

An investigation of how parents and non-parents attend to infant and child faces

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Declaration

I, Chloe Thompson-Booth, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Signature:

A handwritten signature in black ink, appearing to read 'Chloe Thompson-Booth', written in a cursive style.

Abstract

Detecting infant facial cues is a necessary precursor for effective parenting responses. The question arises whether infant faces elicit preferential allocation of attention in order to facilitate such detection. This thesis employed variations of an existing behavioural attentional paradigm (Hodsoll, Viding, & Lavie, 2011) in first-time parents and non-parents. Individual differences in attentional engagement to infant faces were investigated in relation to: parental status; sex; current symptoms of depression; parenting stress; and childhood experience of maltreatment.

Mothers and fathers, and women without children, were found to show greater attentional engagement with infant faces compared to adult, adolescent, and pre-adolescent faces (Chapters 2-4). Parents as compared to non-parents showed the greatest level of attentional engagement with infant faces, and mothers and fathers showed a similar pattern of response (Chapter 4). However, pre-adolescent child faces receive enhanced attentional engagement as compared to older faces, but only when displaying negative affect (Chapters 3 and 4). Emotion was found to play an important role, with parents and non-parents showing enhanced attentional engagement with infant faces when they displayed emotional expressions (Chapters 2-4). Current parenting stress and experience of childhood maltreatment were found to be associated with individual differences in attention to infant compared to adult faces; by contrast, current symptoms of depression were not associated with performance on the attention task (Chapters 1 and 5).

These findings suggest that infant faces are inherently salient stimuli, especially for parents of infants. Increased attention to infant faces may reflect part of a wider set of adaptive behavioural changes associated with becoming a parent. However, these changes appear to be modulated by early or current adverse life experience, which may affect normative attention processes involved in detecting infant facial cues, with possible implications for parenting behaviour.

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Chapter 1: Introduction

Attention to Infant Facial Cues

1.1. Preface

Sensitive parenting behaviour is proposed to be one key hallmark of “good parenting” with research showing that it is linked to mother-offspring attachment styles as well as child developmental outcomes. Many different mechanisms are likely to underlie effective parenting behaviour, of which visual attention to infant faces is just one. However, the degree to which infant faces engage the attention of adults, and particularly parents, is likely to be fundamental in shaping basic care-taking responses. Infants are limited in their ability to communicate their needs to caregivers, and so facial cues are a particularly important mechanism by which infants can solicit attention and care. Furthermore, the ability to selectively attend to infant signals over other environmental cues and maintain attention towards such signals may be critical in facilitating an appropriate parental response. Disruptions in the ability to attend to, recognise, and respond to infant facial cues may play a role in the insensitive parenting behaviour that has been observed in mothers with psychological problems or a history of difficult childhood experiences.

Despite the fact that the very definition of sensitive parenting implicates the ability to recognise and respond appropriately to child emotional cues, the literature of parental or indeed adult perception of infant faces is scarce. Most research regarding attention to faces has focused on processing facial affect using adult stimuli only. There is an emerging literature that supports the hypothesis that infant faces may represent a particularly special class of social stimuli, but most of this evidence has not involved explicitly measuring attentional engagement with infant faces using behavioural paradigms. Furthermore, the existing behavioural studies have not compared parents and non-parents on their attentional engagement with infant faces, and there is little research regarding paternal as opposed to maternal attention to infant facial expressions.

This thesis reports a series of studies that systematically investigate attention towards infant, child and adult faces of differing emotional expressions in adults. Groups of parents (both mothers and fathers) and non-parents were recruited in order to assess whether attention is engaged to a greater degree by infant faces than adult faces, and whether attentional engagement with these faces was modified by emotional expressions and parental status. This introductory chapter provides a review of the extant literature surrounding parenting and attentional processes that may underlie

certain parenting behaviours. The importance of secure parent-child relationships and sensitive parenting behaviour for child development will be reviewed first, including factors that have been found to disrupt parenting behaviour. Next, literature relating to those attentional processes that might be important for sensitive parenting will be reviewed, including a discussion of attention to emotional faces more generally followed by a focussed critique of what is known regarding attention towards infant faces.

1.2. Parenting

1.2.1. Introduction to Parenting: Attachment and Long-Term Implications

Human infants are born unable to care for themselves and so require constant parental care and attention in order to have their needs met. Although infants need adequate parental care to ensure survival, it is also important that they also grow up in an environment that supports and fosters healthy development throughout childhood and into adulthood. It is well accepted that human development and behaviour are the product of an interaction between the growing person and his or her environment (Bronfenbrenner, 1989; Zeanah, 2000). Furthermore, early experiences of being parented can shape patterns of behaviour and relationships throughout life (Bowlby, 1969/1982; Thompson, 1999, 2000). Therefore, the quality of infants' experiences with their caregivers has implications for adaptation and development.

The bond formed between children and their caregivers¹ is also known as *attachment*, a term taken from John Bowlby's attachment theory. Bowlby (1969/1982, 1973, 1980) developed his theory of attachment by integrating evolutionary, biological, developmental, and cognitive concepts into a conceptual framework to explain the development of affective bonds between children and their caregivers, as well as the implications that the quality of these bonds might have for later development. Experimental investigations of attachment followed, with Mary Ainsworth developing a system for classifying the attachment style of infants. In the Strange Situation paradigm infants were separated and reunited with their primary

¹ Throughout this thesis "caregivers" are generally referred to as "parents" as parenting is the focus of the thesis; however, the term "caregivers" will be used where it is deemed more accurate.

caregivers (typically mothers) in a series of steps. By watching how the infant responded to the separation and their behaviour with their mother upon her return, Ainsworth was able to classify infants into different attachment style categories: secure (proximity-seeking behaviour towards caregiver, using the caregiver as a base for exploration, easily comforted after separation); insecure-avoidant (little or no distress at parental separation and avoidance behaviour when the caregiver returns); and insecure-ambivalent (extreme distress at separation, but a failure to be comforted or resistance upon the caregiver's return). A third attachment style known as "disorganised" attachment - characterised by poor organisation of attachment behaviour, such as contradictory behavioural patterns, confusion and apprehension, and sudden stilling - was added later (Ainsworth, Bell, & Stayton, 1971; Ainsworth, Blehar, Waters, & Wall, 1978; Ainsworth & Bell, 1970; Main & Solomon, 1990). These patterns of attachment were believed to reflect the history of interaction that the infant has experienced at home (Ainsworth et al., 1978).

Since the conceptualisation of attachment theory, it has been demonstrated that these attachment patterns are relatively stable across time (although the continuity of attachment can be affected by environmental risks) and that attachment quality has an important influence on child development from infancy and through to adulthood (Bretherton, 1985; Cassidy & Shaver, 2008; Egeland & Farber, 1984; Kobak, Cassidy, Lyons-Ruth, & Ziv, 2006; Matas, Arend, & Sroufe, 1978; Sroufe, 2005; Thompson, 1999; Waters, Weinfield, & Hamilton, 2000). Secure attachment to both mothers as well as fathers is believed to be the most advantageous attachment style in terms of child development. It is well documented that secure attachment is an important protective factor for child development, as evidenced by studies showing that securely attached children are less likely to develop emotional, social and behavioural difficulties than insecurely attached children, as well as developing more positive social-emotional competence, cognitive functioning, physical health and mental health (Bowlby, 2008; Ranson & Urichuk, 2008). On the other hand, "insecure" attachment styles have been shown to be a potential risk for child development. Several cross-sectional and longitudinal studies have shown that insecure and disorganized patterns of attachment are associated with lower cognitive skills, childhood internalising problems, and externalising behaviour problems (Brumariu & Kerns, 2010; Fearon, Bakermans-Kranenburg, Van IJzendoorn, Lapsley, & Roisman, 2010; Fearon & Belsky, 2011; Groh, Roisman, Van IJzendoorn, Bakermans-Kranenburg, & Fearon,

2012; Madigan, Atkinson, Laurin, & Benoit, 2013; Trautmann-Villalba, Gschwendt, Schmidt, & Laucht, 2006; Van IJzendoorn, Schuengel, & Bakermans-Kranenburg, 1999).

The association between attachment security and later functioning is thought to develop from the expectations infants form about their parents as a source of support during times of stress, threat, and novelty. Bowlby (1969/1982, 1973; 1980) suggested that infants form an “internal working model” of their relationship with their attachment figures, which develops based on the caregiving they receive and informs expectations about future interactions. For example, an infant who receives consistent and responsive caregiving will develop the expectation that their caregiver will be available and supportive when needed, which would result in the development of a secure attachment representation. These securely attached infants are likely to turn to the caregiver in times of stress for safety and comfort, as well as feeling supported and secure when exploring the environment. However, an infant who has experienced unsuccessful bids for proximity or a lack of parental support may develop an insecure attachment, and may develop less effective ways of dealing with stressful and challenging situations (Ainsworth, 1979; Goldberg, 1997; Kobak et al., 2006; Thompson, 1999). In turn, these internal working models of attachment representations are thought to eventually become generalised and shape expectations about interactions in other relationships later in life (Bowlby, 1969/1982; Cassidy, 1988; Sroufe, Egeland, Carlson, & Collins, 2005). Therefore, the quality of attachment experiences may play a part in the development of emotion regulation abilities, social competence, self-confidence, and trust and security in interpersonal relationships (Belsky, 1997; Cassidy, 1994; Goldberg, 1997; Sroufe, 2005).

1.2.2. Sensitive Parenting

Given the evidence that attachment quality is associated with later social and emotional functioning, and evidence that attachments to caregivers form based on caregiving experiences, it is important to consider what sort of parenting behaviours might foster the development of secure attachment. Attachment theorists have emphasised the influence of sensitive (vs. insensitive) parenting on the infant’s internal working model (Ainsworth, Bell, & Stayton, 1974; Ainsworth et al., 1978). Sensitive parenting is defined as the ability to accurately perceive and interpret infant attachment

signals and to respond to them promptly and appropriately (Ainsworth et al., 1978). The contingency between a parent's recognition of their infant's needs and consistently appropriate responding is thought to be crucial for the infant's learning about social interactions (Beeghly, Fuertes, Liu, Delonis, & Tronick, 2011). Sensitive parenting behaviour is proposed to reflect the parent's emotional availability and responsiveness, promoting a positive and trusting relationship with the child and the development of secure attachment (Ainsworth et al., 1978). However, a lack of consistent sensitivity is thought to stimulate the development of an insecure bond between infant and caregiver, reflecting a lack of confidence in the parent's emotional availability and responsiveness (Ainsworth, 1979; Ainsworth et al., 1974, 1978).

Many studies have shown that maternal and paternal sensitivity is a key factor in influencing attachment security (De Wolff & Van IJzendoorn, 1997; Goldsmith & Alansky, 1987; Grossmann et al., 2002; NICHD Early Child Care Research Network, 1997; Thompson, 1998; Van IJzendoorn & De Wolff, 1997). It has also been shown that interventions that are effective in encouraging parental sensitivity are also likely to enhance secure attachments (Bakermans-Kranenburg, Van IJzendoorn, & Juffer, 2003; van den Boom, 1994). Furthermore, it has been argued that parental sensitivity represents an ongoing aspect of the caregiving environment and as such may serve to maintain or disrupt attachment representations. It may also have more of an impact on development than an attachment classification measured at one particular time point, usually during infancy (Lamb, Thompson, Gardner, & Charnov, 1985; Lewis, Feiring, & Rosenthal, 2000; Sroufe, 1988). Indeed, it has been found that the predictive power of attachment security on child outcomes is contingent upon the quality of care received. Studies have shown that children with secure attachment histories who subsequently experienced insensitive parenting did not develop as well as might be expected based on their secure attachment classification. Similarly, children a history of insecure attachment who subsequently received sensitive parenting did not develop as poorly as might otherwise have been expected given their earlier insecurity (Belsky & Fearon, 2002; Erickson, Sroufe, & Egeland, 1985). In fact, Belsky and Fearon (2002) found in their longitudinal study that children with insecure attachment classifications at age 15 months who then experienced sensitive mothering (measured at 24 months) significantly outperformed secure children who subsequently experienced low-sensitive mothering on a measures of problem behaviour, social competence, language abilities, and school readiness at age three. Correspondingly,

children who were securely attached and received sensitive care performed the best on these measures, while children who were insecurely attached and received insensitive care performed the worst. This demonstrates the important role that sensitivity may have on child social, emotional, and behavioural development.

Sensitivity to infant behaviour has been associated with several other positive outcomes as well as attachment security, such as the development of social skills, self-worth, self-efficacy, language development, and overall cognitive ability (Bigelow, 1999; Bigelow et al., 2010; Bretherton, 2010; Cahill, Deater-Deckard, Pike, & Hughes, 2007; Jaffee, Caspi, Moffitt, Taylor, & Dickson, 2001; Lewis & Lamb, 2003; Page, Wilhelm, Gamble, & Card, 2010; Tomasello & Farrar, 1986). It has been suggested that contingent and responsive parenting behaviours promote infant development by serving as a model for emotional regulation and social behaviours, as well supporting cognitive development by making the infant feel secure enough to explore their environment (Ainsworth et al., 1978; Landry, Smith, & Swank, 2006; McElwain & Booth-LaForce, 2006; Tronick, 1989). Furthermore, parental behaviour during parent-child interactions that is sensitive to the child's abilities and needs can promote learning and independence (Carr & Pike, 2012; Meins, 1997; Mulvaney, McCartney, Bub, & Marshall, 2006).

However, sensitivity is not an exclusive condition of positive developmental outcomes or attachment security (De Wolff & Van IJzendoorn, 1997; Goldsmith & Alansky, 1987). Other aspects of parenting behaviour, such as mutuality, synchrony, positive attitude and emotional support also appear to be important (De Wolff & Van IJzendoorn, 1997). However, these behaviours might also be considered to be aspects of sensitive parenting. The concept of sensitivity, while ostensibly easier to measure than an unobservable "internal working model", is not consistently operationalised (Meins, Fernyhough, Fradley, & Tuckey, 2001). The behaviours that comprise sensitivity are diverse, but appear to be characterized by socially appropriate and relatively consistent responsiveness to infants' signals and interactions which allow infants to have their needs met, be comforted, and achieve levels of development beyond those they could achieve on their own (McElwain & Booth La-Force, 2006; Meins, 1997; Landry et al., 2006; Page et al., 2010). However, these behaviours in themselves will be comprised of more basic cognitive mechanisms, of which there has been little investigation. In order to respond to infant signals, parents will need to allocate sufficient attention towards their infant and recognise the signals being

provided, in order to respond appropriately. It has been proposed that sensitive parenting behaviour is particularly contingent upon infant emotional cues, with parental responses reflecting back to infants, in a marked and salient manner, the emotional content that parents perceive (Beeghly et al., 2011; Gergely & Watson, 1996, 1999; McElwain & Booth-LaForce, 2006). The association between early sensitivity and later positive infant outcomes suggests that individual differences in parental sensitivity persist over time; that is, it is likely that behaviours that comprise parental sensitivity during early infancy are a manifestation of a more generalised characteristic that exists throughout the infant period and probably beyond (although also depending on other aspects of the environment). Indeed, research on the intergenerational transmission of attachment security indicates that the quality of a mother's parenting behaviour as well as her infant's attachment security are predicted by the mother's childhood relationship with her parents, suggesting that individual differences in sensitivity are stable over years (Main, Kaplan, & Cassidy, 1985; Van IJzendoorn, 1995). Sensitive parenting behaviour is a complex construct that is likely to subsume a myriad of more basic cognitive and information processing mechanisms. Thus, it is likely that there will be basic cognitive mechanisms underlying sensitive parenting, and one candidate is attention towards emotional cues. It has been shown that attention towards emotion can be disrupted in the case of psychopathology, just as psychopathology can disrupt parenting behaviour.

1.2.3. What Are Risk Factors for Poorer Parenting?

There are many risk factors for poorer or more insensitive parenting behaviour, which also convey risks for attachment and child development. This may be because sensitivity emerges in the context of the parent's social and emotional wellbeing. For example, in their study on attachment security and sensitivity, Belsky and Fearon (2002) investigated factors associated with a discontinuity between early secure attachment and later insensitive parenting, and vice versa. The families with securely attached children at age 15 months who later experienced insensitive parenting were found to have experienced more life-stress, depression, and less social support than those families who showed secure attachments and sensitive parenting. Likewise, the families with insecurely attached infants who later experienced sensitive parenting had experienced less stress, less parental depression, and had more social support.

Therefore, stressful lives and the presence of depressive symptomatology may explain why parental behaviour became insensitive. Another study found that securely attached children transitioned to insecure attachments in the context of childhood maltreatment, maternal depression, and poor family functioning (Weinfield, Sroufe, & Egeland, 2000). If sensitive parenting is somewhat dependent upon social emotional functioning of parent, disruptions to such functioning may prompt insensitive behaviour.

1.2.3.1. Depression and Anxiety

Post-natal depression has received considerable research attention and it is now well established that post-natal depression, as well as ongoing maternal depression, can have an impact on parenting behaviour. Maternal depression is associated with reduced maternal responsiveness and insensitive parenting behaviour. For example, it has been shown that depressed mothers show less engagement with their child, less eye contact, are less attuned to their infants and display more negative behaviour and hostility towards infant signals (Cohn, Campbell, Matias, & Hopkins, 1990; Downey & Coyne, 1990; Field, 2010; Lovejoy, Graczyk, O'Hare, & Neuman, 2000; Murray, Fiori-Cowley, Hooper, & Cooper, 1996). A longitudinal study found that mothers with more depressive symptoms or symptoms which increased in severity over time showed the lowest levels of maternal sensitivity, whereas low depressive symptomatology was associated with higher levels of maternal sensitivity and an increase in sensitivity over time (Campbell, Matestic, von Stauffenberg, Mohan, & Kirchner, 2007). Furthermore, studies have suggested that depressed mothers show abnormal physiological responses towards infant distress and have a reduced ability to distinguish between different types of infant distress, which may explain some of the maternal insensitivity exhibited by these mothers (Donovan, Leavitt, & Walsh, 1998; Pearson, Melotti, et al., 2012). Depression during pregnancy may also be associated with poorer parenting behaviour. For example, Pearson and colleagues (2012) found in a longitudinal birth cohort study that women who had high depression symptoms scores during mid pregnancy showed lower maternal responsiveness when their infant was 12 months old compared to women with consistently low levels depression, even if they were no longer depressed after giving birth. Pearson and colleagues argue that there may be a disruptive effect of prenatal depression on the development of important preparations for maternal

responsiveness, which may then have long-term implications on the ability to develop such responses.

Alongside the effects of depression on care-giving behaviour, maternal depression has also been associated with a range of child outcomes. For example, infants of depressed mothers are more likely to: show insecure attachment patterns, present with poorer cognitive and academic performance; develop internalising and externalising problems; and show higher levels of more general negative affect and behaviour alongside lower levels of positive affect and behaviour (Goodman et al., 2011; Kim-Cohen, Moffitt, Taylor, Pawlby, & Caspi, 2005; Martins & Gaffan, 2000; Murray, Hipwell, Hooper, Stein, & Cooper, 1996; Murray et al., 2010, 2011). There is also evidence that fathers who are depressed may be less involved with their children and have poorer relationships with them, which also appears to have implications for their child's social and emotional functioning (Goodman, 2004; Paulson, Dauber, & Leiferman, 2011; Ramchandani, Stein, Evans, & O'Connor, 2005).

Given the importance of parental responsiveness for infant development, the association between depression and reduced parental responsiveness may partly explain why infants of depressed parents are more likely to show poorer emotional, behavioural and cognitive outcomes throughout childhood and adolescence. It is proposed that children of depressed parents may have disruptions in emotional processing and regulation (Cicchetti, Toth, & Lynch, 1995; Garber, Braafladt, & Zeman, 1991; Goodman et al., 2011; Murray et al., 1999; Silk, Shaw, Skuban, Oland, & Kovacs, 2006). As parents become depressed and less engaged, their children may receive less emotional and practical support. This lack of support may then impact on the child's developing skills in emotional regulation, social competency, and their ability to cope with academic demands during the school years (Campbell et al., 2007; Cicchetti et al., 1995; Garber, Braafladt, & Weiss, 1995; Garber et al., 1991; Silk et al., 2006).

Compared with the study of maternal depression, less research has focused on interactions between mothers with anxiety disorders and their infants. Maternal anxiety has been shown to impact on parenting behaviour, such that anxious mothers respond less sensitively and appropriately than non-anxious mothers, and appear to behave more intrusively towards their infants (Feldman, Greenbaum, Mayes, & Erlich, 1997; M. Kaitz & Maytal, 2005; Murray, Cooper, Creswell, Schofield, & Sack, 2007; Warren et al., 2003; Weinberg & Tronick, 1998). However, the effects of maternal

anxiety on parenting sensitivity are less consistent and appear more subtle than those described in the study of depressed mothers (Kaitz & Maytal, 2005; Murray et al., 2007). It is also important to note that symptoms of anxiety often occur alongside symptoms of depression, and so it can be difficult to disentangle the effects of each. There is evidence that symptoms of anxiety are related to depression through pregnancy and the post-natal period (Heron, O'Connor, Evans, Golding, & Glover, 2004; Skouteris, Wertheim, Rallis, Milgrom, & Paxton, 2009). It is also believed that depression and anxiety may have different outcomes on parenting behaviour; maternal depression is thought to correspond to lack of engagement with the child, whereas anxiety may be associated with less than optimal responses towards the child (Feldman et al., 2009). It has been shown that children of anxious parents are more likely to have emotional difficulties, behavioural problems, and be diagnosed with an anxiety disorder than children without anxious parents (Beidel & Turner, 1997; Kaitz, Maytal, Devor, Bergman, & Mankuta, 2010; Van den Bergh & Marcoen, 2004; Van den Bergh, Mulder, Mennes, & Glover, 2005). However, the effects of maternal anxiety on child outcomes appear to be mediated by maternal sensitivity, with one study finding that anxious mothers who still displayed sensitive parenting behaviour had children who showed less negativity (Kertz, Smith, Chapman, & Woodruff-Borden, 2008). These authors concluded that maternal sensitivity accounted for child outcomes to a greater degree than maternal anxiety, and also buffered against negative effects of maternal anxiety.

It may be that depressed and anxious mothers' failure to respond sensitively to their children reflects difficulties in emotional processing and regulation (Cicchetti et al., 1995; Cicchetti & Toth, 1995; Kaitz & Maytal, 2005). However, it may also be that these mothers are preoccupied with their own problems and are therefore unable to devote adequate attention to the needs of their children (Woodruff-Borden, Morrow, Bourland, & Cambron, 2002). Mothers experiencing internalising psychiatric symptoms such as these may also find it difficult to prioritise their child's needs due to other more general stresses and difficulties associated with being a parent.

1.2.3.2. Parenting stress

As well as depression and anxiety, it has been found that the experiences of stressful life events and a chaotic home environment are correlated with psychosocial

adjustment for children and adults (Brown & Harris, 1989; Brown, 1993; Coldwell, Pike, & Dunn, 2006; Goodyer, 1990). It has been suggested that this kind of life stress is different to role-specific stress, such as that associated with the parenting role (Abidin, 1990; Creasey & Reese, 1996; Deater-Deckard, 1998). Parenting stress reflects psychological distress that arises from the demands of parenting, involving the perspective that caregiving demands surpass available resources, which creates a negative mental response attributed to the self and/or the child (Abidin, 1995; Deater-Deckard, 1998). As this stress is specific to the parent role and parent-child relationships, it may be more strongly related to parenting behaviour and child adjustment than individual differences in more general stressful life events and circumstances (Creasey & Reese, 1996; Deater-Deckard, 1998).

Parental stress has, like depression and anxiety, been shown to be associated with reduced parental sensitivity (for both mothers and fathers), poorer parent-child interaction, insecure attachment, and increased risk for psychopathology in children (Barry, Dunlap, Cotten, Lochman, & Wells, 2005; Belsky, Woodworth, & Crnic, 1996; Belsky, 1984; Deater-Deckard, 1998; Holden & Banez, 1996; Huth-Bocks & Hughes, 2008; Jarvis & Creasey, 1991; Pelchat, Bisson, Bois, & Saucier, 2003; Taylor, Guterman, Lee, & Rathouz, 2009; Teti, Nakagawa, Das, & Wirth, 1991). However, parenting stress is usually studied in high-risk samples, such as families with children with developmental, psychological or physical health problems, or families currently at high risk due to low socioeconomic status, low social support, or histories of violence and maltreatment (e.g. Baker et al., 2003; Dumas, Wolf, Fisman, & Culligan, 1991; Huth-Bocks & Hughes, 2008; Schieve, Blumberg, Rice, Visser, & Boyle, 2007; Singer et al., 1999; Taylor et al., 2009). It has also been shown that parenting stress may be a predictor of and a consequence of psychopathology (Leigh & Milgrom, 2008). Furthermore, it has found that parenting stress mediates the relationship between mother's self-reported history of childhood maltreatment and her later insensitive parenting behaviour (Pereira et al., 2012). Thus, while the transition to parenthood can be challenging for all parents, it may be particularly stressful for those who are already at risk for poorer parenting, who may have less perceived competence, less emotional and social support, and who may view their children as more difficult (Mash & Johnston, 1990; Perren, von Wyl, Bürgin, Simoni, & von Klitzing, 2005; Williford, Calkins, & Keane, 2007). Parenting stress may also represent a pathway through which

maternal history of poor childhood experiences, or current maternal adversity, may be linked to decreased maternal sensitivity.

1.2.3.3. Maltreatment

A parent's own childhood experiences are important to consider when discussing factors that affect parenting behaviour. The implications of infant and child attachment with parents have previously been discussed; there is evidence suggesting that parent-infant attachment can have enduring effects on later relationships. These may include relationships with one's own children. Among the many risk factors for poorer parenting, at the extreme end is the experience of childhood maltreatment.

Childhood maltreatment can be defined as any act of commission (i.e. verbal, physical, or sexual abuse) or omission (i.e. emotional or physical neglect) that is potentially harmful or insensitive to a child and which occurs before the age of 18 years old (Egeland, 2009; Gilbert et al., 2009). Although a troubled childhood is by no means deterministic of negative outcomes (Cicchetti & Valentino, 2006; Collishaw, Pickles, et al., 2007; Kinard, 1998), the experience of maltreatment can create a pervasive, enduring and influential negative context for child development with effects that persist into adulthood (Egeland, 2009; Gibb, Chelminski, & Zimmerman, 2007; Gilbert et al., 2009; Glaser, 2002; Hildyard & Wolfe, 2002; McCrory & Viding, 2010; Perepletchikova & Kaufman, 2010; Spinhoven et al., 2010; Teicher, Samson, Polcari, & McGreenery, 2006). Childhood maltreatment has been shown to be significantly associated with psychiatric morbidity, substance use, difficulties in interpersonal relationships, long-term stress physiology and neurobiology, and aggression to self and others (Cicchetti & Toth, 2005; Gibb et al., 2007; Johnson, Cohen, Brown, Smailes, & Bernstein, 1999; Kendler, Kuhn, & Prescott, 2004; Kendler, 2000; MacMillan et al., 2001, 2009; Malinosky-Rummell & Hansen, 1993; Watts-English, Fortson, Gibler, Hooper, & De Bellis, 2006; Widom, DuMont, & Czaja, 2007; Widom, 1999).

Among the many intra- and interpersonal problems associated with the experience of childhood maltreatment across the lifespan are difficulties in subsequent parenting. Associations have been identified between childhood maltreatment and a range of maladaptive parenting outcomes which may contribute to poor caregiver-child relationships, including a lack of emotional availability, emotional overdependence upon the child, lower parenting self-efficacy, harsh discipline and hostility, low levels

of parental involvement, and a lack of attention towards child needs (Alexander, Teti, & Anderson, 2000; Bailey, DeOliveira, Wolfe, Evans, & Hartwick, 2012; Fitzgerald, Shipman, Jackson, McMahon, & Hanley, 2005; Moehler, Biringen, & Poustka, 2007; Newcomb & Locke, 2001; Ruscio, 2001). Parents who were maltreated during childhood have higher rates of insecure or disorganized attachment styles than those from non-maltreating families, with suggestions that disorganised attachment may mediate relations between early experience and later psychopathology (Baer & Martinez, 2006; Carlson, 1998; Van IJzendoorn, Goldberg, Kroonenberg, & Frenkel, 1992; Van IJzendoorn et al., 1999). In turn, it has been found that parents' history of childhood maltreatment is predictive of disorganized attachment in their own children and poorer offspring adjustment, suggesting intergenerational risk transmission of adverse childhood experiences (Collishaw, Dunn, O'Connor, & Golding, 2007; Fonagy, Steele, Moran, Steele, & Higgitt, 1993; Fraiberg, Adelson, & Shapiro, 1975; Main & Hesse, 1990).

There is also some evidence that a minority of parents with childhood histories of own abuse go on to abuse or neglect their own children (Kaufman & Zigler, 1987), with evidence to support the idea of an intergenerational cycle of maltreatment (Berlin, Appleyard, & Dodge, 2011; Egeland, Jacobvitz, & Sroufe, 1988; Egeland, 1993; Hemenway, Solnick, & Carter, 1994; Hunter & Kilstrom, 1979; Noll, Trickett, Harris, & Putnam, 2009; Pears & Capaldi, 2001; Simons, Whitbeck, Conger, & Wu, 1991; Zaidi, Knutson, & Mehm, 1989). Studies report that approximately 80 – 90% of abusive parents have a history of child maltreatment. However, research also suggests that only approximately one in three individuals who were abused as children repeat the cycle in the next generation, so the “cycle of abuse” is by no means a certainty (Kaufman & Zigler, 1987; Widom, 1989). Indeed, the concept of intergenerational transmission of maltreatment has been widely criticised, and controversy remains surrounding whether causal pathways determining the perpetuation of child maltreatment by parents have been sufficiently explored, as maltreatment is also associated with other demographic risk factors (Ertem, Leventhal, & Dobbs, 2000; Newcomb & Locke, 2001; Widom, 1989).

