11.015
- Dykas, M. J., & Cassidy, J. (2011). Attachment and the processing of social information across the life span: theory and evidence. *Psychological Bulletin*, 137(1), 19–46. doi:10.1037/a0021367
- Eagle, M. N. (1990). Attachment research and psychoanalytic theory. In *Environment* (pp. 105–149).
- Egeland, B., Jacobvitz, D., & Papatola, K. (1987). Intergenerational continuity of abuse. In R. Gelles & J. Lancaster (Eds.), *Child abuse and neglect: Biosocial dimensions* (pp. 255–276). New York: Aldine.
- Egeland, B., Jacobvitz, D., & Sroufe, L. A. (1988). Breaking the Cycle of Abuse. *Child Development*, 59(4), 1080. doi:10.2307/1130274
- Ein-Dor, T., Mikulincer, M., & Shaver, P. R. (2011). Attachment insecurities and the processing of threat-related information: Studying the schemas involved in insecure people's coping strategies. *Journal of Personality and Social Psychology*, 101(1), 78–93. doi:10.1037/a0022503
- Ekman, P. (1992). Facial expressions of emotion: an old controversy and new findings. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 335(1273), 63–9. doi:10.1098/rstb.1992.0008
- Ekman, P., & Rosenberg, E. L. (1997). *What the face reveals: Basic and applied studies of spontaneous expression using the Facial Action Coding System (FACS)*. Oxford University Press.
- Elder, G. H., Johnson, M. K., & Crosnoe, R. (2003). The Emergence and Development of Life Course Theory. In *Handbook of the Life Course* (pp. 3–19). Boston, MA: Springer US. doi:10.1007/978-0-306-48247-2_1
- Ellis, B. J., & Del Giudice, M. (2014). Beyond allostatic load: rethinking the role of stress in regulating human development. *Development and Psychopathology*, 26(1), 1–20. doi:10.1017/S0954579413000849

- Ellis, B. J., Figueredo, A. J., Brumbach, B. H., & Schlomer, G. L. (2009). Fundamental Dimensions of Environmental Risk. *Human Nature*, 20(2), 204–268. doi:10.1007/s12110-009-9063-7
- Ellis, B. J., & Garber, J. (2000). Psychosocial Antecedents of Variation in Girls' Pubertal Timing: Maternal Depression, Stepfather Presence, and Marital and Family Stress. *Child Development*, 71(2), 485–501. doi:10.1111/1467-8624.00159
- Ellis, B. J., McFadyen-Ketchum, S., Dodge, K. A., Pettit, G. S., & Bates, J. E. (1999a). Quality of early family relationships and individual differences in the timing of pubertal maturation in girls: A longitudinal test of an evolutionary model. *Journal of Personality and Social Psychology*, 77(2), 387–401. doi:10.1037/0022-3514.77.2.387
- Ellis, B. J., McFadyen-Ketchum, S., Dodge, K. A., Pettit, G. S., & Bates, J. E. (1999b). Quality of early family relationships and individual differences in the timing of pubertal maturation in girls: A longitudinal test of an evolutionary model. *Journal of Personality and Social Psychology*, 77(2), 387–401. doi:10.1037/0022-3514.77.2.387
- Emde, R. N. (1991). Positive emotions for psychoanalytic theory: Surprises from infancy research and new directions. *Journal of the American Psychoanalytic Association*, 39, 5–44.
- Emde, R. N. (1999). Moving ahead: integrating influences of affective processes for development and for psychoanalysis. *The International Journal of Psychoanalysis*, 80(2), 317–339. doi:10.1516/0020757991598738
- Engert, V., Efanov, S. I., Dedovic, K., Dagher, A., & Pruessner, J. C. (2011). Increased cortisol awakening response and afternoon/evening cortisol output in healthy young adults with low early life parental care. *Psychopharmacology*, 214(1), 261–8. doi:10.1007/s00213-010-1918-4
- Erickson, M. F., Egeland, B., & Pianta, R. (1989). The effects of maltreatment on the development of young children. In D. Cicchetti & V. Carlson (Eds.), *Child maltreatment: Theory and research on the causes and consequences of child abuse and neglect* (pp. 647–684). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511665707
- Ertem, I. O., Leventhal, J. M., & Dobbs, S. (2000). Intergenerational continuity of child physical abuse: how good is the evidence? *The Lancet*, 356(9232), 814–819. doi:10.1016/S0140-6736(00)02656-8
- Esposito, G., Valenzi, S., Islam, T., Mash, C., & Bornstein, M. H. (2015). Immediate and selective maternal brain responses to own infant faces. *Behavioural Brain Research*, 278, 40–43. doi:10.1016/j.bbr.2014.09.018
- Euser, S., Alink, L. R., Stoltenborgh, M., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2015). A gloomy picture: a meta-analysis of randomized controlled trials reveals disappointing effectiveness of programs aiming at

- preventing child maltreatment. *BMC Public Health*, 15(1), 1068.
doi:10.1186/s12889-015-2387-9
- Evans, G. W., Swain, J. E., King, A. P., Wang, X., Javanbakht, A., Ho, S. S., ... Liberzon, I. (2015). Childhood Cumulative Risk Exposure and Adult Amygdala Volume and Function. *Journal of Neuroscience Research*.
doi:10.1002/jnr.23681
- Fairchild, A. J. (2006). Investigating Validity Evidence for the Experiences in Close Relationships-Revised Questionnaire. *Educational and Psychological Measurement*, 66(1), 116–135. doi:10.1177/0013164405278564
- Famularo, R., Fenton, T., & Kinscherff, R. (1992). Medical and Developmental Histories Of Maltreated Children. *Clinical Pediatrics*, 31(9), 536–541.
doi:10.1177/000992289203100904
- Fan, Y., Herrera-Melendez, A. L., Pestke, K., Feeser, M., Aust, S., Otte, C., ... Grimm, S. (2014). Early life stress modulates amygdala-prefrontal functional connectivity: implications for oxytocin effects. *Human Brain Mapping*, 35(10), 5328–39. doi:10.1002/hbm.22553
- Fani, N., Bradley-Davino, B., Ressler, K. J., & McClure-Tone, E. B. (2011). Attention Bias in Adult Survivors of Childhood Maltreatment with and without Posttraumatic Stress Disorder. *Cognitive Therapy and Research*, 35(1), 57–67. doi:10.1007/s10608-010-9294-2
- Farb, N. A. S., Anderson, A. K., Irving, J. A., & Segal, Z. V. (2013). Mindfulness Interventions and Emotion Regulation. In J. J. Gross (Ed.), *Handbook of Emotion Regulation Second Edition* (pp. 548–570). New York: Guilford Press.
- Farc, M.-M., Crouch, J. L., Skowronski, J. J., & Milner, J. S. (2008). Hostility ratings by parents at risk for child abuse: Impact of chronic and temporary schema activation. *Child Abuse & Neglect*, 32(2), 177–193.
doi:10.1016/j.chiabu.2007.06.001
- Feder, A., Nestler, E. J., & Charney, D. S. (2009). Psychobiology and molecular genetics of resilience. *Nature Reviews. Neuroscience*, 10(6), 446–57.
doi:10.1038/nrn2649
- Feeser, M., Fan, Y., Weigand, A., Hahn, A., Gärtner, M., Aust, S., ... Grimm, S. (2014). The beneficial effect of oxytocin on avoidance-related facial emotion recognition depends on early life stress experience. *Psychopharmacology*, 231(24), 4735–44. doi:10.1007/s00213-014-3631-1
- Feldman, R. (2007). On the origins of background emotions: from affect synchrony to symbolic expression. *Emotion*, 7(3), 601–11. doi:10.1037/1528-3542.7.3.601
- Feldman, R., Gordon, I., & Zagoory-Sharon, O. (2011). Maternal and paternal plasma, salivary, and urinary oxytocin and parent-infant synchrony: considering stress and affiliation components of human bonding.

Developmental Science, 14(4), 752–61. doi:10.1111/j.1467-7687.2010.01021.x

- Feldman, R., Weller, A., Zagoory-Sharon, O., & Levine, A. (2007). Evidence for a neuroendocrinological foundation of human affiliation: plasma oxytocin levels across pregnancy and the postpartum period predict mother-infant bonding. *Psychological Science*, 18(11), 965–70. doi:10.1111/j.1467-9280.2007.02010.x
- Felitti, V. J. (2002). The relationship of adverse childhood experiences to adult health: Turning gold into lead/ Belastungen in der Kindheit und Gesundheit im Erwachsenenalter: die Verwandlung von Gold in Blei. *Zeitschrift Für Psychosomatische Medizin Und Psychotherapie*, 48(4), 359–369. doi:10.13109/zptm.2002.48.4.359
- Ferenczi, S. (1931). Child-analysis in the analysis of adults. *The International Journal of Psychoanalysis*, 12, 468–482.
- Ferenczi, S. (1933). Confusions of tongues between adults and the child. In *Final contributions to the problems and methods of Psycho-Analysis* (pp. 156–167). London: Karnac Books, 1980.
- Ferenczi, S., Dupont, J., Balint, M., & Jackson, N. Z. (1995). *The clinical diary of Sandor Ferenczi*. Harvard University Press.
- Ferrari, C., Lega, C., Vernice, M., Tamietto, M., Mende-Siedlecki, P., Vecchi, T., ... Cattaneo, Z. (2014). The Dorsomedial Prefrontal Cortex Plays a Causal Role in Integrating Social Impressions from Faces and Verbal Descriptions. *Cerebral Cortex (New York, N.Y. : 1991)*. doi:10.1093/cercor/bhu186
- Field, T. (2010). Postpartum depression effects on early interactions, parenting, and safety practices: A review. *Infant Behavior and Development*, 33(1), 1–6. doi:10.1016/j.infbeh.2009.10.005
- Figueredo, A., Vasquez, G., Brumbach, B., Schneider, S., Sefcek, J., Tal, I., ... Jacobs, W. (2006). Consilience and Life History Theory: From genes to brain to reproductive strategy. *Developmental Review*, 26(2), 243–275. doi:10.1016/j.dr.2006.02.002
- Flanagan, J. C., Baker, N. L., McRae-Clark, A. L., Brady, K. T., & Moran-Santa Maria, M. M. (2015). Effects of adverse childhood experiences on the association between intranasal oxytocin and social stress reactivity among individuals with cocaine dependence. *Psychiatry Research*, 229(1-2), 94–100. doi:10.1016/j.psychres.2015.07.064
- Fleming, A. S., Steiner, M., & Corter, C. (1997). Cortisol, hedonics, and maternal responsiveness in human mothers. *Hormones and Behavior*, 32(2), 85–98. doi:10.1006/hbeh.1997.1407
- Fonagy, P., & Allison, E. (2014). The role of mentalizing and epistemic trust in the therapeutic relationship. *Psychotherapy*, 51(3), 372–380.

doi:10.1037/a0036505

- Fonagy, P., Gergely, G., Jurist, G., & Target, M. (2002). Affect Regulation, Mentalization, and the Development of the Self. New York: Other Press.
- Fonagy, P., Gergely, G., & Target, M. (2008). Psychoanalytic constructs and attachment theory and research. In J. Cassidy & P. R. Shaver (Eds.), *Handbook of attachment: Theory, research, and clinical applications* (pp. 783–810). New York: Guilford Press.
- Fonagy, P., Luyten, P., & Allison, E. (2015). Epistemic Petrification and the Restoration of Epistemic Trust: A New Conceptualization of Borderline Personality Disorder and Its Psychosocial Treatment. *Journal of Personality Disorders*, 29(5), 575–609. doi:10.1521/pedi.2015.29.5.575
- Fonagy, P., Steele, M., Moran, G., Steele, H., & Higgitt, A. (1993). Measuring the Ghost In the Nursery: An Empirical Study of the Relation between Parents' Mental Representations of Childhood Experiences And Their Infants' Security of Attachment. *Journal of the American Psychoanalytic Association*, 41(4), 957–989. doi:10.1177/000306519304100403
- Fonagy, P., & Target, M. (1997). Attachment and reflective function: Their role in self-organization. *Development and Psychopathology*, 9(04), 679–700.
- Fonagy, P., & Target, M. (2002). Early Intervention and the Development of Self-Regulation. *Psychoanalytic Inquiry*, 22(3), 307–335. doi:10.1080/07351692209348990
- Fonagy, P., & Target, M. (2005). Bridging the transmission gap: an end to an important mystery of attachment research? *Attachment & Human Development*, 7(3), 333–43. doi:10.1080/14616730500269278
- Fonagy, P., Target, M., Steele, H., & Steele, M. (1998). Reflective-functioning manual, version 5.0, for application to adult attachment interviews. London: University College London.
- Fontaine, D., & Nolin, P. (2012). Study of “Hot” Executive Functions in a Sample of Parents Who Have Been Accused of Physical Abuse or Neglect. *Journal of Aggression, Maltreatment & Trauma*, 21(1), 1–18. doi:10.1080/10926771.2012.632391
- Fontana, V. J. (1968). Further reflections on maltreatment of children. *New York State Journal of Medicine*, 68(16), 2214–2215.
- Forman, D. R., O'hara, M. W., Stuart, S., Gorman, L. L., Larsen, K. E., & Coy, K. C. (2007). Effective treatment for postpartum depression is not sufficient to improve the developing mother–child relationship. *Development and Psychopathology*, 19(02). doi:10.1017/S0954579407070289
- Forman-Hoffman, V., Knauer, S., McKeeman, J., Zolotor, A., Blanco, R., Lloyd, S., ... Viswanathan, M. (2013). Child and Adolescent Exposure to Trauma:

- Comparative Effectiveness of Interventions Addressing Trauma Other Than Maltreatment or Family Violence. *Comparative Effectiveness Review*, (107).
- Fraedrich, E. M., Lakatos, K., & Spangler, G. (2010). Brain activity during emotion perception: the role of attachment representation. *Attachment & Human Development*, 12(3), 231–248. doi:10.1080/14616731003759724
- Fraiberg, S. (1980). *Clinical studies in infant mental health: The first year of life*. London: Tavistock.
- Fraiberg, S., Adelson, E., & Shapiro, V. (1975). Ghosts in the Nursery. *Journal of the American Academy of Child Psychiatry*, 14(3), 387–421. doi:10.1016/S0002-7138(09)61442-4
- Fraley, R. C. (2002). Attachment stability from infancy to adulthood: Meta-analysis and dynamic modeling of developmental mechanisms. *Personality and Social Psychology Review*, 6(2), 123–151.
- Fraley, R. C., Hudson, N. W., Heffernan, M. E., & Segal, N. (2015). Are Adult Attachment Styles Categorical or Dimensional? A Taxometric Analysis of General and Relationship-Specific Attachment Orientations. *Journal of Personality and Social Psychology*. doi:10.1037/pspp0000027
- Fraley, R. C., Waller, N. G., & Brennan, K. A. (2000). An item response theory analysis of self-report measures of adult attachment. *Journal of Personality and Social Psychology*, 78(2), 350–365. doi:10.1037//0022-3514.78.2.350
- Frankel, J. (2002). Exploring Ferenczi's Concept of Identification with the Aggressor: Its Role in Trauma, Everyday Life, and the Therapeutic Relationship. *Psychoanalytic Dialogues*, 12(1), 101–139. doi:10.1080/10481881209348657
- Frankenhuis, W. E., & de Weerth, C. (2013). Does Early-Life Exposure to Stress Shape or Impair Cognition? *Current Directions in Psychological Science*, 22(5), 407–412. doi:10.1177/0963721413484324
- Frankenhuis, W. E., Gergely, G., & Watson, J. S. (2013). Infants May Use Contingency Analysis to Estimate Environmental States: An Evolutionary, Life-History Perspective. *Child Development Perspectives*, 7(2), 115–120. doi:10.1111/cdep.12024
- Franklin, T. B., Russig, H., Weiss, I. C., Gräff, J., Linder, N., Michalon, A., ... Mansuy, I. M. (2010). Epigenetic transmission of the impact of early stress across generations. *Biological Psychiatry*, 68(5), 408–15. doi:10.1016/j.biopsych.2010.05.036
- Freud, A. (1936). *The ego and the mechanisms of defense*. New York: International Universities Press.
- Freud, S. (1914). On narcissism: an introduction. In J. Strachey (Ed.), *The Standard Edition of the Complete Psychological Works of Sigmund Freud*

(Vol. 14). London: Hogarth.

Friedrich, W. N., & Boriskin, J. A. (1976). The role of the child in abuse: A review of the literature. *American Journal of Orthopsychiatry*, 46(4), 580–590. doi:10.1111/j.1939-0025.1976.tb00957.x

Friedrich, W. N., & Einbender, A. J. (1983). The abused child: A psychological review. *Journal of Clinical Child Psychology*, 12(3), 244–256. doi:10.1080/15374418309533139

Fries, A. B., Ziegler, T. E., Kurian, J. R., Jacoris, S., & Pollak, S. D. (2005). Early experience in humans is associated with changes in neuropeptides critical for regulating social behavior. *Proceedings of the National Academy of Sciences of the United States of America*, 102(47), 17237–40. doi:10.1073/pnas.0504767102

Friston, K. ., Buechel, C., Fink, G. ., Morris, J., Rolls, E., & Dolan, R. . (1997). Psychophysiological and Modulatory Interactions in Neuroimaging. *NeuroImage*, 6(3), 218–229. doi:10.1006/nimg.1997.0291

Frith, C. D., & Frith, U. (2006). The neural basis of mentalizing. *Neuron*, 50(4), 531–4. doi:10.1016/j.neuron.2006.05.001

Frodi, A. M., & Lamb, M. E. (1980). Child abusers' responses to infant smiles and cries. *Child Development*, 238–241.

Frodi, A. M., Lamb, M. E., Leavitt, L. A., & Donovan, W. L. (1978). Fathers' and mothers' responses to infant smiles and cries. *Infant Behavior and Development*, 1, 187–198.

Fuchs, A., Möhler, E., Resch, F., & Kaess, M. (2015). Impact of a maternal history of childhood abuse on the development of mother–infant interaction during the first year of life. *Child Abuse & Neglect*, 48, 179–189. doi:10.1016/j.chiabu.2015.05.023

Gaines, R., Sandgrund, A., Green, A. H., & Power, E. (1978). Etiological factors in child maltreatment: A multivariate study of abusing, neglecting, and normal mothers. *Journal of Abnormal Psychology*, 87(5), 531–540. doi:10.1037/0021-843X.87.5.531

Galdston, R. (1965a). Observations on children who have been physically abused and their parents. *American Journal of Psychiatry*, 122(4), 440–443. doi:10.1176/ajp.122.4.440

Galdston, R. (1965b). Observations on children who have been physically abused and their parents. *American Journal of Psychiatry*, 122(4), 440–443. doi:10.1176/ajp.122.4.440

Gallese, V. (1998). Mirror neurons and the simulation theory of mind-reading. *Trends in Cognitive Sciences*, 2(12), 493–501. doi:10.1016/S1364-6613(98)01262-5

- Gallese, V. (2009). Mirror Neurons, Embodied Simulation, and the Neural Basis of Social Identification. *Psychoanalytic Dialogues*, 19(5), 519–536. doi:10.1080/10481880903231910
- Gallese, V. (2014). Bodily selves in relation: embodied simulation as second-person perspective on intersubjectivity. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 369(1644), 20130177.
- Gallese, V., & Sinigaglia, C. (2011). What is so special about embodied simulation? *Trends in Cognitive Sciences*, 15(11), 512–519.
- Galvan, A., Hare, T. A., Davidson, M., Spicer, J., Glover, G., & Casey, B. J. (2005). The role of ventral frontostriatal circuitry in reward-based learning in humans. *The Journal of Neuroscience*, 25(38), 8650–6. doi:10.1523/JNEUROSCI.2431-05.2005
- Galynker, I. I., Yaseen, Z. S., Katz, C., Zhang, X., Jennings-Donovan, G., Dashnaw, S., ... Winston, A. (2012). Distinct but overlapping neural networks subserve depression and insecure attachment. *Social Cognitive and Affective Neuroscience*, 7(8), 896–908. doi:10.1093/scan/nsr074
- Gander, M., & Buchheim, A. (2015). Attachment classification, psychophysiology and frontal EEG asymmetry across the lifespan: a review. *Frontiers in Human Neuroscience*, 9, 79. doi:10.3389/fnhum.2015.00079
- Gawronski, B., & Payne, B. K. (2011). *Handbook of implicit social cognition: Measurement, theory, and applications*. Guilford Press.
- Gee, D. G., Gabard-Durnam, L. J., Flannery, J., Goff, B., Humphreys, K. L., Telzer, E. H., ... Tottenham, N. (2013). Early developmental emergence of human amygdala-prefrontal connectivity after maternal deprivation. *Proceedings of the National Academy of Sciences of the United States of America*, 110(39), 15638–43. doi:10.1073/pnas.1307893110
- Gee, D. G., Gabard-Durnam, L., Telzer, E. H., Humphreys, K. L., Goff, B., Shapiro, M., ... Tottenham, N. (2014). Maternal Buffering of Human Amygdala-Prefrontal Circuitry During Childhood but Not During Adolescence. *Psychological Science*, 25(11), 2067–2078. doi:10.1177/0956797614550878
- Gee, D. G., Humphreys, K. L., Flannery, J., Goff, B., Telzer, E. H., Shapiro, M., ... Tottenham, N. (2013). A Developmental Shift from Positive to Negative Connectivity in Human Amygdala-Prefrontal Circuitry. *Journal of Neuroscience*, 33(10), 4584–4593. doi:10.1523/JNEUROSCI.3446-12.2013
- Gee, G. C., Ro, A., Shariff-Marco, S., & Chae, D. (2009). Racial discrimination and health among Asian Americans: evidence, assessment, and directions for future research. *Epidemiologic Reviews*, 31, 130–51. doi:10.1093/epirev/mxp009
- Geier, C. F., Terwilliger, R., Teslovich, T., Velanova, K., & Luna, B. (2010). Immaturities in reward processing and its influence on inhibitory control in

- adolescence. *Cerebral Cortex* (New York, N.Y. : 1991), 20(7), 1613–29.
doi:10.1093/cercor/bhp225
- George, C., Kaplan, N., & Main, M. (1985). Adult Attachment Interview. University of California Press, Berkeley.
- George, C., & Solomon, J. (2008). The caregiving system: A behavioral systems approach to parenting. In J. Cassidy & P. R. Shaver (Eds.), *Handbook of attachment: Theory, research, and clinical applications* (2nd ed.) (pp. 833–856). New York: Guilford Press.
- George, C., & West, M. (2001). The development and preliminary validation of a new measure of adult attachment: the Adult Attachment Projective. *Attachment & Human Development*, 3(1), 30–61.
doi:10.1080/14616730010024771
- George, C., & West, M. L. (2012). *The Adult Attachment Projective Picture System: attachment theory and assessment in adults*. New York: Guilford Press.
- Gianaros, P. J., Marsland, A. L., Sheu, L. K., Erickson, K. I., & Verstynen, T. D. (2013). Inflammatory pathways link socioeconomic inequalities to white matter architecture. *Cerebral Cortex* (New York, N.Y. : 1991), 23(9), 2058–71.
doi:10.1093/cercor/bhs191
- Gibbens, T. C. N., & Walker, A. (1956). Cruel parents. *Institute for the Study and Treatment of Delinquency Pamphlet*.
- Gilboa, A., Shalev, A. Y., Laor, L., Lester, H., Louzoun, Y., Chisin, R., & Bonne, O. (2004). Functional connectivity of the prefrontal cortex and the amygdala in posttraumatic stress disorder. *Biological Psychiatry*, 55(3), 263–272.
doi:10.1016/j.biopsych.2003.08.004
- Gillath, O., Mikulincer, M., Fitzsimons, G. M., Shaver, P. R., Schachner, D. a, & Bargh, J. a. (2006). Automatic activation of attachment-related goals. *Personality & Social Psychology Bulletin*, 32(10), 1375–88.
doi:10.1177/0146167206290339
- Gillath, O., Selcuk, E., & Shaver, P. R. (2008). Moving Toward a Secure Attachment Style: Can Repeated Security Priming Help? *Social and Personality Psychology Compass*, 2(4), 1651–1666. doi:10.1111/j.1751-9004.2008.00120.x
- Glaser, D. (2002). Emotional abuse and neglect (psychological maltreatment): a conceptual framework. *Child Abuse & Neglect*, 26(6-7), 697–714.
doi:10.1016/S0145-2134(02)00342-3
- Glocker, M. L., Langleben, D. D., Ruparel, K., Loughhead, J. W., Gur, R. C., & Sachser, N. (2009). Baby Schema in Infant Faces Induces Cuteness Perception and Motivation for Caretaking in Adults. *Ethology*, 115(3), 257–263. doi:10.1111/j.1439-0310.2008.01603.x

- Glocker, M. L., Langleben, D. D., Ruparel, K., Loughead, J. W., Valdez, J. N., Griffin, M. D., ... Gur, R. C. (2009). Baby schema modulates the brain reward system in nulliparous women. *Proceedings of the National Academy of Sciences*, 106(22), 9115–9119. doi:10.1073/pnas.0811620106
- Gondoli, D. M., & Silverberg, S. B. (1997). Maternal emotional distress and diminished responsiveness: the mediating role of parenting efficacy and parental perspective taking. *Developmental Psychology*, 33(5), 861.
- Gonzalez, A., Atkinson, L., & Fleming, A. S. (2009). Attachment and the comparative psychobiology of mothering. In M. de Haan & M. R. Gunnar (Eds.), *Handbook of developmental social neuroscience* (pp. 225–245). New York: The Guilford Press.
- Gonzalez, A., Jenkins, J. M., Steiner, M., & Fleming, A. S. (2009). The relation between early life adversity, cortisol awakening response and diurnal salivary cortisol levels in postpartum women. *Psychoneuroendocrinology*, 34(1), 76–86. doi:10.1016/j.psyneuen.2008.08.012
- Gonzalez, A., Jenkins, J. M., Steiner, M., & Fleming, A. S. (2012). Maternal early life experiences and parenting: the mediating role of cortisol and executive function. *Journal of the American Academy of Child and Adolescent Psychiatry*, 51(7), 673–82. doi:10.1016/j.jaac.2012.04.003
- Gotlib, I. H., & Joormann, J. (2010). Cognition and Depression: Current Status and Future Directions. *Annual Review of Clinical Psychology*, 6(1), 285–312. doi:10.1146/annurev.clinpsy.121208.131305
- Gould, F., Clarke, J., Heim, C., Harvey, P. D., Majer, M., & Nemeroff, C. B. (2012). The effects of child abuse and neglect on cognitive functioning in adulthood. *Journal of Psychiatric Research*, 46(4), 500–6. doi:10.1016/j.jpsychires.2012.01.005
- Graber, J. A., Brooks-Gunn, J., & Warren, M. P. (1995). The Antecedents of Menarcheal Age: Heredity, Family Environment, and Stressful Life Events. *Child Development*, 66(2), 346–359. doi:10.1111/j.1467-8624.1995.tb00875.x
- Grafton, B., & MacLeod, C. (2013). Regulation of Emotion through Modification of Attention. In J. J. Gross (Ed.), *Handbook of Emotion Regulation Second Edition* (pp. 508–528). New York: Guilford Press.
- Grant, K. E., Compas, B. E., Stuhlmacher, A. F., Thurm, A. E., McMahon, S. D., & Halpert, J. A. (2003). Stressors and child and adolescent psychopathology: Moving from markers to mechanisms of risk. *Psychological Bulletin*, 129(3), 447–466. doi:10.1037/0033-2909.129.3.447
- Grant, M. M., Wood, K., Sreenivasan, K., Wheelock, M., White, D., Thomas, J., ... Deshpande, G. (2015). Influence of Early Life Stress on Intra- and Extra-Amygdaloid Causal Connectivity. *Neuropsychopharmacology*, 40(7), 1782–1793. doi:10.1038/npp.2015.28

- Grasswick, H. E. (2010). Scientific and lay communities: earning epistemic trust through knowledge sharing. *Synthese*, 177(3), 387–409. doi:10.1007/s11229-010-9789-0
- Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: the implicit association test. *Journal of Personality and Social Psychology*, 74(6), 1464.
- Greenwald, A. G., Nosek, B. a., & Banaji, M. R. (2003). Understanding and using the Implicit Association Test: I. An improved scoring algorithm. *Journal of Personality and Social Psychology*, 85(2), 197–216. doi:10.1037/0022-3514.85.2.197
- Greenwald, A. G., Poehlman, T. A., Uhlmann, E. L., & Banaji, M. R. (2009). Understanding and using the Implicit Association Test: III. Meta-analysis of predictive validity. *Journal of Personality and Social Psychology*, 97(1), 17–41. doi:10.1037/a0015575
- Grienemberger, J. F., Kelly, K., & Slade, A. (2005). Maternal reflective functioning, mother-infant affective communication, and infant attachment: exploring the link between mental states and observed caregiving behavior in the intergenerational transmission of attachment. *Attachment & Human Development*, 7(3), 299–311. doi:10.1080/14616730500245963
- Grimm, S., Pestke, K., Feeser, M., Aust, S., Weigand, A., Wang, J., ... Bajbouj, M. (2014). Early life stress modulates oxytocin effects on limbic system during acute psychosocial stress. *Social Cognitive and Affective Neuroscience*, 9(11), 1828–35. doi:10.1093/scan/nsu020
- Groh, A. M., & Roisman, G. I. (2009). Adults' autonomic and subjective emotional responses to infant vocalizations: The role of secure base script knowledge. *Developmental Psychology*, 45(3), 889–893. doi:10.1037/a0014943
- Groh, A. M., Roisman, G. I., Haydon, K. C., Bost, K., McElwain, N., Garcia, L., & Hester, C. (2015). Mothers' electrophysiological, subjective, and observed emotional responding to infant crying: The role of secure base script knowledge. *Development and Psychopathology*, 27(4 Pt 1), 1237–50. doi:10.1017/S0954579414000881
- Groppe, S. E., Gossen, A., Rademacher, L., Hahn, A., Westphal, L., Gründer, G., & Spreckelmeyer, K. N. (2013). Oxytocin influences processing of socially relevant cues in the ventral tegmental area of the human brain. *Biological Psychiatry*, 74(3), 172–9. doi:10.1016/j.biopsych.2012.12.023
- Gross, J. J. (1998). The emerging field of emotion regulation: An integrative review. *Review of General Psychology*, 2(3), 271–299. doi:10.1037/1089-2680.2.3.271
- Gross, J. J. (2013a). Emotion regulation: Conceptual and empirical foundations. In J. J. Gross (Ed.), *Handbook of Emotion Regulation Second Edition* (Vol. 2, pp. 3–20). New York: Guilford.

- Gross, J. J. (2013b). Emotion Regulation: Taking Stock and Moving Forward. *Emotion*. doi:10.1037/a0032135
- Grossmann, K., Fremmer-Bombik, E., Rudolph, J., & Grossmann, K. E. (1988). Maternal attachment representations as related to patterns of infant-mother attachment and maternal care during the first year. *Relationships within Families*, 241–260.
- Guyer, A. E., Kaufman, J., Hodgdon, H. B., Masten, C. L., Jazbec, S., Pine, D. S., & Ernst, M. (2006). Behavioral alterations in reward system function: the role of childhood maltreatment and psychopathology. *Journal of the American Academy of Child and Adolescent Psychiatry*, 45(9), 1059–67. doi:10.1097/01.chi.0000227882.50404.11
- Hackman, D. A., & Farah, M. J. (2009). Socioeconomic status and the developing brain. *Trends in Cognitive Sciences*, 13(2), 65–73. doi:10.1016/j.tics.2008.11.003
- Hagan, M. J., Roubinov, D. S., Purdom Marreiro, C. L., & Luecken, L. J. (2014). Childhood interparental conflict and HPA axis activity in young adulthood: examining nonlinear relations. *Developmental Psychobiology*, 56(4), 871–80. doi:10.1002/dev.21157
- Han, Z. R., & Shaffer, A. (2013). The relation of parental emotion dysregulation to children's psychopathology symptoms: the moderating role of child emotion dysregulation. *Child Psychiatry and Human Development*, 44(5), 591–601. doi:10.1007/s10578-012-0353-7
- Hanson, J. L., Chung, M. K., Avants, B. B., Rudolph, K. D., Shirtcliff, E. A., Gee, J. C., ... Pollak, S. D. (2012). Structural variations in prefrontal cortex mediate the relationship between early childhood stress and spatial working memory. *The Journal of Neuroscience*, 32(23), 7917–25. doi:10.1523/JNEUROSCI.0307-12.2012
- Hanson, J. L., Hariri, A. R., & Williamson, D. E. (2015). Blunted Ventral Striatum Development in Adolescence Reflects Emotional Neglect and Predicts Depressive Symptoms. *Biological Psychiatry*, 78(9), 598–605. doi:10.1016/j.biopsych.2015.05.010
- Hanson, J. L., Nacewicz, B. M., Sutterer, M. J., Cayo, A. A., Schaefer, S. M., Rudolph, K. D., ... Davidson, R. J. (2015). Behavioral problems after early life stress: contributions of the hippocampus and amygdala. *Biological Psychiatry*, 77(4), 314–23. doi:10.1016/j.biopsych.2014.04.020
- Hardt, J., & Rutter, M. (2004). Validity of adult retrospective reports of adverse childhood experiences: review of the evidence. *Journal of Child Psychology and Psychiatry*, 45(2), 260–273. doi:10.1111/j.1469-7610.2004.00218.x
- Hariri, A. R., Mattay, V. S., Tessitore, A., Fera, F., & Weinberger, D. R. (2003). Neocortical modulation of the amygdala response to fearful stimuli. *Biological Psychiatry*, 53(6), 494–501. doi:10.1016/S0006-3223(02)01786-9

- Hautamäki, A., Hautamäki, L., Neuvonen, L., & Maliniemi-Piispanen, S. (2010). Transmission of attachment across three generations: Continuity and reversal. *Clinical Child Psychology and Psychiatry*, 15(3), 347–54. doi:10.1177/1359104510365451
- He, W., Boesveldt, S., de Graaf, C., & de Wijk, R. A. (2014). Dynamics of autonomic nervous system responses and facial expressions to odors. *Frontiers in Psychology*, 5, 110. doi:10.3389/fpsyg.2014.00110
- Heim, C., Plotsky, P. M., & Nemeroff, C. B. (2004). Importance of studying the contributions of early adverse experience to neurobiological findings in depression. *Neuropsychopharmacology*, 29(4), 641–8. doi:10.1038/sj.npp.1300397
- Heim, C., Shugart, M., Craighead, W. E., & Nemeroff, C. B. (2010). Neurobiological and psychiatric consequences of child abuse and neglect. *Developmental Psychobiology*, 52(7), 671–690. doi:10.1002/dev.20494
- Heim, C., Young, L. J., Newport, D. J., Mletzko, T., Miller, A. H., & Nemeroff, C. B. (2009). Lower CSF oxytocin concentrations in women with a history of childhood abuse. *Molecular Psychiatry*, 14(10), 954–8. doi:10.1038/mp.2008.112
- Heinrichs, M., Baumgartner, T., Kirschbaum, C., & Ehlert, U. (2003). Social support and oxytocin interact to suppress cortisol and subjective responses to psychosocial stress. *Biological Psychiatry*, 54(12), 1389–1398. doi:10.1016/S0006-3223(03)00465-7
- Herrenkohl, E. C., Herrenkohl, R. C., Toedter, L. J., & Finkelhor, D. (1983). Perspectives on the intergenerational transmission of abuse. In D. Finkelhor (Ed.), *The dark side of families: Current family violence research* (pp. 305–316). Sage Beverly Hills, CA.
- Herrington, R. J., Birn, R. M., Ruttle, P. L., Burghy, C. A., Stodola, D. E., Davidson, R. J., & Essex, M. J. (2013). Childhood maltreatment is associated with altered fear circuitry and increased internalizing symptoms by late adolescence. *Proceedings of the National Academy of Sciences of the United States of America*, 110(47), 19119–24. doi:10.1073/pnas.1310766110
- Herrington, J. D., Taylor, J. M., Grupe, D. W., Curby, K. M., & Schultz, R. T. (2011). Bidirectional communication between amygdala and fusiform gyrus during facial recognition. *NeuroImage*, 56(4), 2348–2355. doi:10.1016/j.neuroimage.2011.03.072
- Hesse, E. (2008). The Adult Attachment Interview: Protocol, method of analysis, and empirical studies. In J. Cassidy & P. R. Shaver (Eds.), *Handbook of attachment: Theory, research, and clinical applications* (2nd ed.) (pp. 552–598). New York: Guilford Press.
- Hesse, E., & Main, M. (1999). Second generation effects of unresolved trauma in nonmaltreating parents: Dissociated, frightened, and threatening parental