There are several possible explanations for the effect that maltreatment has on later parenting behaviour. One idea, based on attachment theory, is that the experience of maltreatment becomes internalised as an internal working model of self and other in relationships, leading to more negative perceptions about parenting and difficulties in

the parent-child relationship (Bowlby, 1969/1982; Finzi, Ram, Har-Even, Shnit, & Weizman, 2001; Fraley, 2002; Lamb et al., 1985; Rholes, Simpson, Blakely, Lanigan, & Allen, 1997). It is also theorised that maltreated individuals may learn and legitimise their parents' parental practices and use them to guide their own parenting (Simons et al., 1991). Another suggestion is that insensitive parenting behaviours in parents who have experienced maltreatment may be directly related to the impoverished, inconsistent, or dysfunctional early emotional experiences that typify maltreatment, and which in turn make learning about emotional information more difficult. For example, studies of maltreating families suggest that neglectful and abusive parents show dysfunctional emotional interaction with their children, such as displaying poor quality emotional expressions, less positive emotion, more negative emotion, and fewer affective exchanges with their children (Bousha & Twentyman, 1984; Bugental, Blue, & Lewis, 1990; Herrenkohl, Herrenkohl, Egolf, & Wu, 1991; Shackman et al., 2010). It has also been shown that these families tend to isolate themselves from others, leaving their children exposed to fewer non-parental models of emotional communication (Salzinger, Feldman, Hammer, & Rosario, 1993). These factors may create an environment for poorer social and emotional development (Denham, Zoller, & Couchoud, 1994; Pollak, 2012; Shackman et al., 2010), which has implications for other social relationships including those with offspring.

Indeed, it has been shown that maltreatment is linked to problems in recognising, expressing and regulating emotions, as well as social information processing biases (Camras et al., 1990; Camras, Sachs-Alter, & Ribordy, 1996; Gibb, Schofield, & Coles, 2009; Pollak, Cicchetti, Hornung, & Reed, 2000; Pollak & Tolley-Schell, 2003). These problems in emotional processing and regulation may impact on these parents' ability to recognise, respond to, and regulate their own child's emotions. These difficulties in emotion processing are also associated with various psychological disorders (Cicchetti & Toth, 1995, 2005; McCrory et al., 2013; Pollak, 2012). Therefore, the experience of maltreatment may also impact parenting via higher levels of parental psychopathology, which is itself linked to insecure attachments (both with own parents and with offspring) and poorer parenting (Banyard, Williams, & Siegel, 2003; Caldwell, Shaver, Li, & Minzenberg, 2011; Cicchetti, Rogosch, & Toth, 2006; Cicchetti & Toth, 2005; Minzenberg, Poole, & Vinogradov, 2006; Pereira et al., 2012). These social and emotional difficulties may undermine a parent's role of fostering their child's socio-emotional development and forming secure and nurturing attachments

(DeOliveira, Bailey, Moran, & Pederson, 2004; Koren-Karie, Oppenheim, & Getzler-Yosef, 2004; Moran, Bailey, Gleason, DeOliveira, & Pederson, 2008).

A history of childhood maltreatment, insecure or disorganised attachment styles, and psychopathology are thus all considered risk factors for parenting behaviour and parent-child relationships. However, the strength and direction of associations between early adversity, attachment styles, childhood and adult psychopathology and problems in parenting - as well as a repetition of these patterns in the next generation - are still poorly understood. A common factor that may underlie all of these problems is a deficit in emotion recognition and regulation (Barrett & Fleming, 2011; Cicchetti & Toth, 2005; McCrory et al., 2013; Pearson, Cooper, Penton-Voak, Lightman, & Evans, 2010; Pollak, 2012). However, the ability to detect, recognise, orient towards, and respond to infant emotional signals are all important components of parenting behaviour.

1.3. Attention Processes Involved in Parenting

To date, there has been little investigation into the more basic cognitive mechanisms that might constitute sensitive parenting behaviour, including attentional orienting towards child cues. Deficits in this early stage of infant face processing may interfere with parents' ability to respond appropriately to their child's needs, which may contribute to insensitive parental responses. Furthermore, emotional disorders, which are a risk factor for poorer parenting, are also associated with aberrant emotional information processing and attentional control. The following review will focus on discussion of visual attention towards infant faces as one of the possible more basic mechanisms underlying parenting behaviour. Firstly, attention to emotional faces in general will be discussed, followed by a specific focus on attention to infant faces.

1.3.1. Attention to Emotional Faces

At any one time, there is an overwhelming amount of information in the environment that is competing for attention and further processing. It is therefore important to be able to efficiently select which pieces of information are prioritised for subsequent processing and action (Allport, 1980; Desimone & Duncan, 1995; James,

1890/2000; Lavie, 2005; Posner & Rothbart, 2007; Treisman & Gelade, 1980; Treisman & Gormican, 1988; Vuilleumier, 2005). It has been suggested that human perceptual systems have evolved to prioritise the detection of classes of stimuli that have high biological significance, such as emotional faces (Eastwood, Smilek, & Merikle, 2001, 2003; Fox, Russo, Bowles, & Dutton, 2001; Fox, Russo, & Dutton, 2002; Hansen & Hansen, 1988; Öhman & Mineka, 2001; Pinkham, Griffin, Baron, Sasson, & Gur, 2010; Vuilleumier, 2005). Facial expressions of emotion are a good example of biologically significant stimuli, as they provide particularly powerful social signals that might be critical for social interactions and ultimately for survival (Alley, 1988; Darwin, 1904; Dimberg & Öhman, 1996; Ekman, 1992, 1997; Gerritsen, Frischen, Blake, Smilek, & Eastwood, 2008; Hansen & Hansen, 1988; Keltner, Ekman, Gonzaga, & Beer, 2003; Lazarus, 1991; Öhman, 1993). The ability to recognise basic emotional expressions from facial displays is critical for the development of adaptive functioning and successful social interactions (Hampson, van Anders, & Mullin, 2006; Izard & Harris, 1995). It has been found that emotion recognition abilities develop at an early age (Reichenbach & Masters, 1983; Walden & Field, 1982), and similarities in emotion recognition are found across different cultures (Ekman, Sorenson, & Friesen, 1969; Izard, 1971).

1.3.2. Attention to Emotion Paradigms

Prioritising emotional stimuli for processing over other stimuli is adaptive in the sense that it increases awareness of aspects of the environment that may require action. However, it also has the consequence of being detrimental to task performance when emotional stimuli are not directly relevant for a current task or goal, as these stimuli function as a distraction from that task. Many studies have shown that selective attention to certain stimuli is not always under conscious control and it is not unusual to be distracted by something that is not task-relevant (e.g. Broadbent & Broadbent, 1987; Folk, Remington, & Johnston, 1992; Theeuwes, 1994; Yantis & Jonides, 1984). This phenomenon has been used to develop paradigms to study attention to emotion; these paradigms typically measure the effect of a task-irrelevant stimulus on “primary task” performance. Studies using these paradigms explore whether observers can ignore something they expect but know to be irrelevant or whether unexpected objects can capture attention, such as emotional facial expressions.

Three of the most popular paradigms used to study attention to emotion are the “additional singleton” task, the “irrelevant feature search” and the “dot-probe” task. In the additional singleton task participants perform a visual search among a display featuring one item with a unique, distinctive feature (the ‘singleton’) that is unrelated to the search task and is never the target item. If the presence of the irrelevant singleton slows performance relative to trials with no irrelevant singleton, then attention is considered “captured” by this singleton (Theeuwes, 1994). The irrelevant feature search uses similar displays, except the irrelevant feature can also be the target of the search. Therefore, rather than simply measuring an overall reduction in search speed, capture is inferred from a change in search speed as the number of distractors in the display changes (Theeuwes, 1991, 1992; Yantis & Hillstrom, 1994). In the dot-probe paradigm, subjects view an uninformative spatial cue prior to performing a search task. The cue is no more likely than chance to predict the location of the target in the search task (i.e. it can be a valid cue or an invalid cue), and subjects are aware that the cue is uninformative (e.g. Folk & Remington, 1998). Attentional capture is inferred when performance is speeded if the cue happens to appear at the target location (valid cue) and slowed if it appears at a distractor location (invalid cue).

Each of the tasks described above have been used to investigate attentional capture by emotional faces and data from these tasks suggest that the emotional content of faces affects the extent to which attention is paid to the face (e.g. Calvo, Avero, & Lundqvist, 2006; Eastwood et al., 2001, 2003; Hahn & Gronlund, 2007; Hodsoll, Viding, & Lavie, 2011; Horstmann & Becker, 2008; Lamy, Amunts, & Bar-Haim, 2008; Öhman, Lundqvist, & Esteves, 2001; Öhman, 1993; Pinkham et al., 2010; Schubö, Gendolla, Meinecke, & Abele, 2006; Williams, Moss, Bradshaw, & Mattingley, 2005). Both schematic and photographic facial stimuli have been used in previous studies and overall the findings suggest that emotional facial expressions, particularly negative or threatening expressions, confer attentional advantage (Eastwood et al., 2001, 2003; Fenske & Eastwood, 2003; Hansen & Hansen, 1988; Horstmann & Bauland, 2006; Horstmann, Scharlau, & Ansorge, 2006; Öhman et al., 2001; although see Preston & Stansfield, 2008; Williams et al., 2005 for effect of positive emotions).

However, in most attentional capture experiments emotion is in some way relevant to the task or is expected in some way, such as explicitly asking participants to categorise emotional words or the emotion of a target face – e.g “search for the happy

face” (e.g. Eastwood et al., 2001, 2003; Horstmann & Bauland, 2006), or asking them to search for the odd-one-out, defined by emotion (e.g. Horstmann & Bauland, 2006; Fox et al., 2001; Eastwood et al., 2001; Öhman et al., 2001; Schubö et al., 2006). If the emotional stimulus is an integral part of the task, it is not possible to determine whether any effects on response times (RTs) are due to the bottom-up salience caused by emotional content or due to participants’ top-down goals of searching for or explicitly ignoring the emotional stimulus (Hodsoll et al., 2011). Recently, a series of experiments by Hodsoll and colleagues (2011) found attentional capture by emotional faces in a search task in which emotion was entirely irrelevant. Participants searched for a photographic male target face among two non-target female faces and indicated whether the target face was tilted to the left or right. They found that the presence (vs. absence) of an irrelevant emotional expression (fearful, angry, or happy) on one of the non-target faces slowed down RTs to the target when compared to trials in which all faces were neutral and trials in which an emotion appeared on the target face. This effect could not be accounted for by a visual “odd-one-out” effect, as Hodsoll found that a single neutral face among emotional faces did not capture attention. This study thus established attentional capture by emotional faces, despite emotion being entirely task irrelevant.

Similar attentional capture effects have been reported in a study using schematic face stimuli to investigate whether task-irrelevant facial expressions involuntarily capture attention (e.g. Horstmann & Becker, 2008). However, these researchers also found that search performance was impaired when a negative emotional singleton was presented at the position of the target face. Participants were asked to search for a target face with a yellow nose among distractors with green noses and had to report whether the target face had eyes that were tilted to the left or to the right. They found that RTs were slower when the target face displayed an emotion among neutral distractors than in conditions displaying no emotional singletons. This demonstrates another form of attentional capture that can occur when emotional stimuli are presented on the target face, suggesting that emotion can distract attention away from the primary search task even when present at the target location.

1.3.3. *Why Infant Faces are Special*

In comparison to the wealth of literature describing attention towards adult facial expressions, there are relatively few studies describing attentional processing of infant faces. An infant face might be considered to be a particularly special stimulus, given that infants are highly biologically relevant for members of a species, as their survival is necessary for reproductive success. It has been theorised that infant faces elicit a phylogenetically based readiness for response preparation (as emotional information does) because appropriate behaviour toward newborns, such as providing warmth and nurturance, is relevant for survival of the species (Brosch, Sander, Pourtois, & Scherer, 2008; Brosch, Sander, & Scherer, 2007). Indeed, the ethologist Konrad Lorenz proposed that the configuration of perceptual features found in infants across species, such as a rounded face and large eyes, function as an “innate releasing mechanism” for caretaking behaviour (Lorenz, 1943, 1971). These “*Kindchenschema*” (baby schema) features are theorised to elicit positive emotions and patterns of caretaking behaviour, such as approach tendencies, protective behaviour, and increased attention toward the infant (Bard, 1994; Bowlby, 1982; Hrdy, 2005; Lorenz, 1943; Tinbergen, 1951). There is empirical evidence supporting such a proposition; it has been shown that people prefer pictures of babies, think that are babies exhibiting high levels of *Kindchenschema* features are cuter and more vulnerable, show more motivation to take care of infants showing more *Kindchenschema* features, and even prefer adults and inanimate objects that have more baby-like features (Alley, 1981, 1983; Berry & McArthur, 1986; Glocker, Langleben, Ruparel, Loughhead, Gur, et al., 2009; Keating, Randall, Kendrick, & Gutshall, 2003; Luo, Li, & Lee, 2011; Miesler, Leder, & Herrmann, 2011; Sanefuji, Ohgami, & Hashiya, 2007; Zebrowitz & Montepare, 1992). Furthermore, it has been noted in primates that the loss of infantile characteristics as offspring age coincides with the subsiding of parental responses (Struhsaker, 1971). In order to promote adequate caregiving responses, infantile features should not only be preferred and elicit positive responses, but also receive attentional priority over the processing of other stimuli. Attentional prioritisation of infant faces would facilitate caregivers' ability to detect and respond to important infant communicative messages about their needs (Brosch et al., 2007; Hodsoll, Quinn, & Hodsoll, 2010). However, the attentional processes implicated in viewing infant faces have only recently begun to be investigated. Furthermore, many of these studies have

only indirectly investigated attention, with the primary focus of interest on the neural basis of the parenting response.

1.3.3.1. Neuro-imaging studies of infant face processing: fMRI and PET

Neuroimaging research has begun to investigate the motivational neural networks that might underpin maternal responses to infant faces. Studies have reported that images of infants activate face-selective areas in mothers to a greater degree than images of adult faces, perhaps reflecting increased attention towards infant faces (Bartels & Zeki, 2004; Leibenluft, Gobbini, Harrison, & Haxby, 2004). Viewing one's own child as compared to other children has been shown to activate motivational neural networks such as the amygdala and dopaminergic meso-limbic system, which are also involved in reward processing and approach motivation, as well as regions associated with theory of mind (Bartels & Zeki, 2004; Leibenluft et al., 2004; Noriuchi, Kikuchi, & Senoo, 2008; Ranote et al., 2004; Strathearn, Li, Fonagy, & Montague, 2008; Swain, Lorberbaum, Kose, & Strathearn, 2007; Swain, 2008, 2011). These studies typically recruit mothers, but there are indications that fathers also activate reward networks when viewing their own infants' faces (Atzil, Hendler, Zagoory-Sharon, Winetraub, & Feldman, 2012; Swain et al., 2007; Swain, 2008, 2011). Some of these studies have compared mothers' neural responses to different infant emotional expressions. For example, one study by Noriuchi and colleagues used video clips of mothers' own and other infants in play or separation situations. They found increased activity in brain regions associated with arousal and reward learning, such as the orbitofrontal cortex (OFC) and anterior insula, when mothers viewed their own infants. They also found greater activation when mothers viewed their infant's distress in regions associated with behavioural responding and social behaviours; these authors speculate that this activation may underlie prompt recognition and appropriate responses to infant distress (Noriuchi et al., 2008).

Other studies have begun to investigate how a mother's neural response to infant faces might correlate with her relationship with her own infant. One study found that OFC activations to images of one's own child correlated positively with pleasant mood ratings. However, areas of the visual cortex, which also discriminated between own and unfamiliar infants, were not related to mood ratings (Nitschke et al., 2004). These authors speculate that the OFC may be involved in a mother's affective

responses to her infant, and that individual differences in OFC activity to infant faces may be an important dimension of the maternal child relationship. It has also been shown that maternal neural responses may be linked to mothers' attachment classification (Strathearn, Fonagy, Amico, & Montague, 2009). Strathearn and colleagues found that when viewing their own smiling and crying infants' faces mothers with secure attachment styles showed greater activation of mesocorticolimbic reward brain regions than insecure mothers. They also found that secure mothers activated oxytocinergic and dopamine-associated reward processing regions of the brain. These activations were correlated with mothers' peripheral oxytocin levels measured after contact with their infant. Lower activations in reward processing regions for insecure mothers might reduce these mothers' engagement with infant signals, which may explain one way in which insecure attachment style could lead to less sensitive parenting behaviour. However, insecurely attached mothers showed greater anterior insula activation in response to their own infant's sad faces. The anterior insula has been functionally associated with processing feelings of unfairness, pain, and disgust (Montague & Lohrenz, 2007); however, it has also been shown to be linked to empathy (Singer et al., 2004). It is theorised that increased insula activation in these insecure mothers may reflect an empathic over-arousal linked to personal distress, which may then interfere with a compassionate parental response (Swain, 2011). Another study found that neural responses associated with empathy might be associated with maternal responding. Lenzi and colleagues (2009) found that the mirror neuron system, including the insula and amygdala, was more active when mothers imitated their own child's facial expressions than another child's. They also found that the strength of the insula response correlated with measures of maternal empathy (Lenzi et al., 2009).

It has been found that mothers differ from women without children in their neural responses to infant faces, thought to reflect the structural and functional changes that occur in the brain during pregnancy and motherhood. For example, Nishitani and colleagues (2011) found that mothers show increased right prefrontal cortex (PFC) activation when discriminating infant facial expressions compared to non-mothers. However, when discriminating adult facial expressions there was no difference in PFC activation between mothers and non-mothers, suggesting that the right PFC may be involved in maternal specific discrimination of infant emotional cues (Nishitani, Doi, Koyama, & Shinohara, 2011). However, it has also been shown that infant faces

expressing a higher degree of *Kindchenschema*-type features activate the nucleus accumbens, a key region involved in reward processing, in women who do not have children (Glocker, Langleben, Ruparel, Loughhead, Valdez, et al., 2009). Another study found that happy infant faces activate reward-processing regions, whereas sad faces activate regions associated with empathy, in women without children (Montoya et al., 2012). These studies suggest that infant faces may also activate reward and motivation regions in non-mothers, although perhaps to a lesser extent than for mothers.

Taken together, this emerging neuroimaging literature is beginning to elucidate the key regions associated with viewing infant facial stimuli and implicates these regions with parental responding. Regions and circuits involved in reward, motivation, empathy and visual processing appear to discriminate between viewing infant and adult faces, own infant and other-infant faces, and different infant emotions. However, studies employing fMRI techniques are unable to delineate the early attentional processes that might be involved in prioritising and responding to infant facial signals. One study by Kringelbach and colleagues (2008) has gone some way to addressing this issue by using magnetoencephalography (MEG), which allows the detection of very early responses within the time period when most visual perception occurs (Grill-Spector & Kanwisher, 2005). This study recruited a mixed group of women and men (most of whom were not parents) and found a surge in activity in the medial OFC within 130 ms, followed by increased activity in face-specific processing regions, in response to unfamiliar infant faces but not to adult faces. The authors suggest that early unconscious recognition of the saliency of infant faces occurs within reward-processing regions, which may “tag” these faces as emotionally significant and provide top-down amplification of activity in face-processing areas. Such a process would then allow for increased attention towards infant faces and the preparation of appropriate response (Kringelbach et al., 2008).

1.3.3.2. Neuro-imaging studies of infant face processing: Electrophysiological Studies

There are a growing number of electrophysiological studies measuring event-related potentials (ERPs) in response to infant faces. Attentional processes occur within early and narrow time frames that are difficult to capture with functional neuroimaging techniques, which are better at functional localisation. The ERP

technique has a high temporal resolution and thus allows the investigation of the time course of visual encoding of infant faces (Rutherford & Mayes, 2011). Studies using ERP techniques have found activation patterns suggestive of increased attentional allocation to images of infants and children as compared to adult faces. For example, one study recruited birth mothers and foster or adoptive mothers of children aged 1-5 years old and asked them to view images of their own child, and familiar and unfamiliar children and adults. It was found that all mothers exhibited increased ERP amplitudes, beginning at 100-150ms after stimulus onset, in response to unfamiliar child faces than unfamiliar adult faces, and in response to own child's face as compared to both familiar and unfamiliar child and adult faces. These results are suggestive of enhanced sensitivity to child as compared to adult faces, particularly for one's own child (Grasso, Moser, Dozier, & Simons, 2009). These authors also reported that late positive ERP patterns (350-700ms after stimulus onset) indicative of greater allocation of attention were associated with mothers' ratings of their relationship with their child as positive and influential on their child's development. This suggests that mothers who are more aware of the important role they play in their child's life may demonstrate a greater awareness of infant social cues, which may offer some explanation of individual differences in mothers' response to infant bids for attention.

Other studies have demonstrated differences in visual cortical responses to infant faces as a function of sex and parental status. For example, one study found that early responses to infant facial expressions, which occurred between 90 and 140ms, were larger in women as compared to men and larger in mothers as compared to all other groups (Proverbio, Brignone, Matarazzo, Del Zotto, & Zani, 2006). This study also found that non-parents responded similarly to infants' expressions of intense and mild distress, whereas parents, especially mothers, showed greater responses to very distressed infant faces. This suggests that parental status may modulate the encoding of infant facial expressions more strongly in women than in men. However, the behavioural data reported in this study indicated that women and men did not differ in their ability to discriminate infant facial expressions. Furthermore, later in the ERP waveform fathers and mothers showed similar activations to infant distress, but much stronger responses than non-parents. Thus, parents were more sensitive to differences in the intensity of suffering demonstrated by the infants. These sensitivities to infant faces observed in parents as compared to non-parents are thought to be related to neural mechanisms supporting protectiveness and empathy. However, it should be

noted that this study did not control for the number of children that parents had and it is not clear whether mothers and fathers differed in this regard.

Another study from this research group compared male and female non-parents on ERP responding to infant and child faces as compared to adult faces, as well as using source reconstruction analysis to identify the brain regions from which the responses originated (Proverbio, Riva, Zani, & Martin, 2011). It was found that both men and women showed larger early ERP responses, reflecting activity in face processing brain regions (such as the fusiform gyrus), to infant than to adult faces, although this activation was larger for women than for men. A later peak in the ERP waveform associated with activation in the fusiform gyrus and mesocorticolimbic reward processing regions was larger in response to child and infant faces than adult faces for both men and women; however, men did not seem to discriminate between child and infant faces, whereas women showed larger responses to infants than to children. These data suggest both men and women show preferential response to infant and child as compared to adult faces, although these effects may be more pronounced in women, who also responded differentially to infant as compared to child faces. It is possible that women in this study found infant faces more rewarding than men, facilitating their attention towards infant facial cues and assisting their discrimination between different aged faces (Proverbio et al., 2011). However, it is not yet clear how these observed patterns of neural activation when viewing infant and child faces are associated with attentional processes and behavioural responses towards these stimuli.

1.3.3.3. Studies using Attention Paradigms / Behavioural Studies

The extant neuroimaging and electrophysiological literature has begun to delineate differences in neural activation in response to infant versus adult faces, different infant facial expressions, differences between men and women, and differences between parents and non-parents. These studies indicate a neural basis for parental behaviours in response to infant signals. However, somewhat surprisingly, this neuroimaging research has preceded systematic behavioural investigations of sensitive parenting behaviour. Early attentional biases for infant faces could reflect an important aspect of maternal sensitivity, ensuring that infant cues are prioritised over other aspects of the immediate environment, allowing the parent to rapidly prepare to act in order to fulfil the infant's needs.

Only relatively recently has it been shown that infant faces, like emotional faces more generally, have attentional capturing effects (Brosch et al., 2007, 2008; Pearson et al., 2010; Thompson-Booth et al., 2013). For example, Brosch and colleagues asked college students to complete a dot probe task in which infant and adult faces were presented simultaneously either side of a central fixation cross, followed by a dot which replaced either the infant or adult face. It was found that response times to the dot were faster when it replaced an infant face, indicative of attentional capture by infant faces. Furthermore, response times towards infant faces correlated with arousal ratings of these faces, suggesting that stimuli rated as more emotionally arousing receive preferential allocation of attention. This might reflect a synchronisation of the attention and autonomic systems in order to prepare a response. In their follow-up study using the same task, Brosch and colleagues employed ERP techniques and found a peak of activity early in the ERP waveform indicative of early attentional capture by infant faces (Brosch et al., 2008). However, neither of these studies specifically recruited parents and thus do not shed any light on possible attentional processing differences between parents and non-parents.

The cognitive mechanisms necessary for sensitive parental responding are hypothesised to develop over the course of pregnancy, perhaps corresponding to the neurological and hormonal changes that occur during pregnancy (Brunton & Russell, 2008; Feldman, 2012; Kinsley & Amory-Meyer, 2011; Pearson et al., 2010; Pearson, Lightman, & Evans, 2009; Rutherford & Mayes, 2011; Swain, 2011). An improved ability to encode emotional facial expressions has been observed during late as compared to early pregnancy. This may reflect an adaption in sensitivity and vigilance towards emotional signals in order to prepare women for motherhood (Pearson et al., 2009). Another study employed an attention paradigm in order to assess engagement with infant as compared to adult faces. Pregnant women completed a task that required disengaging attention from a central signal in order to respond to a peripheral target. However, infant and adult faces showing different emotional expressions were superimposed over this central signal. Response times to the peripheral target were measured, such that slower response times indicated that it took longer to disengage attention from stimuli appearing at the centre of the screen. It was found that these women took longer to disengage attention from infant than from adult faces, and from distressed infant faces as compared to non-distressed infant faces (Pearson et al., 2010). In a follow-up study Pearson, Lightman, and Evans (2011a) found that

individual differences in attentional bias towards infant distress during pregnancy were associated with the mothers' self-reported relationship with their infants after birth. Specifically, for every 50 ms increase in attentional bias towards infant distress (as compared to non-distress), the odds ratio for reporting a weaker parent-child relationship was 0.43. These results suggest that basic attentional processing of infant facial expressions may develop during pregnancy and could play a role in the parent-child relationship after birth, perhaps by influencing the mothers' responsiveness towards her infant. However, the women recruited for this series of studies were only assessed for their attentional processing of infant faces during pregnancy, so it is not possible to determine whether these biases for infant distress persisted into motherhood. Furthermore, these studies did not control for whether the women were first-time expectant parents or already parents of one or several children. Finally, none of these behavioural studies have made comparisons between parents and non-parents, nor recruited fathers, in order to assess more thoroughly how parenthood might impact attentional processing of infant faces.

1.4. Disruption in Attentional Processes

Selectively attending to salient stimuli such as faces is considered important for adaptive social behaviours, including parenting, as it allows the preparation of appropriate responses to social signals. However, maladaptive patterns in these processes such over-attending to or avoiding particular stimuli may have implications for physiological and behavioural responses to social and emotional information. Indeed, individual differences in the ability to allocate attention towards or away from emotional faces are thought to be implicated in depression and anxiety (Gotlib & MacLeod, 1997; Mineka, Rafeali-Mor, & Yovel, 2003; Williams, 2006). Misreading facial expressions may have profound consequences for the interpretation of a situation and can affect the selection and the effectiveness of emotion-regulation strategies and behavioural responses (Mathews & MacLeod, 2005; Williams, 2006). The consequences of not noticing, avoiding, or misinterpreting infant facial expressions may have particularly severe consequences for parental responding.

1.4.1. Disruptions in Attention to Emotion and Emotional Faces

Deficits in the ability to accurately process facial expressions have been linked to emotional disorders, such as depression and anxiety, as well as to antisocial conduct and a history of childhood maltreatment (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & Van IJzendoorn, 2007; Blair & Mitchell, 2009; Gotlib & Joormann, 2010; Mathews & MacLeod, 2005; Pollak, 2008, 2012). Much of the work on attention to faces with these individuals has focused cognitive biases such as allocating attention towards or away from positive or negative emotions. Although it is adaptive for attention to be selectively engaged by salient stimuli, successful emotional regulation and social behaviour also requires some flexibility over attentional processes as well as appropriate interpretation of stimuli. Maladaptive biases or misinterpretation of emotional information may therefore have implications for emotional wellbeing (Pollak, 2008; Williams, 2006). Much of the literature surrounding altered attention to emotional content has focused on anxiety disorders. However, as depressive symptomatology and history of maltreatment are more robustly associated with parenting difficulties (e.g. Bailey et al., 2012; Kaitz & Maytal, 2005; Murray, Fiori-Cowley, et al., 1996) and of most interest for the purposes of this thesis, these topics are the focus of this part of the review.

Depressed individuals have been found to show deficits in accurately recognising emotional and neutral facial expressions, as well as attributing negative emotions to neutral and positive faces and judging negative facial expressions to be more negative (Carton, Kessler, & Pape, 1999; Gollan, Pane, McCloskey, & Coccaro, 2008; Gotlib & Joormann, 2010; Gur et al., 1992; Joormann & Gotlib, 2006; Leppänen, Milders, Bell, Terriere, & Hietanen, 2004; Rubinow & Post, 1992). They require a greater intensity of emotion to correctly identify happy facial expressions but less intensity to identify sad expressions than those without depression (Joorman & Gotlib, 2006). It has also been found that depression is associated with biases for processing negatively valenced scenes and sad faces, as well as avoidance of happy faces (Caseras, Garner, Bradley, & Mogg, 2007; Eizenman et al., 2003; Gotlib, Krasnoperova, Yue, & Joormann, 2004; Mogg & Bradley, 2005; Williams et al., 2007). Many of these studies employ a dot-probe paradigm, in which negative and neutral stimuli are paired, finding that depressed individuals respond faster when the dot replaces negative faces than neutral faces (Gotlib et al., 2004; Joormann & Gotlib,

2007). These findings of poor recognition of emotions and attentional biases to sad faces have also been found to persist after individuals have recovered from a depressive episode (Joorman & Gotlib, 2007; Leppänen et al., 2004). This suggests that attentional biases may play a role in the vulnerability to depression, rather than simply being a symptom of depression. Both depression and anxiety disorders are thought to involve facilitated attentional engagement with and impaired attentional disengagement from negative stimuli (Rudaizky, Basanovic, & MacLeod, 2013).

Studies have also begun to elucidate the causal nature of the association between selective attention to negative stimuli and emotional disorders. Variations of the dot-probe task have been used in order to induce attentional bias towards negative information in people with low levels of anxiety, leading to increased stress vulnerability (e.g. MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002). Other studies have utilised tasks to encourage attention away from negative information, leading to a reduction in symptoms (Bar-Haim, 2010; Hakamata et al., 2010). These studies support the hypothesis that a biased attentional response to negative information contributes to vulnerabilities in emotional disorders. The attentional biases observed in those with psychological disorders may thus develop early in life, and could be associated with the quality of the emotional environment in which one was raised (Gibb, 2002; Pollak, 2012; Romens & Pollak, 2012).