- behavior. *Psychoanalytic Inquiry*, 19(4), 481–540.
doi:10.1080/07351699909534265
- Heuer, K., Rinck, M., & Becker, E. S. (2007). Avoidance of emotional facial expressions in social anxiety: The Approach–Avoidance Task. *Behaviour Research and Therapy*, 45(12), 2990–3001. doi:10.1016/j.brat.2007.08.010
- Hibbing, J. R., Smith, K. B., & Alford, J. R. (2014). Differences in negativity bias underlie variations in political ideology. *The Behavioral and Brain Sciences*, 37(3), 297–307. doi:10.1017/S0140525X13001192
- Hodel, A. S., Hunt, R. H., Cowell, R. A., Van Den Heuvel, S. E., Gunnar, M. R., & Thomas, K. M. (2015). Duration of early adversity and structural brain development in post-institutionalized adolescents. *NeuroImage*, 105, 112–9. doi:10.1016/j.neuroimage.2014.10.020
- Holmes, J. (2000). Attachment theory and psychoanalysis: a rapprochement. *British Journal of Psychotherapy*, 17(2), 157–172. doi:10.1111/j.1752-0118.2000.tb00572.x
- Holz, N. E., Boecker, R., Hohm, E., Zohsel, K., Buchmann, A. F., Blomeyer, D., ... Laucht, M. (2015). The long-term impact of early life poverty on orbitofrontal cortex volume in adulthood: results from a prospective study over 25 years. *Neuropsychopharmacology*, 40(4), 996–1004. doi:10.1038/npp.2014.277
- Howard, K. S. (2010). Paternal attachment, parenting beliefs and children's attachment. *Early Child Development and Care*, 180(1-2), 157–171. doi:10.1080/03004430903415031
- Huesmann, L. R., Eron, L. D., Lefkowitz, M. M., & Walder, L. O. (1984a). Stability of aggression over time and generations. *Developmental Psychology*, 20(6), 1120–1134. doi:10.1037/0012-1649.20.6.1120
- Huesmann, L. R., Eron, L. D., Lefkowitz, M. M., & Walder, L. O. (1984b). Stability of aggression over time and generations. *Developmental Psychology*, 20(6), 1120–1134. doi:10.1037/0012-1649.20.6.1120
- Huffmeijer, R., Tops, M., Alink, L. R. A., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2011). Love withdrawal is related to heightened processing of faces with emotional expressions and incongruent emotional feedback: evidence from ERPs. *Biological Psychology*, 86(3), 307–13. doi:10.1016/j.biopsycho.2011.01.003
- Hunter, R. S., & Kilstrom, N. (1979). Breaking the cycle in abusive families. *American Journal of Psychiatry*, 136(10), 1320–1322. doi:10.1176/ajp.136.10.1320
- Inbar, Y., & Pizarro, D. (2014). Disgust, politics, and responses to threat. *The Behavioral and Brain Sciences*, 37(3), 315–6. doi:10.1017/S0140525X13002598

- Innamorati, M., Sarracino, D., & Dazzi, N. (2010). Motherhood constellation and representational change in pregnancy. *Infant Mental Health Journal*, 31(4), 379–396. doi:10.1002/imhj.20261
- Insel, T. R. (1997). A neurobiological basis of social attachment. *American Journal of Psychiatry*, 154(6), 726–735.
- Iwaniec, D., Larkin, E., & Higgins, S. (2006). Research Review: Risk and resilience in cases of emotional abuse. *Child & Family Social Work*, 11(1), 73–82. doi:10.1111/j.1365-2206.2006.00398.x
- Jeanne, M., Gross, J. J., Persons, J. B., & Hahn, J. (1998). Mood Matters: Negative Mood Induction Activates Dysfunctional Attitudes in Women Vulnerable to Depression. *Cognitive Therapy and Research*, 22(4), 363–376. doi:10.1023/A:1018709212986
- Jedd, K., Hunt, R. H., Cicchetti, D., Hunt, E., Cowell, R. A., Rogosch, F. A., ... Thomas, K. M. (2015). Long-term consequences of childhood maltreatment: Altered amygdala functional connectivity. *Development and Psychopathology*, 27(4 Pt 2), 1577–89. doi:10.1017/S0954579415000954
- Jenkinson, M., Bannister, P., Brady, M., & Smith, S. (2002). Improved Optimization for the Robust and Accurate Linear Registration and Motion Correction of Brain Images. *NeuroImage*, 17(2), 825–841. doi:10.1006/nimg.2002.1132
- Johnson, A. J., & Tottenham, N. (2015). Regulatory skill as a resilience factor for adults with a history of foster care: A pilot study. *Developmental Psychobiology*, 57(1), 1–16. doi:10.1002/dev.21227
- Johnston, C., Mash, E. J., Miller, N., & Ninowski, J. E. (2012). Parenting in adults with attention-deficit/hyperactivity disorder (ADHD). *Clinical Psychology Review*, 32(4), 215–28. doi:10.1016/j.cpr.2012.01.007
- Jonas, W., Mileva-Seitz, V. R., Girard, A. W., Bisceglia, R., Kennedy, J. L., Sokolowski, M., ... Steiner, M. (2013). Genetic variation in oxytocin rs2740210 and early adversity associated with postpartum depression and breastfeeding duration. *Genes, Brain, and Behavior*, 12(7), 681–94. doi:10.1111/gbb.12069
- Jones, J. D., Brett, B. E., Ehrlich, K. B., Lejuez, C. W., & Cassidy, J. (2014). Maternal Attachment Style and Responses to Adolescents' Negative Emotions: The Mediating Role of Maternal Emotion Regulation. *Parenting, Science and Practice*, 14(3-4), 235–257. doi:10.1080/15295192.2014.972760
- Jones, J. D., Cassidy, J., & Shaver, P. R. (2015a). Adult Attachment Style and Parenting. In J. A. Simpson & W. S. Rholes (Eds.), *Attachment Theory and Research: New Directions and Emerging Themes* (p. 234). Guilford Publications.
- Jones, J. D., Cassidy, J., & Shaver, P. R. (2015b). Parents' self-reported attachment styles: a review of links with parenting behaviors, emotions, and

- cognitions. *Personality and Social Psychology Review*, 19(1), 44–76.
doi:10.1177/1088868314541858
- Jong, T. R. d., Menon, R., Bludau, A., Grund, T., Biermeier, V., Klampfl, S. M., ... Neumann, I. D. (2015). Salivary oxytocin concentrations in response to running, sexual self-stimulation, breastfeeding and the Trier Social Stress Test (TSST): an oxytocin challenge study. *Psychoneuroendocrinology*. doi:10.1016/j.psyneuen.2015.08.027
- Joosen, K. J., Mesman, J., Bakermans-Kranenburg, M. J., Pieper, S., Zeskind, P. S., & van IJzendoorn, M. H. (2013). Physiological Reactivity to Infant Crying and Observed Maternal Sensitivity. *Infancy*, 18(3), 414–431.
doi:10.1111/j.1532-7078.2012.00122.x
- Jorm, A. F., Christensen, H., Rodgers, B., Jacomb, P. A., & Easteal, S. (2004). Association of adverse childhood experiences, age of menarche, and adult reproductive behavior: does the androgen receptor gene play a role? *American Journal of Medical Genetics. Part B, Neuropsychiatric Genetics : The Official Publication of the International Society of Psychiatric Genetics*, 125B(1), 105–111. doi:10.1002/ajmg.b.20114
- Juul, S. H., Hendrix, C., Robinson, B., Stowe, Z. N., Newport, D. J., Brennan, P. A., & Johnson, K. C. (2015). Maternal early-life trauma and affective parenting style: the mediating role of HPA-axis function. *Archives of Women's Mental Health*. doi:10.1007/s00737-015-0528-x
- Karreman, A., van Tuijl, C., van Aken, M. A. G., & Deković, M. (2006). Parenting and self-regulation in preschoolers: a meta-analysis. *Infant and Child Development*, 15(6), 561–579. doi:10.1002/icd.478
- Katznelson, H. (2014). Reflective functioning: A review. *Clinical Psychology Review*, 34(2), 107–117. doi:10.1016/j.cpr.2013.12.003
- Kaufman, J., & Charney, D. S. (2001). Effects of early stress on brain structure and function: Implications for understanding the relationship between child maltreatment and depression. *Development and Psychopathology*, 13(3), 451–471. doi:10.1017/S0954579401003030
- Kaufman, J., & Zigler, E. (1987). Do abused children become abusive parents? *American Journal of Orthopsychiatry*, 57(2), 186–192. doi:10.1111/j.1939-0025.1987.tb03528.x
- Kazui, M., Endo, T., Tanaka, A., Sakagami, H., & Suganuma, M. (2000). Intergenerational transmission of attachment: Japanese mother–child dyads. *Japanese Journal of Educational Psychology*.
- Kempe, C. H. (1973). A practical approach to the protection of the abused child and rehabilitation of the abusing parent. *Pediatrics*, 51(4), 804–809.
- Kerr, D. C. R., Capaldi, D. M., Pears, K. C., & Owen, L. D. (2009). A prospective three generational study of fathers' constructive parenting: influences from

- family of origin, adolescent adjustment, and offspring temperament. *Developmental Psychology*, 45(5), 1257–75. doi:10.1037/a0015863
- Keuken, M. C., Hardie, A., Dorn, B. T., Dev, S., Paulus, M. P., Jonas, K. J., ... Pineda, J. A. (2011). The role of the left inferior frontal gyrus in social perception: an rTMS study. *Brain Research*, 1383, 196–205. doi:10.1016/j.brainres.2011.01.073
- Kiang, L., Moreno, A. J., & Robinson, J. L. (2004). Maternal Preconceptions About Parenting Predict Child Temperament, Maternal Sensitivity, and Children's Empathy. *Developmental Psychology*, 40(6), 1081–1092. doi:10.1037/0012-1649.40.6.1081
- Kida, T., Nishitani, S., Tanaka, M., Takamura, T., Sugawara, M., & Shinohara, K. (2013). I love my grandkid! An NIRS study of grandmaternal love in Japan. *Brain Research*. doi:10.1016/j.brainres.2013.10.028
- Kiff, C. J., Lengua, L. J., & Zalewski, M. (2011). Nature and nurturing: parenting in the context of child temperament. *Clinical Child and Family Psychology Review*, 14(3), 251–301. doi:10.1007/s10567-011-0093-4
- Killeen, L. A., & Teti, D. M. (2012). Mothers' frontal EEG asymmetry in response to infant emotion states and mother-infant emotional availability, emotional experience, and internalizing symptoms. *Development and Psychopathology*, 24(1), 9–21. doi:10.1017/S0954579411000629
- Kilmann, P. R., Vendemia, J. M. C., Parnell, M. M., & Urbaniak, G. C. (2009). PARENT CHARACTERISTICS LINKED WITH DAUGHTERS' ATTACHMENT STYLES. *Adolescence*, 44(175), 557.
- Kilner, J. M., Neal, A., Weiskopf, N., Friston, K. J., & Frith, C. D. (2009). Evidence of mirror neurons in human inferior frontal gyrus. *The Journal of Neuroscience*, 29(32), 10153–10159.
- Kim, J., & Cicchetti, D. (2010). Longitudinal pathways linking child maltreatment, emotion regulation, peer relations, and psychopathology. *Journal of Child Psychology and Psychiatry*, 51(6), 706–16. doi:10.1111/j.1469-7610.2009.02202.x
- Kim, K., & Smith, P. K. (1998a). Childhood stress, behavioural symptoms and mother-daughter pubertal development. *Journal of Adolescence*, 21(3), 231–40. doi:10.1006/jado.1998.0149
- Kim, K., & Smith, P. K. (1998b). Childhood stress, behavioural symptoms and mother-daughter pubertal development. *Journal of Adolescence*, 21(3), 231–40. doi:10.1006/jado.1998.0149
- Kim, M. J., Gee, D. G., Loucks, R. A., Davis, F. C., & Whalen, P. J. (2011). Anxiety Dissociates Dorsal and Ventral Medial Prefrontal Cortex Functional Connectivity with the Amygdala at Rest. *Cerebral Cortex*, 21(7), 1667–1673. doi:10.1093/cercor/bhq237

- Kim, P., Evans, G. W., Angstadt, M., Ho, S. S., Sripada, C. S., Swain, J. E., ... Phan, K. L. (2013). Effects of childhood poverty and chronic stress on emotion regulatory brain function in adulthood. *Proceedings of the National Academy of Sciences of the United States of America*, 110(46), 18442–7. doi:10.1073/pnas.1308240110
- Kim, P., Feldman, R., Mayes, L. C., Eicher, V., Thompson, N., Leckman, J. F., & Swain, J. E. (2011). Breastfeeding, brain activation to own infant cry, and maternal sensitivity. *Journal of Child Psychology and Psychiatry*, 52(8), 907–915. doi:10.1111/j.1469-7610.2011.02406.x
- Kim, P., Ho, S. S., Evans, G. W., Liberzon, I., & Swain, J. E. (2015). Childhood social inequalities influences neural processes in young adult caregiving. *Developmental Psychobiology*. doi:10.1002/dev.21325
- Kim, P., Leckman, J. F., Mayes, L. C., Newman, M.-A., Feldman, R., & Swain, J. E. (2010a). Perceived quality of maternal care in childhood and structure and function of mothers' brain. *Developmental Science*, 13(4), 662–73. doi:10.1111/j.1467-7687.2009.00923.x
- Kim, P., Leckman, J. F., Mayes, L. C., Newman, M.-A., Feldman, R., & Swain, J. E. (2010b). Perceived quality of maternal care in childhood and structure and function of mothers' brain. *Developmental Science*, 13(4), 662–73. doi:10.1111/j.1467-7687.2009.00923.x
- Kim, S., Fonagy, P., Allen, J., & Strathearn, L. (2014). Mothers' unresolved trauma blunts amygdala response to infant distress. *Social Neuroscience*, 9(4), 352–63. doi:10.1080/17470919.2014.896287
- Kirschbaum, C., Pirke, K.-M., & Hellhammer, D. H. (1993). The "Trier Social Stress Test" – A Tool for Investigating Psychobiological Stress Responses in a Laboratory Setting. *Neuropsychobiology*, 28(1-2), 76–81. doi:10.1159/000119004
- Klein Velderman, M., Bakermans-Kranenburg, M. J., Juffer, F., & van IJzendoorn, M. H. (2006). Effects of attachment-based interventions on maternal sensitivity and infant attachment: Differential susceptibility of highly reactive infants. *Journal of Family Psychology*, 20(2), 266–274. doi:10.1037/0893-3200.20.2.266
- Kleiner, M., Brainard, D. H., Pelli, D. G., Broussard, C., Wolf, T., & Niehorster, D. (2007). What's new in Psychtoolbox-3? *Perception*, 36, S14. doi:10.1068/v070821
- Klika, J. B., & Herrenkohl, T. I. (2013). A review of developmental research on resilience in maltreated children. *Trauma, Violence & Abuse*, 14(3), 222–34. doi:10.1177/1524838013487808
- Knutson, B., & Cooper, J. C. (2005). Functional magnetic resonance imaging of reward prediction. *Current Opinion in Neurology*, 18(4), 411–417. doi:10.1097/01.wco.0000173463.24758.f6

- Koenig, M. A., & Harris, P. L. (2007). The Basis of Epistemic Trust: Reliable Testimony or Reliable Sources? *Episteme*, 4(03), 264–284. doi:10.3366/E1742360007000081
- Kohler, E. (2002). Hearing Sounds, Understanding Actions: Action Representation in Mirror Neurons. *Science*, 297(5582), 846–848. doi:10.1126/science.1070311
- Kohlhoff, J., & Barnett, B. (2013). Parenting self-efficacy: links with maternal depression, infant behaviour and adult attachment. *Early Human Development*, 89(4), 249–56. doi:10.1016/j.earlhumdev.2013.01.008
- Komisaruk, R. (1966a). Clinical evaluation of child abuse - scarred families: a preliminary report. *Juvenile and Family Court Journal*, 17(2), 66–70. doi:10.1111/j.1755-6988.1966.tb00360.x
- Komisaruk, R. (1966b). Clinical evaluation of child abuse - scarred families: a preliminary report. *Juvenile and Family Court Journal*, 17(2), 66–70. doi:10.1111/j.1755-6988.1966.tb00360.x
- Koren-Karie, N., Oppenheim, D., Dolev, S., Sher, E., & Etzion-Carasso, A. (2002). Mothers' insightfulness regarding their infants' internal experience: Relations with maternal sensitivity and infant attachment. *Developmental Psychology*, 38(4), 534–542. doi:10.1037/0012-1649.38.4.534
- Kovan, N. M., Chung, A. L., & Sroufe, L. A. (2009). The intergenerational continuity of observed early parenting: A prospective, longitudinal study. *Developmental Psychology*, 45(5), 1205–1213. doi:10.1037/a0016542
- Kringelbach, M. L., Lehtonen, A., Squire, S., Harvey, A. G., Craske, M. G., Holliday, I. E., ... Stein, A. (2008). A specific and rapid neural signature for parental instinct. *PloS One*, 3(2), e1664. doi:10.1371/journal.pone.0001664
- Krpan, K. M., Coombs, R., Zinga, D., Steiner, M., & Fleming, A. S. (2005). Experiential and hormonal correlates of maternal behavior in teen and adult mothers. *Hormones and Behavior*, 47(1), 112–22. doi:10.1016/j.yhbeh.2004.08.006
- Krugers, H. J., & Joëls, M. (2014). Long-lasting Consequences of Early Life Stress on Brain Structure, Emotion and Cognition. *Current Topics in Behavioral Neurosciences*, 18, 81–92. doi:10.1007/7854_2014_289
- Kujawa, A., Proudfit, G. H., Laptook, R., & Klein, D. N. (2015). Early Parenting Moderates the Association between Parental Depression and Neural Reactivity to Rewards and Losses in Offspring. *Clinical Psychological Science: A Journal of the Association for Psychological Science*, 3(4), 503–515. doi:10.1177/2167702614542464
- Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. B. (2014). lmerTest: Tests for random and fixed effects for linear mixed effect models (lmer objects of lme4 package). R package version 2.0-6.

- Kuznetsova, A., Brockhoff, P. B., Haubo, R., & Christensen, B. (2014). lmerTest: Tests in Linear Mixed Effects Models. R package version 2.0-20. Retrieved from <http://cran.r-project.org/package=lmerTest>
- LaGasse, L. L., Neal, A. R., & Lester, B. M. (2005). Assessment of infant cry: acoustic cry analysis and parental perception. *Mental Retardation and Developmental Disabilities Research Reviews*, 11(1), 83–93. doi:10.1002/mrdd.20050
- Landi, N., Montoya, J., Kober, H., Rutherford, H. J. V., Mencl, W. E., Worhunsky, P. D., ... Mayes, L. C. (2011). Maternal neural responses to infant cries and faces: relationships with substance use. *Frontiers in Psychiatry*, 2, 32. doi:10.3389/fpsy.2011.00032
- Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1998). Emotion, motivation, and anxiety: brain mechanisms and psychophysiology. *Biological Psychiatry*, 44(12), 1248–1263. doi:10.1016/S0006-3223(98)00275-3
- Laranjo, J., Bernier, A., Meins, E., & Carlson, S. M. (2014). The roles of maternal mind-mindedness and infant security of attachment in predicting preschoolers' understanding of visual perspective taking and false belief. *Journal of Experimental Child Psychology*, 125, 48–62. doi:10.1016/j.jecp.2014.02.005
- Laurent, H. K., Stevens, A., & Ablow, J. C. (2011). Neural correlates of hypothalamic-pituitary-adrenal regulation of mothers with their infants. *Biological Psychiatry*, 70(9), 826–832. doi:10.1016/j.biopsych.2011.06.011
- LeDoux, J. (2012). Rethinking the emotional brain. *Neuron*, 73(4), 653–76. doi:10.1016/j.neuron.2012.02.004
- Lee, S. W., Yoo, J. H., Kim, K. W., Lee, J.-S., Kim, D., Park, H., ... Jeong, B. (2015). Aberrant function of frontoamygdala circuits in adolescents with previous verbal abuse experiences. *Neuropsychologia*, 79(Pt A), 76–85. doi:10.1016/j.neuropsychologia.2015.10.029
- Leerkes, E. M. (2010). Predictors of Maternal Sensitivity to Infant Distress. *Parenting, Science and Practice*, 10(3), 219–239. doi:10.1080/15295190903290840
- Leerkes, E. M., & Siepak, K. J. (2006). Attachment linked predictors of women's emotional and cognitive responses to infant distress. *Attachment & Human Development*, 8(1), 11–32. doi:10.1080/14616730600594450
- Leerkes, E. M., Supple, A. J., O'Brien, M., Calkins, S. D., Haltigan, J. D., Wong, M. S., & Fortuna, K. (2014). Antecedents of Maternal Sensitivity During Distressing Tasks: Integrating Attachment, Social Information Processing, and Psychobiological Perspectives. *Child Development*. doi:10.1111/cdev.12288
- Leitman, D. I., Wolf, D. H., Ragland, J. D., Laukka, P., Loughhead, J., Valdez, J. N.,

- ... Gur, R. C. (2010). "It's Not What You Say, But How You Say it": A Reciprocal Temporo-frontal Network for Affective Prosody. *Frontiers in Human Neuroscience*, 4, 19. doi:10.3389/fnhum.2010.00019
- Lench, H. C., Quas, J. A., & Edelstein, R. S. (2006). My Child Is Better Than Average: The Extension and Restriction of Unrealistic Optimism. *Journal of Applied Social Psychology*, 36(12), 2963–2979. doi:10.1111/j.0021-9029.2006.00137.x
- Lenzi, D., Trentini, C., Pantano, P., Macaluso, E., Lenzi, G. L., & Ammaniti, M. (2013). Attachment models affect brain responses in areas related to emotions and empathy in nulliparous women. *Human Brain Mapping*, 34(6), 1399–414. doi:10.1002/hbm.21520
- León, I., Rodrigo, M. J., Quiñones, I., Hernández, J. A., Lage, A., Padrón, I., & Bobes, M. A. (2014). Electrophysiological responses to affective stimuli in neglectful mothers. *PloS One*, 9(1), e87808. doi:10.1371/journal.pone.0087808
- Lieberman, A. F. (2007). Ghosts and angels: Intergenerational patterns in the transmission and treatment of the traumatic sequelae of domestic violence. *Infant Mental Health Journal*, 28(4), 422–439. doi:10.1002/imhj.20145
- Lieberman, A. F., Padrón, E., Van Horn, P., & Harris, W. W. (2005). Angels in the nursery: The intergenerational transmission of benevolent parental influences. *Infant Mental Health Journal*, 26(6), 504–520. doi:10.1002/imhj.20071
- Linnen, A.-M., Ellenbogen, M. A., Cardoso, C., & Joobor, R. (2012). Intranasal oxytocin and salivary cortisol concentrations during social rejection in university students. *Stress (Amsterdam, Netherlands)*, 15(4), 393–402. doi:10.3109/10253890.2011.631154
- Lomanowska, A. M., Boivin, M., Hertzman, C., & Fleming, A. S. (2015). Parenting begets parenting: A neurobiological perspective on early adversity and the transmission of parenting styles across generations. *Neuroscience*. doi:10.1016/j.neuroscience.2015.09.029
- Lotzin, A., Schiborr, J., Barkmann, C., Romer, G., & Ramsauer, B. (2015). Maternal emotion dysregulation is related to heightened mother-infant synchrony of facial affect. *Development and Psychopathology*, 1–13. doi:10.1017/S0954579415000516
- Lounds, J. J., Borkowski, J. G., Whitman, T. L., Maxwell, S. E., & Weed, K. (2005). Adolescent Parenting and Attachment During Infancy and Early Childhood. *Parenting*, 5(1), 91–118. doi:10.1207/s15327922par0501_4
- Lovic, V., & Fleming, A. S. (2004). Artificially-reared female rats show reduced prepulse inhibition and deficits in the attentional set shifting task—reversal of effects with maternal-like licking stimulation. *Behavioural Brain Research*, 148(1-2), 209–219. doi:10.1016/S0166-4328(03)00206-7

- Lovic, V., & Fleming, A. S. (2015). Propagation of maternal behavior across generations is associated with changes in non-maternal cognitive and behavioral processes. *Behavioural Processes*, 117, 42–47. doi:10.1016/j.beproc.2015.02.016
- Luecken, L. J., & Appelhans, B. M. (2006). Early parental loss and salivary cortisol in young adulthood: the moderating role of family environment. *Development and Psychopathology*, 18(1), 295–308. doi:10.1017/S0954579406060160
- Luecken, L. J., Hagan, M. J., Wolchik, S. A., Sandler, I. N., & Tein, J.-Y. (2015). A Longitudinal Study of the Effects of Child-Reported Maternal Warmth on Cortisol Stress Response 15 Years After Parental Divorce. *Psychosomatic Medicine*. doi:10.1097/PSY.0000000000000251
- Lupien, S. J., McEwen, B. S., Gunnar, M. R., & Heim, C. (2009). Effects of stress throughout the lifespan on the brain, behaviour and cognition. *Nature Reviews. Neuroscience*, 10(6), 434–45. doi:10.1038/nrn2639
- Lyons–Ruth, K., Bronfman, E., & Atwood, G. (2000). A relational diathesis model of hostile-helpless states of mind: Expressions in mother-infant interaction. In J. Solomon & C. George (Eds.), *Attachment disorganization*. New York: Guilford Press.
- Lyons-Ruth, K., Connell, D. B., Grunebaum, H. U., & Botein, S. (1990). Infants at Social Risk: Maternal Depression and Family Support Services as Mediators of Infant Development and Security of Attachment. *Child Development*, 61(1), 85–98. doi:10.1111/j.1467-8624.1990.tb02762.x
- Lyons–Ruth, K., Yellin, C., Melnik, S., & Atwood, G. (2005). Expanding the concept of unresolved mental states: Hostile/Helpless states of mind on the Adult Attachment Interview are associated with disrupted mother–infant communication and infant disorganization. *Development and Psychopathology*, 17(01). doi:10.1017/S0954579405050017
- MacMillan, H. L., Wathen, C. N., Barlow, J., Fergusson, D. M., Leventhal, J. M., & Taussig, H. N. (2009). Interventions to prevent child maltreatment and associated impairment. *The Lancet*, 373(9659), 250–266. doi:10.1016/S0140-6736(08)61708-0
- MacPhee, D., Lunkenheimer, E., & Riggs, N. (2015). Resilience as Regulation of Developmental and Family Processes. *Family Relations*, 64(1), 153–175. doi:10.1111/fare.12100
- Madigan, S., Bakermans-Kranenburg, M. J., Van Ijzendoorn, M. H., Moran, G., Pederson, D. R., & Benoit, D. (2006). Unresolved states of mind, anomalous parental behavior, and disorganized attachment: A review and meta-analysis of a transmission gap. *Attachment & Human Development*, 8(2), 89–111. doi:10.1080/14616730600774458
- Maestripieri, D., & Mateo, J. M. (Eds.). (2009). *Maternal effects in mammals*. Chicago: University of Chicago Press.

- Magai, C., Hunziker, J., Mesias, W., & Culver, L. C. (2000). Adult attachment styles and emotional biases, *24*(3), 301–309.
- Mahrer, N. E., Winslow, E., Wolchik, S. A., Tein, J.-Y., & Sandler, I. N. (2014). Effects of a Preventive Parenting Intervention for Divorced Families on the Intergenerational Transmission of Parenting Attitudes in Young Adult Offspring. *Child Development*, n/a–n/a. doi:10.1111/cdev.12258
- Main, M. (1991). Metacognitive knowledge, metacognitive monitoring, and singular (coherent) vs. multiple (incoherent) models of attachment. In C. M. Parkes, J. Stevenson-Hinde, & P. Marris (Eds.), *Attachment across the life cycle* (pp. 127–159). London: Tavistock/Routledge.
- Main, M. (1995). *Recent studies in attachment: Overview, with selected implications for clinical work*. Hillsdale, NJ, US: Analytic Press, Inc.
- Main, M., & Hesse, E. (1990). Parents' unresolved traumatic experiences are related to infant disorganized attachment status: Is frightened and/or frightening parental behavior the linking mechanism? In M. Greenberg, D. Cicchetti, & E. M. Cummings (Eds.), *Attachment in the preschool years: theory, research and intervention* (pp. 161–184). Chicago: University of Chicago Press.
- Main, M., Kaplan, N., & Cassidy, J. (1985). Security in Infancy, Childhood, and Adulthood: A Move to the Level of Representation. *Monographs of the Society for Research in Child Development*, *50*(1/2), 66. doi:10.2307/3333827
- Majer, M., Nater, U. M., Lin, J.-M. S., Capuron, L., & Reeves, W. C. (2010). Association of childhood trauma with cognitive function in healthy adults: a pilot study. *BMC Neurology*, *10*, 61. doi:10.1186/1471-2377-10-61
- Makovac, E., Meeten, F., Watson, D. R., Herman, A., Garfinkel, S. N., D. Critchley, H., & Ottaviani, C. (2015). Alterations in Amygdala-Prefrontal Functional Connectivity Account for Excessive Worry and Autonomic Dysregulation in Generalized Anxiety Disorder. *Biological Psychiatry*. doi:10.1016/j.biopsych.2015.10.013
- Malhotra, N. K. (2005). Attitude and affect: new frontiers of research in the 21st century. *Journal of Business Research*, *58*(4), 477–482. doi:10.1016/S0148-2963(03)00146-2
- Markin, R. D. (2013). Mentalization-based psychotherapy interventions with mothers-to-be. *Psychotherapy*, *50*(3), 360–365. doi:10.1037/a0031993
- Marsh, A. A., Ambady, N., & Kleck, R. E. (2005). The Effects of Fear and Anger Facial Expressions on Approach- and Avoidance-Related Behaviors. *Emotion*, *5*(1), 119–124. doi:10.1037/1528-3542.5.1.119
- Martinez-Torteya, C., Dayton, C. J., Beeghly, M., Seng, J. S., McGinnis, E., Broderick, A., ... Muzik, M. (2014). Maternal parenting predicts infant biobehavioral regulation among women with a history of childhood

- maltreatment. *Development and Psychopathology*, 26(2), 379–92.
doi:10.1017/S0954579414000017
- Marusak, H. A., Furman, D. J., Kuruvadi, N., Shattuck, D. W., Joshi, S. H., Joshi, A. A., ... Thomason, M. E. (2015). Amygdala responses to salient social cues vary with oxytocin receptor genotype in youth. *Neuropsychologia*.
doi:10.1016/j.neuropsychologia.2015.10.015
- Marusak, H. A., Martin, K. R., Etkin, A., & Thomason, M. E. (2015). Childhood trauma exposure disrupts the automatic regulation of emotional processing. *Neuropsychopharmacology*, 40(5), 1250–8. doi:10.1038/npp.2014.311
- Marysko, M., Reck, C., Mattheis, V., Finke, P., Resch, F., & Moehler, E. (2010). History of Childhood Abuse Is Accompanied by Increased Dissociation in Young Mothers Five Months Postnatally. *Psychopathology*, 43(2), 104–109.
doi:10.1159/000276999
- Masten, A. S. (2001). Ordinary magic: Resilience processes in development. *American Psychologist*, 56(3), 227–238. doi:10.1037/0003-066X.56.3.227
- Masten, A. S., & Coatsworth, J. D. (1995). Competence, resilience, and psychopathology. In D. Cicchetti & D. J. Cohen (Eds.), *Developmental psychopathology, Vol. 2: Risk, disorder, and adaptation* (pp. 715–752). Oxford, England: John Wiley & Sons.
- Masten, C. L., Guyer, A. E., Hodgdon, H. B., McClure, E. B., Charney, D. S., Ernst, M., ... Monk, C. S. (2008). Recognition of facial emotions among maltreated children with high rates of post-traumatic stress disorder. *Child Abuse & Neglect*, 32(1), 139–153. doi:10.1016/j.chiabu.2007.09.006
- Mathews, A., & MacLeod, C. (2005). Cognitive Vulnerability to Emotional Disorders. *Annual Review of Clinical Psychology*, 1(1), 167–195.
doi:10.1146/annurev.clinpsy.1.102803.143916
- Matt, G. E., Vázquez, C., & Campbell, W. K. (1992). Mood-congruent recall of affectively toned stimuli: A meta-analytic review. *Clinical Psychology Review*, 12(2), 227–255. doi:10.1016/0272-7358(92)90116-P
- Mazursky-Horowitz, H., Felton, J. W., MacPherson, L., Ehrlich, K. B., Cassidy, J., Lejuez, C. W., & Chronis-Tuscano, A. (2015). Maternal emotion regulation mediates the association between adult attention-deficit/hyperactivity disorder symptoms and parenting. *Journal of Abnormal Child Psychology*, 43(1), 121–31. doi:10.1007/s10802-014-9894-5
- McCanne, T. R., & Hagstrom, A. H. (1996). Physiological hyperreactivity to stressors in physical child abusers and individuals at risk for being physically abusive. *Aggression and Violent Behavior*, 1(4), 345–358.
doi:10.1016/S1359-1789(96)00004-3
- McCrary, E. J., De Brito, S. A., Kelly, P. A., Bird, G., Sebastian, C. L., Mechelli, A., ... Viding, E. (2013). Amygdala activation in maltreated children during pre-

- attentive emotional processing. *The British Journal of Psychiatry : The Journal of Mental Science*, 202(4), 269–76. doi:10.1192/bjp.bp.112.116624
- McCrory, E. J., De Brito, S. A., Sebastian, C. L., Mechelli, A., Bird, G., Kelly, P. A., & Viding, E. (2011). Heightened neural reactivity to threat in child victims of family violence. *Current Biology : CB*, 21(23), R947–8. doi:10.1016/j.cub.2011.10.015
- McCullough, C., Han, Z. R., Morelen, D., & Shaffer, A. (2015). The Moderating Effects of Maternal Age at Childbirth and Emotion Dysregulation on the Intergenerational Continuity of Emotionally Unsupportive Parenting Behaviors. *Journal of Family Issues*. doi:10.1177/0192513X15597290
- McMahon, C. A., Barnett, B., Kowalenko, N. M., & Tennant, C. C. (2006). Maternal attachment state of mind moderates the impact of postnatal depression on infant attachment. *Journal of Child Psychology and Psychiatry*, 47(7), 660–669.
- Mehta, M. A., Golembo, N. I., Nosarti, C., Colvert, E., Mota, A., Williams, S. C. R., ... Sonuga-Barke, E. J. S. (2009). Amygdala, hippocampal and corpus callosum size following severe early institutional deprivation: the English and Romanian Adoptees study pilot. *Journal of Child Psychology and Psychiatry*, 50(8), 943–51. doi:10.1111/j.1469-7610.2009.02084.x
- Mehta, M. A., Gore-Langton, E., Golembo, N., Colvert, E., Williams, S. C. R., & Sonuga-Barke, E. (2010). Hyporesponsive reward anticipation in the basal ganglia following severe institutional deprivation early in life. *Journal of Cognitive Neuroscience*, 22(10), 2316–25. doi:10.1162/jocn.2009.21394
- Meinischmidt, G., & Heim, C. (2007). Sensitivity to intranasal oxytocin in adult men with early parental separation. *Biological Psychiatry*, 61(9), 1109–11. doi:10.1016/j.biopsych.2006.09.007
- Meins, E., Centifanti, L. C. M., Fernyhough, C., & Fishburn, S. (2013). Maternal Mind-Mindedness and Children's Behavioral Difficulties: Mitigating the Impact of Low Socioeconomic Status. *Journal of Abnormal Child Psychology*, 41(4), 543–553. doi:10.1007/s10802-012-9699-3
- Meins, E., Fernyhough, C., de Rosnay, M., Arnott, B., Leekam, S. R., & Turner, M. (2012). Mind-Mindedness as a Multidimensional Construct: Appropriate and Nonattuned Mind-Related Comments Independently Predict Infant-Mother Attachment in a Socially Diverse Sample. *Infancy*, 17(4), 393–415. doi:10.1111/j.1532-7078.2011.00087.x
- Meins, E., Fernyhough, C., Fradley, E., & Tuckey, M. (2001). Rethinking maternal sensitivity: Mothers' comments on infants' mental processes predict security of attachment at 12 months. *Journal of Child Psychology and Psychiatry*, 42(5), 637–648.
- Meins, E., Fernyhough, C., & Harris-Waller, J. (2014). Is mind-mindedness trait-like or a quality of close relationships? Evidence from descriptions of