The experience of abuse and neglect in childhood has also been associated with impaired abilities to recognise, discriminate between and allocate attention towards emotional information (Cicchetti, 2002; Gibb, 2002; Pollak, 2008, 2012). The majority of studies investigating attentional processing of emotion in those with maltreatment histories have been conducted with child samples. It has been found that abused children are over-sensitive to threatening stimuli; they identify facial displays of anger on basis of minimal sensory input and judge ambiguous facial expressions as showing anger, suggesting that they have facilitated access to representations of anger (Pollak & Kistler, 2002; Pollak & Sinha, 2002). Electrophysiological studies have shown that maltreated children exhibit enhanced ERP responses reflective of selective attention towards angry faces as compared to other emotions, even when they are told to ignore them, as well as displaying difficulties disengaging attention away from angry faces (Pollak, Cicchetti, Klorman, & Brumaghim, 1997; Pollak, Klorman, Thatcher, & Cicchetti, 2001; Pollak & Tolley-Schell, 2003; Shackman, Shackman, & Pollak, 2007). Children who have experienced maltreatment also have more difficulties regulating

their physiological responses to perceived hostility, which may further contribute to alterations in processing emotional information (Pollak, Vardi, Putzer Bechner, & Curtin, 2005). It has also been found that while both abused and neglected children have difficulties in discriminating different emotional expressions, neglected children appear to have more difficulties in emotional discrimination whereas physically abused children more readily identify anger than non-abused children (Pollak, Cicchetti, Hornung, & Reed, 2000). This finding may reflect the types of emotional experiences these groups of children have been exposed to; abused children need to be vigilant to anger, as it may signal immediate threat, whereas neglected children experience a lack of any emotional input from which they can learn (Pollak et al., 2000).

Attentional biases towards threatening faces and increased sensitivity for detecting angry facial expressions have also been found in one study of young adults (mean age 19 years old) who reported a history of childhood maltreatment, suggesting the experience of maltreatment may contribute to information processing biases observed later in life (Gibb et al., 2009). However, as this study was cross-sectional, it is not known whether such biases persist from childhood through to adulthood in a trait-like manner. Furthermore, given that childhood maltreatment is a risk factor for psychological disorders such as depression and anxiety, difficulties in emotional information processing may be one mechanism linking the experience of maltreatment to later emotional problems (Gibb et al., 2007; Harkness, Bruce, & Lumley, 2006; Pollak, 2008; Romens & Pollak, 2012; Widom et al., 2007). It has been found that the degree of attentional bias towards angry faces correlates both with the magnitude of the maltreatment and the child's severity of anxiety symptoms, which suggests that patterns of information processing may connect adverse childhood experiences with risk for developing anxiety disorders (Shackman, Shackman, & Pollak, 2007). It has also been reported that children with maltreatment histories and current symptoms of PTSD show a pattern of attentional avoidance of angry faces, which was associated with severity of abuse and PTSD symptomatology (Pine et al., 2005). This finding is consistent with studies reporting that individuals with symptoms of post-traumatic stress disorder (PTSD) direct their attention away from threat (Constans, McCloskey, Vasterling, Brailey, & Mathews, 2004; Wald et al., 2011). A study in adults found that the experience of childhood maltreatment correlated with current PTSD symptomatology in adulthood (Fani, Bradley-Davino, Ressler, & McClure-Tone, 2011). This study also reported that there was not an association between childhood

maltreatment and attentional biases either towards or away from threatening faces, but there was an association with attentional bias towards happy faces. Furthermore, this attentional bias towards happy faces mediated the relationship between childhood maltreatment and PTSD symptoms of avoidance and numbing. These authors speculate that individuals who experienced childhood maltreatment may have learnt to attend to positive cues as a means of coping with environmental adversity. However, this selective attention for positive stimuli may play a role developing PTSD symptoms such as avoidance, serving to maintain post-traumatic psychopathology (Fani et al., 2011).

It has also been found that maltreated children show heightened attention to depression-relevant cues. Romens and Pollak (2012) examined attentional bias for sad facial expressions in children with and without experience of maltreatment, both before and after the induction of sad mood. They found that children with histories of maltreatment showed preferential attention to sad faces but only after they had experienced a sad emotional state. However, maltreated children who also reported high levels of trait rumination showed attentional bias toward sad faces throughout the study, as well as a trend to avoid happy faces. Furthermore, these effects remained when controlling for symptoms of depression, suggesting that current symptomatology did not account for these findings. This suggests that maltreated children show patterns of increased attentional allocation to depression-relevant cues, but only in the context of a recent sad experience or if they also engage in rumination. It may be that maltreated children who demonstrate attentional biases to sad stimuli after a stressor are at heightened risk for developing depression, consistent with the idea that early experiences may predispose individuals to depression. Taken together, these studies suggest that children may adjust their perceptual processing of emotional information in order to process aspects of their environment that have become salient through learning from their social experiences, which persist into adulthood and may have implications for their mental health.

1.4.2. Disruption in Attention to Infant Faces

The studies discussed above have employed adult facial stimuli; again, the literature surrounding disrupted processing of infant face stimuli is scarce in comparison to that surrounding facial emotion processing more generally. However,

there is emerging evidence that psychopathology or the experience of childhood maltreatment may impact on attention towards and processing of infant facial stimuli. One study examined whether post-natal depression and anxiety affected perception of infant and adult faces (Gil, Teissèdre, Chambres, & Droit-Volet, 2011). Three days after birth, mothers rated the intensity of facial expressions of adult and infants displaying anger, happiness, sadness, and neutrality. It was found that mothers with symptoms of depression judged neutral faces to be more negative than non-depressed mothers, whereas symptoms of anxiety were associated with more negative perceptions of all infant emotional expressions, but not adult emotional expressions. These findings suggest that mothers with post-natal symptoms of mood disorders may display negative biases when judging emotional expressions, which appears to be primarily directed towards infant faces and might represent an indicator of potential risk for insensitive mother-child interactions (Gil et al., 2011). Individual differences in mood and anxiety symptoms have also been associated with maternal brain responses to infants shortly after birth (Barrett et al., 2012). Barrett and colleagues (2012) found that when compared to viewing an unfamiliar infant, greater amygdala response to a mother's own positive infant face was associated with lower maternal anxiety and depression, lower parental distress, and more positive attachment-related feelings about her infant. These authors conclude that amygdala response may be involved in the pro-social and motivational aspects of maternal responsiveness, which can be disrupted in the context of maternal psychological problems and poor mother-infant attachment (Barrett et al., 2012).

It has also been found that attentional biases for distressed infant faces exist for pregnant women without symptoms of depression, whereas women who were currently experiencing symptoms of depression did not appear to discriminate between distressed and non-distressed infant faces (Pearson et al., 2010). The same research group also found that depressed pregnant women showed increased systolic blood pressure in response to images of infant distress, and suggested that reduced attentional engagement with infant distress might be explained by sympathetic over-sensitivity and avoidance of infant distress (Pearson, Lightman, & Evans, 2012). Furthermore, it has been found that symptoms of depression may modulate neurophysiological responsiveness to infant faces. Noll, Mayes, and Rutherford (2012) observed a positive correlation between depression symptom severity and amplitude of an ERP marking early visual processing in a group of mothers and non-mothers when viewing infant

faces, one interpretation of which is effortful avoidance of these stimuli. These findings are consistent with observational studies showing that depressed mothers avoid their own infant's distress signals (Field, 2010; Murray, Fiori-Cowley, et al., 1996).

However, it has also been found that attempts to reduce depressive symptomatology also have an effect on attentional biases to infant distress. In a follow-up study of depressed pregnant women it was found that a short course of cognitive behavioural therapy (CBT) increased attentional biases to infant distress, such that the previously depressed women became comparable to non-depressed women in their responses to distressed infant faces (Pearson et al., 2013). In contrast, no improvement was seen in women who were assigned to care as usual as compared to the CBT group. Although this study only recruited a sample of 24 women, the results tentatively suggest that a treatment for depression which addresses cognitive symptoms may also help improve expectant mothers' basic processing of infant stimuli. However, it is not yet clear whether this improvement was due to amelioration of the depressive symptoms, leading to a motivational shift to engage with infant faces, or due to some element of the therapy itself, such as re-training these women to tolerate and approach rather than avoid stimuli they find distressing (Pearson et al., 2013).

There are very few studies investigating whether parents' histories of childhood maltreatment are associated with disrupted processing of and response towards infant faces, which is surprising given the implications of maltreatment for later parenting behaviour. A preliminary fMRI study of 12 mothers found that retrospective reports of childhood maltreatment and bonding were related to anterior cingulate cortex (ACC) response to own infant faces as compared to unfamiliar infants, such that greater ACC response was associated with poorer parental bonding and more emotional abuse during childhood (Barrett et al., 2009). These authors stress that as these results are preliminary it is difficult to discern the implications of increased ACC response to own infant faces for maternal behaviour in the context of poor childhood experiences. However, they speculate that as the ACC has been shown to be involved in self- and other-evaluation and with affective arousal and responding, this ACC response in mothers with histories of poor quality care may be related to negative evaluation of infant facial cues and less sensitive parenting behaviour (Barrett et al., 2009). In terms of the relationship between infant face perception and real-life parenting behaviour, it has been reported that neglectful mothers differ from non-neglectful mothers in infant

face perception at the neural level (Rodrigo et al., 2011). In this study, a group of neglectful mothers recruited from social services were compared to non-neglectful mothers in their ERP responses to viewing distressed, positive, and neutral infant facial expressions. It was found that non-neglectful mothers showed increased ERP amplitudes at time points associated with face processing (within 250 ms of stimulus onset) in response to distressed infant faces as compared to other emotions, whereas neglectful mothers did not appear to differentiate between different infant emotional expressions at the neurophysiological level. A lack of differentiation among infant emotional cues may arise from a deficit in “tagging” certain stimuli as socially relevant, which could lead to inappropriate parental responses that are not contingent on the child’s signal and poor engagement with offspring (Rodrigo et al., 2011).

1.5. Summary and Aims

The experiences during infancy and childhood may set the stage for child development and functioning in later life. During infancy, humans are completely dependent on their caregivers, typically their parents, for their survival. However, during the preverbal stage infants have limited resources with which to engage with their parents and communicate their needs. It is therefore imperative that infant facial characteristics are able to promote nurturing responses and suppress aggressive responses. If parents are able to detect, discriminate, and respond appropriately to infant facial cues they are likely to better enhance their own offspring's survival. Indeed, the degree to which parents engage with their children, recognise the needs that they are communicating, and respond to them in an appropriate and non-intrusive manner has been termed “sensitive parenting”. Such sensitive parenting behaviour has been shown to have significant implications for mother-infant attachment, and for future child development. Sensitive parenting behaviour is typically studied by observing mothers interact with their children. However, there are likely to be several more basic cognitive mechanisms that underlie the ability to parent sensitively, which may develop based on or be altered by mothers’ own childhood experiences and symptoms of mental health difficulties.

There is a growing body of evidence from neuroimaging and electrophysiological studies indicating that viewing infant faces may be associated with activation in brain circuits involved in early visual attention, face processing, reward and motivation, and empathy. Some of these studies also suggest that activation in these circuits may differ for parents and non-parents and in women and men. There is also emerging behavioural evidence supporting the idea that attentional engagement with infant faces, which may be necessary for appropriate parental responses, develops during pregnancy and is associated with mothers' attitudes towards their child after birth. However, compared with the wealth of literature regarding attentional prioritisation of emotional expressions in adult faces, there is a paucity of evidence regarding attentional engagement with infant faces. Given that emotional faces are thought to be selectively attended to due to their high biological significance, it is surprising that such little research has been carried out using infant faces as stimuli of interest. While emotional expressions more generally carry powerful social information that signals possible threat and affiliation, infant faces and facial expressions contain valuable information about that infant's needs, for which a parent is entirely responsible.

There remain several important gaps in the literature surrounding visual attention towards infant faces. Firstly, the behavioural evidence surrounding attentional engagement with infant faces has been confined to a series of studies on the same sample of women who were assessed during pregnancy (Pearson et al., 2010, 2011, 2013) or in non-parent samples (Brosch et al., 2007, 2008). These studies have not specifically focused on women who are already mothers and have not made comparisons between mothers and non-mothers. Also, there is a dearth of literature surrounding fathers' attentional engagement with infant cues. In fact, the entire parenting literature is somewhat lacking for fathers as compared to mothers. It is also not clear whether child facial cues receive preferential attentional engagement only during infancy, or whether face stimuli from children at other stages in development who also require parental care will be processed differentially to adult faces. Finally, there is a lack of investigation as to whether individual differences in childhood experiences and symptoms of psychopathology, which are linked to parenting problems, are also linked to differences in attentional responses to infant faces.

This thesis aims to address several important outstanding questions by using an attention capture paradigm to investigate attentional processes in the presence of infant

faces. This paradigm, described in detail in Chapter 2, is used throughout all the experiments reported in this thesis to characterise attentional engagement with infant faces, with and without emotional expressions. In **Chapter 2**, this paradigm was administered to a group of first-time mothers and women without children. Participants were asked to search for a target feature on screen in the presence of either infant or adult faces, and in search conditions containing all neutral faces or a face expressing emotion, which was irrelevant to the task. Emotion and face identity were task irrelevant, so by measuring response times in different conditions (emotion vs. neutral; adult faces vs. infant faces) it is possible to discern whether non-target features of the scene (faces or emotion) are engaging attention and interfering with task performance. Comparisons of attentional engagement with infant faces were made between mothers and non-mothers. Furthermore, associations between the degree of attentional engagement with infant faces and current symptoms of depression and parental stress were also assessed.

In **Chapter 3** another group of mothers and non-mothers were recruited and completed a modified version of this attention task that included face stimuli from pre-adolescent children and adolescents, as well as infant and adult faces. This allowed the investigation of whether infant faces receive more attention than faces from all other age groups, or whether other young faces also receive heightened allocation of attention, particularly when they signal emotional distress. This task was replicated in **Chapter 4** with a group of fathers and non-fathers, in order to investigate whether parental status impacts processing of infant faces for men. Comparisons are also made between this sample of men and the sample of mothers and non-mothers who participated in the study reported in Chapter 3. The final empirical study is reported in **Chapter 5**, which investigated whether the experience of childhood maltreatment was associated with individual differences in attentional engagement with infant faces. In **Chapter 6** the findings from these four empirical studies are summarised and the implications of the findings are discussed.

1.5.1. Thesis Aims

This thesis aimed to address several outstanding research questions:

- 1) Do neutral and emotional infant faces engage attention to a greater degree than adult faces? (Chapter 2).

- 2) Is attentional engagement towards child as compared to adult faces influenced by cues signalling developmental vulnerability, such as younger age and negative affect? (Chapter 3).
- 3) Are attentional biases towards infant faces more pronounced for mothers than non-mothers? (Chapter 2 and 3).
- 4) Are attentional biases towards infant faces more pronounced for fathers than for non-fathers? (Chapter 4).
- 5) Are individual differences in attentional engagement with infant faces associated with symptoms of depression, parenting stress (Chapter 2), or experiences of childhood maltreatment (Chapter 5)?

Chapter 2: Attention to infant and adult emotional faces in mothers and non-mothers

2.1. Chapter Introduction

As was discussed in Chapter 1, facial cues play a critical role in an infant's efforts to engage and elicit nurturance from their caregiver. Allocating sufficient attention to infant faces is of adaptive value as it increases the likelihood that the basic needs of a highly dependent infant will be met (Bard, 1994). Human faces in general have been shown to elicit preferential allocation of attention, in part due to the social information they provide (e.g. Öhman et al., 2001; Ro, Russell, & Lavie, 2001; Vuilleumier & Schwartz, 2001; Vuilleumier, 2005). The question arises whether infant faces are a special case. Lorenz (1943, 1971) was the first to propose the concept of *Kindchenschema* or "baby schema", a configuration of perceptual features found in newborns across species, including a high, slightly bulging forehead, large eyes, and rounded cheeks. He suggested that these newborn cues elicited a set of affective and behavioural responses that formed the foundation of caretaking behaviour. Developmental studies using behavioural and observational measures have demonstrated that individual differences in recognising and responding to infant cues contribute to maternal sensitivity, which in turn can profoundly influence later child development (e.g. Ainsworth et al., 1978; McElwain & Booth-LaForce, 2006; Mills-Koonce et al., 2007; Swain et al., 2007; Swain, 2011). The current study sought to extend previous research on processing of infant faces and with the primary aim of investigating the impact of parental status and facial affect on attention towards infant faces. A secondary aim was to explore whether levels of maternal depressive symptoms and parenting stress were associated with attention towards infant faces.

2.1.1. Attention to Infant Faces

There has been a relative dearth of behavioural studies in the attention literature investigating whether adults in general, and parents in particular, differentially process infant facial cues as compared to adult faces. In one study, Brosch and colleagues used a dot-probe task with a group of college students to investigate the relative degree of attentional capture to infant as compared to adult faces (Brosch et al., 2007). On trials where an adult and infant neutral face were simultaneously presented, participants were found to respond significantly faster to a target that followed the infant compared to the adult face. Furthermore, the magnitude of the attentional modulation was

positively correlated with subjective arousal ratings of the infant faces. Later work using the same paradigm while recording scalp event related potentials (ERPs) also demonstrated neural activation indicative of early attentional capture to infant faces (Brosch et al., 2008). While these findings provide evidence that infant faces are prioritized by the attention system in adults, they do not address whether attentional processing is influenced by the presence of infant affect or parental status. These issues were partly addressed in a study of pregnant women by Pearson and colleagues (2010), who investigated the ability of pregnant women to disengage attention from infant and adult faces displaying negative, positive and neutral emotional superimposed over a go/no-go signal. As predicted, reaction times (RTs) to a peripheral target were found to be slower when infant compared to adult faces appeared on the central go/no-go signal (Pearson et al., 2010). However, to date no study has specifically investigated whether attentional orientation towards infant faces differs in mothers and non-mothers.

2.1.2. Influence of Parental Status on Attention to Infant Faces

While these preliminary experimental findings suggest that infant compared to adult faces preferentially engage the attentional system, the influence of parental status has not been directly investigated. An enhanced pattern of attentional allocation to infant faces in parents compared to non-parents would make evolutionary sense, and may help promote the adult's caregiving responses. Parent-specific effects may follow from the direct experience of caregiving or from the biological demands of becoming a parent. For example, pregnancy and childbirth are associated with a cascade of changes in neuroendocrine systems (e.g. dopamine-reward and oxytocinergic systems), which have been hypothesized to in turn influence maternal behaviour (Brunton & Russell, 2008; Kinsley & Amory-Meyer, 2011; Rutherford & Mayes, 2011; Strathearn et al., 2009; Swain, 2011).

An emerging neuroimaging literature suggests that parents do indeed process infant cues differently. Images of a mother's own child have been shown to activate a neural network comprising emotion and reward processing regions, which may underpin maternal attachment and caregiving behaviors, setting the maternal relationship apart from other social attachments (Strathearn et al., 2009; Bartels & Zeki, 2004). The extant evidence further suggests that differences in neural activation are evident even when mothers view an unfamiliar infant. For example, in a near-

infrared spectroscopy (NIRS) study Nishitani and colleagues compared activity in the prefrontal cortex (PFC) while mothers and non-mothers discriminated emotional facial expressions of unfamiliar adults and children. Mothers were found to show increased right PFC activation when discriminating infant facial expressions compared to non-mothers. However, there was no difference in PFC activation between mothers and non-mothers when discriminating adult faces, suggesting that the right PFC may be involved in maternal specific behaviours (Nishitani et al., 2011).

These neuroimaging findings are broadly consistent with a small number of electrophysiological studies that have begun to delineate the early time course of attentional allocation to infant facial stimuli. It has been reported that mothers demonstrate event-related potential (ERP) patterns indicative of increased attentional allocation to their own child's face compared to the faces of other children or adults (Grasso et al., 2009). In line with fMRI findings, ERP studies have also reported differential processing of unfamiliar infant faces in parents compared to non-parents (although see Noll et al., 2012). Proverbio and colleagues reported greater neural response in mothers compared to non-mothers to infant facial expression; it is suggested that this may reflect a greater empathic response or increased arousal to infant faces in parents (Proverbio et al., 2006). Interestingly, the neural response in the parents was influenced by the degree of infant distress, an effect not seen in the non-parent group. These preliminary neurobiological findings provide a tentative basis to predict altered attentional allocation to infant faces also at the behavioural level in parents compared to non-parents. However, even among parents individual differences in attentional processing of infant facial cues are likely.

2.1.3. Influence of Depression Symptoms and Parenting Stress on Attention to Infant Faces

Symptoms of depression or stress, as well as the nature of the maternal-infant relationship, are thought to partly account for differences observed among parents in attention to infant signals. For example, Pearson and colleagues, in their go/no-go study of pregnant women, also investigated the influence of depression symptoms on processing infant affect. They found that non-depressed pregnant women took longer to disengage attention from distressed compared with non-distressed infant faces, but no such effect was observed in women experiencing depressive symptoms (Pearson et

al., 2010). In a follow-up study of a subsample of these depressed women, it was found that following a course of Cognitive Behavioural Therapy (CBT) the depressed women's attentional biases towards infant distress became comparable to non-depressed women (Pearson et al., 2013). Thus, the presence of depressive symptoms may serve to moderate attentional processing of infant cues. This would be consistent with a broader literature of behavioural and observational studies that have suggested that symptoms of depression correlate with maternal insensitivity to infant cues and to poor quality caregiving (e.g. Brockington, Aucamp, & Fraser, 2006; Laurent & Ablow, 2012; Murray & Cooper, 2003; Murray, Fiori-Cowley, et al., 1996).

Similarly, parental stress (that is, stress associated with the parenting role or the parent child relationship) is associated with reduced parental sensitivity and poorer parent-child interaction (Belsky, 1984; Deater-Deckard, 1998; Huth-Bocks & Hughes, 2008; Taylor et al., 2009). For example, studies have shown that parents experiencing higher levels of parenting stress show less sensitive interactive behaviours when playing with their children during observed play sequences (e.g. Pelchat et al., 2003). It has also been shown that parenting stress mediates the relationship between maltreatment history and maternal insensitivity in a community sample of mothers (Pereira et al., 2012). However, research into parenting stress tends to recruit high-risk samples and rely on self-report and observations; previous studies have not investigated the impact of parenting stress on processing of infant faces.

2.1.4. The Current Study

The study reported in this chapter used an irrelevant feature visual search paradigm, modified from Theeuwes (1991, 1992, 1994) and from Hodsoll and colleagues (2011) in order to investigate attention towards infant and adult faces. This type of paradigm permits the investigation of whether a unique feature of a scene, unrelated to the primary search task, can capture or engage attention. Participants were asked to search for a blue-eyed target face (the "odd-one out") among two brown-eyed non-target (distractor) faces, and then indicate if the blue eyed target was tilted to the left or right. The age of the face was varied and response times to adult versus infant faces were measured. In addition, the emotional expression of the target and non-target faces was manipulated. The advantages of this paradigm are that face age and affect

are completely independent of the eye-colour based search task and that the face stimuli do not appear at fixation, allowing measurement of attentional capture by face age and emotion (Hodsoll et al., 2011).

This task was used in a group of parents (first-time mothers) and non-parents (women without children) in order to ask four main questions. *Firstly, do infant compared to adult faces engage greater attention?* On the basis of previous studies, it was predicted that RTs would be slower in search arrays containing infant faces across both parents and non-parents. *Secondly, does being a parent enhance the degree to which attention is engaged by infant faces?* While previous studies investigating parents and non-parents separately have reported preferential attentional allocation to infant faces, these groups have not previously been compared directly. The neuroimaging evidence indicating that parental status is associated with altered neural processing of infant facial affect provides a tentative basis to predict greater attentional allocation for infant faces at the behavioural level, in the parent compared to the non-parent group. *Thirdly, does affect alter attentional processing of infant facial cues?* On the basis of previous neuroimaging and neurophysiological studies, it was hypothesised that the presence of facial affect would heighten the degree of attentional processing of faces and that this would be more pronounced for infant compared to adult faces (e.g. Proverbio et al., 2006). *Finally, are concurrent levels of depression and parental stress associated with individual differences during attentional processing of infant facial affect?* Previous studies suggest that levels of psychopathology can impact on attentional processing of infant faces (Pearson et al., 2010), as well as impacting on parenting behaviour (e.g. Murray & Cooper, 2003; Deater-Deckard, 1998). If attentional processing of infant signals is one mechanism underlying parenting behaviour, symptoms that may disrupt parenting behaviour may also impair attentional processing of infant cues.

2.2. Method

2.2.1. Participants

Sixty-nine women, 31 first-time mothers and 38 non-mothers, were recruited for the study. Three participants (two mothers and one non-mother) were subsequently excluded due to reporting pregnancy during the course of the study. One participant (a mother) was removed from all analyses due to having a high error rate across all trials in the task ($>40\%$). This left a final sample of 28 mothers and 37 non-mothers. All participants classified their ethnicity as Caucasian, reported normal or corrected-to-normal vision, and were right handed. All of the mothers had a singleton pregnancy, reported that they had at some point breast-fed their child but that they were no longer breast-feeding, and their children were aged between 6 and 21 months ($M = 11.92$ months, $SD = 4.06$). All of the non-parents reported some experience of caring for young children (answering yes to either of the questions “I have cared for friends’ children” or “I have cared for younger family members”), but none reported working with children on a daily basis or having any non-biological step-children. Further information on participant demographics can be found in Table 2.1.

Table 2.1. *Participant demographics*

	Non-Mothers (N=37)		Mothers (N=28)		<i>p</i>
	Mean (<i>SD</i>)	Range	Mean (<i>SD</i>)	Range	
Age	28.68 (4.7)	23 - 43	30.79 (5.0)	23 - 41	.10
WASI 2-subtest estimated FSIQ	116.78 (5.7)	108 - 129	118.14 (4.5)	110 - 126	.30
Years in Education	17.73 (2.1)	14 - 22	17.21 (2.7)	13 - 23	.39
Household Income	<i>n</i>	%	<i>n</i>	%	
£0 - £15,000	5	13.51	1	3.57	.19
£15,000 - £30,000	11	29.73	4	14.29	
£30,000 - £50, 000	10	27.03	9	32.14	
£50,000 +	11	29.73	14	50.00	

2.2.2. Questionnaire Measures

2.2.2.1. Assessment of general ability

The two-subtest form of the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) was used to produce an estimate of general cognitive ability. This includes assessment of vocabulary and matrix reasoning and provides an estimate of Full Scale IQ Scores (FSIQ).

2.2.2.2. Assessment of symptoms of depression

Both mothers and non-mothers completed the Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996), which is a 21-item self-report questionnaire designed to assess the intensity of symptoms of depression. This inventory includes items covering the major components of depression, including sadness, pessimism, a feeling of failure, feelings of guilt and punishment, self-dislike, and lack of energy. For each item participants are required to indicate which statement best describes how they felt during the past two weeks, including the current day. Each item is assessed on a 4-point scale from 0-3, with higher scores indicating more severe depressive symptoms. The total BDI score is calculated by summing the scores from all 21 items. The BDI has been shown to have high internal consistency, excellent internal reliability, good test-retest reliability, and correlates with other measures of depression (Beck et al., 1996; Beck, Steer, & Carbin, 1988; Dozois, Dobson, & Ahnberg, 1998).

2.2.2.3. Assessment of symptoms of parenting stress

The short-form of the Parenting Stress Index (PSI-SF; Abidin, 1995) was administered to mothers only. It is a measure that screens for stress in the parent-child relationship, identifies dysfunctional parenting and predicts the potential for parental behaviour problems and difficulties within the family. The short form is derived from the full-scale PSI and consists of 36 items regarding the parent's relationship with their child, which they rate on a 5-point Likert scale from "strongly agree" to "strongly disagree". These items comprise three subscales: Parental distress, difficult child characteristics, and dysfunctional parent-child interaction. The parental distress scale assesses feelings of parental incompetence, stresses associated with restrictions on lifestyle, conflicts with the child's other parent, lack of social support, and depression

(e.g. “Since having this child, I have been unable to do new and different things”). The parent-child dysfunctional interaction scale assesses the parent’s perception that the child does not measure up to expectations (“My child doesn’t seem to learn as quickly as most children”). Finally, the difficult child scale assesses the temperament and manageability of the child (“My child easily gets upset over the smallest things”). Correlation between total scores on the long and short form of the PSI is high (.87; Abidin, 1995). The scales of the PSI and PSI-SF have been shown to have adequate internal consistency and 6-month test-retest reliability, and are correlated with observed parent-child behaviour (Abidin, 1995; Haskett, Ahern, Ward, & Allaire, 2006; Reitman, Currier, & Stickle, 2002).

2.2.3. *Stimuli*

Participants completed two attentional capture tasks that were adapted from Hodsoll et al. (2011). One task contained 24 colour images of the faces of four different Caucasian infants: two female and two male infants, aged 6-12 months. These images were provided by Baylor College of Medicine (see Strathearn et al., 2009). The other task contained 24 colour images of four different Caucasian adult faces; two females and two males, taken from the MacBrain Face Stimulus Set (Tottenham et al., 2009). For both adult and infant stimuli, each identity had an image showing a neutral expression, a distressed/sad expression, and a content/happy expression. All of the images were edited using Paint.net² software so that each identity displayed blue eyes on some trials (when target) and brown eyes on other trials (when non-target/distractor). Images were also edited so that the same iris colours were used across infant and adult faces and iris and sclera size were matched across infant and adult stimuli (see below). The dimensions of the stimuli were 2.1 cm (vertically) by 1.7cm (horizontally). The faces were presented on a black background in a virtual triangle with the centre of each image placed at 1.3 cm from a central fixation cross (see Figure 2.1). There was a 0.5cm gap between images. Stimuli were viewed at a distance of 60cm meaning that they were subtended at a visual angle of 4.5° vertically and 3.6° horizontally.

² Free software available from <http://www.getpaint.net>

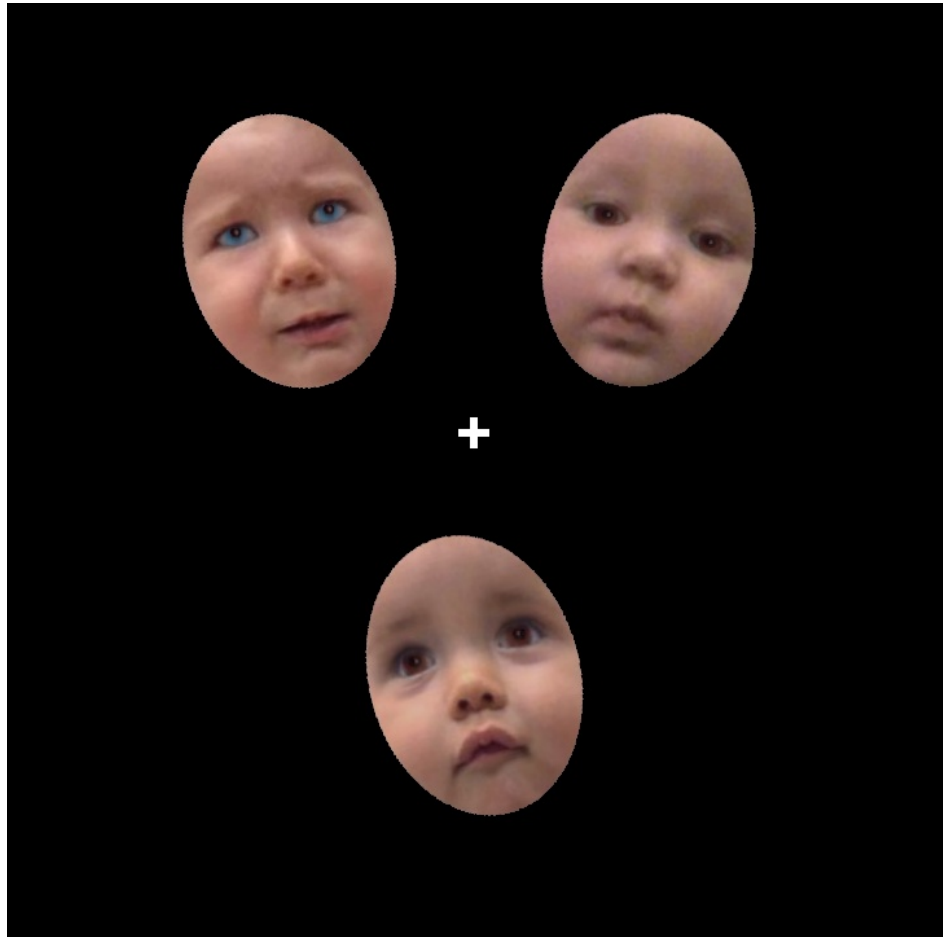


Figure 2.1. Example of display from visual search task (not to scale). This shows an example of infant stimuli with an emotional (sad) blue-eyed target among two neutral brown-eyed non-targets.

2.2.3.1. Stimuli ratings

In a preliminary study, ten individuals (4 mothers and 6 non-mothers) who did not take part in the main study rated all images for valence and arousal on a scale of 1-5. Analysis of the valence and arousal ratings indicated that happy adult and infant stimuli were rated as more positive than both neutral ($M = 4.7$, $SE = .09$ vs. $M = 3.0$, $SE = .05$, $p < .001$) and distressed adult and infant stimuli ($M = 1.2$, $SE = .09$, $p < .001$). Distressed adult and infant stimuli were rated as more negative than neutral adult and infant stimuli ($M = 1.2$, $SE = .09$ vs. $M = 3.0$, $SE = .05$, $p < .001$). Baby stimuli were rated as more arousing than adult stimuli ($M = 3.9$, $SE = .06$ vs. $M = 3.6$, $SE = .07$; $F(1, 9) = 19.31$, $p < .01$). Distressed infant and adult stimuli were rated as

more arousing than both happy ($M = 4.7$, $SE = .08$ vs. $M = 4.3$, $SE = .07$, $p < .05$) and neutral infant and adult stimuli ($M = 2.3$, $SE = .11$, $p < 0.001$), while happy infant and adult stimuli were rated as more arousing than neutral infant and adult stimuli ($M = 4.3$, $SE = .07$ vs. $M = 2.3$, $SE = .11$, $p < .01$).

2.2.3.2. *Stimuli eye size*

The mean diameter of the irises of the stimuli was 2.60mm for infant faces and 2.79mm for adult faces, and 2.54mm for happy faces, 2.29mm for sad faces and 3.05mm for neutral faces (with 1 pixel = 0.44mm). To confirm that iris and sclera sizes were matched across face ages, mixed model ANOVAs were conducted on the size of each (in pixels) for the adult and infant stimuli, with emotion entered as a within-subjects variable and face age as a between-subjects variable. This analysis indicated a main effect of emotion for sclera size ($F(2,12) = 6.83$, $p < .01$), with happy faces ($M=8.75$, $SE=.38$) and sad faces ($M=8.88$, $SE=.35$) having smaller sclera than neutral faces ($M=10.38$, $SE=.24$). There was also a main effect for iris size ($F(2,12) = 47.62$, $p < .001$), with happy faces ($M=44.25$, $SE=.25$) and sad faces ($M=45.38$, $SE=.32$) having smaller irises than neutral faces ($M=48.36$, $SE=.52$). No effect was found of face age for either sclera size ($F(1,6) = 1.0$, $p=.36$) or iris size ($F(1,6) = 2.18$, $p=.13$), and no interactions between emotion type and face age were found. Thus, while eye size varied by emotion, there were no differences in iris and sclera size across infant and adult stimuli.

2.2.4. *Procedure*

The study was granted ethical approval from University College London (UCL) Ethics Committee (Ethics approval number 2407/001). Participants visited the testing laboratory for approximately 1.5 hours, completing the questionnaire measures first followed by the computer tasks. Participants were tested individually and were given instructions at the beginning of each task. The computer tasks were conducted using a Hewlett Packard Compaq Windows PC laptop with a 2.8-GHz Pentium Four Processor and a 15" monitor with a resolution of 1024 x 768 and a screen refresh rate of 60 Hertz. Stimuli were presented and RTs recorded using E-Prime V.1.2 (Schneider, Eschman, & Zuccolotto, 2002).

Participants completed the adult and infant attentional capture tasks in the same session, with the order counterbalanced across participants. These tasks were identical with the exception of the stimuli presented. Each task consisted of two blocks of 96 trials that were preceded by a short practice block of 12 trials. Within each block, one quarter of the trials (24 trials) were neutral conditions in which no emotional faces were present. On one half (48 trials) of the total trials within each block, the non-target face had an emotional expression (emotional non-target condition). On the other quarter (24 trials) of the trials the target face had an emotional expression (emotional target condition). Taking the adult and infant tasks together, a 2 (Face Age: Adult or infant) x 2 (Emotion: Happy or sad) x 3 (Search condition: Emotional target, emotional non-target, and all neutral) repeated-measures design was employed, resulting in 12 experimental conditions.

Within each block, the trial type (i.e. whether emotional faces were absent, or whether the emotional face was the target face or a non-target face) was randomised across trials. The location of the identities and the orientation of each stimulus were also randomised across trials. The identities of the faces were randomised across trials, but the presentation was constrained to ensure that the identity of the target was not the same in trial N as it was in trial N-1 and no same identity was shown on the same trial (e.g. blue eyed Baby A would not appear in the same display as brown eyed Baby A) and the identity of the emotional face was never the same on consecutive trials. Participants were instructed to search for a blue-eyed baby or adult target singleton in a display with two brown-eyed baby or adult non-target faces. Each of the three faces in the display were tilted either 15° to the left or 15° to the right (orientation was randomised). Once the target was located, participants were required to indicate whether it was tilted to the left (by pressing the “m” key – marked with a “L” sticker for left) or right (by pressing the “k” key – marked with a “R” sticker for right). Participants were instructed to focus on a central white fixation cross throughout each trial and to be as fast and accurate in their responses as possible. There was 500 ms between the onset of the fixation cross and the onset of the stimuli. Stimuli remained on screen until a response was made, but a trial was aborted if no response was registered within 3000 ms. Auditory feedback (100 ms tone) was given if an incorrect response was made. In total, the tasks took approximately 30 minutes to complete.

2.3. Results

2.3.1. Descriptive Analysis

Correlation analyses were performed to assess whether participant age, WASI IQ, and years in education were associated with task performance. There were no statistically significant correlations between age, years in education and total RTs for non-mothers (all $r < .13$, all $p > .44$), although there was a correlation between WASI IQ and total RT ($r = -.34$, $p < .05$). There were no statistically significant correlations between any of the demographic variables and total RTs for mothers (all $r < .23$, all $p > .24$).

2.3.2. Reaction Times

The effect of the presence of task-irrelevant emotion (as an emotional singleton on either the target or non-target) on time taken to locate and respond to the target was assessed. Anticipatory (< 150 ms) responses were excluded from the RT analysis (0.42% of total trials), as were incorrect responses (4.27% of total trials). For the remaining data, outliers (2.5 SDs from mean) were calculated for each participant's range of RTs and removed from analysis (7.59% of total trials), and mean correct RTs for each experimental condition were then calculated. Means and standard errors of reaction times can be seen in Table 2.2.

A 2 (Face Age: Adult or infant) x 2 (Emotion category: Happy or sad) x 3 (Search condition: Emotional target, emotional non-target, and all neutral) repeated-measures ANOVA was conducted on the RT data, with Parent Status (mother or non-mother) entered as a between-subjects variable. Effect sizes are reported as partial eta squared (η_p^2), post-hoc power calculations are reported for main effects and interactions (observed power), and 95% confidence intervals are reported for post-hoc comparisons.

Table 2.2 *Descriptive statistics for RTs (ms) for all trial conditions for both mothers and non-mothers.*

	Non-Mothers (N=37)				Mothers (N=28)			
	Infant Faces		Adult Faces		Infant Faces		Adult Faces	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Happy Target RT	1037.42	184.11	878.19	162.48	1254.12	278.85	966.49	149.43
Happy Non-Target RT	896.66	152.74	805.15	152.02	1052.97	223.32	914.58	142.38
Neutral trials within Happy Blocks RT	889.57	150.43	809.96	151.38	1039.41	211.35	898.22	151.98
Sad Target RT	1039.21	202.4	853.81	151.72	1230.34	314.95	942.94	153.58
Sad Non-Target RT	883.77	162.72	830.72	148.02	1082.81	251.49	913.83	156.36
Neutral trials within Sad Blocks RT	890.94	156.79	813.13	140.13	1060.52	264.54	984.55	149.06

A main effect of Face Age was observed ($F(1, 63)=60.19, p<.001, \eta_p^2=.49$, observed power=1.00), such that RTs to correct responses were significantly slower in infant face conditions than adult face conditions (mean difference = 153.01 ms). This was qualified by an interaction between Face Age and Parent Status ($F(1, 63)=5.26, p<.05, \eta_p^2=.08$, observed power=.62), indicating that the RTs to infant and adult face targets differed for parents and non-parents. Inspection of the data (see Table 2.2 and Figure 2.2), indicates that although RTs to correct responses were slower for infant face conditions than adult face conditions in both mothers (mean difference = 198.26, $p<.001$, 95% CI [119.77-276.75]) and non-mothers (mean difference = 107.77, $p<.001$, 95% CI [70.23-145.30]), the effect was more pronounced for mothers, suggesting that mothers' RTs were particularly affected by infant stimuli. There was also a main effect of Parent Status ($F(1, 63)=12.30, p<.005, \eta_p^2=.16$, observed power=.93), such that mothers had longer RTs to correct responses overall compared to non-mothers (mean difference = 135.19 ms).

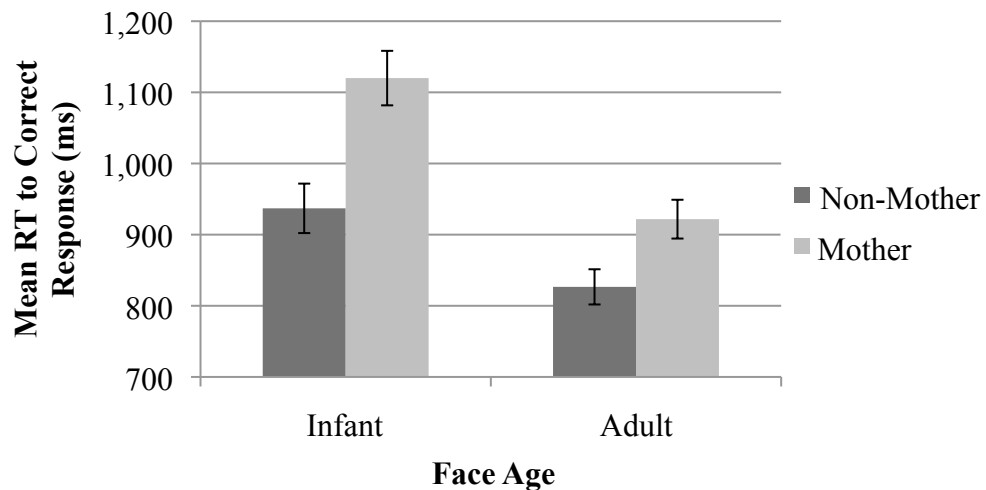


Figure 2.2. Mean RT to correct response for non-mothers and mothers as a function of Face Age. Error bars represent standard errors.

There was no main effect of Emotion category ($F(1, 63)=.01, p=.94$, observed power=.05), and no Face Age x Emotion interaction ($F(1, 63)=.24, p=.63$, observed power=.08). There was a main effect of Search condition ($F(2, 126)=225.43, p<.001, \eta_p^2=.78$, observed power=1.00). Post-hoc pairwise comparisons with Bonferroni correction applied indicated that participants' RTs to correct responses were slower in

emotional target conditions than emotional non-target conditions (mean difference=102.75, $p<.001$, 95% CI [86.32-119.19]), and slower in emotional target conditions than in neutral conditions (mean difference=113.28, $p<.001$, 95% CI [97.44-129.11]). There was also a significant difference between emotional non-target and neutral conditions (mean difference=10.52, $p<0.05$, 95% CI [.04-21.01]). These findings suggest that facial emotion was associated with longer RTs, especially when emotion appeared on a target face. There was also an Emotion x Search condition interaction ($F(2, 126)=4.98$, $p<.05$, $\eta_p^2=.07$, observed power=.80). Further investigation of this interaction using post-hoc comparisons, with Bonferroni correction applied, revealed that RTs to correct response were significantly longer for both happy and sad target conditions as compared to neutral conditions. However, while there was a trend for RTs to be longer in sad non-target conditions as compared to neutral conditions (mean difference = 13.0, $p=.08$, 95% CI [-1.27-27.27]), the difference in RTs between happy non-target conditions as compared to neutral conditions did not approach significance (mean difference = 8.05, $p=.56$, 95% CI [-22.82-6.72]).

Finally, there was also a Face Age by Search condition interaction ($F(2, 126)=74.27$, $p<.001$, $\eta_p^2=.54$, observed power=1.00). This indicates that the Search condition (i.e. whether a task-irrelevant emotion was present or not) affected RTs to correct responses differently for adult and infant facial stimuli. To further investigate this interaction, contrasts were performed comparing RTs to correct responses in emotional singleton conditions to RTs in neutral conditions across adult and infant stimuli. These revealed that the effect of longer RTs for emotional target conditions as compared to neutral conditions was particularly pronounced for infant stimuli as compared to adult stimuli ($F(1, 63)=97.35$, $p<.001$, $\eta_p^2=.61$, observed power=1.00; see Figure 2.3). There were no other group interactions or other interactions.

In summary, for both groups RTs to correct responses were significantly slower to infant stimuli than to adult stimuli; this effect was more pronounced for mothers as compared to non-mothers. For both infant and adult stimuli, RTs were slower when an emotional face was present than when all faces were neutral. The effect of slowed RTs for emotional non-targets as compared to neutral conditions appeared to be driven by sad faces, whereas both happy and sad target faces slowed RTs as compared to neutral conditions. RTs were slowest when the target face displayed an emotion as compared to neutral conditions and this effect was particularly pronounced for infant stimuli.

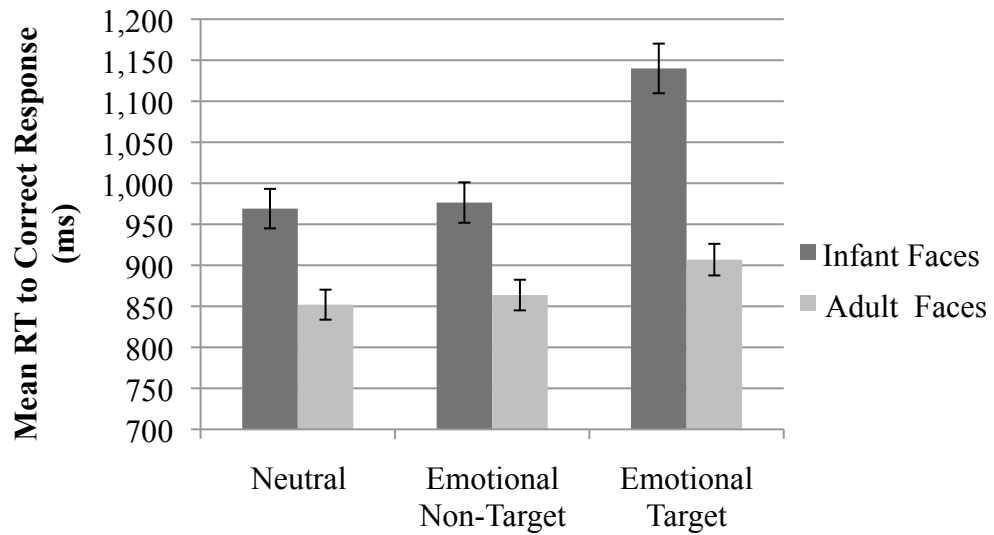


Figure 2.3. Mean RT to correct response for each experimental condition as a function of Face Age. Error bars represent standard errors.

2.3.3. Correlations

Correlations were run in order to assess whether task RTs for adult and infant stimuli were associated with measures of depression and parental stress using exploratory two-tailed Pearson correlations. Mean, standard deviation and range of scores on the measures of stress and depression are reported in Table 2.3.

Table 2.3. Descriptive statistics for measures of depression and parenting stress.

	Non-Mother (N=37)		Mother (N=29)	
	Mean (SD)	Range	Mean (SD)	Range
BDI	7.64 (7.12)	0 - 30	8.04 (4.86)	1 - 19
PSI Total	-	-	61.82 (17.76)	42 - 107
PSI Distress	-	-	23.79 (7.58)	12 - 41
PSI Dysfunctional Interaction	-	-	16.57 (5.66)	12 - 36
PSI Difficult Child	-	-	21.68 (7.22)	14 - 43

Age did not significantly correlate with RT to infant ($r(64)=.12, p=.37$) or adult faces ($r(64)=.08, p=.52$). There were also no significant correlations between BDI scores and RT to infant ($r(64)=-.12, p=.33$) or adult faces ($r(64)=-.03, p=.83$). As PSI was only measured in mothers, correlations between PSI scores and RTs to correct responses were investigated for mothers only. There were no significant correlations between RTs to correct responses for adult faces and the difficult child subscale ($r(28)=.18, p=.36$) or the dysfunctional interaction subscale ($r(28)=.15, p=.45$), nor between RTs to correct responses for infant faces and the difficult child subscale ($r(28)=-.16, p=.41$) or the dysfunctional interaction subscale ($r(28)=-.06, p=.75$). As shown in Figure 2.4, there was a significant negative correlation between the distress subscale of the PSI and RTs for infant faces ($r(28)=-.40; p<.05$) but not for adult faces ($r(28)=-.02; p=.93$). These exploratory correlational analyses suggest that in mothers RTs to infant images are associated with level of parental distress; higher levels of parental distress appear to be associated with less attentional capture by emotional infant faces.

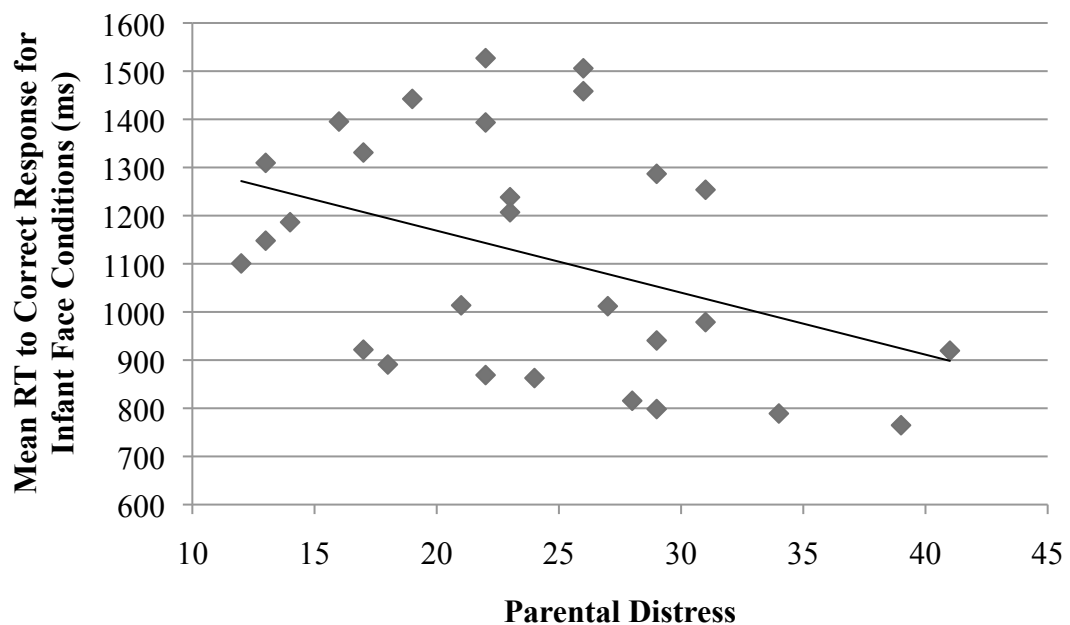


Figure 2.4. Correlation between PSI Distress subscale and RT to infant faces (mothers only).

2.3.4. *Errors*

Error rates were low (<5% of total trials). As errors were rare and non-normally distributed, comparisons reported here use non-parametric statistics and median percent errors are reported. Errors differed between face age (3.1% Adult, 4.2% Infant, $p<.05$), but did not differ between emotional condition (7.3% sad, 7.3% happy, $p=.53$), or search condition (3.1% neutral, 3.6% emotional non-target, 4.1% emotional target, $p=.13$). Furthermore, mothers and non-mothers did not differ in total error rate (3.4% non-mothers, 3.4% mothers, $p=.85$). For completeness, error rates for all conditions are reported in Table 2.4.

Table 2.4. *Median percent error for all trial conditions for mothers and non-mothers*

	Non-Mother (N=37)				Mother (N=28)			
	Infant Faces		Adult Faces		Infant Faces		Adult Faces	
	Median	Range	Median	Range	Median	Range	Median	Range
Happy Target % Error	4.17	0-29.17	4.17	0-16.67	4.17	0-25.00	4.17	0-12.50
Happy Non-Target % Error	4.17	0-29.17	4.17	0-16.67	4.17	0-22.92	2.08	0-14.58
Neutral Trials within Happy								
Blocks % Error	0	0-29.17	4.17	0-16.67	4.17	0-16.67	4.17	0-12.50
Sad Target % Error	4.17	0-29.17	4.17	0-16.67	4.17	0-25.00	4.17	0-12.50
Sad Non-Target % Error	4.17	0-29.17	4.17	0-25.00	4.17	0-22.92	2.08	0-10.42
Neutral Trials within Sad								
Blocks % Error	0	0-29.17	4.17	0-16.67	4.17	0-16.67	2.08	0-8.33

2.4. Discussion

The first empirical study in this thesis investigated attentional processing of adult and infant emotional facial expressions in a sample of parents and non-parents. It was found that responses to infant face targets were slower than adult face targets. This effect was modulated by parental status, such that parents showed longer response times to infant compared to adult faces than non-parents. Responses were slower when a task-irrelevant emotion was present on the target face; however this was moderated by stimulus type, such that responses were particularly slow to infant emotional target faces. A correlation analysis also revealed that mothers' self-reported parental distress was negatively correlated with responses to infant faces, but not to adult faces. This discussion will first focus on the observed differential responses to infant versus adult faces and how this was influenced by parental status, and then consider the influence of facial affect on task performance.

2.4.1. *Attention to Infant versus Adult Faces*

Consistent with previous research in pregnant women (Pearson et al., 2010), it was found that RTs were significantly slower when participants searched for target stimuli in the presence of infant faces than in the presence of adult faces. This suggests that, across conditions, infant stimuli interfered with task performance more than adult faces, slowing response decision times. There may be a quality intrinsic to infant faces, which facilitates increased allocation of attention. This is in line with appraisal theories of emotion, which predict that stimuli that are evaluated as important or significant demand increased allocation of attention and processing (Brosch et al., 2008, 2007; Sander, Grandjean, & Scherer, 2005). Infant faces may have also have engaged more attention, interfering with task performance, because they were more arousing (Brosch et al., 2007; Lorenz, 1943). Indeed, the infant stimuli used in this study were rated as more emotionally arousing than the adult stimuli, even when showing neutral facial expressions. Similarly, Brosch and colleagues (2007) observed increased attentional bias towards neutral infant faces as compared to neutral adult faces, and found that this attentional bias was modulated by the arousal potential of the stimuli. However, if greater arousal ratings were driving greater attentional interference then we would have expected to observe slower reaction times for

distressed versus happy emotions. In fact, no difference was found between these conditions. This suggests that a simple conceptualisation of arousal would not be sufficient on its own to account for the observed pattern of slower responses to infant faces. Nonetheless, these findings indicate that infant faces are processed in a manner that differs in important ways from the way in which adult faces are processed. Such a bias in how infant faces are processed has possible evolutionary value as it allows adults to pay attention to, recognise and process child cues which may be important for their care and well-being (Lorenz, 1943).

2.4.2. Differences Observed between Mothers and Non-Mothers

The study reported in this chapter also investigated whether processing of infant and adult faces would be modulated by parental status. The difference in RTs between infant and adult stimuli conditions was found to be larger for mothers than for non-mothers, suggesting that parental status affects responsiveness to infant faces as compared to adult faces. This finding is consistent with neuroimaging evidence that has demonstrated differential neural processing of infant and adult faces for mothers as compared with non-mothers (e.g. Nishitani et al., 2011; Proverbio et al., 2006) and provides important evidence that parenting is associated with a behavioural change in processing infant cues. The neural and hormonal changes associated with pregnancy and parenting may underlie the development of parenting behaviours, such as sensitivity to infant visual cues (Brunton & Russell, 2008; Strathearn et al., 2009). Mothers may give infant faces attentional priority over other features in a scene because they find them more salient than non-parents. Mothers may also experience increased arousal to infant faces or an increased empathic response (Strathearn et al., 2009; Nishitani et al., 2011). The difference in responding between parents and non-parents may also reflect familiarity or “expertise” with infant faces. Furthermore, it is necessary for mothers to prioritise and maintain attention to infant signals as this enables them to engage with and sensitively respond to infant cues, which is necessary for adapting to the specific demands of infant care, whereas non-parents are not yet required to fulfil a caregiving role on a day-to-day basis.

It was also found that mothers had slower responses overall than non-mothers, including to adult faces. One possibility is that the slower RTs seen in mothers reflects an increase in attention to social stimuli in general for parents as compared to non-

parents. The transition to parenthood may involve a more general shift in processing of social and emotional stimuli rather than just infant-focused attentional changes. This hypothesis requires further investigation.

2.4.3. *Effect of Emotion on Attention to Faces*

The paradigm used in this study also allowed the exploration of how the presence of emotional expressions (happiness and sadness) both on target faces and on non-target faces impacted on attention towards infant and adult faces. In a previous study using a similar paradigm, it was found that the presence of emotion on a non-target face “captured attention”, slowing response times in these conditions as compared to both neutral and emotional target conditions (Hodsoll et al., 2011). However, in this study we found that, across both adult and infant stimuli, responses to the search task were slower when an emotional facial expression appeared on the *target face* compared to when all faces in the scene were neutral and compared to when emotion appeared on a non-target face. Responses were also slower when an emotion appeared on non-target faces as compared to when all faces were neutral, however the emotion by condition interaction appeared to suggest that this effect was driven by sad non-target faces. This attentional capture effect for emotional non-target faces was not as strong as the effect seen for emotional target faces.

It is possible that the specific demands of the current task may have attenuated the influence of non-target “distractors” on attention. For example, Hodsoll’s study required participants to search for target faces based on the gender discrimination (“search for the male face”), which is not practical with infant stimuli. In the current study, participants were requested to search for the infant or adult face with a pre-specified eye colour, which focuses attention to the eye area of non-target images, whereas gender discrimination requires holistic processing of the whole face. One consequence of this directed attention would be to reduce holistic face processing and therefore potentially minimize processing of the facial affect in non-target distractors (Horstmann & Becker, 2008). Slow RTs in emotional target conditions compared to other search conditions suggests that an emotional target face distracts attention away from the primary search task. This effect may occur because once the target face has been located on the basis of eye colour and participants scan the whole face in order to report the direction of the tilt (rather than one specific feature), the emotional

expression then captures attention and delays execution of the search task. This emotional interference effect for emotional target faces was found to be larger for infant stimuli than for adult stimuli, suggesting that not only do adults respond differentially to infant and adult stimuli, but also that they appear to be attuned to emotionally salient infant faces. Again, increased attention towards emotional infant signals may be an important adaption to facilitate sensitivity to infant needs and promote caregiving behaviour (Ainsworth et al., 1978).

2.4.4. Symptoms of Depression and Parenting Stress

Finally, a correlation analysis explored the association between responses to infant and adult faces and measures of depression and parental stress. RTs to adult faces and infant faces were not found to correlate with symptoms of depression for either parents or non-parents. By contrast, previous research has shown that depressed women process emotional infant faces somewhat differently to non-depressed women (Pearson et al., 2010). One possibility is that such effects are evident only in clinically depressed samples and more normative symptom levels do not account for individual differences in attentional processing. However, there was a negative correlation between RTs to infant faces and levels of parental distress in the mothers, as measured by the distress subscale of the PSI. Parental distress appears to influence the mothers' attentional bias, with infant faces engaging attention less in mothers with higher levels of parental distress. Although only a modest effect, this preliminary finding suggests that mothers experiencing higher levels of parental distress are less sensitive to infant stimuli than parents who experience lower levels of parental distress. This may be interpreted in two ways; mothers who allocate less attentional resources to infant stimuli may consequently experience higher levels of parental distress, as they may feel that infant signals are more ambiguous (cognition to parental distress effect). Alternatively, higher levels of parental distress may cause difficulties in processing infant cues, perhaps due to problems in emotion regulation (parental distress to cognition effect). It is not possible in the current study to elucidate the direction of association between parental stress and attention towards infant faces; future studies with larger samples and/or longitudinal designs may enable better understanding of the pathways between parental stress, attention to infant cues, and parenting behaviour.