- significant others, famous people, and works of art. *Cognition*, 130(3), 417–427. doi:10.1016/j.cognition.2013.11.009
- Meins, E., Fernyhough, C., Wainwright, R., Das Gupta, M., Fradley, E., & Tuckey, M. (2002). Maternal Mind-Mindedness and Attachment Security as Predictors of Theory of Mind Understanding. *Child Development*, 73(6), 1715–1726. doi:10.1111/1467-8624.00501
- Melchior, M., Moffitt, T. E., Milne, B. J., Poulton, R., & Caspi, A. (2007). Why Do Children from Socioeconomically Disadvantaged Families Suffer from Poor Health When They Reach Adulthood? A Life-Course Study. *American Journal of Epidemiology*, 166(8), 966–974. doi:10.1093/aje/kwm155
- Melnick, B., & Hurley, J. (1969). Distinctive Personality Attributes of Child-Abusing Mothers. *Journal of Consulting and Clinical Psychology*, 33(6), 746.
- Mercy, J. A. (2009). Creating a Healthier Future Through Early Interventions for Children. *JAMA*, 301(21), 2262. doi:10.1001/jama.2009.803
- Meyer, B., & Pilkonis, P. A. (2005). An attachment model of personality disorders. *Major Theories of Personality Disorder*, 2, 231–281.
- Meyer-Lindenberg, A., Domes, G., Kirsch, P., & Heinrichs, M. (2011). Oxytocin and vasopressin in the human brain: social neuropeptides for translational medicine. *Nature Reviews. Neuroscience*, 12(9), 524–38. doi:10.1038/nrn3044
- Mezzich, A. (1997). Substance use and risky sexual behavior in female adolescents. *Drug and Alcohol Dependence*, 44(2-3), 157–166. doi:10.1016/S0376-8716(96)01333-6
- Midgley, N., & Vrouva, I. (2013). *Minding the Child: Mentalization-based interventions with children, young people and their families*. New York: Routledge.
- Mikulincer, M. (1998). Adult attachment style and individual differences in functional versus dysfunctional experiences of anger. *Journal of Personality and Social Psychology*, 74(2), 513.
- Mikulincer, M., Birnbaum, G., Woddis, D., & Nachmias, O. (2000). Stress and accessibility of proximity-related thoughts: exploring the normative and intraindividual components of attachment theory. *Journal of Personality and Social Psychology*, 78(3), 509–23. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/10743877>
- Mikulincer, M., Dolev, T., & Shaver, P. R. (2004a). Attachment-Related Strategies During Thought Suppression: Ironic Rebounds and Vulnerable Self-Representations. *Journal of Personality and Social Psychology*, 87(6), 940–956. doi:10.1037/0022-3514.87.6.940
- Mikulincer, M., Dolev, T., & Shaver, P. R. (2004b). Attachment-Related Strategies

During Thought Suppression: Ironic Rebounds and Vulnerable Self-Representations. *Journal of Personality and Social Psychology*, 87(6), 940–956. doi:10.1037/0022-3514.87.6.940

Mikulincer, M., Gillath, O., & Shaver, P. R. (2002). Activation of the attachment system in adulthood: Threat-related primes increase the accessibility of mental representations of attachment figures. *Journal of Personality and Social Psychology*, 83(4), 881–895. doi:10.1037//0022-3514.83.4.881

Mikulincer, M., & Horesh, N. (1999). Adult attachment style and the perception of others: the role of projective mechanisms. *Journal of Personality and Social Psychology*, 76(6), 1022–34. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/10402684>

Mikulincer, M., & Shaver, P. R. (2007). *Attachment in adulthood: Structure, dynamics, and change*. New York: Guilford Press.

Mikulincer, M., & Shaver, P. R. (2008). Adult Attachment and Affect Regulation. In J. Cassidy & P. R. Shaver (Eds.), *Handbook of attachment: Theory, research, and clinical applications. Second Edition* (pp. 503–531). New York: Guilford Press.

Mikulincer, M., Shaver, P. R., Gillath, O., & Nitzberg, R. A. (2005). Attachment, caregiving, and altruism: boosting attachment security increases compassion and helping. *Journal of Personality and Social Psychology*, 89(5), 817.

Mileva-Seitz, V. R., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2015). Genetic mechanisms of parenting. *Hormones and Behavior*. doi:10.1016/j.yhbeh.2015.06.003

Mileva-Seitz, V. R., Steiner, M., Atkinson, L., Meaney, M. J., Levitan, R., Kennedy, J. L., ... Fleming, A. S. (2013). Interaction between oxytocin genotypes and early experience predicts quality of mothering and postpartum mood. *PloS One*, 8(4), e61443. doi:10.1371/journal.pone.0061443

Millisecond Software. (2013). Inquisit. Seattle, WA.

Moffitt, T. E., Caspi, A., Belsky, J., & Silva, P. A. (1992). Childhood Experience and the Onset of Menarche: A Test of a Sociobiological Model. *Child Development*, 63(1), 47–58. doi:10.1111/j.1467-8624.1992.tb03594.x

Moffitt, T., Poulton, R., & Caspi, A. (2013). Lifelong Impact of Early Self-Control. *American Scientist*, 101(5), 352. doi:10.1511/2013.104.352

Mohiyeddini, C., Opacka-Juffry, J., & Gross, J. J. (2014). Emotional suppression explains the link between early life stress and plasma oxytocin. *Anxiety, Stress, and Coping*, 27(4), 466–75. doi:10.1080/10615806.2014.887696

Montoya, E. R., Bos, P. A., Terburg, D., Rosenberger, L. A., & van Honk, J. (2014). Cortisol administration induces global down-regulation of the brain's reward circuitry. *Psychoneuroendocrinology*, 47, 31–42.

doi:10.1016/j.psyneuen.2014.04.022

Montoya, J. L., Landi, N., Kober, H., Worhunsky, P. D., Rutherford, H. J. V., Mencl, W. E., ... Potenza, M. N. (2012). Regional brain responses in nulliparous women to emotional infant stimuli. *PloS One*, 7(5), e36270. doi:10.1371/journal.pone.0036270

Morelen, D., Shaffer, A., & Suveg, C. (2014). Maternal Emotion Regulation: Links to Emotion Parenting and Child Emotion Regulation. *Journal of Family Issues*. doi:10.1177/0192513X14546720

Morgan, J. K., Shaw, D. S., & Forbes, E. E. (2014a). Maternal depression and warmth during childhood predict age 20 neural response to reward. *Journal of the American Academy of Child and Adolescent Psychiatry*, 53(1), 108–117.e1. doi:10.1016/j.jaac.2013.10.003

Morgan, J. K., Shaw, D. S., & Forbes, E. E. (2014b). Maternal depression and warmth during childhood predict age 20 neural response to reward. *Journal of the American Academy of Child and Adolescent Psychiatry*, 53(1), 108–117.e1. doi:10.1016/j.jaac.2013.10.003

Moutsiana, C., Fearon, P., Murray, L., Cooper, P., Goodyer, I., Johnstone, T., & Halligan, S. (2014). Making an effort to feel positive: insecure attachment in infancy predicts the neural underpinnings of emotion regulation in adulthood. *Journal of Child Psychology and Psychiatry*, 55(9), 999–1008. doi:10.1111/jcpp.12198

Murray, A. D. (1985). Aversiveness is in the mind of the beholder: perception of infant crying by adults. In B. M. Lester & C. F. Z. Boukydis (Eds.), *Infant crying: Theoretical and Research Perspectives* (pp. 217–240). New York: Plenum Press.

Musser, E. D., Kaiser-Laurent, H., & Ablow, J. C. (2012). The neural correlates of maternal sensitivity: an fMRI study. *Developmental Cognitive Neuroscience*, 2(4), 428–36. doi:10.1016/j.dcn.2012.04.003

Narváez, D., Panksepp, J., Schore, A. N., & Gleason, T. R. (2012). *Evolution, early experience and human development: From research to practice and policy*. Oxford University Press.

Nathanson, A. I., & Manohar, U. (2012). Attachment, Working Models of Parenting, and Expectations for Using Television in Childrearing. *Family Relations*, 61(3), 441–454. doi:10.1111/j.1741-3729.2012.00701.x

Neppl, T. K., Conger, R. D., Scaramella, L. V., & Ontai, L. L. (2009). Intergenerational continuity in parenting behavior: Mediating pathways and child effects. *Developmental Psychology*, 45(5), 1241–1256. doi:10.1037/a0014850

Neumann, I. D., & Landgraf, R. (2012). Balance of brain oxytocin and vasopressin: implications for anxiety, depression, and social behaviors. *Trends in*

Neurosciences, 35(11), 649–59. doi:10.1016/j.tins.2012.08.004

Neumann, I. D., Wigger, A., Torner, L., Holsboer, F., & Landgraf, R. (2001). Brain Oxytocin Inhibits Basal and Stress-Induced Activity of the Hypothalamo-Pituitary-Adrenal Axis in Male and Female Rats: Partial Action Within the Paraventricular Nucleus. *Journal of Neuroendocrinology*, 12(3), 235–243. doi:10.1046/j.1365-2826.2000.00442.x

Noldus. (2013). FaceReader: Tool for automatic analysis of facial expression: Version 5.0.15. Wageningen, The Netherlands: Noldus Information Technology B. V.

Norman, R. E., Byambaa, M., De, R., Butchart, A., Scott, J., & Vos, T. (2012). The Long-Term Health Consequences of Child Physical Abuse, Emotional Abuse, and Neglect: A Systematic Review and Meta-Analysis. *PLoS Medicine*, 9(11), e1001349. doi:10.1371/journal.pmed.1001349

Numan, M., & Woodside, B. (2010). Maternity: neural mechanisms, motivational processes, and physiological adaptations. *Behavioral Neuroscience*, 124(6), 715–41. doi:10.1037/a0021548

Nusslock, R., & Miller, G. E. (2015). Early-life adversity and physical and emotional health across the lifespan: A neuro-immune network hypothesis. *Biological Psychiatry*. doi:10.1016/j.biopsych.2015.05.017

O'Callaghan, M. F., Borkowski, J. G., Whitman, T. L., Maxwell, S. E., & Keogh, D. (1999). A Model of Adolescent Parenting: The Role of Cognitive Readiness to Parent. *Journal of Research on Adolescence*, 9(2), 203–225. doi:10.1207/s15327795jra0902_5

Ochsner, K., & Gross, J. J. (2005). The cognitive control of emotion. *Trends in Cognitive Sciences*, 9(5), 242–249. doi:10.1016/j.tics.2005.03.010

Ochsner, K. N., Silvers, J. A., & Buhle, J. T. (2012). Functional imaging studies of emotion regulation: a synthetic review and evolving model of the cognitive control of emotion. *Annals of the New York Academy of Sciences*, 1251(1), E1–E24. doi:10.1111/j.1749-6632.2012.06751.x

Okagaki, L., & Bingham, G. E. (2005). Parents' social cognitions and their parenting behaviors. In T. Luster & L. Okagaki (Eds.), *Parenting: An ecological perspective* (Vol. 2, pp. 3–33). Lawrence Erlbaum Mahwah, NJ.

Oldfield, R. C. (1971). The assessment and analysis of handedness: The Edinburgh inventory. *Neuropsychologia*, 9(1), 97–113. doi:10.1016/0028-3932(71)90067-4

Oliveri, M., Koch, G., Torriero, S., & Caltagirone, C. (2005a). Increased facilitation of the primary motor cortex following 1Hz repetitive transcranial magnetic stimulation of the contralateral cerebellum in normal humans. *Neuroscience Letters*, 376(3), 188–193. doi:10.1016/j.neulet.2004.11.053

- Oliveri, M., Koch, G., Torriero, S., & Caltagirone, C. (2005b). Increased facilitation of the primary motor cortex following 1Hz repetitive transcranial magnetic stimulation of the contralateral cerebellum in normal humans. *Neuroscience Letters*, 376(3), 188–193. doi:10.1016/j.neulet.2004.11.053
- Olmsted, R. W., Altemeier, W. A., O'Connor, S., Vietze, P. M., Sandler, H. M., & Sherrod, K. B. (1982). Antecedents of child abuse. *The Journal of Pediatrics*, 100(5), 823–829. doi:10.1016/S0022-3476(82)80604-5
- Olsavsky, A. K., Telzer, E. H., Shapiro, M., Humphreys, K. L., Flannery, J., Goff, B., & Tottenham, N. (2013). Indiscriminate amygdala response to mothers and strangers after early maternal deprivation. *Biological Psychiatry*, 74(11), 853–60. doi:10.1016/j.biopsych.2013.05.025
- Opacka-Juffry, J., & Mohiyeddini, C. (2012). Experience of stress in childhood negatively correlates with plasma oxytocin concentration in adult men. *Stress (Amsterdam, Netherlands)*, 15(1), 1–10. doi:10.3109/10253890.2011.560309
- Oppenheim, D., Koren-Karie, N., & Sagi, A. (2001). Mothers' empathic understanding of their preschoolers' internal experience: Relations with early attachment. *International Journal of Behavioral Development*, 25(1), 16–26. doi:10.1080/01650250042000096
- Osborne, Y. H., Hinz, L. D., Rappaport, N. B., Williams, H. S., & Tuma, J. M. (1988). Parent Social Attractiveness, Parent Sex, Child Temperament, and Socioeconomic Status as Predictors of Tendency to Report Child Abuse. *Journal of Social and Clinical Psychology*, 6(1), 69–76. doi:10.1521/jscp.1988.6.1.69
- Osgood, C. E., Suci, G. J., & Tannenbaum, P. H. (1957). *The measurement of meaning* (Vol. 47). Urbana: University of Illinois Press.
- Out, D., Bakermans-Kranenburg, M. J., van Pelt, J., & Van IJzendoorn, M. H. (2012). Salivary -Amylase and Intended Harsh Caregiving in Response to Infant Crying: Evidence for Physiological Hyperreactivity. *Child Maltreatment*, 17(4), 295–305. doi:10.1177/1077559512464427
- Out, D., Pieper, S., Bakermans-Kranenburg, M. J., & Van IJzendoorn, M. H. (2010). Physiological reactivity to infant crying: a behavioral genetic study. *Genes, Brain and Behavior*, 9(8), 868–876. doi:10.1111/j.1601-183X.2010.00624.x
- Parke, R. D., & Collmer, C. W. (1975). Child abuse: An interdisciplinary analysis.
- Parsons, C. E., Young, K. S., Bhandari, R., van IJzendoorn, M. H., Bakermans-Kranenburg, M. J., Stein, A., & Kringelbach, M. L. (2014). The bonnie baby: experimentally manipulated temperament affects perceived cuteness and motivation to view infant faces. *Developmental Science*, 17(2), 257–69. doi:10.1111/desc.12112
- Parsons, C. E., Young, K. S., Craske, M. G., Stein, A. L., & Kringelbach, M. L.

- (2014). Introducing the Oxford Vocal (OxVoc) Sounds database: a validated set of non-acted affective sounds from human infants, adults, and domestic animals. *Frontiers in Psychology*, 5. doi:10.3389/fpsyg.2014.00562
- Parsons, C. E., Young, K. S., Mohseni, H., Woolrich, M. W., Thomsen, K. R., Joensson, M., ... Kringelbach, M. L. (2013). Minor structural abnormalities in the infant face disrupt neural processing: a unique window into early caregiving responses. *Social Neuroscience*, 8(4), 268–74. doi:10.1080/17470919.2013.795189
- Parsons, C. E., Young, K. S., Parsons, E., Stein, A., & Kringelbach, M. L. (2012). Listening to infant distress vocalizations enhances effortful motor performance. *Acta Paediatrica (Oslo, Norway: 1992)*, 101(4), e189–91. doi:10.1111/j.1651-2227.2011.02554.x
- Pat-Horenczyk, R., Cohen, S., Ziv, Y., Achituv, M., Asulin-Peretz, L., Blanchard, T. R., ... Brom, D. (2015). Emotion regulation in mothers and young children faced with trauma. *Infant Mental Health Journal*, 36(3), 337–48. doi:10.1002/imhj.21515
- Paulson, J. F., Dauber, S., & Leiferman, J. A. (2006). Individual and Combined Effects of Postpartum Depression in Mothers and Fathers on Parenting Behavior. *Pediatrics*, 118(2), 659–668. doi:10.1542/peds.2005-2948
- Pears, K. C., & Capaldi, D. M. (2001). Intergenerational transmission of abuse: a two-generational prospective study of an at-risk sample. *Child Abuse & Neglect*, 25(11), 1439–1461.
- Pechtel, P., Lyons-Ruth, K., Anderson, C. M., & Teicher, M. H. (2014). Sensitive periods of amygdala development: the role of maltreatment in preadolescence. *NeuroImage*, 97, 236–44. doi:10.1016/j.neuroimage.2014.04.025
- Pechtel, P., & Pizzagalli, D. A. (2011). Effects of early life stress on cognitive and affective function: an integrated review of human literature. *Psychopharmacology*, 214(1), 55–70. doi:10.1007/s00213-010-2009-2
- Pederson, D. R., & Moran, G. (1995). Appendix B: Maternal Behavior Q-Set. *Monographs of the Society for Research in Child Development*, 60(2/3), 247. doi:10.2307/1166182
- Pelli, D. G. (1997). The VideoToolbox software for visual psychophysics: transforming numbers into movies. *Spatial Vision*, 10(4), 437–442. doi:10.1163/156856897X00366
- Perry, J. C., & Henry, M. (2004). Studying defense mechanisms in psychotherapy using the Defense Mechanism Rating Scales. In U. Hentschel, G. Smith, J. Draguns, & W. Ehlers. (Eds.), *Defense Mechanisms: Theoretical, Research and Clinical Perspectives* (pp. 165–192). Amsterdam: Elsevier.
- Pessoa, L. (2008). On the relationship between emotion and cognition. *Nature*

- Reviews Neuroscience*, 9(2), 148–158. doi:10.1038/nrn2317
- Pessoa, L. (2010). Emotion and cognition and the amygdala: From “what is it?” to “what’s to be done?” *Neuropsychologia*, 48(12), 3416–3429. doi:10.1016/j.neuropsychologia.2010.06.038
- Pessoa, L., & Adolphs, R. (2010). Emotion processing and the amygdala: from a “low road” to “many roads” of evaluating biological significance. *Nature Reviews Neuroscience*, 11(11), 773–783. doi:10.1038/nrn2920
- Petty, R. E., DeSteno, D., & Rucker, D. D. (2001). The role of affect in attitude change. *Handbook of Affect and Social Cognition*, 212–233.
- Phillips, M. L., Ladouceur, C. D., & Drevets, W. C. (2008). A neural model of voluntary and automatic emotion regulation: implications for understanding the pathophysiology and neurodevelopment of bipolar disorder. *Molecular Psychiatry*, 13(9), 833–857. doi:10.1038/mp.2008.65
- Piallini, G., De Palo, F., & Simonelli, A. (2015). Parental brain: cerebral areas activated by infant cries and faces. A comparison between different populations of parents and not. *Frontiers in Psychology*, 6. doi:10.3389/fpsyg.2015.01625
- Pierrehumbert, B., Torrisi, R., Ansermet, F., Borghini, A., & Halfon, O. (2012). Adult attachment representations predict cortisol and oxytocin responses to stress. *Attachment & Human Development*, 14(5), 453–76. doi:10.1080/14616734.2012.706394
- Pierrehumbert, B., Torrisi, R., Laufer, D., Halfon, O., Ansermet, F., & Beck Popovic, M. (2010). Oxytocin response to an experimental psychosocial challenge in adults exposed to traumatic experiences during childhood or adolescence. *Neuroscience*, 166(1), 168–77. doi:10.1016/j.neuroscience.2009.12.016
- Pietromonaco, P. R., & Barrett, L. F. (2000). The internal working models concept: What do we really know about the self in relation to others? *Review of General Psychology*, 4(2), 155–175. doi:10.1037/1089-2680.4.2.155
- Pine, D. S., Mogg, K., Bradley, B. P., Montgomery, L., Monk, C. S., McClure, E., ... Kaufman, J. (2005). Attention bias to threat in maltreated children: implications for vulnerability to stress-related psychopathology. *The American Journal of Psychiatry*, 162(2), 291–6. doi:10.1176/appi.ajp.162.2.291
- Pollak, S. D. (2008). Mechanisms Linking Early Experience and the Emergence of Emotions: Illustrations From the Study of Maltreated Children. *Current Directions in Psychological Science*, 17(6), 370–375. doi:10.1111/j.1467-8721.2008.00608.x
- Porges, S. W. (2007). The polyvagal perspective. *Biological Psychology*, 74(2), 116–143.