2.4.5. Limitations and Future Directions

There are some limitations to note in this study. While all of the non-parents reported at least some experience of caring for infants, it will be important in future to investigate whether there are differences in infant face processing between groups of non-mothers with different levels of exposure to the daily care of young infants (e.g. nursery workers or teachers as compared to those with no experience of childcare). This would help tease out whether the parent specific effects observed here are due to the experience of parenting per se, or simply due to differences in childcare experience. Another limitation is that this study did not control for the women's menstrual cycle stage or use of hormonal contraceptives, which may impact on perception of infant faces (Perrett et al., 2010; Sprengelmeyer et al., 2009). It should also be noted that the data presented in this study were cross-sectional and the mothers had children aged from 6 to 19 months. Future studies may wish to restrict age range of children to very young infants, or investigate if the attentional bias towards infant faces changes from non-parent, through pregnancy, to becoming a first-time parent. A further limitation is that the current design used pictures of unfamiliar infants. It will be important for future studies to explore how attentional processes may vary in relation to a mother's own child.

2.5. Conclusions

This chapter describes a behavioural study that extends previous research of visual processing of infant and adult emotional cues in parents and non-parents. It was found that infant faces in general and emotional infant faces in particular preferentially engage attention compared to adult faces. This study also demonstrates for the first time, at the behavioural level, that this attentional bias for infant faces is more pronounced in mothers than in non-mothers. Infant social and emotional cues are necessary to elicit appropriate caregiving responses; it is therefore important that individuals are able to rapidly attend and respond to infant cues in an environment where there is other information competing for attention. The findings reported in this chapter suggest that motherhood is associated with increased attention to infant faces, perhaps reflecting part of a wider set of adaptive behavioural changes associated with

parenthood. Further understanding the attentional processing of infant facial cues will help delineate the basic cognitive mechanisms that contribute to maternal sensitivity and may help inform clinical interventions for parents at risk.

The next chapter aims to extend these findings by investigating whether the effect of heightened attentional allocation to infant faces compared to adult faces is also observed in older children or if it uniquely observed in response to infant faces.

Chapter 3: An investigation of attention to infant, child, and adult emotional faces in mothers and non-mothers

3.1. Chapter Introduction

The previous chapter demonstrated that women with and without children show increased allocation of attention to infant faces as compared to adult faces, particularly when they are emotional. This “attentional bias” to infant faces was found to be more pronounced in women who are mothers of infants. These findings extend the previous literature and suggest that infant faces may be a particularly special class of social stimuli. However, it is not clear whether increased salience of infant faces as compared to adult faces extends to children older than infant age, or whether infants demand preferential attentional allocation as compared to a variety of other juvenile faces. To investigate this question, the current study employed the same task as reported in the previous chapter to investigate attentional processing of a variety of different aged faces: infants, pre-adolescent children, adolescents, and adults. Faces were shown with neutral and sad emotional facial expressions, in order to investigate the effects of face age and presence of emotion on task performance.

3.1.1. *Attention to Emotional Faces: Threat and Vulnerability*

As discussed previously, faces preferentially engage attention and provide valuable information essential for successful social interaction and survival (e.g. Darwin, 1872/1904; Öhman et al., 2001; Ro et al., 2001). Glimpsing a face, even momentarily, provides a wealth of information about an individual’s identity, age, gender, ethnic background and emotional state (Bronfenbrenner, 1989; Zebrowitz, 2006). There is a need, therefore, to selectively deploy attentional resources to those faces that signal potentially important information. It is well established that faces expressing anger or fear, indicating that we may be vulnerable to harm, preferentially engage attention (Brosch et al., 2008, 2007; Mogg, Garner, & Bradley, 2007; Öhman et al., 2001). By contrast, relatively little is known about whether other cues indicating that another person may be vulnerable operate in a similar manner. It has been shown that faces of infants, who are considered vulnerable due to requiring a high level of care and protection from adults, preferentially engage our attention (Brosch et al., 2007, 2008; Thompson-Booth et al., 2013 [Chapter 2]). However, it is unclear whether faces of older children, who are nonetheless still somewhat dependent on adult care

and therefore vulnerable, are also processed differently to adult faces, and whether the affective state of the child influences adult responses.

The presence of emotional content is perhaps the most robust feature known to influence attention to faces (Palermo & Rhodes, 2007; Vuilleumier & Schwartz, 2001; Vuilleumier, 2005); it is well established that attention is greater for emotional than neutral faces (Eastwood et al., 2001; 2003; Hodsoll et al., 2011; Williams et al., 2005). For example, Hodsoll and colleagues (2011) demonstrated attentional capture by emotional distractor faces (fearful, angry, or happy) in a search task in which emotional expression is entirely irrelevant. Other studies have demonstrated that faces expressing positive and negative emotion differ in the relative effectiveness with which they capture attention as compared to neutral faces; faces expressing negative emotion guide focal attention more effectively than do faces expressing positive emotion (Eastwood et al., 2001; 2003). Threatening faces are detected more quickly than friendly faces among neutral, emotional or sad distractors (Öhman et al., 2001). Our response to facial threat is in fact often rapid and even unconscious in manner (Palermo & Rhodes, 2007), consistent with the view that it is evolutionarily adaptive to preferentially attend and respond to threat-related stimuli (LeDoux, 1998; Öhman & Mineka, 2001). Taken together, these studies suggest that emotional faces influence the allocation of attention, and that these effects are most marked for faces that signal we may be at risk of harm.

3.1.2. Attention to Faces of Different Ages

Faces provide a rich source of information about a person's age, which may also affect how we attend to them (Brosch et al., 2008, 2007; Ebner & Johnson, 2010). Particularly robust effects of age relate to the attentional capture effects of *Kindchenschema* (baby schema) (Brosch et al., 2007, 2008), typically characterized by a large round face, high forehead, large eyes, small mouth and nose (Alley, 1981; Lorenz, 1943). Arguably these specific perceptual features, which delineate young age, also indicate heightened vulnerability and need for care and promote caretaking behaviour and affective orientation towards infants, with the evolutionary function of enhancing offspring survival (Bowlby, 1969/1982; Darwin, 1872/1904; Hrdy, 2005; Lorenz, 1943; Tinbergen, 1951). Consistent with this proposal, it has been found that both children and adults prefer pictures of infants to pictures of adults, rating them as

more “cute” (Sanefuji et al., 2007). Moreover, adults in general show preferential attentional allocation to infant compared to adult faces (Brosch et al., 2007; Thompson-Booth et al., 2013 [see Chapter 2]). Neuroimaging research further supports the contention that infant faces are particularly salient. Compared to adult faces, infant faces elicit enhanced activation in a distributed network implicated in face perception, reward processing and attentional processing (Kringelbach et al., 2008; Leibenluft et al., 2004, Swain, 2011). Parametrically manipulating baby schema content to make them “cuter” is associated with greater activation of the nucleus accumbens (Glocker, Langleben, Ruparel, Loughhead, Valdez, et al., 2009), consistent with the hypothesis that baby schema represent a rewarding sensory stimulus that may motivate caretaking behaviour.

Preferential allocation of attention to infant faces over adult faces may help promote survival of those who are dependent on others for food, shelter and comfort. However, this putative evolutionary mechanism may be further sensitised in parents, who have constant caregiving responsibilities. Both behavioural and neuroimaging studies suggest that mothers of infants process infant cues differently to non-mothers (Nishitani et al., 2011; Thompson-Booth et al., 2013 [Chapter 2]). Furthermore, mothers and pregnant women appear to find emotional infant faces particularly engaging (Pearson et al., 2010; Thompson-Booth et al., 2013 [Chapter 2]). These findings suggest that parenthood may be associated with a greater empathic response or increased arousal to infant faces (Proverbio et al., 2006).

There remains surprisingly scant empirical evidence regarding attentional processing of children’s faces. Although pre-adolescent and to some degree, adolescent children are dependent on adult care, there is a reduction over time in the adult nurturance that they require, and significant cross-cultural differences in this regard (Paikoff & Brooks-Gunn, 1991). Furthermore, as faces age, the degree of baby schema they express lessens, with infants having the strongest baby schema characteristics before the age of 1 year (Hildebrandt & Fitzgerald, 1979), although children’s cranial facial structure continues to undergo gradual growth well into adolescence (Enlow, 1982). It has been observed in primates that the loss of infantile characteristics as offspring age coincides with the subsiding of parental responses (Struhsaker, 1971). However, studies have found that preferences for younger faces as compared to older faces may extend beyond infant faces, with one study showing that adults rated younger children’s faces (up to age 4.5 years) as more likeable and attractive than

older children's faces (Luo et al., 2011). The findings of a recent electrophysiological study showed a larger face-specific neural response in women to infant than to pre-adolescent child and adult faces. They also found that a neural response associated with brain areas involved in face and reward processing was affected by face age, with larger amplitudes to infant faces than to child faces, and larger amplitudes to child faces than to adult faces (Proverbio et al., 2011). These findings are consistent with the notion that infant faces may elicit preferential attentional allocation, but that children's faces in general may also be processed preferentially compared to adult faces.

3.1.3. The Current Study

The study reported in this chapter aimed to investigate whether women (with and without children) preferentially attend to cues signalling developmental vulnerability beyond infancy, using the same visual search task as reported in the previous chapter. This task was used in order to establish whether the previously observed pattern of preferential attention to infant faces extends to the faces of pre-adolescent and adolescent children expressing neutral or negative affect. Based on previous evidence, it was predicted that RTs in the visual search task would be slowed in response to the faces of infants and pre-adolescent children (Proverbio et al., 2011), with infant effects enhanced in parents who had young children themselves as compared to a non-parent group (Thompson-Booth et al., 2013 [Chapter 2]). It was also predicted that negative affect would enhance attentional allocation to infant and pre-adolescent faces, on the basis that this affective cue is likely to signal enhanced vulnerability (Wilson, Demetriooff, & Porter, 2008). No differences in attentional processing were predicted in relation to adolescent faces, as this stage was hypothesized to reflect a relatively autonomous developmental period (Paikoff & Brooks-Gunn, 1991).

3.2. Method

3.2.1. Participants

A new cohort of eighty-six women, 40 first-time mothers and 46 non-mothers, were recruited for the study. Two women (one mother and one non-mother) were excluded from analyses due to high error rates (>30%), leaving a final sample of 84 women. These women were aged between 23 and 39 years old. All participants were Caucasian, reported normal or corrected-to-normal vision, and were right handed. All of the mothers had a singleton pregnancy and their children were aged between 2 and 30 months ($M = 15.79$ months, $SD = 9.74$). For more information on participant demographics see Table 3.1.

3.2.2. Questionnaire Measures

3.2.2.1. Assessment of general ability

The two-subtest form of the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) was used to produce an estimate of general cognitive ability. This includes assessment of vocabulary and matrix reasoning and provides an estimate of Full Scale IQ Scores (FSIQ).

Table 3.1. *Participant demographics.*

	Non-Mothers (N=45)		Mothers (N=39)		<i>p</i>
	Mean (<i>SD</i>)	Range	Mean (<i>SD</i>)	Range	
Age	28.22 (4.26)	23 - 37	29.95 (4.9)	23 - 39	.10
WASI 2-subtest estimated FSIQ [§]	114.32 (7.8)	99 - 135	112.28 (7.0)	101 - 133	.11
Years in Education	17.44 (1.6)	15 - 23	16.67 (2.8)	12 - 22	.22
Household Income	<i>n</i>	%	<i>n</i>	%	
£0 - £15,000	13	28.89	8	20.51	.40
£15,000 - £30,000	12	26.67	8	20.51	
£30,000 - £50,000	12	26.67	10	25.64	
£50,000 +	8	17.78	13	33.33	

§ WASI data was missing from one non-mother

3.2.3. Stimuli

Participants completed a similar visual search task to that reported in Chapter 2. In this version, the task contained colour images of male and female Caucasian faces of different ages; infants (N=4; aged 6-12 months), pre-adolescent children (N=4; aged 4-7 years old), adolescents (N=4; aged 13-16 years old), and adults (N=4). Images were provided by Baylor College of Medicine (see Strathearn et al., 2009), the MacBrain Face Stimulus Set (Tottenham et al., 2009), and from original photographs. There were images of each identity showing neutral and sad facial expressions. Examples of pre-adolescent, adolescent and adult face stimuli are shown in Figure 3.1; infant stimuli were the same as those shown in Chapter 2 (see Figure 2.1).

As in the previous study, all of the images were edited using Paint.net software so that each identity displayed blue eyes on some trials (when target) and brown eyes on other trials (when non-target). Eye-size (measured in pixels) was matched across stimuli. The dimensions of the stimuli were 2.6 cm (vertically) by 2.1 cm (horizontally). The faces were presented on a black background in a virtual triangle with the centre of each image placed at 2.4 cm from a central fixation cross. Stimuli were viewed at a distance of 60cm meaning that they were subtended at a visual angle of 5.6° vertically and 4.6° horizontally.



Figure 3.1. Examples of adult, adolescent, and pre-adolescent face stimuli used in the visual search task (not to scale).

3.2.3.1. Stimuli ratings

In a preliminary study, 14 individuals who did not take part in the main study rated all images for age, valence, arousal, and vulnerability on a scale of 1-5.

A one-way ANOVA revealed that Age ratings differed according to the Face Age category ($F(2,52)=2284.39, p<.001$). Post-hoc comparisons with Bonferroni correction applied revealed that infant faces were rated as younger ($M=.81$ years, $SE=.05$) than pre-adolescent faces ($M=5.23$ years, $SE=.19, p<.001$), adolescent faces ($M=13.98$ years, $SE=.17, p<.001$), and adult faces ($M=43.18$ years, $SE=.76, p<.001$). Pre-adolescent faces were rated as younger than adolescent faces ($p<.001$) and adult faces ($p<.001$). Finally, adolescent faces were rated as younger than adult faces ($p<.001$).

Participants were also asked to rate all stimuli for valence on a scale of 1 (negative) to 5 (positive). A 4 (Face Age: infant, pre-adolescent, adolescent, adult) x 2 (Emotion: neutral or sad) repeated-measures ANOVA was conducted on the valence ratings. There was no main effect of Face Age ($F(3,39)=.29, p=.88$). There was a main effect of Emotion ($F(1,13)=770.73, p<.001, \eta_p^2=.02$), with sad faces ($M=1.14, SE=.04$) rated as more negative than neutral faces ($M=2.99, SE=.05$). There was no stimulus by emotion interaction ($F(3,39)=1.07, p=.37$).

Participants were also asked to rate the stimuli for emotional arousal. A 4 (Face Age: infant, pre-adolescent, adolescent, adult) x 2 (Emotion: neutral or sad) repeated-measures ANOVA was conducted on the emotional arousal ratings. There was a main effect of Face Age ($F(3,39)=45.94, p<.001, \eta_p^2=.78$). Post-hoc comparisons with Bonferroni correction applied revealed that infant faces were rated as more emotionally arousing than adult faces (mean difference=1.33, $SE=.14, p<.001$), adolescent faces (mean difference=1.22, $SE=.14, p<.001$), and pre-adolescent faces (mean difference=.47, $SE=.15, p<.05$). Pre-adolescent faces were rated as more emotionally arousing than adult (mean difference=.87, $SE=.14, p<.001$), and adolescent faces (mean difference=.76, $SE=.12, p<.001$). There were no differences in emotional arousal ratings between adolescent faces and adult faces (mean difference=.11, $SE=.11, p=1.0$). There was a main effect of Emotion ($F(1,13)=67.44, p<.001, \eta_p^2=.84$), with sad ($M=3.49, SE=.05$) rated as more emotionally arousing than neutral ($M=2.38, SE=.14$). There was not a significant stimulus by emotion interaction ($F(1,13)=68.65, p=.07$).

Finally, participants were also asked to rate the stimuli for perceived vulnerability on scales of 1 (low) to 5 (high). A 4 (Face Age: infant, pre-adolescent, adolescent, adult) x 2 (Emotion: neutral or sad) repeated-measures ANOVA was conducted on the vulnerability ratings. There was a main effect of Face Age ($F(3,39)=78.75, p<.001, \eta_p^2=.86$). Post-hoc comparisons with Bonferroni correction applied revealed that infant faces were rated as more vulnerable than adult faces (mean difference=1.81, $SE=.18, p<.001$), adolescent faces (mean difference=1.46, $SE=.13, p<.001$), and pre-adolescent faces (mean difference=.51, $SE=.10, p<.01$). Pre-adolescent faces were rated as more vulnerable than adult (mean difference=.13, $SE=.16, p<.001$), and adolescent faces (mean difference=.96, $SE=.13, p<.001$). Finally, adolescent faces were rated as more vulnerable than adult faces (mean difference=.36, $SE=.08, p<.01$). There was a main effect of emotion ($F(1,13)=55.70, p<.001, \eta_p^2=.81$), with sad ($M=3.47, SE=.05$) rated as more vulnerable than neutral ($M=2.55, SE=.11$).

There was an interaction between Face Age and Emotion ($F(3,39)=8.99, p<.001, \eta_p^2=.41$). Post-hoc comparisons with Bonferroni correction applied revealed that for neutral conditions, infant faces were rated as more vulnerable than adult neutral faces (mean difference=2.14, $SE=.19, p<.001$), adolescent neutral faces (mean difference=1.84, $SE=.17, p<.001$), and pre-adolescent neutral faces (mean difference=.68, $SE=.14, p<.01$). Pre-adolescent neutral faces were rated as more emotionally arousing than adult neutral faces (mean difference=1.16, $SE=.19, p<.001$), and adolescent neutral faces (mean difference=1.46, $SE=.20, p<.001$). However, there was not a difference in vulnerability ratings between adolescent neutral faces and adult neutral faces (mean difference=.30, $SE=.10, p=.07$). For sad conditions, infant faces were rated as more vulnerable than adult sad faces (mean difference=1.48, $SE=.20, p<.001$) and adolescent sad faces (mean difference=1.07, $SE=.13, p<.001$). However, the difference between infant and child sad faces did not quite reach statistical significance (mean difference=.34, $SE=.11, p=.06$). Pre-adolescent sad faces were rated as more emotionally arousing than adult sad faces (mean difference=1.14, $SE=.17, p<.001$), and adolescent sad faces (mean difference=.73, $SE=.11, p<.001$). Finally, adolescent sad faces were rated as more vulnerable than adult sad faces (mean difference=.41, $SE=.11, p<.05$). Thus, the difference in vulnerability ratings between infant and pre-adolescent faces is only significant in neutral conditions, while the difference between adult and adolescent faces is only significant in sad emotional conditions. Furthermore, although other differences between infant, child, adolescent

and adult faces exist for both neutral and emotional conditions, the mean difference between the ratings for the different ages is reduced slightly for sad as compared to neutral conditions.

3.2.4. Procedure

The study was granted ethical approval from UCL Division of Psychology and Language Sciences (PaLS) Ethics Committee (Ethics approval number CEHP/2010A/019). Participants were assessed individually for 2 hours as part of a larger battery of experiments. The visual search task was conducted using a Sony Vaio Windows 7 PC laptop with a 2.4-GHz Intel Core Duo processor and a 13” wide screen monitor (60 Hz, 1366 x 768 resolution). Stimuli were presented and RTs recorded using Psyttools software (Delosis Limited). Trials were blocked by face age, with the order counterbalanced across participants. Each block consisted of 72 trials, with a slightly modified distribution to that reported in Chapter 2. In this version of the task, within each block two thirds of the trials (48 trials) were neutral conditions in which no emotional faces were present. On the other third (24 trials) an emotional expression was present; in half of these trials (12 trials) the emotional expression was present on a non-target face and in the other half the emotional expression was present on the target face. Taking all the conditions together, a 4 (Face Age: Infant, Child, Adolescent or Adult) x 3 (Search condition: Emotional target, emotional non-target, and all neutral) repeated-measures design was employed, resulting in 12 experimental conditions. Randomisation criteria of conditions and face identities were the same as in Chapter 2. Task instructions and timings were also the same as those reported in Chapter 2.

3.3. Results

3.3.1. Descriptive Analysis

Correlation analyses were performed to assess whether participant age, IQ, and years in education were associated with task performance. There was no statistically significant correlations between any of these demographic variables and total RTs for either non-mothers (all $r < .15$, all $p > .33$) or mothers (all $r < .25$, all $p > .09$).

3.3.2. Reaction Times

Anticipatory (<150 ms) responses (.01%) and incorrect responses (3.58% of total trials) were excluded from the reaction time (RT) analysis. Outliers (2.5 SDs from mean) were calculated for each participant's range of RTs and removed from analysis (2.48% of total trials), and mean correct RTs for each experimental condition were then calculated for analysis. Means and standard errors of reaction times are presented in Table 3.2.

A 4 (Face Age: Infant, pre-adolescent, adolescent, adult) x 3 (Search condition: Emotional target, emotional non-target, and all neutral) repeated-measures ANOVA was conducted on the RT data, with parent status (mother or non-mother) entered as a between-subjects variable. Effect sizes are reported as partial eta squared (η_p^2), post-hoc power calculations are reported for main effects and interactions (observed power), and 95% confidence intervals are reported for post-hoc comparisons.

Table 3.2. *Descriptive statistics for RTs (ms) for all trial conditions for mothers and non-mothers.*

Face Age	Non-Mother (N=45)						Mother (N=39)					
	Neutral Search		Sad Non-Target		Sad Target Search		Neutral Search		Sad Non-Target		Sad Target Search	
	Condition		Search Condition		Condition		Condition		Search Condition		Condition	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Infant	924.06	124.42	922.86	113.43	957.58	134.61	1083.75	207.97	1105.20	231.89	1164.69	234.30
Pre-adolescent	913.12	149.90	933.62	163.00	970.10	188.62	981.19	186.56	1009.34	185.43	1049.69	195.96
Adolescent	894.82	176.80	910.78	143.00	911.63	140.78	989.08	176.22	1002.84	173.32	1003.38	170.31
Adult	883.73	150.10	908.78	132.80	913.70	136.07	977.12	196.34	1006.44	180.93	1012.74	169.50

A main effect of Face Age was observed (Greenhouse-Geisser corrected $F(2.6, 216.4) = 12.81, p < .001, \eta_p^2 = .14$, observed power = 1.00; See Figure 3.2). Pairwise comparisons with Bonferroni correction applied revealed that RTs were slower for infant face conditions than for adult face conditions (mean difference = 75.93 ms, $p < .001$, 95% CI [44.40-107.46]), slower for infant face conditions than for adolescent face conditions (mean difference = 74.26 ms, $p < .001$, 95% CI [33.36-115.16]), and slower for infant face conditions than for pre-adolescent face conditions (mean difference = 50.17 ms, $p < .05$, 95% CI [5.21-95.13]). There were no differences in RTs between adult and adolescent face conditions (mean difference = 1.67, $p = 1.0$, 95% CI [-31.87-35.21]), or between adult and pre-adolescent face conditions (mean difference = 25.76, $p = .36$, 95% CI [-10.64-62.64]). Finally, there were no differences in RTs between adolescent and pre-adolescent face conditions (mean difference = 24.09, $p = .55$, 95% CI [-13.97-62.14]).

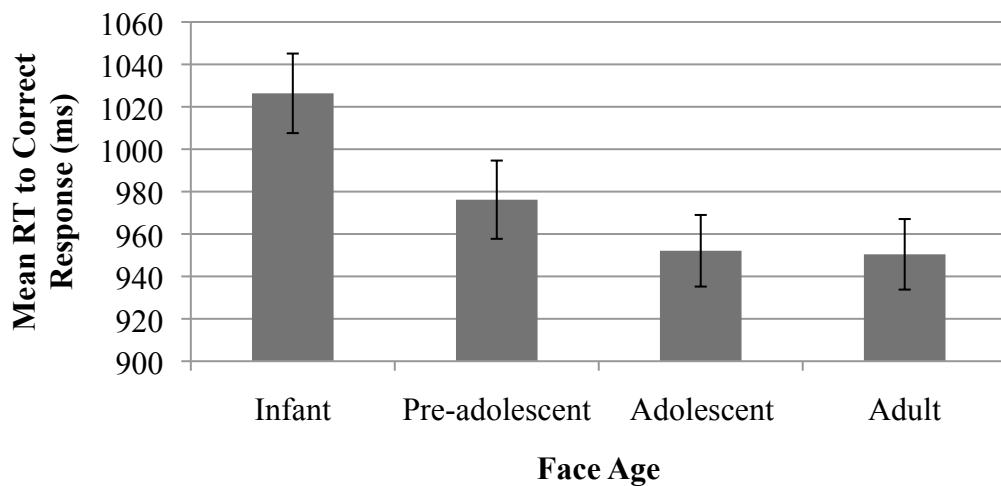


Figure 3.2. Mean RT to correct response as a function of Face Age. Error bars represent standard errors.

There was a main effect of Search condition ($F(2, 164) = 29.31, p < .001, \eta_p^2 = .26$, observed power = 1.00). Post-hoc pairwise comparisons (Bonferroni corrected) indicated that participants' RTs to correct responses were slower in emotional non-target conditions than in neutral conditions (mean difference = 19.12 ms, $p < .01$, 95% CI [5.91-32.34]), and slower in emotional target conditions than in neutral conditions (mean difference = 42.08, $p < .001$, 95% CI [27.51-56.64]). Finally, RTs were slower in

emotional target conditions than in emotional non-target conditions (mean difference=22.95 ms, $p<.001$, 95% CI [10.46-35.44]).

There was also a Face Age by Search condition interaction (Greenhouse-Geisser corrected $F(5.1, 415.4)=3.82$, $p<.001$, $\eta_p^2=.04$, observed power=.94). This indicates that the Search condition (i.e. whether a task-irrelevant emotion was present or not) affected RTs differently for differently aged stimuli. Post-hoc comparisons with Bonferroni corrections revealed that for neutral conditions, RTs were slower to infant faces than to adult (mean difference=73.47 ms, $p<.001$, 95% CI [37.08-109.87]), adolescent (mean difference=61.95 ms, $p<.01$, 95% CI [12.01-111.88]), and pre-adolescent faces (mean difference=56.75 ms, $p<.01$, 95% CI [10.96-102.53]). For emotional non-target conditions, RTs were slower to infant stimuli than adult (mean difference=56.42 ms, $p<.001$, 95% CI [20.21-92.64]) and adolescent stimuli (mean difference=57.22 ms, $p<.05$, 95% CI [14.54-99.90]), but not slower to infant faces as compared to pre-adolescent faces (mean difference 42.55 ms, $p=.10$, 95% CI [-4.66-89.76]). For emotional target conditions, RTs were slower to infant faces than to adult (mean difference=97.90 ms, $p<.001$, 95% CI [56.54-139.26]) and adolescent faces (mean difference=103.62 ms, $p<.001$, 95% CI [60.15-147.08]), and approached statistical significance compared to pre-adolescent faces (mean difference = 51.23, $p=.09$, 95% CI [-4.42-106.86]). Furthermore, RTs were slower to pre-adolescent faces as compared to adolescent faces (mean difference=52.39 ms, $p<.05$, 95% CI [6.29-98.49]), and adult faces (mean difference=46.67 ms, $p<.05$, 95% CI [3.00-90.35]; see Figure 3.3). Inspection of Figure 3.3 also shows that RTs were particularly slower to infant faces in the sad target condition.

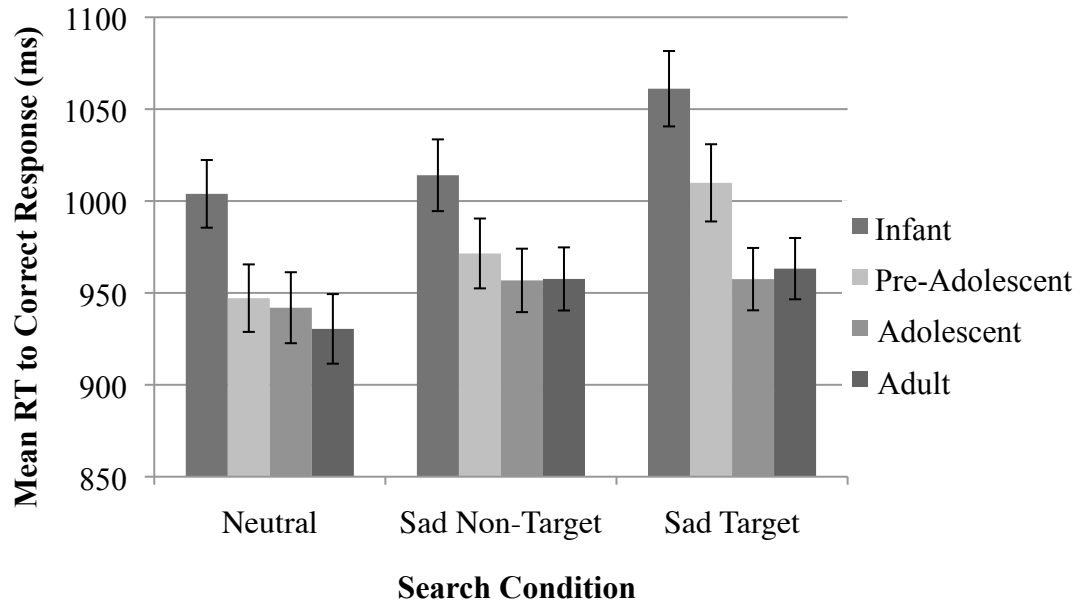


Figure 3.3. Mean RT to correct response for each experimental condition as a function of Face Age. Error bars represent standard errors.