- Proverbio, A. M., Brignone, V., Matarazzo, S., Del Zotto, M., & Zani, A. (2006). Gender and parental status affect the visual cortical response to infant facial expression. *Neuropsychologia*, 44(14), 2987–2999. doi:10.1016/j.neuropsychologia.2006.06.015
- Quinton, D., & Rutter, M. (1984). Parents with children in care-II. Intergenerational continuities. *Journal of Child Psychology and Psychiatry*, 25(2), 231–250. doi:10.1111/j.1469-7610.1984.tb00146.x
- Quinton, D., Rutter, M., & Liddle, C. (1984). Institutional rearing, parenting difficulties and marital support. *Psychological Medicine*, 14(01), 107. doi:10.1017/S0033291700003111
- Quirin, M., Kuhl, J., & Düsing, R. (2011). Oxytocin buffers cortisol responses to stress in individuals with impaired emotion regulation abilities. *Psychoneuroendocrinology*, 36(6), 898–904. doi:10.1016/j.psyneuen.2010.12.005
- R Development Core Team. (2013). The R Project for Statistical Computing. (R. D. C. Team, Ed.) *Text*. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from <http://www.r-project.org/>
- Raby, K. L., Lawler, J. M., Shlafer, R. J., Hesemeyer, P. S., Collins, W. A., & Sroufe, L. A. (2015). The interpersonal antecedents of supportive parenting: A prospective, longitudinal study from infancy to adulthood. *Developmental Psychology*, 51(1), 115–123. doi:10.1037/a0038336
- Raby, K. L., Steele, R. D., Carlson, E. A., & Sroufe, L. A. (2015). Continuities and changes in infant attachment patterns across two generations. *Attachment & Human Development*, 1–15. doi:10.1080/14616734.2015.1067824
- Redlich, R., Stacey, D., Opel, N., Grotegerd, D., Dohm, K., Kugel, H., ... Dannlowski, U. (2015). Evidence of an IFN- γ by early life stress interaction in the regulation of amygdala reactivity to emotional stimuli. *Psychoneuroendocrinology*, 62, 166–173. doi:10.1016/j.psyneuen.2015.08.008
- Reijneveld, S. A., van der Wal, M. F., Brugman, E., Sing, R. A. H., & Verloove-Vanhorick, S. P. (2004). Infant crying and abuse. *Lancet*, 364(9442), 1340–2. doi:10.1016/S0140-6736(04)17191-2
- Renner, L. M., & Slack, K. S. (2006). Intimate partner violence and child maltreatment: Understanding intra- and intergenerational connections. *Child Abuse & Neglect*, 30(6), 599–617. doi:10.1016/j.chiabu.2005.12.005
- Rholes, W. S., Simpson, J. A., Kohn, J. L., Wilson, C. L., Martin, A. M., Tran, S., & Kashy, D. A. (2011). Attachment orientations and depression: a longitudinal study of new parents. *Journal of Personality and Social Psychology*, 100(4), 567–86. doi:10.1037/a0022802
- Richetin, J., Costantini, G., Perugini, M., & Schönbrodt, F. (2015). Should We Stop

Looking for a Better Scoring Algorithm for Handling Implicit Association Test Data? Test of the Role of Errors, Extreme Latencies Treatment, Scoring Formula, and Practice Trials on Reliability and Validity. *PLoS One*, 10(6), e0129601. doi:10.1371/journal.pone.0129601

- Riem, M. M. E., Alink, L. R. A., Out, D., Van IJzendoorn, M. H., & Bakermans-Kranenburg, M. J. (2015). Beating the brain about abuse: Empirical and meta-analytic studies of the association between maltreatment and hippocampal volume across childhood and adolescence. *Development and Psychopathology*, 27(2), 507–20. doi:10.1017/S0954579415000127
- Riem, M. M. E., Bakermans-Kranenburg, M. J., Huffmeijer, R., & van IJzendoorn, M. H. (2013). Does intranasal oxytocin promote prosocial behavior to an excluded fellow player? A randomized-controlled trial with Cyberball. *Psychoneuroendocrinology*, 38(8), 1418–25. doi:10.1016/j.psyneuen.2012.12.023
- Riem, M. M. E., Bakermans-Kranenburg, M. J., Pieper, S., Tops, M., Boksem, M. A. S., Vermeiren, R. R. J. M., ... Rombouts, S. A. R. B. (2011). Oxytocin modulates amygdala, insula, and inferior frontal gyrus responses to infant crying: a randomized controlled trial. *Biological Psychiatry*, 70(3), 291–7. doi:10.1016/j.biopsych.2011.02.006
- Riem, M. M. E., Bakermans-Kranenburg, M. J., van IJzendoorn, M. H., Out, D., & Rombouts, S. A. R. B. (2012). Attachment in the brain: adult attachment representations predict amygdala and behavioral responses to infant crying. *Attachment & Human Development*, 14(6), 533–51. doi:10.1080/14616734.2012.727252
- Riem, M. M. E., Bakermans-Kranenburg, M. J., Voorthuis, A., & van IJzendoorn, M. H. (2014). Oxytocin effects on mind-reading are moderated by experiences of maternal love withdrawal: an fMRI study. *Progress in Neuro-Psychopharmacology & Biological Psychiatry*, 51, 105–12. doi:10.1016/j.pnpbp.2014.01.014
- Riem, M. M. E., Pieper, S., Out, D., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2011). Oxytocin receptor gene and depressive symptoms associated with physiological reactivity to infant crying. *Social Cognitive and Affective Neuroscience*, 6(3), 294–300. doi:10.1093/scan/nsq035
- Riem, M. M. E., van IJzendoorn, M. H., Tops, M., Boksem, M. A. S., Rombouts, S. A. R. B., & Bakermans-Kranenburg, M. J. (2013). Oxytocin effects on complex brain networks are moderated by experiences of maternal love withdrawal. *European Neuropsychopharmacology : The Journal of the European College of Neuropsychopharmacology*, 23(10), 1288–95. doi:10.1016/j.euroneuro.2013.01.011
- Rifkin-Graboi, A. (2008). Attachment status and salivary cortisol in a normal day and during simulated interpersonal stress in young men. *Stress*, 11(3), 210–24. doi:10.1080/10253890701706670

- Rifkin-Graboi, A., Kong, L., Sim, L. W., Sanmugam, S., Broekman, B. F. P., Chen, H., ... Qiu, A. (2015). Maternal sensitivity, infant limbic structure volume and functional connectivity: a preliminary study. *Translational Psychiatry*, 5, e668. doi:10.1038/tp.2015.133
- Rinck, M., & Becker, E. S. (2007). Approach and avoidance in fear of spiders. *Journal of Behavior Therapy and Experimental Psychiatry*, 38(2), 105–120. doi:10.1016/j.jbtep.2006.10.001
- Rizzolatti, G., & Sinigaglia, C. (2010). The functional role of the parieto-frontal mirror circuit: interpretations and misinterpretations. *Nature Reviews. Neuroscience*, 11(4), 264–74. doi:10.1038/nrn2805
- Roberts, B. W., Caspi, A., & Moffitt, T. E. (2001). The kids are alright: Growth and stability in personality development from adolescence to adulthood. *Journal of Personality and Social Psychology*, 81(4), 670–683. doi:10.1037/0022-3514.81.4.670
- Roberts, J. E., Gotlib, I. H., & Kassel, J. D. (1996). Adult attachment security and symptoms of depression: The mediating roles of dysfunctional attitudes and low self-esteem. *Journal of Personality and Social Psychology*, 70(2), 310.
- Robinson, D. L., Zitzman, D. L., & Williams, S. K. (2011). Mesolimbic dopamine transients in motivated behaviors: focus on maternal behavior. *Frontiers in Psychiatry*, 2, 23. doi:10.3389/fpsy.2011.00023
- Rodrigo, M. J., León, I., Quiñones, I., Lage, A., Byrne, S., & Bobes, M. A. (2011). Brain and personality bases of insensitivity to infant cues in neglectful mothers: an event-related potential study. *Development and Psychopathology*, 23(1), 163–76. doi:10.1017/S0954579410000714
- Roelofs, K., Elzinga, B. M., & Rotteveel, M. (2005). The effects of stress-induced cortisol responses on approach–avoidance behavior. *Psychoneuroendocrinology*, 30(7), 665–677. doi:10.1016/j.psyneuen.2005.02.008
- Roisman, G. I., Holland, A., Fortuna, K., Fraley, R. C., Clausell, E., & Clarke, A. (2007a). The Adult Attachment Interview and self-reports of attachment style: an empirical rapprochement. *Journal of Personality and Social Psychology*, 92(4), 678–97. doi:10.1037/0022-3514.92.4.678
- Roisman, G. I., Holland, A., Fortuna, K., Fraley, R. C., Clausell, E., & Clarke, A. (2007b). The Adult Attachment Interview and self-reports of attachment style: an empirical rapprochement. *Journal of Personality and Social Psychology*, 92(4), 678–97. doi:10.1037/0022-3514.92.4.678
- Roisman, G. I., Padron, E., Sroufe, L. A., & Egeland, B. (2002). Earned-Secure Attachment Status in Retrospect and Prospect. *Child Development*, 73(4), 1204–1219. doi:10.1111/1467-8624.00467
- Rossi, S., Hallett, M., Rossini, P. M., & Pascual-Leone, A. (2011). Screening

- questionnaire before TMS: an update. *Clinical Neurophysiology*, 122(8), 1686.
- Rowe, A., & Carnelley, K. B. (2003). Attachment style differences in the processing of attachment-relevant information: Primed-style effects on recall, interpersonal expectations, and affect. *Personal Relationships*, 10(1), 59–75. doi:10.1111/1475-6811.00036
- Rutherford, H. J. V, Wallace, N. S., Laurent, H. K., & Mayes, L. C. (2015). Emotion regulation in parenthood. *Developmental Review*, 36, 1–14. doi:10.1016/j.dr.2014.12.008
- Rutherford, H. J. V., Booth, C. R., Crowley, M. J., & Mayes, L. C. (2015). Investigating the relationship between working memory and emotion regulation in mothers. *Journal of Cognitive Psychology*, 1–8. doi:10.1080/20445911.2015.1075542
- Sagi, A., van IJzendoorn, M. H., Scharf, M., Joels, T., Koren-Karie, N., & Aviezer, O. M. O. (1997). Ecological constraints for intergenerational transmission of attachment. *International Journal of Behavioral Development*, 20(2), 287–299.
- Sameroff, A. J., & Emde, R. N. (1989). *Relationship disturbances in early childhood: A developmental approach*. Basic Books (AZ).
- Sameroff, A. J., & Fiese, B. H. (2000). Transactional regulation: The developmental ecology of early intervention. In J. P. Shonkoff & S. J. Meisels (Eds.), *Handbook of early childhood intervention* (Vol. 2, pp. 135–159). New York: Cambridge Univ Press.
- Samuelson, K. W., Krueger, C. E., & Wilson, C. (2012). Relationships between maternal emotion regulation, parenting, and children's executive functioning in families exposed to intimate partner violence. *Journal of Interpersonal Violence*, 27(17), 3532–50. doi:10.1177/0886260512445385
- Sanchez, M. M., McCormack, K. M., & Howell, B. R. (2015). Social buffering of stress responses in nonhuman primates: Maternal regulation of the development of emotional regulatory brain circuits. *Social Neuroscience*, 10(5), 512–526. doi:10.1080/17470919.2015.1087426
- Sander, D., Grafman, J., & Zalla, T. (2003). The Human Amygdala: An Evolved System for Relevance Detection. *Reviews in the Neurosciences*, 14(4). doi:10.1515/REVNEURO.2003.14.4.303
- Sanders, G. (1990). Psychological stress of exposure to uncontrollable noise increases plasma oxytocin in high emotionality women. *Psychoneuroendocrinology*, 15(1), 47–58. doi:10.1016/0306-4530(90)90046-C
- Sanders, M. R. (2012). Development, Evaluation, and Multinational Dissemination of the Triple P-Positive Parenting Program. *Annual Review of Clinical*

- Psychology*, 8(1), 345–379. doi:10.1146/annurev-clinpsy-032511-143104
- Sandler, I. N., Schoenfelder, E. N., Wolchik, S. A., & MacKinnon, D. P. (2011). Long-Term Impact of Prevention Programs to Promote Effective Parenting: Lasting Effects but Uncertain Processes. *Annual Review of Psychology*, 62(1), 299–329. doi:10.1146/annurev.psych.121208.131619
- Santona, A., Tagini, A., Sarracino, D., De Carli, P., Pace, C. S., Parolin, L., & Terrone, G. (2015). Maternal depression and attachment: the evaluation of mother–child interactions during feeding practice. *Frontiers in Psychology*, 6. doi:10.3389/fpsyg.2015.01235
- Saridjan, N. S., Huizink, A. C., Koetsier, J. A., Jaddoe, V. W., Mackenbach, J. P., Hofman, A., ... Tiemeier, H. (2010). Do social disadvantage and early family adversity affect the diurnal cortisol rhythm in infants? The Generation R Study. *Hormones and Behavior*, 57(2), 247–54. doi:10.1016/j.yhbeh.2009.12.001
- Sarıtaş, D., Grusec, J. E., & Gençöz, T. (2013). Warm and harsh parenting as mediators of the relation between maternal and adolescent emotion regulation. *Journal of Adolescence*, 36(6), 1093–101. doi:10.1016/j.adolescence.2013.08.015
- Sarracino, D., Presaghi, F., Degni, S., & Innamorati, M. (2011). Sex-specific relationships among attachment security, social values, and sensation seeking in early adolescence: Implications for adolescents' externalizing problem behaviour. *Journal of Adolescence*, 34(3), 541–554. doi:10.1016/j.adolescence.2010.05.013
- Scaramella, L. V., Neppl, T. K., Ontai, L. L., & Conger, R. D. (2008). Consequences of socioeconomic disadvantage across three generations: parenting behavior and child externalizing problems. *Journal of Family Psychology*, 22(5), 725–33. doi:10.1037/a0013190
- Schaffer, R. (1977). *Mothering*. Cambridge, MA: Harvard University Press.
- Scharf, M., & Mayseless, O. (2011). Buds of Parenting in Emerging Adult Males: What We Learned From Our Parents. *Journal of Adolescent Research*, 26(4), 479–505. doi:10.1177/0743558411402339
- Schatz, J. N., Smith, L. E., Borkowski, J. G., Whitman, T. L., & Keogh, D. A. (2008). Maltreatment risk, self-regulation, and maladjustment in at-risk children. *Child Abuse & Neglect*, 32(10), 972–982. doi:10.1016/j.chiabu.2008.09.001
- Schermerhorn, A. C., Cummings, E. M., & Kail, R. V. (2008). Transactional family dynamics: A new framework for conceptualizing family influence processes. In R. V Kail (Ed.), *Advances in child development and behavior* (Vol. 36, p. 187). San Diego: Elsevier.
- Schofield, T. J., Lee, R. D., & Merrick, M. T. (2013). Safe, Stable, Nurturing

Relationships as a Moderator of Intergenerational Continuity of Child Maltreatment: A Meta-Analysis. *Journal of Adolescent Health*, 53(4), S32–S38. doi:10.1016/j.jadohealth.2013.05.004

- Schore, A. N. (1994). *Affect Regulation and the Origin of the Self: The Neurobiology of Emotional Development*. Hillsdale, New Jersey: Lawrence Erlbaum Associates.
- Schore, A. N. (2003). *Affect Regulation & the Repair of the Self*. New York: W.W. Norton.
- Schore, A. N. (2012). *The Science of the Art of Psychotherapy*. W. W. Norton. Retrieved from http://books.google.it/books?id=A0L5Tf_XzoQC
- Schore, J. R., & Schore, A. N. (2007). Modern Attachment Theory: The Central Role of Affect Regulation in Development and Treatment. *Clinical Social Work Journal*, 36(1), 9–20. doi:10.1007/s10615-007-0111-7
- Schuppert, H. M., Giesen-Bloo, J., van Gemert, T. G., Wiersema, H. M., Minderaa, R. B., Emmelkamp, P. M. G., & Nauta, M. H. (2009). Effectiveness of an emotion regulation group training for adolescents - a randomized controlled pilot study. *Clinical Psychology & Psychotherapy*, 16(6), 467–478. doi:10.1002/cpp.637
- Schweizer, S., Walsh, N., Stretton, J., Dunn, V., Goodyer, I. M., & Dalgleish, T. (2015). Enhanced emotion regulation capacity, and its neural substrates in those exposed to moderate childhood adversity. *Social Cognitive and Affective Neuroscience*. doi:10.1093/scan/nsv109
- Seidel, E.-M., Habel, U., Kirschner, M., Gur, R. C., & Derntl, B. (2010). The impact of facial emotional expressions on behavioral tendencies in women and men. *Journal of Experimental Psychology: Human Perception and Performance*, 36(2), 500–507. doi:10.1037/a0018169
- Seifritz, E., Esposito, F., Neuhoﬀ, J. G., Lüthi, A., Mustovic, H., Dammann, G., ... Di Salle, F. (2003). Differential sex-independent amygdala response to infant crying and laughing in parents versus nonparents. *Biological Psychiatry*, 54(12), 1367–1375. doi:10.1016/S0006-3223(03)00697-8
- Seltzer, L. J., Ziegler, T., Connolly, M. J., Prosofski, A. R., & Pollak, S. D. (2014). Stress-induced elevation of oxytocin in maltreated children: evolution, neurodevelopment, and social behavior. *Child Development*, 85(2), 501–12. doi:10.1111/cdev.12136
- Seltzer, L. J., Ziegler, T. E., & Pollak, S. D. (2010). Social vocalizations can release oxytocin in humans. *Proceedings. Biological Sciences / The Royal Society*, 277(1694), 2661–6. doi:10.1098/rspb.2010.0567
- Shaffer, A., Burt, K. B., Obradović, J., Herbers, J. E., & Masten, A. S. (2009). Intergenerational continuity in parenting quality: The mediating role of social competence. *Developmental Psychology*, 45(5), 1227–1240.

doi:10.1037/a0015361

- Shafra, P., Eaves, B., Navarro, D. J., & Perfors, A. (2012). Epistemic trust: modeling children's reasoning about others' knowledge and intent. *Developmental Science*, 15(3), 436–447. doi:10.1111/j.1467-7687.2012.01135.x
- Shamay-Tsoory, S. G., & Abu-Akel, A. (2015). The social salience hypothesis of oxytocin. *Biological Psychiatry*. doi:10.1016/j.biopsych.2015.07.020
- Shamay-Tsoory, S. G., Aharon-Peretz, J., & Perry, D. (2009). Two systems for empathy: a double dissociation between emotional and cognitive empathy in inferior frontal gyrus versus ventromedial prefrontal lesions. *Brain: A Journal of Neurology*, 132(Pt 3), 617–27. doi:10.1093/brain/awn279
- Shamay-Tsoory, S. G., Fischer, M., Dvash, J., Harari, H., Perach-Bloom, N., & Levkovitz, Y. (2009). Intranasal administration of oxytocin increases envy and schadenfreude (gloating). *Biological Psychiatry*, 66(9), 864–70. doi:10.1016/j.biopsych.2009.06.009
- Shaver, P. R., & Mikulincer, M. (2013). Patterns of Relating and of Thinking about Relationships. In C. Hazan & M. I. Campa (Eds.), *Human Bonding: The Science of Affectional Ties* (p. 251). Guilford Press.
- Shields, A. M., Cicchetti, D., & Ryan, R. M. (1994). The development of emotional and behavioral self-regulation and social competence among maltreated school-age children. *Development and Psychopathology*, 6(01), 57–75. doi:10.1017/S0954579400005885
- Shields, A., Ryan, R. M., & Cicchetti, D. (2001). Narrative representations of caregivers and emotion dysregulation as predictors of maltreated children's rejection by peers. *Developmental Psychology*, 37(3), 321–337. doi:10.1037/0012-1649.37.3.321
- Shlafer, R. J., Raby, K. L., Lawler, J. M., Hesemeyer, P. S., & Roisman, G. I. (2015). Longitudinal associations between adult attachment states of mind and parenting quality. *Attachment & Human Development*, 17(1), 83–95. doi:10.1080/14616734.2014.962064
- Sibley, C. G., Fischer, R., & Liu, J. H. (2005). Reliability and validity of the revised experiences in close relationships (ECR-R) self-report measure of adult romantic attachment. *Personality & Social Psychology Bulletin*, 31(11), 1524–36. doi:10.1177/0146167205276865
- Sidebotham, P., & Golding, J. (2001). Child maltreatment in the “Children of the nineties.” *Child Abuse & Neglect*, 25(9), 1177–1200. doi:10.1016/S0145-2134(01)00261-7
- Sidebotham, P., & Heron, J. (2003). Child maltreatment in the “children of the nineties:” the role of the child. *Child Abuse & Neglect*, 27(3), 337–352. doi:10.1016/S0145-2134(03)00010-3

- Siegel, D. (1999). *The Developing Mind*. New York, NY: Guilford Press.
- Siegel, D. J. (2012). *Developing Mind, Second Edition: How Relationships and the Brain Interact to Shape Who We Are*. Retrieved from http://books.google.com/books?hl=it&lr=&id=IF-BA_cdEO0C&pgis=1
- Simons, R. L., Whitbeck, L. B., Conger, R. D., & Wu, C. (1991). Intergenerational transmission of harsh parenting. *Developmental Psychology*, 27(1), 159–171. doi:10.1037/0012-1649.27.1.159
- Simpson, J. A., & Belsky, J. (2008). Attachment theory within a modern evolutionary framework. In J. Cassidy & P. R. Shaver (Eds.), *Handbook of attachment: Theory, research, and clinical applications*. New York: Guilford Press.
- Simpson, J. A., & Belsky, J. (2016). Attachment theory within a modern evolutionary framework. In J. Cassidy & P. R. Shaver (Eds.), *Handbook of attachment: Theory, research, and clinical applications (3rd ed.)* (pp. 91–116). New York: Guilford Press.
- Singmann, H., Bolker, B., Højsgaard, S., Fox, J., Lawrence, M. A., Mertens, U., & Singmann, M. H. (2014). Package “afex.”
- Skowron, E. A., Kozlowski, J. M., & Pincus, A. L. (2010). Differentiation, self–other representations, and rupture–repair processes: Predicting child maltreatment risk. *Journal of Counseling Psychology*, 57(3), 304–316. doi:10.1037/a0020030
- Skuse, D. H., & Gallagher, L. (2009). Dopaminergic-neuropeptide interactions in the social brain. *Trends in Cognitive Sciences*, 13(1), 27–35. doi:10.1016/j.tics.2008.09.007
- Slade, A., Belsky, J., Aber, J. L., & Phelps, J. L. (1999). Mothers’ representations of their relationships with their toddlers: links to adult attachment and observed mothering. *Developmental Psychology*, 35(3), 611–9. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/10380853>
- Slade, A., Grienemberger, J., Bernbach, E., Levy, D., & Locker, A. (2005). Maternal reflective functioning, attachment, and the transmission gap: A preliminary study. *Attachment & Human Development*, 7(3), 283–298.
- Smeets, T., Otgaar, H., Candel, I., & Wolf, O. T. (2008). True or false? Memory is differentially affected by stress-induced cortisol elevations and sympathetic activity at consolidation and retrieval. *Psychoneuroendocrinology*, 33(10), 1378–86. doi:10.1016/j.psyneuen.2008.07.009
- Smith, C. A., & Farrington, D. P. (2004). Continuities in antisocial behavior and parenting across three generations. *Journal of Child Psychology and Psychiatry*, 45(2), 230–247. doi:10.1111/j.1469-7610.2004.00216.x
- Smith, S. M., Jenkinson, M., Woolrich, M. W., Beckmann, C. F., Behrens, T. E. J.,

- Johansen-Berg, H., ... Matthews, P. M. (2004). Advances in functional and structural MR image analysis and implementation as FSL. *NeuroImage*, 23, S208–S219. doi:10.1016/j.neuroimage.2004.07.051
- Solarz, A. K. (1960). Latency of instrumental responses as a function of compatibility with the meaning of eliciting verbal signs. *Journal of Experimental Psychology*, 59(4), 239–245. doi:10.1037/h0047274
- Solomon, J., & George, C. (2006). Intergenerational Transmission of Dysregulated Maternal Caregiving: Mothers Describe Their Upbringing and Childrearing. In O. Mayseless (Ed.), *Parenting Representations* (pp. 265–295). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511499869.010
- Soltis, J. (2004). The signal functions of early infant crying. *Behavioral and Brain Sciences*, 27(04), 443–458. doi:10.1017/S0140525X0400010X
- Sperber, D., Clément, F., Heintz, C., Mascaro, O., Mercier, H., Origgi, G., & Wilson, D. (2010). Epistemic Vigilance. *Mind & Language*, 25(4), 359–393. doi:10.1111/j.1468-0017.2010.01394.x
- Spinetta, J. J., & Rigler, D. (1972). The child-abusing parent: A psychological review. *Psychological Bulletin*, 77(4), 296–304. doi:10.1037/h0032419
- Sroufe, L. A., Egeland, B., Carlson, E. A., & Collins, W. A. (2009). *The development of the person: The Minnesota study of risk and adaptation from birth to adulthood*. New York: Guilford Press.
- Sroufe, L. A., & Jacobvitz, D. (1989). Diverging pathways, developmental transformations, multiple etiologies and the problem of continuity in development. *Human Development*, 32(3-4), 196–203.
- Stallings, J., Fleming, A. S., Corter, C., Worthman, C., & Steiner, M. (2001). The Effects of Infant Cries and Odors on Sympathy, Cortisol, and Autonomic Responses in New Mothers and Nonpostpartum Women. *Parenting*, 1(1-2), 71–100. doi:10.1080/15295192.2001.9681212
- Stearns, S. C. (1992). *The evolution of life histories* (Vol. 249). Oxford University Press Oxford.
- Steele, B. F., & Pollock, C. B. (1968). A psychiatric study of parents who abuse infants and small children. In R. E. Heifer & C. H. Kempe (Eds.), *The battered child* (pp. 89–133). Chigaco: University of Chicago Press.
- Steinberg, L. (1988). Reciprocal relation between parent-child distance and pubertal maturation. *Developmental Psychology*, 24(1), 122–128. doi:10.1037/0012-1649.24.1.122
- Steinhauer, A., Villani, V., Pereira, J., Leung, E., & Atkinson, L. (2009). Signals, Attention allocation and maternal responsivity to infant. In *American Psychological Association Conference*.
- Stern, D. N. (1985). *The interpersonal world of the infant*. New York Basic. New

York: Basic Books. Retrieved from
http://scholar.google.nl/scholar?hl=en&q=infant&btnG=Search&as_sdt=0,5&as_ylo=&as_vis=0#1

- Stern, D. N. (1993). The role of feelings for an interpersonal self. In *The perceived self: Ecological and interpersonal sources of self-knowledge. Emory symposia in cognition* 5 (pp. 202–215). New York: Cambridge University Press.
- Stern, D. N. (1995a). *The motherhood constellation*. New York: Basic Books.
- Stern, D. N. (1995b). *The Motherhood Constellation: A Unified View of Parent-Infant Psychotherapy*. New York: Karnac Books.
- Stern, D. N. (2010). *Forms of vitality: Exploring dynamic experience in psychology, the arts, psychotherapy, and development*. New York: Oxford University Press.
- Stoltenborgh, M., Bakermans-Kranenburg, M. J., Alink, L. R. A., & van IJzendoorn, M. H. (2012a). The Universality of Childhood Emotional Abuse: A Meta-Analysis of Worldwide Prevalence. *Journal of Aggression, Maltreatment & Trauma*, 21(8), 870–890. doi:10.1080/10926771.2012.708014
- Stoltenborgh, M., Bakermans-Kranenburg, M. J., Alink, L. R. A., & van IJzendoorn, M. H. (2012b). The Universality of Childhood Emotional Abuse: A Meta-Analysis of Worldwide Prevalence. *Journal of Aggression, Maltreatment & Trauma*, 21(8), 870–890. doi:10.1080/10926771.2012.708014
- Stovall-McClough, K. C., & Cloitre, M. (2006). Unresolved attachment, PTSD, and dissociation in women with childhood abuse histories. *Journal of Consulting and Clinical Psychology*, 74(2), 219–28. doi:10.1037/0022-006X.74.2.219
- Strathearn, L., Fonagy, P., Amico, J., & Montague, P. R. (2009). Adult attachment predicts maternal brain and oxytocin response to infant cues. *Neuropsychopharmacology: Official Publication of the American College of Neuropsychopharmacology*, 34(13), 2655–66. doi:10.1038/npp.2009.103
- Strathearn, L., Li, J., Fonagy, P., & Montague, P. R. (2008). What's in a smile? Maternal brain responses to infant facial cues. *Pediatrics*, 122(1), 40–51. doi:10.1542/peds.2007-1566
- Sung, S., Simpson, J. A., Griskevicius, V., Sally, I., Kuo, C., Schlomer, G. L., & Belsky, J. (2016). Secure infant-mother attachment buffers the effect of early-life stress on age of menarche.
- Swain, J. E. (2011). The human parental brain: In vivo neuroimaging. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, 35(5), 1242–1254. doi:10.1016/j.pnpb.2010.10.017
- Swain, J. E., Kim, P., Spicer, J., Ho, S. S., Dayton, C. J., Elmadih, A., & Abel, K. M. (2014). Approaching the biology of human parental attachment: brain

- imaging, oxytocin and coordinated assessments of mothers and fathers. *Brain Research*, 1580, 78–101. doi:10.1016/j.brainres.2014.03.007
- Swenson, C. C., Schaeffer, C. M., Henggeler, S. W., Faldowski, R., & Mayhew, A. M. (2010). Multisystemic therapy for child abuse and neglect: A randomized effectiveness trial. *Journal of Family Psychology*, 24(4), 497–507. doi:10.1037/a0020324
- Tarabulsy, G. M., Bernier, A., Provost, M. A., Maranda, J., Larose, S., Moss, E., ... Tessier, R. (2005). Another look inside the gap: ecological contributions to the transmission of attachment in a sample of adolescent mother-infant dyads. *Developmental Psychology*, 41(1), 212.
- Tarullo, A. R., & Gunnar, M. R. (2006). Child maltreatment and the developing HPA axis. *Hormones and Behavior*, 50(4), 632–9. doi:10.1016/j.yhbeh.2006.06.010
- Taylor, S. E., Eisenberger, N. I., Saxbe, D., Lehman, B. J., & Lieberman, M. D. (2006). Neural responses to emotional stimuli are associated with childhood family stress. *Biological Psychiatry*, 60(3), 296–301. doi:10.1016/j.biopsych.2005.09.027
- Taylor, S. E., Gonzaga, G. C., Klein, L. C., Hu, P., Greendale, G. A., & Seeman, T. E. (2006). Relation of oxytocin to psychological stress responses and hypothalamic-pituitary-adrenocortical axis activity in older women. *Psychosomatic Medicine*, 68(2), 238–45. doi:10.1097/01.psy.0000203242.95990.74
- Teicher, M. H., Andersen, S. L., Polcari, A., Anderson, C. M., Navalta, C. P., & Kim, D. M. (2003). The neurobiological consequences of early stress and childhood maltreatment. *Neuroscience & Biobehavioral Reviews*, 27(1-2), 33–44. doi:10.1016/S0149-7634(03)00007-1
- Teige-Mocigemba, S., Klauer, K. C., & Sherman, J. W. (2010). A practical guide to implicit association tests and related tasks. In *Handbook of implicit cognition: Measurement, theory, and applications* (Vol. 2, pp. 117–139).
- Terzis, V., Moridis, C. N., & Economides, A. A. (2012). The effect of emotional feedback on behavioral intention to use computer based assessment. *Computers & Education*, 59(2), 710–721. doi:10.1016/j.compedu.2012.03.003
- Thomason, M. E., Marusak, H. A., Tocco, M. A., Vila, A. M., McGarragle, O., & Rosenberg, D. R. (2015). Altered amygdala connectivity in urban youth exposed to trauma. *Social Cognitive and Affective Neuroscience*, 10(11), 1460–8. doi:10.1093/scan/nsv030
- Thompson, R. (2006). Exploring the Link Between Maternal History of Childhood Victimization and Child Risk of Maltreatment. *Journal of Trauma Practice*, 5(2), 57–72. doi:10.1300/J189v05n02_04
- Thornberry, T. P. (2009). The Apple Doesn't Fall Far from the Tree (or Does It?):

Intergenerational Patterns of Antisocial Behavior-The American Society of Criminology 2008 Sutherland Address. *Criminology; an Interdisciplinary Journal*, 47(2), 297–325. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/25308976>

Thornberry, T. P., Freeman-Gallant, A., Lizotte, A. J., Krohn, M. D., & Smith, C. A. (2003). Linked Lives: The Intergenerational Transmission of Antisocial Behavior. *Journal of Abnormal Child Psychology*, 31(2), 171–184. doi:10.1023/A:1022574208366

Timmer, S., & Urquiza, A. (Eds.). (2014). *Evidence-Based Approaches for the Treatment of Maltreated Children* (Vol. 3). Dordrecht: Springer Netherlands. doi:10.1007/978-94-007-7404-9

Tkaczyszyn, M., Olbrycht, T., Makowska, A., Soboń, K., Paleczny, B., Rydlewska, A., & Jankowska, E. A. (2013). The influence of the sounds of crying baby and the sounds of violence on haemodynamic parameters and autonomic status in young, healthy adults. *International Journal of Psychophysiology : Official Journal of the International Organization of Psychophysiology*, 87(1), 52–9. doi:10.1016/j.ijpsycho.2012.10.017

Tops, M., van Peer, J. M., & Korf, J. (2007). Individual differences in emotional expressivity predict oxytocin responses to cortisol administration: relevance to breast cancer? *Biological Psychology*, 75(2), 119–23. doi:10.1016/j.biopsycho.2007.01.001

Tost, H., Champagne, F. A., & Meyer-Lindenberg, A. (2015). Environmental influence in the brain, human welfare and mental health. *Nature Neuroscience*, 18(10), 1421–31. doi:10.1038/nn.4108

Tottenham, N. (2012). Human amygdala development in the absence of species-expected caregiving. *Developmental Psychobiology*, 54(6), 598–611. doi:10.1002/dev.20531

Tottenham, N. (2015). Social scaffolding of human amygdala-mPFC circuit development. *Social Neuroscience*, 10(5), 489–499. doi:10.1080/17470919.2015.1087424

Tottenham, N., Hare, T. A., Millner, A., Gilhooly, T., Zevin, J. D., & Casey, B. J. (2011). Elevated amygdala response to faces following early deprivation. *Developmental Science*, 14(2), 190–204. doi:10.1111/j.1467-7687.2010.00971.x

Tottenham, N., Hare, T. A., Quinn, B. T., McCarry, T. W., Nurse, M., Gilhooly, T., ... Casey, B. J. (2010). Prolonged institutional rearing is associated with atypically large amygdala volume and difficulties in emotion regulation. *Developmental Science*, 13(1), 46–61. doi:10.1111/j.1467-7687.2009.00852.x

Trevarthen, C. (1979). Communication and cooperation in early infancy: A description of primary intersubjectivity. In M. Bullowa (Ed.), *Before speech: The beginning of interpersonal communication* (pp. 321–347). New York:

Cambridge University Press.