There was a main effect of Parent Status ($F(1, 82) = 12.98, p < .001, \eta_p^2 = .14$, observed power = .95), such that mothers had longer RTs to correct responses overall ($M = 1032.12, SE = 22.69$) compared to non-mothers ($M = 920.40, SE = 21.13$). There was also an interaction between Face Age and Parent Status ($F(3, 246) = 6.01, p < .001, \eta_p^2 = .07$, observed power = .96). This indicates that the RTs in the presence of the differently aged face stimuli differed for parents and non-parents. To investigate this interaction, ANOVAs were performed separately for mothers and non-mothers on RT data. For non-mothers, it was found that RTs to correct responses were slower in infant than in adult conditions (mean difference = 32.76 ms, $p < .05$, 95% CI [.49-65.04]); no other comparisons were significant. For mothers, RTs to correct response were slower in infant face conditions than in pre-adolescent (mean difference = 104.46 ms, $p < .01$, 95% CI [26.18-182.75]), adolescent (mean difference = 119.44 ms, $p < .001$, 95% CI [46.82-192.05]), and adult face conditions (mean difference = 119.10 ms, $p < .001$, 95% CI [60.28-177.92]), showing that the effect of slowed RTs to infant face conditions is particularly pronounced for mothers (see Figure 3.4).

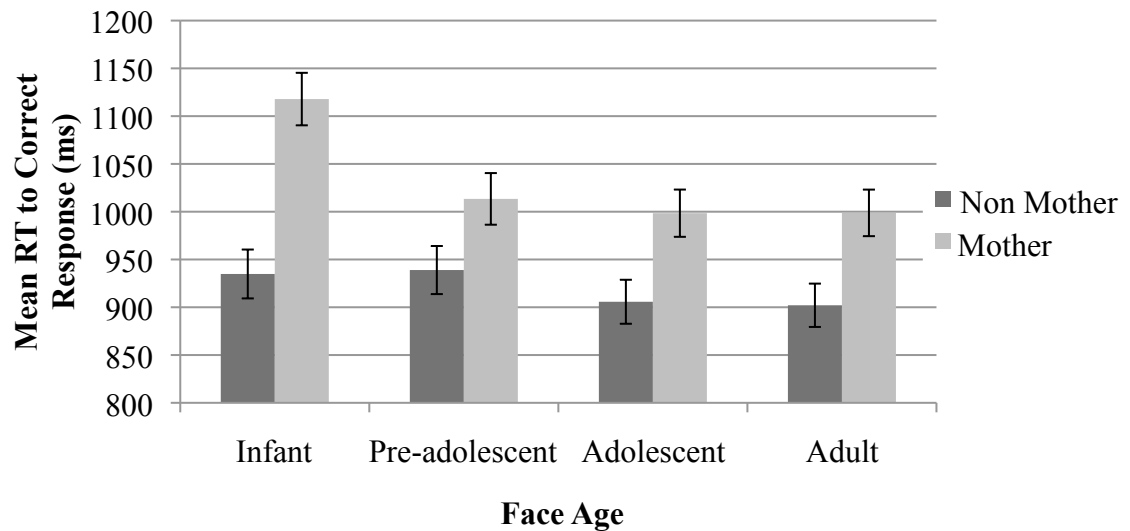


Figure 3.4. Mean RT for non-mothers and mothers as a function of Face Age. Error bars represent standard errors.

In summary, overall RTs were slowed to infant faces as compared to other aged faces (pre-adolescent, adolescent, and adult), particularly in the presence of a sad affect. Responses were slowest when a target infant face displayed a sad facial expression. RTs for target faces of pre-adolescent children were also slower compared to adolescent and adult faces, but only when they displayed sad affect. Finally, women who were parents, as compared to those without children, displayed greatest task interference when processing infant faces.

3.3.3. Errors

Error rates were low (<3.6% of total trials; highest total error rate of any one participant was 14.58%). As errors were rare and non-normally distributed, comparisons reported here use non-parametric statistics and median percent errors are reported. Errors did not differ between face age conditions (3.5% Adult, 2.8% Adolescent, 2.8% Pre-adolescent, 2.8% Infant, $p=.31$), but they did differ between search condition (3.1% neutral, 4.2% emotional non-target, 2.1% emotional target, $p<.01$). Furthermore, mothers and non-mothers did not differ in total error rate (3.5% non-mothers, 2.8% mothers, $p=.50$). For completeness, error rates for all conditions are reported in Table 3.3.

Table 3.3. *Median percent errors for all trial conditions for mothers and non-mothers.*

Face Age	Non-Mother (N=45)						Mother (N=39)					
	Neutral % Error		Sad Non-Target % Error		Sad Target % Error		Neutral % Error		Sad Non-Target % Error		Sad Target % Error	
	Median	Range	Median	Range	Median	Range	Median	Range	Median	Range	Median	Range
Infant	2.08	0-12.50	0	0-25.00	0	0-25.00	2.08	0-20.83	0	0-8.33	0	0-41.67
Pre-adolescent	4.17	0-18.75	0	0-33.33	0	0-41.67	2.08	0-12.50	0	0-16.67	0	0-16.67
Adolescent	4.17	0-35.41	0	0-33.33	0	0-33.33	3.13	0-12.50	0	0-25.00	0	0-25.00
Adult	4.17	0-25.00	4.17	0-33.33	0	0-33.33	2.08	0-16.67	0	0-33.33	0	0-16.67

3.4. Discussion

The current study investigated whether women (first-time mothers of infants and women without children) preferentially attended to cues signalling developmental vulnerability using a visual search task. As predicted, RTs to a target stimulus were slowed in the presence of infant faces compared to faces of adults, adolescents, and pre-adolescent children, with greatest task interference when infants displayed sad affect. Mothers' RTs were particularly slow to infant faces. Slower RTs were also observed in relation to pre-adolescent faces as compared to adolescent and adult faces, but only when the target pre-adolescent face displayed negative affect. Taken together, these results suggest that facial cues that signal vulnerability, such as young developmental age and negative affect, preferentially engage attention.

3.4.1. *Attention to Infant Faces*

The finding that RTs were more slowed in infant face conditions than in other-aged face conditions are in line with previous work showing that infant faces more readily engage our attention compared to adult faces (Brosch et al., 2007, 2008, Pearson et al., 2010, Thompson-Booth et al., 2013 [Chapter 2]) and extend these findings by establishing that such infant faces are more salient even compared to other age children. This is perhaps not surprising given the high degree of vulnerability that characterises the infancy period, during which adult care and nurturance is critical for survival. The unique perceptual configuration of infant faces is thought to signify this vulnerability and need for care, increasing the likelihood of eliciting caretaking responses (Bowlby 1969; Hrdy 2005; Lorez, 1971; Tinbergen, 1951). The findings reported here, consistent with previous behavioural and neuroimaging studies (Nishitani et al., 2011; Proverbio et al., 2006; Thompson-Booth et al., 2013 [Chapter 2]), suggest that parenthood is associated with enhanced allocation of attention to infant faces. It is possible that biological changes associated with becoming a parent may partly account for changes in the way infant cues are processed and prioritized (e.g. Kinsley & Amory-Meyer, 2011; Nishitani et al., 2011; Swain, 2011). Equally, however, experience of infant cues on a daily basis may drive changes in attentional allocation. Future studies of non-mothers with varying degrees of childcare experience,

as well as longitudinal investigation of infant processing in women before, during and after pregnancy would help shed light on this question.

3.4.2. Attention to Pre-adolescent Faces

Children continue to remain relatively dependent on adult care to meet their emotional and physical needs (Belsky, 1984). Unlike infants however, they are able to communicate their needs verbally, without relying entirely on vocal, facial and bodily cues. In light of this, it was hypothesised that faces of preadolescent children would preferentially engage attention compared to adolescent or adult faces, but to a lesser extent than that observed for infant faces. Surprisingly, no statistically significant differences in attentional engagement were observed between pre-adolescent faces and adolescent or adult faces when neutral affect was displayed. This suggests a steep decline in facial saliency between infancy and early childhood, which may parallel the diminishing strength of the “baby schema” as the child ages (Alley, 1981; Lorenz, 1971; Luo et al., 2011; Struhsaker, 1971). However, pre-adolescent child faces displaying sadness were associated with a significant increase in task interference (when the target face) compared to sad adolescent or adult faces. In other words, developmental age and affective state appear to interact to engage attention. It is possible that sad affect in children of this age (as in infancy) signals enhanced vulnerability and need for care, compared to expressions of sad affect in older individuals. Pre-adolescent children are able to do a number of things independently and can verbalise their needs, but still require parental support to regulate emotional distress. By adolescence children in many societies are regarded as mature and capable of self-care and indeed parenting children themselves (Kramer & Lancaster, 2010; Paikoff & Brooks-Gunn, 1991). They tend to have other sources of support, including peers (Helsen, Vollebergh, & Meeus, 2000) and therefore require less parental monitoring. In line with this, our findings suggest that adolescent facial cues are equivalent to those in adult faces in their capacity to elicit attention from adults.

3.4.3. Attention to Emotional Faces of Different Ages as Compared to Neutral Faces

A generic impact of sadness in slowing responses across all ages, compared to responses to neutral faces, was observed. This is in line with the broader attention

literature, which suggests that negative facial affect preferentially engages our attention (e.g. Eastwood et al., 2001; 2003; Vuilleumier, 2005). Unlike anger, which signals potential threat and vulnerability to self, sadness is a powerful social cue that can signal reduced dominance in either males or females (Hareli, Shomrat, & Hess, 2009). However, in both infants and pre-adolescent children where developmental age is likely to indicate reduced status within a hierarchy, sadness may be more relevant in cuing vulnerability than relative dominance. Consistent with this hypothesis, it was observed that sadness in infants represents a particularly powerful cue, enhancing attentional allocation to these stimuli. In the absence of verbal communication, enhanced saliency of infant affect is likely to be adaptive in eliciting protection and nurturance from adults.

3.4.4. Limitations and Future Directions

There are a number of limitations to this study. As only first-time mothers of infants were recruited, it remains possible that parents show altered processing of child cues congruent with their own-age offspring. Future studies with parents of pre-adolescent and adolescent children are needed to investigate this possibility further. Second, as in the previous chapter, information on hormonal status of women in this study was not collected. As previous research has shown that female reproductive hormones can affect sensitivity to differences in infant cuteness (Perrett et al., 2010; Sprengelmeyer et al., 2009), future studies should assess whether or not women are using hormonal contraceptives and their menstrual cycle stage, as this may impact perception and judgements of different-aged faces. Third, this study investigated only women, therefore it is not possible to make inferences about sex differences or to generalise these findings to men (fathers and non-fathers). Studies recruiting both men and women with and without children may help further delineate whether parent and non-parent differences in processing infant faces are specific to motherhood or relate to the experience of parenting more generally.

3.5. Conclusions

The findings reported in this chapter suggest that age and affect are relevant in shaping attentional responses of adult women to infant and child faces. Infant faces are extremely salient, and preferentially engage attention over other-aged faces, particularly when they are expressing negative emotion. Unsurprisingly, women who were parents of infants displayed greatest task interference when processing infant faces. However, pre-adolescent child faces also preferentially engage attentional allocation relative to adolescent and adult faces, but *only* when they expressed negative emotion. By contrast, adolescent faces, whether or not they display negative facial affect, were processed like adult faces. These findings are consistent with the view that an individual's vulnerability is cued by both face age and facial affect during the preadolescent period. These vulnerability cues appear to automatically engage attentional resources, which may reflect an important evolutionary mechanism promoting care-giving responses from adults.

The next chapter reports an extension of this study in a sample of men with and without children, in order to investigate whether infant and emotional child faces elicit similar patterns of preferential attentional processing responses in men as observed in women.

Chapter 4: An investigation of attention to infant, child, and adult emotional faces in fathers and non-fathers

4.1. Chapter Introduction

The findings of the first two empirical chapters have established that women show increased allocation of attention to infant faces as compared to adult, adolescent and pre-adolescent faces, particularly if they are mothers of infants. It has also been demonstrated that attention is particularly captured by emotional infant faces (Chapters 2 and 3) and, to a lesser extent, by emotional pre-adolescent faces (Chapter 3). The aim of the current chapter was to investigate whether infant faces elicit preferential attentional processing in a sample of fathers and men without children, using the paradigm employed in Chapter 3 with mothers and non-mothers.

As previously discussed, the literature in relation to attentional biases to infant faces remains relatively sparse in comparison to the breadth of studies investigating the effects that other emotionally relevant stimuli have on attention. Findings from several behavioural studies now point to the possibility that infant faces are a special class of social stimuli that preferentially capture our attention (Brosch et al, 2007, 2008; Pearson et al., 2010; Thompson-Booth et al., 2013; Chapters 2 & 3 of this thesis). In addition, it appears that there are individual differences in attentional biases to infant faces that pertain to level of psychological distress (Pearson et al., 2010, 2013; Thompson-Booth et al., 2013 [Chapter 2]), or parenting status (Thompson-Booth et al., 2013; Chapters 2 & 3 of this thesis). However, with the exception of the two studies reported in the first two empirical chapters of this thesis, these studies have been conducted with samples of women who are either non-parents or currently pregnant (with current number of children not controlled for). There are no behavioural studies that have compared fathers and non-fathers for attentional biases to infant faces. There are also few studies have compared the responses of mothers and fathers towards infant faces. The current study aimed to investigate whether the preferential allocation of attention towards infant faces observed in women would also be observed in a sample of men, and if so, whether such a pattern would be more pronounced for fathers than for non-fathers. A secondary aim was to compare this sample of men to the sample of women reported in Chapter 3 in order to investigate effects of parenting status and sex.

4.1.1. *Do Infant Faces Engage Attention in Men and Women to a Similar Degree?*

As previously discussed, infant faces are thought to have a unique set of properties that preferentially elicits the attention of adults and prompts them to orient towards the infant and provide care, which is likely to be adaptive as providing care to vulnerable young helps ensure species survival (Darwin, 1872/1904; Glocker et al., 2009; Lorenz, 1943). However, it is unclear whether human beings in general pay particular attention to infant faces, or whether this something seen particularly in women and mothers due to their traditional role in childcare, or because of biological differences. If infant faces are special due to their putatively high biological significance, they might be expected to elicit a phylogenetically based readiness for response preparation in all human adults, as generally seen with signals of threat (Brosch et al., 2007, 2008). However, it might equally be the case that this effect is more pronounced in women, as they arguably have a special biological role in infant care (for example, only females are able to breastfeed and therefore may have developed specific emotional reactions towards infantile cues). A number of studies have shown that women are superior at recognising emotions from facial cues, regardless of childcare experience, although these studies tend to look at explicit emotion recognition and decoding rather than attention to emotion (Babchuk, Hames, & Thompson, 1985; Hall & Matsumoto, 2004; Hampson et al., 2006; Merten, 2005; Rotter & Rotter, 1988; Thayer & Johnsen, 2000; although see Orozco & Ehlers, 1998; Wild, Erb, & Bartels, 2001). For example, Hampson and colleagues (2006) found that women were faster to identify both positive and negative facial expressions than men but were not faster to respond to non-emotional stimuli, suggesting that this sex difference for emotion discrimination was not due to differences in perceptual speed more generally. It has been suggested that a female superiority effect for emotion recognition is due to women's near-universal responsibility for child-rearing, which has evolved to enhance the probability of offspring survival (Babchuck et al., 1985).

For similar reasons, it has often been implicitly assumed that women have a greater interest in infants than men (Harlow, 1971; Money & Tucker, 1975), with some experimental evidence to back up this assumption (Maestripieri & Pelka, 2002). It has also been shown that women have a greater ability to discriminate cuteness cues (according to *Kindchenschema*-type attributes) in infant faces than men (Lobmaier, Sprengelmeyer, Wiffen, & Perrett, 2010; Sprengelmeyer et al., 2009). However,

behavioural studies have failed to find significant gender differences among non-parents in attention capture to infant faces (Brosch et al., 2007) and time spent viewing infant faces (Parsons, Young, Kumari, Stein, & Kringelbach, 2011; although see Hahn, Xiao, Sprengelmeyer, & Perrett, 2013). For example, Brosch and colleagues (2007) found that both men and women showed faster responses in a dot-probe task when the dot replaced infant faces than when it replaced adult faces, indicating that infant faces confer attentional advantage for both men and women. Furthermore, men and women do not appear to differ in their ability to discriminate age or emotion in infant faces (Hildebrandt & Fitzgerald, 1979; Lobmaier et al., 2010). However, when comparing men and women with regards to how they process and respond to infant faces there are stronger grounds to infer sex differences. For example, Glocker and colleagues (2009) found that baby faces induced stronger caretaking motivation in women than men, yet there were no sex differences in how “cute” they rated the baby faces to be (Glocker, Langleben, Ruparel, Loughead, Gur, et al., 2009). In an electrophysiological study, it was found that male and female non-parents both showed larger neural responses to infant faces and to child faces than to adult faces, although the difference in response between infant and adult faces was larger in women than in men, and men did not seem to discriminate between infant and child faces (Proverbio et al., 2011). When locating the source of these neural responses, they identified sex differences in activation of the mesocorticolimbic system, with women showing more activation in these brain regions than men. Overall, the current evidence based on non-parents suggests both men and women pay more attention infant faces than adult faces; however, the tendency toward caregiving motivation may be stronger in women. This could be evolutionarily advantageous, considering that women are typically the primary caregivers in most societies (Eibl-Eibesfeldt, 1989). Equally, however, such differences may be culturally influenced.

4.1.2. Are Infant Cues as Important for Fathers as Mothers?

Any sex differences in attention to, processing of, and response to infant facial cues is further complicated by exposure to parenting experience. Infants depend heavily on the early caregiver-infant relationship (Ainsworth, 1969; Bowlby, 1969/1982), and so it would be reasonable to hypothesize that the special biological function of infant faces to promote nurturance would be particularly strong in parents.

Every day, parents must recognise social cues from their infants in order to identify their needs and respond with appropriate care while regulating their own emotional responses. It seems reasonable to suggest that part of becoming a parent involves a further adaptation in the ability to pay particular attention to infant faces (Pearson et al., 2010; Thompson-Booth et al., 2013 [Chapter 2]), which is likely to even further enhance offspring survival and development (Bowlby, 1982; Eibl-Eibesfeldt, 1989; Hrdy, 2005; Konner, 2010). While evidence now suggests that mothers show a greater degree of attentional allocation to infant faces over other-aged faces (Pearson et al., 2010; Thompson-Booth et al., 2013 [Chapter 2]; Chapter 3), it remains unclear what we should expect for fathers. Although women in general may be thought of as “primed” to provide child care, men with children actually *are* providing child care, and so attention towards infant facial cues are likely to be important to fathers.

Father-infant relationships are far less well researched than mother-infant relationships (Cowan, 1997), probably because it was initially believed that infants only directed attachment behaviours towards the primary caregiver, which was typically the mother (Ainsworth, 1969; Bowlby, 1958, 1982). Yet there is now a general consensus that infants equally form attachments with fathers (Bretherton, 2010; Lamb, Hwang, Frodi, & Frodi, 1982; Lamb, 1977a, 1977b, 2010; Main & Weston, 1981; Schaffer & Emerson, 1964) and that paternal responses to infant cues are important for this relationship and as well as for later child outcomes.

The literature is mixed with regards to whether infant-father relationships are similar or different to mother-infant relationships, and whether these two relationship types have differential consequences for the child. Although fathers typically spend less time with young infants than do mothers (Bailey, 1994), studies also show that mothers and fathers show similar levels of sensitivity towards and mutual engagement with their infants (Braungart-Rieker, Courtney, & Garwood, 1999; Braungart-Rieker, Garwood, Powers, & Notaro, 1998; Goossens & Van IJzendoorn, 1990). It has also been shown that paternal sensitive behaviour is linked to infant-father attachment, albeit that the strength of this association is less than that between maternal sensitivity and mother-infant relationships (Van IJzendoorn & De Wolff, 1997), and that father–infant attachment relationships predict positive developmental outcomes (e.g. Easterbrooks & Goldberg, 1984; Lamb, 2010). In terms of newborn infants, studies have shown that fathers interact with newborn infants much like mothers do, providing warmth and security (Christensson, 1996; Rödhölm & Larsson, 1982). Furthermore,

like mothers, fathers are able to quickly learn about the uniqueness of their own children, although the evidence suggests that mothers soon become more perceptive (Bader & Phillips, 1999; Kaitz, Chriki, Bear-scharf, Nir, & Eidelman, 2000; Marsha Kaitz, Shiri, Danziger, Hershko, & Eidelman, 1994).

However, other studies show that there may be differences between mothers and fathers in terms of the antecedents of secure relationships, their interactive styles, and child outcomes (Braungart-Rieker, Garwood, Powers, & Wang, 2001; Grossmann, Grossmann, Huber, & Wartner, 1981; Grossmann et al., 2002; Lamb, 1978; Lewis & Lamb, 2003; Lundy, 2002; Main & Weston, 1981). For example, it has been reported that new mothers are able to soothe their newborns more effectively than new fathers (Kaitz et al., 2000). It has been shown that fathers use more tactile stimulation and physical play, whereas mothers engage in more social play with infants (Clarke-Stewart, 1978; Parke & Tinsley, 1987), and also that fathers may have more of a role in play than in basic care-giving tasks (Bailey, 1994; Belsky, 1979; Clarke-Stewart, 1978; Grossmann et al., 2002; Lamb, 1977a, 1977b), a finding which appears to exist across many cultures (Lewis & Lamb, 2003) and exists even when men believe that parents should share child-care responsibilities (Hyde & Texidor, 1988). However, Clarke-Stewart (1978) found that fathers' play elicited more positive responses from infants and Belsky (1979) found that infants responded more positively to being held by fathers than by mothers, probably because mothers picked them up for caregiving, whereas fathers picked them up to play. On the other hand, babies tend to prefer their mothers in more stressful situations (Lamb, 1977a, 1977b). Although some investigations have found associations between paternal sensitivity and attachment quality (Cox, Owen, Kay, & Margand, 1992; Van IJzendoorn & De Wolff, 1997), other studies have not (e.g. Braungart-Rieker et al., 2001; Notaro & Volling, 1999; Rosen & Burke, 1999). Child-father attachment itself appears less predictive for social-emotional outcomes than the quality of child-mother attachment (Aviezer, Sagi, Resnick, & Gini, 2002; Steele, Steele, Croft, & Fonagy, 1999). However, paternal sensitivity has been shown to be a better predictor of children's long-term attachment representation than early infant-father attachment security (Grossmann et al., 2002).

Another consideration concerning the difference between mothers and fathers relates to the neuro-hormonal changes known to occur during pregnancy and childbirth, which prepare the mother for the expression of adequate caregiving (e.g. Brunton & Russell, 2008; Kinsley & Amory-Meyer, 2011; Swain, 2011). However,

research has shown that new fathers also show similar changes in hormonal levels to mothers (decreased levels of testosterone and estradiol and increased levels of prolactin and cortisol) around the birth of their infants (Storey, Walsh, Quinton, & Wynne-Edwards, 2000; Storey & Walsh, 2012). Other studies show that neuroendocrine responses (such as plasma and salivary OT) are similar when mothers and fathers interact with their children (Feldman, Gordon, Schneiderman, Weisman, & Zagoory-Sharon, 2010; Gordon, Zagoory-Sharon, Leckman, & Feldman, 2010). So while from an evolutionary perspective, the maternal and paternal roles are distinct, they may share a number of underlying physiological mechanisms (Storey & Walsh, 2012).

Overall, the current literature demonstrates both similarities and differences between mothers and fathers in terms of the parenting of their child. There is some evidence that mothers and fathers provide different kinds of experiences for their infants, and that infants develop different expectations and learn different behaviour patterns from each parent. It is possible that these two relationships have differential consequences for children's socio-emotional development. Yet, that mothers and fathers have different propensities for aspects of parenting does not preclude the possibility that common attentional biases underpin infant face processing and subsequent parental responses. Such a proposition would also be consistent with the absence of sex difference in processing infant faces in non-parents (Brosch et al., 2007; Parsons et al., 2011). Automatic attentional allocation is a basic cognitive process that occurs at early stages of processing (Vuilleumier, 2005). Therefore, it is possible that preferentially attending to infant faces is a mechanism likely to characterise parenting response more generally, even if there are differences in subsequent behavioural patterns between mothers and fathers. This would be consistent with a common enhanced sensitivity to infant cues in parents as compared to non-parents.

4.1.3. Teasing Apart Parenting and Sex Effects on Processing Infant Faces

Few studies have recruited both men and women with and without children in order to try to tease apart parenting and sex differences in infant face processing. One study examined the ability of men and women differing in their experience with infants to interpret infant facial expressions. Women were found to show a significantly higher level of accuracy compared to men, and that expertise positively affected facial

expressions decoding only among women (Proverbio, Matarazzo, Brignone, Zotto, & Zani, 2007). This would suggest that sex has a bigger role in perception of infant emotion than expertise. However, the “experts” in this sample were not necessarily parents, but rather those who had any kind of regular experience with infants (including being a parent to one or several children, having a young child in the family, or working with children), as compared to those with no experience. The age range of this sample was also extremely large (from 21-65 years old), with “expert” participants being older on average than “non-experts”, introducing age as a salient confound.

Another study from the same research group used electrophysiological techniques to look at the influence of sex and parental status on the brain potentials elicited by viewing infant facial expressions (Proverbio et al., 2006). Event-Related Potentials (ERPs) were recorded in male and female parents and non-parents during processing of unfamiliar infant facial expressions that varied in valence and intensity. They found differences in early visual processing between mothers and non-mothers and between women and men (regardless of parental status), with women (especially mothers) showing larger neural responses, suggestive of more efficient visual processing for infant facial expressions. They also found that while non-parents tended to respond similarly to expressions of intense distress and mild discomfort, parents (especially mothers) showed greater sensitivity to very sad infant faces. This sensitivity, which was demonstrated as early as 170ms after viewing facial expressions of pain, may be related to neural mechanisms supporting protectiveness and empathy (Carr, Iacoboni, Dubeau, Mazziotta, & Lenzi, 2003). However, the behavioural data reported in this study indicated that women did not show an enhanced ability than men to discriminate neonatal facial expressions. Another study, this time using fMRI, found effects of both sex and parental status on differences in brain activation among men and women when listening to familiar and unfamiliar infants crying and laughing (Seifritz et al., 2003). Infant cries evoked stronger activation in the amygdala and interconnected limbic regions in parents versus non-parents. However, women but not men (irrespective of parental status) showed a deactivation in the anterior cingulate cortex in response to both infant crying and laughing. This gender effect was interpreted as a reflection of women’s preference for certain sensory stimuli, in this case infant vocalizations. On the other hand, the parental status effect was interpreted as an indication of neuroplastic changes in the brain as a result of parenting experience, likely to subserve the biological need for parental care.

4.1.4. The Current Study

The aim of the current study was to investigate whether men with and without children show attentional preferences to infant faces over other-aged faces, as indexed by slower response times to a primary search task in the presence of infant faces as compared to other-aged face conditions. Although the literature regarding attentional processing of emotionally relevant stimuli is mixed, there is some evidence to suggest that infant faces capture attention relative to adult faces in both men and women (Brosch et al., 2007). Therefore, it was hypothesised that, similar to the pattern of responses shown by women in Chapters 2 and 3, men would respond slowest when processing infant faces. Since parental status is associated with biological changes in men and women as well as increased exposure to infant cues, it was hypothesised that men with children should show slower responses to infant faces compared to adult faces, than men without children, as seen in mothers compared to non-mothers. It was also hypothesized that emotional faces would elicit greater attentional processing compared to neutral faces and (on the basis of findings from Chapter 3) that emotional pre-adolescent faces would elicit greater attentional processing compared to adolescent and adult faces.

A final aim was to then compare the sample of men in this chapter with the responses from the sample of women reported in Chapter 3, in order to explore parenting and sex effects by directly comparing mothers, fathers, and women and men without children. No differences were hypothesised in relation to attentional processing.

4.2. Method

4.2.1. Participants

Sixty-two men, 27 first-time fathers and 35 non-fathers, were recruited for the study from the UCL Subject pool and local communities in London and Essex. Five non-fathers were removed from analyses due to having a high error rate across all trials in the task (>30%). This left a final sample of 27 fathers and 30 non-fathers. All participants classified their ethnicity as Caucasian, reported normal or corrected-to-normal vision and were right handed. All of the fathers were first-time fathers of

infants (44.4% female infant) aged between 2 - 38 months (mean age 18.07 months, $SD=11.19$), whose partner had a singleton pregnancy, and who still lived at home with their child, although none of the fathers reported being stay-at-home fathers. All of the non-parents reported some experience of caring for young children (answering yes to either of the questions “I have cared for friends’ children” or “I have cared for younger family members”), but none reported working with children on a daily basis or having any non-biological step-children. More information on participant demographics can be found in Table 4.1.

4.2.2. Questionnaire Measures

4.2.2.1. Assessment of general ability

The two-subtest form of the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) was used to produce an estimate of general cognitive ability. This includes assessment of vocabulary and matrix reasoning and provides an estimate of Full Scale IQ Scores (FSIQ).

4.2.3. Stimuli and Procedure

The experimental task and conditions did not differ from those described in Chapter 3.

Table 4.1. *Participant demographics.*

	Non-Fathers (N=30)		Fathers (N=27)		<i>p</i>
	Mean (SD)	Range	Mean (SD)	Range	
Age	28.47 (4.97)	23 - 42	30.92 (4.72)	23 - 40	.07
WASI 2-subtest estimated FSIQ [§]	114.00 (7.03)	100 - 130	115.75 (7.44)	104 - 127	.41
Years in Education	17.07 (1.82)	14 - 21	16.52 (3.00)	12 - 26	.40
Household Income	<i>n</i>	%	<i>n</i>	%	
£0 - £15,000	7	23.3	0	0	.01
£15,000 - £30,000	13	43.3	5	18.5	
£30,000 - £50, 000	5	16.7	11	40.7	
£50,000 +	5	16.7	11	40.7	

§ WASI data available for 24 fathers and 25 non-fathers

4.3. Results

4.3.1. Descriptive Analysis

Correlation analyses (Pearson and Spearman correlation coefficients) were performed to assess whether participant age, IQ, and years in education were associated with task performance. There was no statistically significant correlations between any of these demographic variables and total RTs for either non-fathers (all $r < .17$, all $p > .36$) or fathers (all $r < .14$, all $p > .51$).

As there was a significant difference between fathers and non-fathers in household income, a one-way ANOVA was conducted with total RT as the dependent variable and income category as the independent variable; there was no significant effect of income on RTs ($F(3, 53) = .78, p = .51$).