- Trevarthen, C. (1994). Infant semiosis. In W. Nöth (Ed.), *Origins of semiosis: Sign evolution in nature and culture* (p. 119). Berlin: Walter de Gruyter.
- Trevarthen, C., & Aitken, K. J. (2001). Infant Intersubjectivity: Research, Theory, and Clinical Applications. *Journal of Child Psychology and Psychiatry*, 42(1), 3–48. doi:10.1111/1469-7610.00701
- Tronick, E. Z., & Gianino, A. F. (1986). The transmission of maternal disturbance to the infant. *New Directions for Child and Adolescent Development*, 1986(34), 5–11. doi:10.1002/cd.23219863403
- Tuteur, W., & Glotzer, J. (1966). Further observations on murdering mothers. *Journal of Forensic Sciences*, 11(3), 373.
- Tybur, J. M., Lieberman, D., Kurzban, R., & DeScioli, P. (2013). Disgust: evolved function and structure. *Psychological Review*, 120(1), 65–84. doi:10.1037/a0030778
- Umiltà, M. A., Wood, R., Loffredo, F., Ravera, R., & Gallese, V. (2013). Impact of civil war on emotion recognition: the denial of sadness in Sierra Leone. *Frontiers in Psychology*, 4. doi:10.3389/fpsyg.2013.00523
- Urquiza, A., & Timmer, S. (2014). Parent-Child Interaction Therapy for Maltreated Children. In S. Timmer & A. Urquiza (Eds.), *Evidence-Based Approaches for the Treatment of Maltreated Children* (pp. 123–144). Dordrecht: Springer. doi:10.1007/978-94-007-7404-9_8
- van der Werff, S. J. A., Pannekoek, J. N., Veer, I. M., van Tol, M.-J., Aleman, A., Veltman, D. J., ... van der Wee, N. J. A. (2013). Resilience to childhood maltreatment is associated with increased resting-state functional connectivity of the salience network with the lingual gyrus. *Child Abuse & Neglect*, 37(11), 1021–1029. doi:10.1016/j.chiabu.2013.07.008
- van der Werff, S. J. A., Pannekoek, J. N., Veer, I. M., van Tol, M.-J., Aleman, A., Veltman, D. J., ... van der Wee, N. J. A. (2013a). Resting-state functional connectivity in adults with childhood emotional maltreatment. *Psychological Medicine*, 43(9), 1825–36. doi:10.1017/S0033291712002942
- van der Werff, S. J. A., Pannekoek, J. N., Veer, I. M., van Tol, M.-J., Aleman, A., Veltman, D. J., ... van der Wee, N. J. A. (2013b). Resting-state functional connectivity in adults with childhood emotional maltreatment. *Psychological Medicine*, 43(9), 1825–36. doi:10.1017/S0033291712002942
- van der Werff, S. J. A., van den Berg, S. M., Pannekoek, J. N., Elzinga, B. M., & van der Wee, N. J. A. (2013). Neuroimaging resilience to stress: a review. *Frontiers in Behavioral Neuroscience*, 7, 39. doi:10.3389/fnbeh.2013.00039
- van Harmelen, A.-L., van Tol, M.-J., Dalgleish, T., van der Wee, N. J. A., Veltman, D. J., Aleman, A., ... Elzinga, B. M. (2014). Hypoactive medial prefrontal

- cortex functioning in adults reporting childhood emotional maltreatment. *Social Cognitive and Affective Neuroscience*, 9(12), 2026–33. doi:10.1093/scan/nsu008
- van Harmelen, A.-L., van Tol, M.-J., Demenescu, L. R., van der Wee, N. J. A., Veltman, D. J., Aleman, A., ... Elzinga, B. M. (2012). Enhanced amygdala reactivity to emotional faces in adults reporting childhood emotional maltreatment. *Social Cognitive and Affective Neuroscience*, 8(4), 362–9. doi:10.1093/scan/nss007
- van Harmelen, A.-L., van Tol, M.-J., van der Wee, N. J. A., Veltman, D. J., Aleman, A., Spinhoven, P., ... Elzinga, B. M. (2010). Reduced medial prefrontal cortex volume in adults reporting childhood emotional maltreatment. *Biological Psychiatry*, 68(9), 832–8. doi:10.1016/j.biopsych.2010.06.011
- van IJzendoorn, M. H. (1992). Intergenerational transmission of parenting: A review of studies in nonclinical populations. *Developmental Review*, 12(1), 76–99. doi:10.1016/0273-2297(92)90004-L
- van IJzendoorn, M. H. (1995a). Adult attachment representations, parental responsiveness, and infant attachment: A meta-analysis on the predictive validity of the Adult Attachment Interview. *Psychological Bulletin*, 117(3), 387–403. doi:10.1037/0033-2909.117.3.387
- van IJzendoorn, M. H. (1995b). Of the way we were: On temperament, attachment, and the transmission gap: A rejoinder to Fox (1995).
- van IJzendoorn, M. H., & Bakermans-Kranenburg, M. J. (1997). Intergenerational transmission of attachment: A move to the contextual level. In L. Atkinson & K. J. Zucker (Eds.), *Attachment and psychopathology* (pp. 135–170). Guilford Press New York.
- van IJzendoorn, M. H., Huffmeijer, R., Alink, L. R. A., Bakermans-Kranenburg, M. J., & Tops, M. (2011). The Impact of Oxytocin Administration on Charitable Donating is Moderated by Experiences of Parental Love-Withdrawal. *Frontiers in Psychology*, 2, 258. doi:10.3389/fpsyg.2011.00258
- Van Leijenhorst, L., Gunther Moor, B., Op de Macks, Z. A., Rombouts, S. A. R. B., Westenberg, P. M., & Crone, E. A. (2010). Adolescent risky decision-making: neurocognitive development of reward and control regions. *NeuroImage*, 51(1), 345–55. doi:10.1016/j.neuroimage.2010.02.038
- van Marle, H. J. F., Hermans, E. J., Qin, S., & Fernández, G. (2009). From Specificity to Sensitivity: How Acute Stress Affects Amygdala Processing of Biologically Salient Stimuli. *Biological Psychiatry*, 66(7), 649–655. doi:10.1016/j.biopsych.2009.05.014
- Van Zeijl, J., Mesman, J., Van IJzendoorn, M. H., Bakermans-Kranenburg, M. J., Juffer, F., Stolk, M. N., ... Alink, L. R. A. (2006). Attachment-based intervention for enhancing sensitive discipline in mothers of 1- to 3-year-old

- children at risk for externalizing behavior problems: a randomized controlled trial. *Journal of Consulting and Clinical Psychology*, 74(6), 994–1005. doi:10.1037/0022-006X.74.6.994
- Verhage, M. L., Schuengel, C., Madigan, S., Fearon, R. M. P., Oosterman, M., Cassibba, R., ... van IJzendoorn, M. H. (2015). Narrowing the Transmission Gap: A Synthesis of Three Decades of Research on Intergenerational Transmission of Attachment . *Psychological Bulletin*. doi:10.1037/bul0000038
- Vrijzen, J. N., van Oostrom, I., Speckens, A., Becker, E. S., & Rinck, M. (2013). Approach and Avoidance of Emotional Faces in Happy and Sad Mood. *Cognitive Therapy and Research*, 37(1), 1–6. doi:10.1007/s10608-012-9436-9
- Vrtička, P., & Vuilleumier, P. (2012). Neuroscience of human social interactions and adult attachment style. *Frontiers in Human Neuroscience*, 6(July), 212. doi:10.3389/fnhum.2012.00212
- Vuilleumier, P., Armony, J. L., Driver, J., & Dolan, R. J. (2001). Effects of Attention and Emotion on Face Processing in the Human Brain. *Neuron*, 30(3), 829–841. doi:10.1016/S0896-6273(01)00328-2
- Vuilleumier, P., & Pourtois, G. (2007). Distributed and interactive brain mechanisms during emotion face perception: Evidence from functional neuroimaging. *Neuropsychologia*, 45(1), 174–194. doi:10.1016/j.neuropsychologia.2006.06.003
- Vuilleumier, P., Richardson, M. P., Armony, J. L., Driver, J., & Dolan, R. J. (2004). Distant influences of amygdala lesion on visual cortical activation during emotional face processing. *Nature Neuroscience*, 7(11), 1271–1278. doi:10.1038/nn1341
- Vyas, A., Bernal, S., & Chattarji, S. (2003). Effects of chronic stress on dendritic arborization in the central and extended amygdala. *Brain Research*, 965(1-2), 290–294. doi:10.1016/S0006-8993(02)04162-8
- Vyas, A., Pillai, A. G., & Chattarji, S. (2004). Recovery after chronic stress fails to reverse amygdaloid neuronal hypertrophy and enhanced anxiety-like behavior. *Neuroscience*, 128(4), 667–73. doi:10.1016/j.neuroscience.2004.07.013
- Waller, C., Wittfoth, M., Fritzsche, K., Timm, L., Wittfoth-Schardt, D., Rottler, E., ... Gündel, H. (2015). Attachment representation modulates oxytocin effects on the processing of own-child faces in fathers. *Psychoneuroendocrinology*, 62, 27–35. doi:10.1016/j.psyneuen.2015.07.003
- Warren, S. L., Huston, L., Egeland, B., & Sroufe, L. (1997). Child and adolescent anxiety disorders and early attachment. *Journal of the American Academy of Child & Adolescent Psychiatry*, 36(5), 637–644.
- Waters, H. S., & Rodrigues-Doolabh, L. (2004). Manual for decoding secure base

narratives. *Unpublished Manuscript, State University of New York at Stony Brook*. State University of New York at Stony Brook.

- Waters, H. S., & Waters, E. (2006). The attachment working models concept: among other things, we build script-like representations of secure base experiences. *Attachment & Human Development*, 8(3), 185–97. doi:10.1080/14616730600856016
- Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, 54(6), 1063–1070. doi:10.1037/0022-3514.54.6.1063
- Webster-Stratton, C. L. (2014). Incredible Years® Parent and Child Programs for Maltreating Families. In S. Timmer & A. Urquiza (Eds.), *Evidence-Based Approaches for the Treatment of Maltreated Children* (pp. 81–104). Dordrecht: Springer. doi:10.1007/978-94-007-7404-9_6
- Weed, K., & Nicholson, J. S. (2015). Differential social evaluation of pregnant teens, teen mothers and teen fathers by university students. *International Journal of Adolescence and Youth*, 20(1), 1–16. doi:10.1080/02673843.2014.963630
- Weinberg, M. K., & Tronick, E. Z. (1994). Beyond the Face: An Empirical Study of Infant Affective Configurations of Facial, Vocal, Gestural, and Regulatory Behaviors. *Child Development*, 65(5), 1503. doi:10.2307/1131514
- Weisman, O., & Feldman, R. (2013). Oxytocin effects on the human brain: findings, questions, and future directions. *Biological Psychiatry*, 74(3), 158–9. doi:10.1016/j.biopsych.2013.05.026
- Weisman, O., Zagoory-Sharon, O., & Feldman, R. (2012). Oxytocin administration to parent enhances infant physiological and behavioral readiness for social engagement. *Biological Psychiatry*, 72(12), 982–9. doi:10.1016/j.biopsych.2012.06.011
- Wells, J. C. K. (2003). Parent-Offspring Conflict Theory, Signaling of Need, and Weight Gain in Early Life. *The Quarterly Review of Biology*, 78(2), 169–202. doi:10.1086/374952
- Westen, D. (1991). Social cognition and object relations. *Psychological Bulletin*, 109(3), 429–455. doi:10.1037//0033-2909.109.3.429
- Whittle, S., Yap, M. B. H., Yucel, M., Sheeber, L., Simmons, J. G., Pantelis, C., & Allen, N. B. (2009). Maternal responses to adolescent positive affect are associated with adolescents' reward neuroanatomy. *Social Cognitive and Affective Neuroscience*, 4(3), 247–256. doi:10.1093/scan/nsp012
- Wickham, H. (2009). *ggplot2: elegant graphics for data analysis*. Springer Science & Business Media.

- Widom, C. S. (1989). The cycle of violence. *Science*, 244(4901), 160–166. doi:10.1126/science.2704995
- Widom, C. S., Czaja, S. J., & DuMont, K. A. (2015). Intergenerational transmission of child abuse and neglect: real or detection bias? *Science*, 347(6229), 1480–5. doi:10.1126/science.1259917
- Wigboldus, D. H. J., Holland, R. W., & Van Knippenberg, A. (2004). Single target implicit associations. *Unpublished Manuscript*.
- Wilson, C. L., Rholes, W. S., Simpson, J. A., & Tran, S. (2007). Labor, delivery, and early parenthood: an attachment theory perspective. *Personality & Social Psychology Bulletin*, 33(4), 505–18. doi:10.1177/0146167206296952
- Winnicott, D. W. (1960). Ego distortion in terms of true and false self. In *The maturational processes and the facilitating environment* (pp. 140–152). New York: International Universities Press.
- Winnicott, D. W. (1965). *The maturational processes and the facilitating environment: Studies in the theory of emotional development*. Oxford, UK: International Universities Press.
- Winnicott, D. W. (1971). *Playing and reality*. London: Psychology Press.
- Worthman, C. M. (2009). Habits of the heart: Life history and the developmental neuroendocrinology of emotion. *American Journal of Human Biology*, 21(6), 772–781. doi:10.1002/ajhb.20966
- Young, K. S., Parsons, C. E., Jegindoe Elmholdt, E.-M., Woolrich, M. W., van Hartevelt, T. J., Stevner, A. B. A., ... Kringelbach, M. L. (2015). Evidence for a Caregiving Instinct: Rapid Differentiation of Infant from Adult Vocalizations Using Magnetoencephalography. *Cerebral Cortex*, bhv306. doi:10.1093/cercor/bhv306
- Young, K. S., Parsons, C. E., Stein, A., & Kringelbach, M. L. (2012). Interpreting infant vocal distress: The ameliorative effect of musical training in depression. *Emotion*, 12(6), 1200–1205. doi:10.1037/a0028705
- Zayas, V., & Shoda, Y. (2005). Do automatic reactions elicited by thoughts of romantic partner, mother, and self relate to adult romantic attachment? *Personality & Social Psychology Bulletin*, 31(8), 1011–25. doi:10.1177/0146167204274100
- Zeanah, C. H., & Zeanah, P. D. (1989). Intergenerational transmission of maltreatment: Insights from attachment theory and research. *Psychiatry*, 52(2), 177–196.
- Zeifman, D. M. (2001). An ethological analysis of human infant crying: answering Tinbergen's four questions. *Developmental Psychobiology*, 39(4), 265–85. doi:10.1002/dev.1005
- Zerach, G., Kanat-Maymon, Y., Aloni, R., & Solomon, Z. (2016). The role of

fathers' psychopathology in the intergenerational transmission of captivity trauma: A twenty three-year longitudinal study. *Journal of Affective Disorders*, 190, 84–92. doi:10.1016/j.jad.2015.09.072

Zeskind, P. S., & Lester, B. M. (2001). Analysis of infant crying. In L. T. Singer & P. S. Zeskind (Eds.), *Biobehavioral assessment of the infant* (pp. 149–166). New York: Guilford Press.

Acknowledgments

First I want to thank my advisor Laura for guiding and supporting me over the years. She gave me a key to interpret reality, the papers will come. I got two main take home messages from her: 1. Always try to scratch the surface of everything. We live in a complex world. If you think it is complex it is certainly even more complex. 2. Pietro, the next morning you have to be there. Please be “on the task”. Thanks.

I want to thank also Marinus and Marian because they welcomed me and represent two scientific guiding lights. I hope our collaboration will grow. Thanks to Madelon as well, kindness and proficiency.

Thanks to Alessandra who always supports me from “behind the scenes”. And Diego of course.

Thanks to (Tiziano) Ferrix to be one of the most surprising things of academia. Yes, I will start my therapy.

Thanks to Brambi, he is probably not aware but I learnt a lot from him. In fact, his second favorite topic is science.

Thanks to my TMS team, Carlotta and Beatrice, for the dedication. And Zaira for the kind supervision.

Thanks to La Frizzi because she reminds me we are qualitatively useful.

Thanks to all the office: Federica (the mum), Carlotta (the grandma), Darione, Elena, Paola, Erica, Laura, Giusto, Ila.

Thanks to MY colleague, La Franceschina. It was supposed to be difficult; I think I’ve found a friend.

Thanks to my other colleagues, 4 years of complaints, laughs and beers: Andrea, Luca, Luca, Erika, Elena, Elena, Vittorio.

Thanks to the “others”: Prof P, Sutte, Roxy, Mary etc etc. I know that “I disagree”, but not this time.

Thanks to my family for their constant support in every possible way. At least to the extent that they do not forget me when I do not show up for months. Leti and her family, because they have deep roots now. La Rufi because I know she is tough. Ga because he is making his own way. However, we know where we are building this. Thanks to Mile as well.

I cannot “review” all my friends but this thesis belongs to them, at least because it took away a lot of their time in these months. In particular, I miss the ones who are increasing in number.

Finally, My (other?) Valentina! She probably hates this thesis, but she has to be aware that she kept my pieces together. My personal regulator of affects. Home is a place with a chimney in a dark bathroom. :)