4.3.2. Reaction Times

Anticipatory (<150 ms) responses (.03%) and incorrect responses (2.83% of total trials) were excluded from the reaction time (RT) analysis. Outliers (2.5 SDs from mean) were calculated for each participant's range of RTs and removed from analysis (2.52% of total trials), and mean correct RTs for each experimental condition were then calculated for analysis. Means and standard errors of reaction times are presented in Table 4.2.

A 4 (Face Age: infant, preadolescent, adolescent, adult) x 3 (Search condition: Emotional target, emotional non-target, and all neutral) repeated-measures ANOVA was conducted on the RT data, with parent status (father or non-father) entered as a between-subjects variable. Effect sizes are reported as partial eta squared (η_p^2), post-hoc power calculations are reported for main effects and interactions (observed power), and 95% confidence intervals are reported for post-hoc comparisons.

A main effect of Face Age was observed ($F(3, 165) = 10.30, p < .001, \eta_p^2 = .16$, observed power = .99). Pairwise comparisons with Bonferroni correction applied revealed that RTs were slower for infant face conditions than for adult face conditions (mean difference = 68.37 ms, $p < .001$, 95% CI [28.20-108.53]), slower for infant face conditions than for adolescent face conditions (mean difference = 62.34 ms, $p < .001$, 95% CI [25.28-99.39]), and slower for infant face conditions than for pre-adolescent face conditions (mean difference = 52.12 ms, $p < .01$, 95% CI [9.72-94.53]). There were

no differences in RTs between adult and adolescent face conditions (mean difference = 6.03, $p=1.0$, 95% CI [-22.18-34.24]), or between adult and pre-adolescent face conditions (mean difference = 16.25, $p=1.0$, 95% CI [-22.56-54.05]). Finally, there were no differences in RTs between adolescent and pre-adolescent face conditions (mean difference = 10.22, $p=1.0$, 95% CI [-28.33-48.76]).

There was a main effect of Search condition ($F(2, 110)=6.27$, $p<.01$, $\eta_p^2=.10$, observed power=.89). Post-hoc pairwise comparisons (Bonferroni corrected) indicated that participants' RTs were slower in emotional target conditions than in neutral conditions (mean difference=21.49 ms, $p<.01$, , 95% CI [6.18-36.80]). There were no statistically significant differences in RTs in emotional non-target conditions as compared to emotional target conditions (mean difference=13.11, $p=.184$, , 95% CI [-3.83-30.05]) or neutral conditions (mean difference=8.38, $p=.332$, 95% CI [-4.38-21.14]).

There was also a Face Age by Search condition interaction (Greenhouse-Geisser corrected $F(4.9, 269.5)=4.27$, $p<.001$, $\eta_p^2=.07$, observed power=.98; see Figure 4.1). This indicates that the Search condition (i.e. whether a task-irrelevant emotion was present or not) affected RTs differently for differently aged stimuli. Post-hoc comparisons with Bonferroni corrections revealed that for neutral conditions, RTs were slower to infant faces than to adult (mean difference=58.34 ms, $p<.001$, 95% CI [21.26-95.43]), adolescent (mean difference=45.05 ms, $p<.05$, 95% CI [5.12-84.98]), and pre-adolescent (mean difference=45.58 ms, $p<.01$, 95% CI [9.33-81.83]). For emotional non-target conditions, the difference in RTs between infant stimuli and adult stimuli conditions was not statistically significant (mean difference=40.97 ms, $p=.10$, 95% CI [-7.96-89.90]), nor was the difference between RTs in infant stimuli and pre-adolescent stimuli conditions (mean difference=38.96 ms, $p=.26$, 95% CI [-12.63-90.55]). However, RTs were slower to infant stimuli than adolescent stimuli (mean difference=52.28 ms, $p<.01$, 95% CI [9.31-95.25]). For emotional target conditions, RTs were slower to infant faces than to adult faces (mean difference=105.78 ms, $p<.001$, 95% CI [53.51-158.06]), adolescent faces (mean difference=89.68 ms, $p<.001$, 95% CI [44.04-135.33]), and pre-adolescent faces (mean difference=71.82 ms, $p<.01$, 95% CI [19.46-124.17]). However, there was no statistically significant difference between RTs to pre-adolescent faces and adult faces (mean difference=33.96, $p=.393$, 95% CI [-15.49-83.42]). No other comparisons were statistically significant.

Table 4.2. *Descriptive statistics for RTs (ms) for all trial conditions for fathers and non-fathers.*

Face Age	Non-Father (N=30)						Father (N=27)					
	Neutral Search		Sad Non-Target		Sad Target Search		Neutral Search		Sad Non-Target		Sad Target Search	
	Condition		Search Condition		Condition		Condition		Search Condition		Condition	
	Mean	<i>SD</i>	Mean	<i>SD</i>	Mean	<i>SD</i>	Mean	<i>SD</i>	Mean	<i>SD</i>	Mean	<i>SD</i>
Infant	898.47	173.64	901.58	188.52	929.06	204.20	988.30	161.41	993.57	178.79	1059.83	212.03
Pre-adolescent	869.88	158.60	892.69	193.37	876.66	163.33	925.72	190.68	924.54	206.84	968.60	220.90
Adolescent	877.09	157.38	870.30	159.70	880.46	147.82	919.58	180.41	920.29	203.39	929.07	165.64
Adult	872.02	162.55	890.65	169.93	875.08	165.72	898.06	164.77	922.56	184.38	902.25	142.24

There was no main effect of Parent Status ($F(1,55)=1.99, p=.16$, observed power=.28), but there was an interaction between Face Age and Parent Status ($F(3, 165) = 2.75, p<.05, \eta_p^2=.05$, observed power=.66). This indicates that the RTs in the presence of the differently aged face stimuli differed for parents and non-parents. To investigate this interaction, ANOVAs were performed separately for fathers and non-fathers on RT data. For non-fathers, there were no statistically significant differences in RTs between the different face age conditions ($F(3,87)=1.60, p=.20$, observed power=.41). For fathers, RTs to correct response were slower in infant face conditions than in pre-adolescent (mean difference = 74.28 ms, $p<.05$, 95% CI [.23-148.79]), adolescent (mean difference = 90.92 ms, $p<.001$, 95% CI [39.37-142.48]), and adult face conditions (mean difference = 106.28 ms, $p<.001$, 95% CI [38.82-173.74]). This pattern of results suggests that the effect of slowed RTs to infant face conditions only existed for fathers (see Figure 4.2).

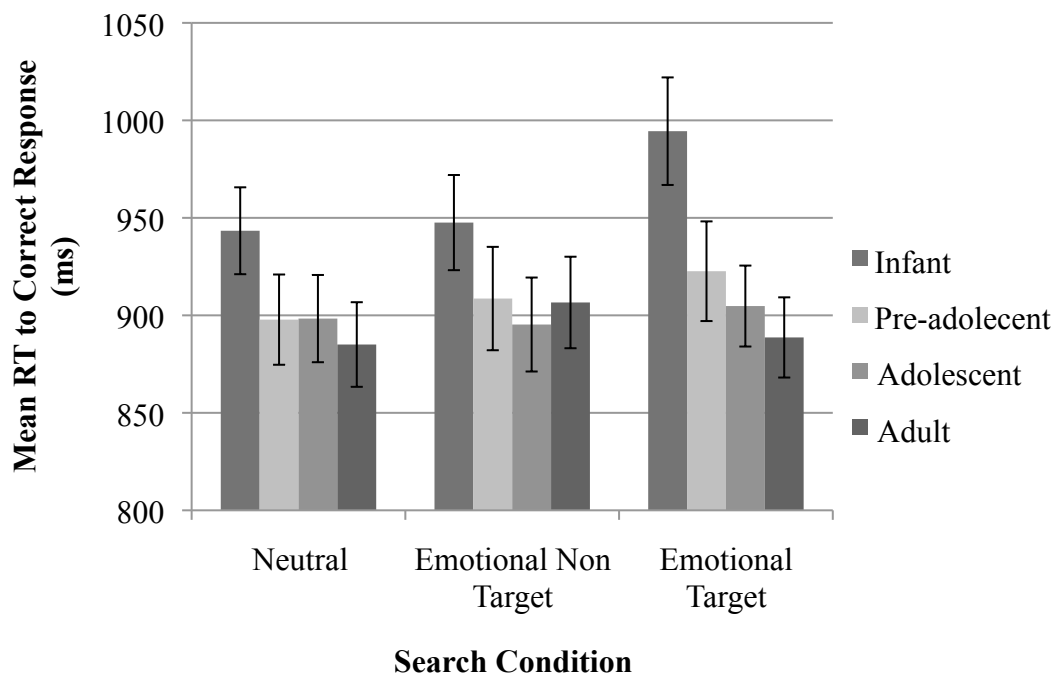


Figure 4.1. Mean RT to correct response for each experimental condition as a function of Face Age. Error bars represent standard errors.

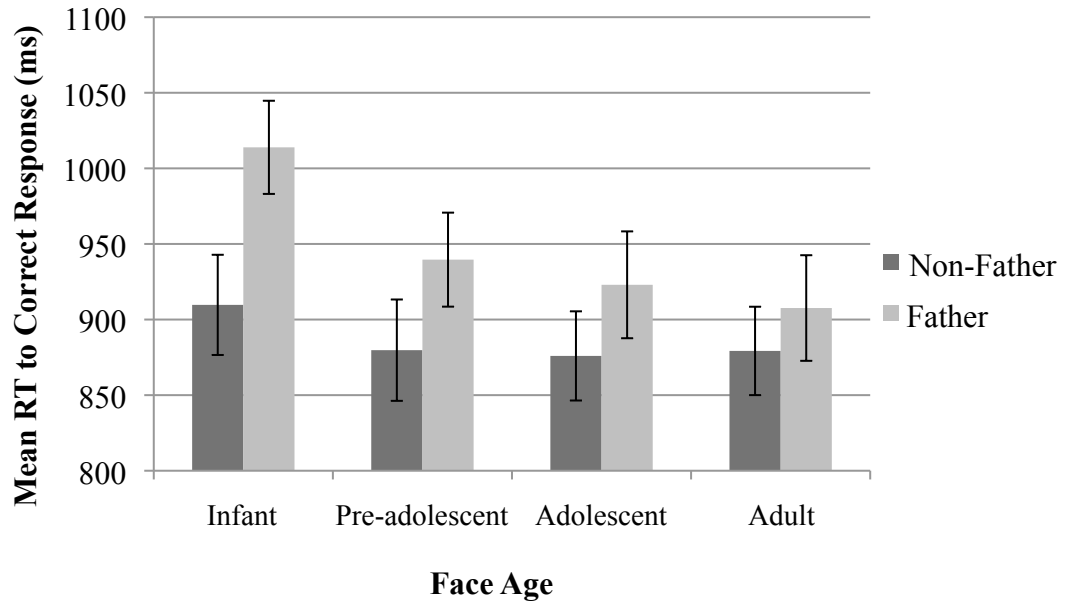


Figure 4.2. Mean RT to correct response for non-fathers and fathers as a function of Face Age. Error bars represent standard errors.

There was no interaction between Parent Status and Search condition ($F(2, 110) = 2.20, p = .116$, observed power = .44) and no three-way interaction between Face Age, Search condition and Parent Status (Greenhouse-Geisser corrected $F(4.9, 269.5) = 1.34, p = .24$, observed power = .47).

In summary, overall RTs were slowed to infant faces as compared to other aged faces (pre-adolescent, adolescent, and adult), although this effect was only observed for fathers. However, across both fathers and non-fathers, RTs to infant faces were generally slower as compared to other-aged faces in emotional target conditions.

4.3.3. Comparison of Mothers, Fathers, and Non-parents

Next, task performance of this male sample was compared with the female sample of mothers and non-mothers reported in Chapter 3. A 4 (Face Age: Infant, pre-adolescent, adolescent, adult) \times 3 (Search condition: Emotional target, emotional non-target, and all neutral) repeated-measures ANOVA was conducted on the RT data, with parent status (parent or non-parent) and sex (male or female) entered as between-subjects variables. Effect sizes are reported as partial eta squared (η_p^2), post-hoc power

calculations are reported for main effects and interactions (observed power), and 95% confidence intervals are reported for post-hoc comparisons.

As before, a main effect of Face Age was observed (Greenhouse-Geisser corrected $F(2.7, 378.8) = 21.60, p < .001, \eta_p^2 = .14$, observed power = 1.00). Pairwise comparisons with Bonferroni correction applied revealed that RTs were slower for infant face conditions than for adult face conditions (mean difference = 72.17 ms; $p < .001$, 95% CI [47.41-96.94]), slower for infant face conditions than for adolescent face conditions (mean difference = 68.77 ms; $p < .001$, 95% CI [40.33-97.22]), and slower for infant face conditions than for pre-adolescent face conditions (mean difference = 51.65 ms; $p < .001$, 95% CI [19.80-83.49]). There were no differences in RTs between adult and adolescent face conditions (mean difference = 3.40, $p = 1.0$, 95% CI [-19.53-26.33]), or between adult and pre-adolescent child conditions (mean difference = 20.53, $p = .24$, 95% CI [-6.03-47.08]). Finally, there were no differences in RTs between adolescent and pre-adolescent face conditions (mean difference = 17.12, $p = .59$, 95% CI [-10.35-44.60]).

There was a main effect of Search condition ($F(2, 276) = 29.83, p < .001, \eta_p^2 = .18$, observed power = 1.00). Post-hoc pairwise comparisons (Bonferroni corrected) indicated that participants' RTs to correct responses were slower in emotional non-target conditions than in neutral conditions (mean difference = 14.04, $p < .01$, 95% CI [4.63-23.46]), and slower in emotional target conditions than in neutral conditions (mean difference = 32.03, $p < .001$, 95% CI [21.36-42.71]). Finally, RTs to correct responses were slower in emotional target conditions than in emotional non-target conditions (mean difference = 17.99, $p < .001$, 95% CI [7.88-28.10]).

There was also a Face Age by Search condition interaction (Greenhouse-Geisser corrected $F(5.5, 756.0) = 6.57, p < .001, \eta_p^2 = .05$, observed power = 1.00). This indicates that the Search condition (i.e. whether a task-irrelevant emotion was present or not) affected RTs to correct responses differently for differently aged stimuli. Post-hoc comparisons with Bonferroni corrections revealed that for neutral conditions, RTs were slower to infant faces than to adult (mean difference = 66.48, $p < .001$, 95% CI [40.06-92.90]), adolescent (mean difference = 54.74, $p < .001$, 95% CI [21.34-88.13]), and pre-adolescent faces (mean difference = 51.97, $p < .001$, 95% CI [20.85-83.10]). For emotional non-target conditions, RTs were slower to infant faces than adult faces (mean difference = 48.65, $p < .001$, 95% CI [19.47-77.83]), adolescent faces (mean difference = 55.27, $p < .001$, 95% CI [24.44-86.10]), and pre-adolescent faces (mean

difference=41.12, $p<.05$, 95% CI [6.13-76.12]). For emotional target conditions, RTs were slower to infant faces than to adult (mean difference=101.38, $p<.001$, 95% CI [68.96-133.81]), adolescent faces (mean difference=96.31, $p<.001$, 95% CI [64.52-128.10]), and pre-adolescent faces (mean difference=61.84, $p<.001$, 95% CI [22.51-101.18]). Furthermore, RTs were slowed to pre-adolescent faces as compared to adolescent faces (mean difference=34.47, $p<.05$, 95% CI [.87-68.06]), and adult faces (mean difference=39.54, $p<.05$, 95% CI [6.66-72.42]).

There was a main effect of Parent Status ($F(1, 138) = 11.34$, $p<.001$, $\eta_p^2=.08$, observed power=.92), such that parents had longer RTs to correct responses overall compared to non-parents (mean difference = 85.92). There was also an interaction between Face Age and Parent Status (Greenhouse-Geisser corrected $F(2.7, 378.8) = 7.16$, $p<.001$, $\eta_p^2=.05$, observed power=.97). This indicates that the RTs to correct response in the presence of the differently aged face stimuli differed for parents and non-parents. To investigate this interaction, ANOVAs were performed separately for non-parents and parents on RT data. For non-parents, RTs to correct response were slower in infant face conditions than in adult conditions (mean difference = 31.91 ms, $p<.05$, 95% CI [5.24-58.57]), and there was a non-significant trend for RTs to be slower in infant than in adolescent conditions (mean difference = 32.07 ms, $p=.07$, 95% CI [-1.61-65.75]); no other comparisons were significant. For parents, RTs to correct response were slower in infant face conditions than in pre-adolescent (mean difference = 92.12, $p<.001$, 95% CI [38.52-145.73]), adolescent (mean difference = 107.77, $p<.001$, 95% CI [61.31-154.23]), and adult face conditions (mean difference = 113.86, $p<.001$, 95% CI [71.15-156.56]), showing that the effect of slowed RTs to infant face conditions is particularly pronounced for parents (see Figure 4.3).

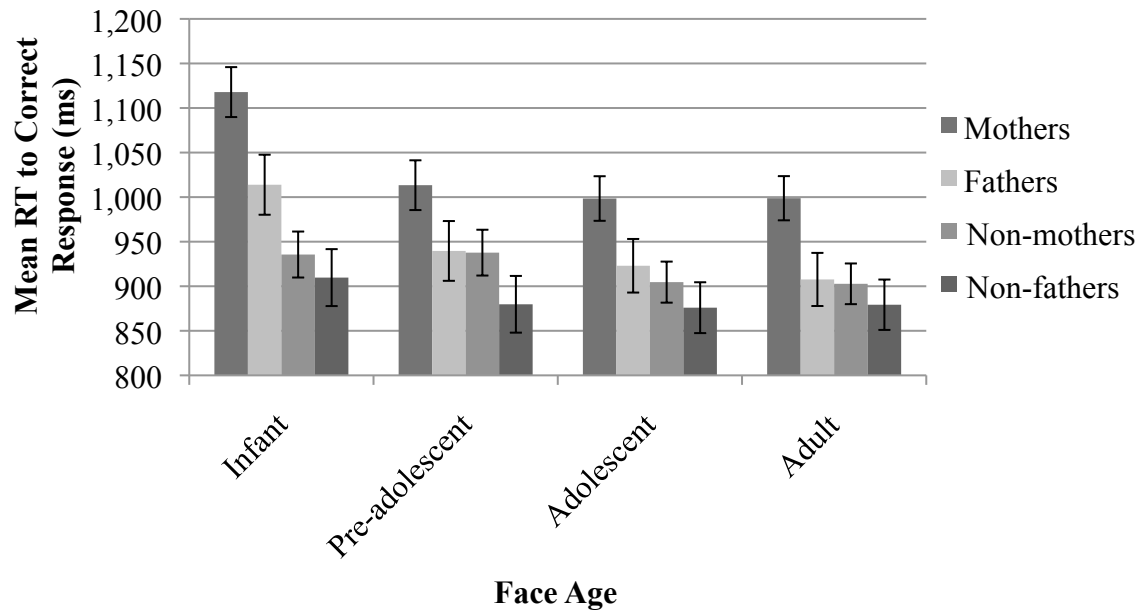


Figure 4.3. Mean RT to correct response for mothers, fathers, non-mothers and non-fathers as a function of Face Age. Error bars represent standard errors.

There was a main effect of Sex ($F(1, 138) = 5.54, p < .05, \eta_p^2 = .04$, observed power = .65), such that women had longer RTs to correct response than men (mean difference = 60.04 ms). However, there was no interaction between Sex and Face Age ($p = .88$, observed power = .09), or between Sex and Parent Status ($p = .31$, observed power = .17), and there was no three-way interaction between Face Age, Parental Status and Sex ($p = .43$, observed power = .24).

There was a non-significant trend for an interaction between Search condition and Parent Status ($p = .07$, observed power = .53), and there was an interaction of Search condition and Sex ($F(2, 276) = 3.22, p < .05, \eta_p^2 = .02$, observed power = .61). Post-hoc comparisons with Bonferroni correction applied revealed that for males there was no effect of slowed RTs in sad non-target conditions as compared to neutral conditions (mean difference = 8.44, $p = .31$, 95% CI [-4.19-21.07]). There was an effect of slowed RTs in sad target conditions as compared to neutral conditions (mean difference = 20.93, $p < .01$, 95% CI [5.40-36.47]), but not as compared to emotional non-target conditions (mean difference = 12.50, $p = .23$, 95% CI [-4.69-29.68]). However, for female participants there was an effect of slowed RTs in sad non-target conditions as compared to neutral conditions (mean difference = 19.42, $p < .001$, 95% CI [6.48-32.36]). Female participant RTs were also slowed to sad target conditions as compared to

neutral (mean difference=41.98, $p<.001$, 95% CI [27.58-56.38]) and sad non-target conditions (mean difference=22.56, $p<.001$, 95% CI [10.29-34.83]). There was no three way interaction between Search condition, Parent Status and Sex ($p=.64$, observed power=.12).

There was no three-way interaction between Face Age, Condition and Parent Status ($p=.18$, observed power=.59), or between Face Age, Condition and Sex ($p=.50$, observed power=.36), and no four-way interaction between Face Age, Search condition, Parent Status and Sex ($p=.77$, observed power=.23).

4.3.4. *Errors*

Error rates were very low (2.83% of total trials for dads and non-dads, and 3.58% of total trials for mums and non-mums; 3.28% of total trials for all four groups). As errors were rare and non-normally distributed, comparisons reported here use non-parametric statistics and median percent errors are reported. There were no differences in overall error rates between fathers (2.8%), non-fathers (3.1%), mothers (2.8%), and non-mothers (3.5%; $p=.29$).

Error rates for mothers and non-mothers are reported in the previous chapter. For fathers and non-fathers, there was a non-significant trend for error rates to differ between different face age conditions (2.8% infant, 2.8% preadolescent, 1.4% adolescent, 3.4% adult, $p=.07$). Error rates did not differ between search condition (2.6% neutral, 2.1% emotional non-target, 2.1% emotional target, $p=.25$). For completeness, error rates for all task conditions are shown in Table 4.3.

Table 4.3. *Median percent error for all trial conditions for fathers and non-fathers.*

Face Age	Non-Father (N=30)						Father (N=27)					
	Neutral % Error		Sad Non-Target % Error		Sad Target % Error		Neutral % Error		Sad Non-Target % Error		Sad Target % Error	
	Median	Range	Median	Range	Median	Range	Median	Range	Median	Range	Median	Range
Infant	2.08	0-14.58	0	0-16.67	0	0-16.67	2.08	0-6.25	0	0-25.00	0	0-25.00
Pre-adolescent	2.08	0-14.58	0	0-25.00	0	0-8.33	2.08	0-10.42	0	0-16.67	0	0-16.67
Adolescent	2.08	0-8.33	0	0-8.33	0	0-8.33	2.08	0-6.25	0	0-16.67	0	0-16.67
Adult	2.08	0-10.42	0	0-8.33	0	0-16.67	4.17	0-8.33	0	0-16.67	0	0-8.33

4.4. Discussion

This chapter has described two sets of analyses that attempt to investigate whether fathers, like mothers, show increased attentional allocation to infant faces as compared to other-aged faces, using a visual search task. In the first set of analyses comparing fathers with non-fathers, it was found that in fathers response times were slower for infant faces as compared to adult, adolescent and child faces. Furthermore, men regardless of parental status showed slower response times when a sad facial expression was present on the target face, particularly when the target face was a sad infant. In the second set of analyses comparing fathers and non-fathers with mothers and non-mothers it was found that mothers and fathers did not differ in their attentional allocation to infant faces as compared to other aged faces. Specifically, an interaction between face age and parenting status was observed, but there was no interaction between face age and sex or between face age, sex and parenting status. Across the four groups, all participants, regardless of parenting status, showed slower response times in the presence of a sad infant target face, as well as slower response times in the presence of a sad child target face as compared to adult and adolescent faces. Finally, there was an interaction between search condition and sex, such that women showed slower response times when emotion was present on either a non-target face or a target face, while men only showed slower response times only when emotion was present on a target face.

4.4.1. *Attention to Infant Faces in Fathers and Non-Fathers*

These findings indicate that fathers of infants show slower responses in a visual search task in the presence of infant faces as compared to all other-aged faces, indicative of increased attentional allocation to infant faces, as compared to non-fathers. This is consistent with previous research findings in mothers, which show that mothers show heightened attentional allocation to infant than to older faces as compared to non-mothers (Thompson-Booth et al., 2013 [Chapter 2]; Chapter 3). However, while there was a trend in the expected direction for non-fathers to respond slower to infant faces than older faces, the differences in response times were not statistically significant. Although a previous study suggested that male college students show similar attentional biases to infant faces as female college students, this study did

not explicitly state whether all of the participants were childless (Brosch et al., 2007). Furthermore, it may be that differences in task demands between the task reported in the current study and that reported by Brosch and colleagues accounts for these somewhat discrepant findings. It should also be noted that while non-fathers did not show significantly slower responses to infant faces generally, they did show slower responses in the presence of emotion on an infant target face, as observed in fathers, mothers, and female non-parents. This suggests that the presence of infant distress may have marked the target face as more salient and thus increased attentional engagement for non-fathers, whereas neutral infant faces did signal a similar degree of salience. However, men with children do appear to show more general increased attentional engagement with infant faces, which may reflect their greater experience with viewing and discriminating infant facial cues, or perhaps greater empathic responding or motivation to view infant faces in fathers (Swain et al., 2011). This finding, along with the findings reported in Chapters 2 and 3, suggests that increased attentional engagement with infant faces as compared to faces from other age groups may reflect a common mechanism in mothers and fathers promoting parental responding.

4.4.2. Attention to Infant Faces in Fathers as Compared to Mothers

The second set of analysis reported in this study compared responses to infant faces as a function of parental status and sex. It was found that attentional engagement with infant faces did not differ between mothers and fathers, but that both groups of parents showed increased attentional engagement with infant faces as compared to non-parents. This finding is consistent with electrophysiological and neuroimaging work that has found that fathers and mothers both show larger neural responses to infant faces as compared to non-parents, and that both fathers and mothers show activation in brain circuits involved with reward processing when viewing infant faces or hearing infant cries (Proverbio et al., 2006; Seifritz et al., 2003; Swain et al., 2011). These activations may reflect adaptive changes in the brain as a result of becoming a parent that may be necessary for providing adequate parental care and sufficient parent-infant bonding (Seifritz et al., 2003). However, it has also been reported that there might be subtle differences in neural responding when viewing infant faces between fathers and mothers, with mothers showing greater neural responses to infant expressions of suffering as compared to fathers, although fathers still showed more

activation than non-parents (Proverbio et al., 2006). This was interpreted by Proverbio and colleagues as increased empathy for infant distress in mothers than fathers. Similarly, one recent study found that mother and fathers showed activation in similar brain areas associated with social-cognitive processing when viewing their own infants' faces as compared to unknown infants; however, mothers showed greater activation in limbic areas of the brain, whereas fathers showed greater activation in social-cognitive cortical areas (Atzil et al., 2012). Atzil and colleagues suggested that mothers and fathers appeared to show similar levels of intuitive understanding of infant signals and planning of appropriate caregiving, but that activation of motivational limbic regions might be enhanced for mothers. This interpretation would be in line with studies that suggest that while men and women do not differ in their attention to infant faces, they may differ in their motivation to respond to them (Glocker et al., 2009; Hahn et al., 2013). Nonetheless, the findings of the current study suggest that mothers and fathers show a similar parental effect of enhanced attentional allocation to infant faces, which may facilitate detection of infant cues and subsequent caregiving responses.

The lack of interaction between parental status, face age and sex suggests that men and women without children also respond similarly to infant faces, consistent with previous findings that men and women do not differ in their responses to infant stimuli (Brosch et al., 2007; Parsons et al., 2011). However, whereas the findings reported in Chapter 3 suggest that female non-parents do show enhanced attentional engagement with infant faces as compared to adult faces, albeit a weaker effect than that observed for mothers, the first set of analysis reported in this chapter seemed to suggest that men without children do not show differences in response times to different aged faces. As previously discussed, there was a trend in the expected direction for male non-parents to respond more slowly in the presence of infant faces as compared to older faces, but this did not reach statistical significance. Inspection of RTs suggests that although male and female non-parents showed similar responses to infant as compared to adult faces, male participants' RTs were more variable, which may have contributed to the observed lack of significant difference. It should also be noted that the male sample was smaller than the female sample and statistical calculations revealed lower observed power and wider confidence intervals for males. Thus it is possible that a lack of adequate power may also account for the observed lack of significant difference between RTs to infant and adult faces for male non-parents. A replication of

this experiment with a larger sample of male non-parents may be warranted in order to determine whether men without children do not show attentional biases to infant faces observed for women. As it stands, these findings show a general effect of parenting experience on attention to infant faces, but not an effect of sex. This suggests that parenting experience may impact attentional engagement with infant faces, rather than a biological preparedness based on sex.

4.4.3. Attentional Processing of Emotional Faces

In both sets of analyses there was a main effect of search condition, such that responses were slower in the presence of emotional faces as compared to neutral conditions, suggesting greater attentional capture by emotional faces. However, whereas both mothers and non-mothers show slower response times to both emotional target faces and emotional non-target faces, fathers and non-fathers only showed slower response times in the presence of emotional target faces. This suggests that women were more distracted by the emotional content of non-target faces than men, which may reflect an increased sensitivity to the presence of emotional facial expressions in women as compared to men. Such a proposition is in with line reports that women are better able to discriminate emotion than men (Babchuk et al., 1985; Hall & Matsumoto, 2004; Hampson et al., 2006; McClure, 2000; Merten, 2005; Rotter & Rotter, 1988; Thayer & Johnsen, 2000).

There are several possible explanations for this observed sex difference in attention to emotion. For example, women may be socialised to decode emotions better than men from an early age (Hall & Matsumoto, 2004), which in turn may lead to differences in brain structure, function, and organisation (Godard & Fiori, 2010; Hall & Matsumoto, 2004), differences in reading and interpreting emotional and social information (Bayliss, Pellegrino, & Tipper, 2005), and differences in empathic responding and emotional activation (Proverbio et al., 2006; 2007). However, these studies reporting sex differences have investigated explicit emotion recognition rather than attention to emotion. One speculative hypothesis is that allocating less attention to emotion represents another factor that contributes to relatively poorer emotion decoding in men. Furthermore, women appear more sensitive to subtle differences in facial expressions and features (Hall & Matsumoto, 2004; Lobmaier et al., 2010; Proverbio et al., 2007; Sprengelmeyer et al., 2009). It may therefore be the case that

men in this study did not show slower responses to emotional non-targets because they did not distinguish the emotional non-target face from the neutral faces. When emotion appears on a target face it is highly salient, as it is indexed at the location of the features requiring judgment for responding to the primary search task (i.e. the eyes). Alternatively, it may be that men are not as affected or emotionally aroused by the presence of emotion, or they do not interpret the emotions in the same way. Future studies are required to discriminate between these possibilities.

It has been argued by some that women are better at recognising emotion as they typically have the primary role in affectively engaging with infants and providing care, and the ability to rapidly recognize emotional expressions facilitates effective caregiving (Babchuk et al., 1985; Hampson et al., 2006). This appears unlikely in view of the fact that in the current study all participants, regardless of sex or parent status, were particularly slow to respond to emotional infant faces. So while men may not be as slowed by emotion in general than women, they do appear sensitive to the presence of emotion on infant faces. From an adaptive point of view, increased attentional allocation to infant facial expressions may contribute to the first stage of engaging appropriate behavioural responses to care for and protect the infant.

4.4.4. Attention to Pre-adolescent Faces

The second set of analysis also revealed that, across all participants, there was an effect of increased attention to pre-adolescent faces but only when they displayed sadness in emotional target conditions. Although a lack of an interaction between face age, condition and sex suggested that this effect existed for both women and men, earlier analysis comparing only fathers and non-fathers did not indicate that men showed slower response times in pre-adolescent emotional conditions; therefore, this effect may be driven primarily by women. A previous study has shown that both women and men without children exhibit increased neural responses to preadolescent faces as compared to adult faces, but also found that men did not appear to discriminate between pre-adolescent faces and infant faces (Proverbio et al., 2011). As discussed in the previous chapter, pre-adolescent faces in general may not receive enhanced allocation of attention as, while still dependent on adult care, they are able to communicate their needs verbally rather than relying solely on facial cues. However, when pre-adolescent faces express sadness they may appear more vulnerable,

increasing their saliency to adults who may be able to provide comfort. It may be that men do not allocate attentional resources to emotional pre-adolescent faces to the same degree as women due to less engagement with the emotional content of faces more generally. However, these men may still show increased allocation of attention to emotional infant faces because the fathers were parents to infants; infant faces may therefore appear particularly salient. It is possible that while women show a more general propensity to respond to younger faces, men focus attentional resources more specifically on faces that display the greatest vulnerability or, in the case of fathers, faces that represent a class of stimuli with which they are particularly familiar. However, these hypotheses require further testing as it should be noted that men did show some slowing of response times to pre-adolescent emotional faces which did not reach statistical significance. Given that the male sample was relatively small and that confidence interval for the difference in responding to pre-adolescent and adult emotional target faces was large for men, the current study was likely to be under-powered to detect a statistically significant effect.

4.4.5. Limitations and Future Directions

The current study is the first behavioural study to investigate processing of infant and child emotional and non-emotional faces in fathers and non-fathers. It is also the first to investigate facial attentional processing in fathers and mothers. However, this study is characterised by a number of limitations. Firstly, fathers in this study were slightly older on average than the non-fathers (a non-significant trend). There was no main effect of parental status in the father and non-father comparison and age did not correlate with reaction times, so this small age difference is unlikely to influence the differences seen between fathers and non-fathers. Although the studies reported in Chapters 2 and 3 have better matched parents and non-parents for age, age-matching may also introduce a potential confound; specifically the resulting groups may not be typical of their parity status (Gustafson & Harris, 1990; Noll et al., 2012). For example, recruiting a group of older non-parents may not be representative of people who typically have not yet had children, as they may have particular reasons for choosing to not have children. Likewise, recruiting a group of younger parents may not be representative of typical parents and may also introduce confounds in terms of socio-economic status and education.

Secondly, fathers also reported higher household incomes than non-fathers, although this may be because many of the non-fathers were students. All of our fathers were in full time employment and lived at home with their partners, which could also explain why these men had higher household income. This raises the question of whether the fathers who took part in this study are representative of the general population of fathers. In future, studies should recruit fathers who vary in the amount of time they spend with their children, such as stay at home dads or fathers who live separately to their children, in order to systematically evaluate the influence of this factor on facial attention processing. Previous studies have shown that sensitive paternal behaviour and father-infant attachment can vary according to amount of time fathers spend with their children, their attitude towards parenting, and their satisfaction in their relationship (Feldman, 2000; Flouri & Buchanan, 2003; Lundy, 2002).

An additional limitation is that this study does not include details of the types, quantity, or quality of interactions that these fathers had with their children, nor on the role that they play in their child's life as compared to their partner. It would be of interest in future to recruit mothers and fathers of the same child in order to see if both partners from the same couple show similar attentional biases to infant cues, or whether any differences between them correlate with the types of care they provide for their child. Finally, as in all of the studies reported in this thesis, only parents of infants were assessed. Given the inconclusive findings reported here regarding attention towards preadolescent faces in men, and also considering evidence that fathers' role may differ as their children age and may actually become more important for child outcomes as their child ages (Grossmann et al., 2002), it would be important to recruit fathers of different aged children and assesses attentional preferences for infants and children age-matched to their own child, as compared to older faces.

4.5. Conclusions

This chapter extends the findings of Chapters 2 and 3, showing that fathers differ from non-fathers in their attentional engagement with infant faces in a visual search task, but show a similar pattern of response to that observed in mothers of similarly aged infants. As with mothers and non-mothers, both fathers and non-fathers showed greatest attentional engagement with infant faces when the target face

displayed negative affect. When data were collapsed across fathers and mothers to compare with non-parents, sad pre-adolescent target faces also engaged attention more than adult and adolescent faces; however, this effect was not significant when fathers were compared with non-fathers directly. It was also found that male and female non-parents did not differ in their responses to infant faces as compared to other-aged faces, despite non-fathers only showing a trend towards slower responses to infant faces. Finally, there also appeared to be differences between women and men in their engagement with emotional faces more generally, such that men did not show slowing of responses in emotional non-target conditions. These results suggest that while sex appears to have an effect on emotion processing more generally, engagement with infant faces depends on parental status, with mothers and fathers both showing more attentional engagement with infant faces than preadolescent, adolescent, and adult faces.

The ability to pay attention to signals from one's own infant over and above other cues in the environment is arguably an adaptive response as it increases the chances of facilitating appropriate care giving. The findings reported in this study indicate that both fathers and mothers have this ability even if they differ somewhat in the types of behavioural response they subsequently provide in response to these signals (Bailey, 1994; Braungart-Rieker et al., 2001; Lundy, 2002; Grossman et al., 1981; Lewis & Lamb, 2003).

However, not all parents provide optimal care for their infants. It is possible that processing of infant cues is compromised or less efficient in some individuals than others. The next and final empirical chapter therefore aims to investigate whether individual differences in own childhood experience and current mood may impact on processing of infant and adult emotional faces.

Chapter 5: Attention to infant emotional faces in mothers with a history of childhood maltreatment

5.1. Chapter Introduction

The findings presented in the earlier chapters of this thesis indicate that attention is more engaged by infant faces compared to adult, adolescent and pre-adolescent faces in women with and without children and in fathers, particularly when these faces display emotional expressions. This has been interpreted as an adaptive pattern, such that attention is allocated to those individuals most in need of care and nurturance. Such a response to facial cues indexing vulnerability may represent a basic cognitive mechanism that contributes to sensitive parenting behaviour. However, there appear to be individual differences in the degree of this response. The study reported in Chapter 2 provided preliminary evidence that a “bias” to infant faces may be less strong in those who are experiencing parenting stress. There are likely to be many variables that can affect attentional processing of emotionally relevant and caregiving relevant stimuli. The current chapter will investigate individual differences in attention towards infant faces in mothers, with a specific focus on their experience of childhood maltreatment.

5.1.1. *Childhood Maltreatment: Consequences for Later Parenting*

The experience of maltreatment during childhood is associated with a number of serious and enduring developmental consequences, comprising behavioural, emotional, and social dysfunction (Cicchetti & Toth, 2005; Egeland, 2009; Gibb et al., 2007; Gilbert et al., 2009; McCrory & Viding, 2010; Rogosch, Cicchetti, Shields, & Toth, 1995; Spinhoven et al., 2010). Of relevance to the current thesis is the finding that the experience of childhood maltreatment has an impact on subsequent parenting in adulthood (Bailey et al., 2012; Newcomb & Locke, 2001). For example, it has been found that parents who experienced maltreatment during childhood show lower parental competence, less effective parenting styles, and more emotional difficulties including over-dependence on offspring (also called “role reversal”) and lack of emotional availability and involvement (Alexander et al., 2000; Bailey et al., 2012; Fitzgerald et al., 2005; Moehler et al., 2007; Ruscio, 2001). There is also an elevated risk that parents who have been maltreated may go on to maltreat their own children (Berlin et al., 2011; Egeland et al., 1988; Egeland, 1993; Hemenway et al., 1994;

Hunter & Kilstrom, 1979; Noll et al., 2009; Pears & Capaldi, 2001; Simons et al., 1991; Zaidi et al., 1989).

There is also some evidence of an intergenerational cycle of insecure or disorganised attachment style (Belsky, Jaffee, Sligo, Woodward, & Silva, 2005; Bretherton, 1990; Fonagy et al., 1993; Van IJzendoorn et al., 1992; Van IJzendoorn, 1995). Specifically, parents who have been maltreated are more likely to be insecurely attached to their parents and in turn are less likely to have secure attachment patterns with their own offspring (Baer & Martinez, 2006; Collishaw, Dunn, et al., 2007; Fonagy et al., 1993; Fraiberg et al., 1975; Lyons-Ruth & Block, 1996). This cycle of insecure or disorganised attachment has been conceptualised in relation to the concept of “internal working models” that a child forms of their relationship with their parent, based on the care they receive, which then informs expectations about future interactions (Bowlby, 1969/1982, 1973, 1980; Bretherton, 1985). There is also evidence to suggest that before becoming parents, adults have conceptions about what parenting involves and expectations about how they would relate to their children, based on the parenting they received (Rholes et al., 1997; Simons et al., 1991). Adults who experienced childhood maltreatment may thus differ from non-maltreated adults in their perceptions of the demands and rewards of parenting, how to interact with children, how to discipline, and their level of emotional connection with their children. However, maltreating families are also characterised by abnormal and inconsistent emotional interactions with their children, creating a poorer social environment from which children can learn how to attend to, recognise, and regulate emotional information (Pollak, 2012; Shackman et al., 2010). Dysfunction in these more basic cognitive mechanisms may also have implications for parenting behaviour.

5.1.2. Childhood Maltreatment: Effects on Attention Towards Emotional Stimuli

Problematic parenting behaviour and parent-child relationships may arise as a consequence of the emotional difficulties that have been observed in victims of maltreatment, both in childhood and through to adulthood. It has been found that adults, adolescents, and children who have experienced maltreatment show difficulties in recognizing, processing, expressing, and regulating emotional states, as well as showing atypical biases to certain emotional information (Camras et al., 1990, 1996;

Fani et al., 2011; Gibb et al., 2009; Pollak et al., 2000; Pollak, Cicchetti, & Klorman, 1998).

Much of the work investigating emotional information processing has been conducted with maltreated children; this has generally reported atypical abilities in how such children recognise and process anger. It has been shown that maltreated children are more likely to interpret ambiguous facial expressions as angry (Pollak & Kistler, 2002), detect anger on the basis of less sensory input than non-abused children (Pollak & Sinha, 2002), show attentional biases (rapid orientation and delayed disengagement) for angry faces (Pine et al., 2005; Pollak & Tolley-Schell, 2003), and have more difficulties discriminating other emotional expressions (Pollak et al., 2000; Pollak & Sinha, 2002).

It has also been found that young adults reporting a history of moderate to severe childhood maltreatment are more sensitive in detecting angry facial expressions at lower levels of emotional intensity, as well as exhibiting attentional biases towards angry faces (Gibb et al., 2009). However, another study with adults found that those with histories of childhood maltreatment showed preferential attention towards happy faces, but not towards threatening faces (Fani et al., 2011). Furthermore, childhood maltreatment was found to explain more variance in attentional bias than adult trauma (Fani et al., 2011).

It should also be noted that the experience of childhood maltreatment is associated with elevated rates of emotional disorders such as depression, which in turn is associated with maladaptive information-processing styles (Mathews & MacLeod, 2005; Pollak, 2012). For example, children at-risk for depression and adults with depression show deficits in recognising emotional and neutral facial expressions, as well as attributing negative emotions to neutral and positive faces, judging negative facial expressions to be more negative, and showing preferential attention to sad faces (Carton et al., 1999; Caseras et al., 2007; Gollan et al., 2008; Gur et al., 1992; Joormann & Gotlib, 2006; Leppänen et al., 2004; Rubinow & Post, 1992; Williams et al., 2007). One study by Romens and Pollak (2012) found that maltreated children who were at risk for depression (as measured by high levels of trait-rumination) showed attentional biases for sad faces, particularly after experiencing a sad emotional state. It is hypothesised that the experience of maltreatment might be one route to developing the cognitive biases for negative information observed in individuals with depression (Cicchetti & Toth, 1995; Pollak, 2005, 2008, 2012).

Collectively, these studies suggest that the experience of maltreatment during childhood has measurable and enduring effects on cognitive processing styles. One hypothesis that has been put forward is that early experiences of maltreatment alter sensory thresholds in ways that undermine effective emotional regulation and that perceptual mechanisms are adjusted during childhood to process aspects of the environment that have become salient through learning from negative social experiences (Cicchetti & Toth, 1995, 2005; Cicchetti, 2002; Pollak, 2003, 2008, 2012). Arguably, it may be adaptive to develop increased sensitivity to negative emotional signals, as this may facilitate attempts to avoid harm, whereas biases towards positive information may be used as a coping mechanism to avoid environmental adversity (Fani et al., 2011; Pollak, 2012). However, these biases may become maladaptive if they become trait-like processing styles across development and are applied even in non-adverse environments. It has been suggested that they lead to poorer recognition and misinterpretation of other emotions or social situations and problems with self-regulation (Gotlib & MacLeod, 1997; McCrory et al., 2013; Pollak, 2003, 2008, 2012).

5.1.3. Childhood Maltreatment and Attention to Infant Faces

These potentially maladaptive processing styles may cause particular problems later in life when maltreated children become parents themselves. Given the evidence that maltreatment impacts attention towards and recognition of emotion in adult faces, it is possible that it may also affect processing of infant faces. Preliminary fMRI findings suggest that mothers who have experienced childhood maltreatment show increased anterior cingulate cortex activation in response to viewing infant faces, which was hypothesised to reflect negative evaluation of infant facial cues (Barrett et al., 2009). However, to date no behavioural studies have investigated whether mothers with maltreatment histories show differential attentional processing of infant or adult faces, and whether their processing of infant faces differs from non-maltreated mothers. This is a surprising gap in our understanding of parenting behaviour, given that childhood maltreatment confers risks for later parenting as well as having effects on sensitivity to emotionally relevant information. The ability to recognise, discriminate between and respond to infant facial cues is an important function of sensitive parenting, all of which depend upon allocating sufficient attention to infant cues (Ainsworth et al., 1978; Swain, 2011). In other words the vulnerabilities and

difficulties shown by some parents with experiences of childhood maltreatment may stem in part from altered processes in processing facial cues, particularly emotional facial cues. As has been previously suggested, if preference for infant faces over other environmental stimuli ensures that limited attentional resources are allocated to communicative cues given by the child, any impairment in this system could have an (adverse) impact for parenting behaviour. This has been observed in the case of depression during the antenatal period, which is associated with decreased attentional engagement with infant facial cues (Pearson et al., 2010, 2013).

5.1.4. The Current Study

The current study employed a similar visual search paradigm to that employed in previous chapters in order to investigate the impact of childhood maltreatment on attention to infant and adult emotional faces in a group of mothers. No previous study has directly investigated whether experience of childhood maltreatment is associated with altered attentional processing of infant faces as compared to adult faces. Previous research has shown that both symptoms of depression and the experience of childhood maltreatment are associated with potentially maladaptive attentional biases to certain emotional information (e.g. Mathews & MacLeod, 2005; Pollak, 2008, 2012), and symptoms of depression during pregnancy are associated with less attentional allocation to distressed infant faces (Pearson et al., 2010, 2013). Furthermore, mothers with own-childhood histories of maltreatment appear to respond less sensitively to their infants in “real life” interactions (e.g. Baer & Martinez, 2006; Collishaw et al., 2007). It was therefore hypothesised that mothers who had experienced higher levels of childhood maltreatment would show less attentional bias to infant faces as compared to mothers who had experienced lower levels of childhood maltreatment. Additional analyses were conducted in order to ensure that any observed associations between attentional bias to infant faces and childhood maltreatment were not secondary to individual differences in depression symptoms.

5.2. Method

5.2.1. Participants

Ethical approval for the study was granted from Yale University Human Investigation Committee (Protocol Number 0912006104). Forty-seven women who had a child aged 3 years old or under were recruited for this study and paid \$40 for participation; they were recruited from participant databases at the Child Study Centre, Yale University and from the local community in New Haven, CT, USA. Five women were excluded from task analysis due to incomplete data or high error rates. All women were right-handed, reported normal or corrected-to-normal vision, and screened negative for recent drug use. The sample was racially diverse (61.9% Caucasian, 31.0% African American, 2.4% Hispanic, 4.8% mixed race), approximating the racial distribution of the New Haven population. Participants were aged between 17 and 41 years old ($M=29.10$, $SD=5.67$). The sample included first time mothers and those with more than one child (52.4% primiparous, 42.9% multiparous). The ages of these mothers' youngest children were between 1 and 36 months ($M=12$ months, $SD=8.11$), and 55% of these children were female. Women were split into two groups based on a median split of their scores on an assessment of the experience of childhood maltreatment (the Childhood Trauma Questionnaire, see below). Those who scored above the median were assigned to a "high maltreatment group" and those who scored below were assigned to a "low maltreatment group". Participant demographics for each of the two maltreatment groups are shown in Table 5.1 and Table 5.2.

Table 5.1. *Participant demographics.*

	Low maltreatment group (N=22)			High maltreatment group (N=20)			<i>p</i>
	Mean (<i>SD</i>)	Median	Range	Mean (<i>SD</i>)	Median	Range	
Age	30.1 (5.28)	30	18-41	28.05 (6.00)	27.5	17-38	.25
Years Education	15.60 (3.38)	17	8-20	12.85 (2.18)	12.5	10-20	.01
Age Child	12.52 (7.51)	11	1-30	10.4 (7.51)	8	1-30	.23
CTQ Total	28.68 (2.98)	28.5	25-34	53.55 (17.71)	49	36-108	.001
CTQ Emotional Abuse	5.86 (.89)	6	5-7	11.95 (5.45)	11	5-25	.001
CTQ Physical Abuse	5.32 (.95)	5	5-9	9.80 (5.31)	8	5-25	.001
CTQ Sexual Abuse	5.14 (.47)	5	5-7	7.80 (5.36)	5	5-25	.05
CTQ Emotional Neglect	6.41 (1.87)	6	5-11	14.15 (4.75)	14	5-25	.001
CTQ Physical Neglect	5.95 (1.62)	5	5-10	9.85 (4.55)	9.5	5-21	.001
BDI	3.59 (3.95)	2	0-12	8.85 (8.19)	6.5	0-26	.04

Table 5.2. *Participant demographics (continued).*

	Low maltreatment group		High maltreatment group		<i>p</i>
	n	%	n	%	
Number of Children [§]					
Primiparous	13	65%	9	45%	.20
Multiparous	7	35%	11	55%	
Marital status [§]					
Single	7	35%	12	60%	.11
Married/Cohabiting	13	65%	8	40%	
Income [§]					
\$0-\$20,000	3	16.7	6	40	.29
\$20,000 - \$40,000	2	11.1	3	20	
\$40,000 - \$60,000	3	16.7	3	20	
\$60,000 - \$80,000	2	11.1	1	6.7	
\$80,000 +	8	44.4	2	13.3	
Ethnicity					
Caucasian	16	72.7	10	50	.18
Hispanic	0	0	2	10	
African American	6	27.3	7	35	
Mixed race	0	0	1	5	

§ = Incomplete data

5.2.2. *Questionnaire Measures*

5.2.2.1. *Assessment of history of childhood maltreatment*

Participants were asked to complete the Childhood Trauma Questionnaire (CTQ; Bernstein & Fink, 1998). This 28-item self-report questionnaire measures five subscales of maltreatment on a scale from 1 (never true) to 5 (very often true); Physical abuse, Sexual abuse, Emotional abuse, Physical neglect, Emotional neglect. Scores on each subscale can range from 5-25, with higher scores indicating more severe maltreatment. A total score can be calculated by summing scores from the five subscales. The CTQ is psychometrically sound in community and clinical samples, has good internal and test-retest reliability, as well convergent and divergent validity with trauma histories from other measures, is sensitive to identifying individuals with verified histories, and scores are stable over time (Bernstein & Fink, 1998; Bernstein et al., 2003; Paivio & Cramer, 2004).

5.2.2.2. *Assessment of symptoms of depression*

Participants completed the Beck Depression Inventory (BDI-II; Beck et al., 1996), which is a 21-item self-report questionnaire designed to assess the intensity of symptoms of depression (See Chapter 2).

5.2.3. *Stimuli*

The experimental task was similar to that reported in Chapter 2. The stimuli were the same colour images of male and female Caucasian faces used in Chapter 3 and 4, except this task only included infant and adult stimuli. There were images of each identity showing neutral, sad, and happy facial expressions. As before, images were edited so that each identity displayed blue eyes on some trials (when target) and brown eyes on other trials (when non-target), and eye-size (measured in pixels) was matched across stimuli. The dimensions of the stimuli and arrangement on screen were identical to that previously reported in Chapters 3 and 4.

5.2.3.1. *Stimuli ratings*

In a preliminary study, 14 individuals who did not take part in the main study rated all images for age, valence, arousal, and vulnerability on a scale of 1-5, as

reported in Chapter 3. As this study only includes infant and adult stimuli and also includes the addition of happy facial expressions, ANOVAs for valence, emotional arousal, and vulnerability were repeated for these stimuli.

Participants were asked to rate all stimuli for valence on a scale of 1 (negative) to 5 (positive). A 2 (Face Age: Infant and adult) x 3 (Emotion: Neutral, happy, and sad) repeated-measures ANOVA was conducted on the valence ratings. There was no main effect of Face Age ($F(1, 13)=.57, p=.46$). There was a main effect of Emotion ($F(1, 13)=1153.14, p<.001, \eta_p^2=.99$), with sad faces rated as more negative than neutral faces (mean difference=1.82, $SE=.08, p<.001$), and happy faces (mean difference=3.46, $SE=.07, p<.001$). Happy faces were rated as more positive than neutral faces (mean difference=1.64, $SE=.08, p<.001$). There was no Face Age and Emotion interaction ($F(2, 26)=1.30, p=.29$).

Participants were also asked to rate the stimuli for emotional arousal. A 2 (Face Age: Infant and adult) x 3 (Emotion: Neutral, happy, and sad) repeated-measures ANOVA was conducted on the emotional arousal ratings. There was a main effect of Face Age ($F(1, 13)=105.34, p<.001, \eta_p^2=.89$). Post-hoc comparisons with Bonferroni correction applied revealed that infant faces were rated as more emotionally arousing than adult faces (mean difference=1.15, $SE=.11, p<.001$). There was a main effect of Emotion ($F(2, 26)=53.25, p<.001, \eta_p^2=.80$), with sad rated as more emotionally arousing than neutral (mean difference=1.15, $SE=.14, p<.001$), and happy rated as more emotionally arousing than neutral (mean difference=1.41, $SE=.18, p<.001$). There was no difference in arousal ratings between happy and sad ($p=.09$). However, there was a Face Age and Emotion interaction ($F(2, 26)=5.98, p<.01, \eta_p^2=.31$), such that the difference between neutral conditions and emotional conditions (happy or sad) were larger for adult faces than infants, by virtue of neutral infant faces also being rated as somewhat emotionally arousing ($M=3.21, SE=.21$) whereas neutral adult faces were not rated as highly emotionally arousing ($M=1.71, SE=.15$).

Finally, participants were also asked to rate the stimuli for perceived vulnerability on scales of 1 (low) to 5 (high). A 2 (Face Age: Infant and adult) x 3 (Emotion: Neutral, happy, and sad) repeated-measures ANOVA was conducted on the vulnerability ratings. There was a main effect of Face Age ($F(1, 13)=198.77, p<.001, \eta_p^2=.94$), with infant faces rated as more vulnerable than adult faces (mean difference=2.01, $SE=.14$). There was a main effect of Emotion ($F(2, 26)=25.79, p<.001, \eta_p^2=.67$), such that sad faces were rated as more vulnerable than neutral (mean

difference=.81, $SE=.15$, $p<.001$) and happy faces (mean difference=.84, $SE=.12$, $p<.001$). There was an interaction between Face Age and Emotion (Greenhouse-Geisser corrected $F(1.4, 17.84)=6.23$, $p<.05$, $\eta_p^2=.32$). Post-hoc comparisons with Bonferroni correction applied revealed that for infant faces, sad faces were rated as more vulnerable than neutral faces (mean difference=.48, $SE=.18$, $p=.05$) but not more vulnerable than adult faces (mean difference=.38, $SE=.18$, $p=.30$). For adult faces, sad faces were rated as more vulnerable than neutral faces (mean difference=1.14, $SE=.15$, $p<.001$) and happy faces (mean difference = 1.30, $SE=.18$, $p<.001$). Thus, for infant face conditions, there were smaller differences in perceived vulnerability between emotional (happy or sad) and neutral conditions than for adult faces, by virtue of all infant faces being rated as vulnerable, whereas adult faces are not rated as more vulnerable unless they are showing sadness.

5.2.4. Procedure

The participants visited the testing laboratory at the Yale Child Study Centre for approximately 2 hours, completing the questionnaire measures first followed by the computer task (among a battery of other tasks). Participants were tested individually and were given instructions at the beginning of the task. The computer task was conducted using a Sony Vaio Windows 7 PC laptop with a 2.4-GHz Intel Core Duo processor and a 13" wide screen monitor (60 Hz, 1366 x 768 resolution). Stimuli were presented and RTs recorded using Psytools software (Delosis Limited).

Trials were blocked by face age and emotion, with the order counterbalanced across participants. Each block consisted of 96 trials, with a slightly modified distribution to that reported in previous chapters. In this version of the task, within each block one half of the trials (48 trials) were neutral conditions in which no emotional faces were present. On the other half of the trials and emotional expression was present; in half of these (24 trials) the emotional expression was present on a non-target face and in the other half the emotional expression was present on the target face. Taking all the conditions together, a 2 (Face Age: Infant and Adult) x 2 (Emotional condition: Happy and Sad) x 3 (Search condition: Emotional target, emotional non-target, and all neutral) repeated-measures design was employed, resulting in 12 experimental conditions. Randomisation criteria of conditions and face

identities, task timings, and task instructions were the same as those reported in previous chapters.

5.3. Results

5.3.1. Descriptive Analysis

Correlation analyses were performed to assess whether participant age, WASI IQ, and years in education were associated with task performance. There were no statistically significant correlations between age, years in education and total RTs for mothers in the low maltreatment group (all $r < .30$, all $p > .12$). There were also no statistically significant correlations between age, years in education and total RTs for mothers in the high maltreatment group (all $r < .02$, all $p > .94$).

5.3.2. Reaction Times

Anticipatory (<150 ms) responses (.02%) and incorrect responses (5.5% of total trials) were excluded from the reaction time (RT) analysis. Outliers (2.5 SDs from mean) were calculated for each participant's range of RTs and removed from analysis (2.5% of total trials), and mean correct RTs for each experimental condition were then calculated for analysis. Means and standard errors of reaction times are presented in Table 5.3.

A 2 (Face Age: infant and adult) x 2 (Emotional condition: Happy and Sad) x 3 (Search condition: emotional target, emotional non-target, and all neutral) repeated-measures ANOVA was conducted on the RT data, with maltreatment group (low and high levels of childhood maltreatment) entered as a between-subjects variable. Effect sizes are reported as partial eta squared (η_p^2) and significant effects are followed up with post-hoc pairwise comparisons with Bonferroni correction applied. Post-hoc power calculations are reported for main effects and interactions (observed power) and 95% confidence intervals are reported for post-hoc pairwise comparisons.

Table 5.3. *Descriptive statistics for RTs (ms) for all trial conditions for mothers in the low and high maltreatment groups.*

	Low maltreatment group (N=22)				High maltreatment group (N=20)			
	Infant Stimuli		Adult Stimuli		Infant Stimuli		Adult Stimuli	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Happy Target RT	1256.67	208.72	1152.30	182.16	1240.63	255.41	1253.03	252.88
Happy Non-Target RT	1098.90	176.83	1046.22	189.96	1047.68	235.20	1051.86	206.01
Neutral trials within Happy Blocks RT	1102.79	193.93	1016.77	162.38	1066.72	201.78	1060.53	211.44
Sad Target RT	1170.54	241.93	1086.33	184.09	1157.08	206.93	1120.71	231.69
Sad Non-Target RT	1071.97	172.43	1015.13	196.61	1027.46	158.46	1067.23	189.49
Neutral trials within Sad Blocks RT	1070.17	188.01	1019.83	157.25	1077.26	170.37	1052.73	173.66

A main effect of face age was observed ($F(1, 40) = 8.56, p < .01, \eta_p^2 = .18$, observed power = .82), such that RTs to correct responses were significantly slower in infant face conditions than adult face conditions (mean difference = 37.10 ms, $SE = 12.66$). There was also a main effect of emotion ($F(1, 40) = 9.75, p < .01, \eta_p^2 = .19$, observed power = .86), such that RTs were significantly slower in the presence of happy faces than sad faces (mean difference = 38.14 ms, $SE = 12.22$). There was also a main effect of condition (Greenhouse-Geisser adjusted $F(1.6, 63.6) = 177.50, p < .001, \eta_p^2 = .82$, observed power = 1.00). Post-hoc pairwise comparisons indicated that participants' RTs were slower in emotional target conditions than in emotional non-target conditions (mean difference = 126.36 ms, $p < .001$, 95% CI [104.98-147.73]) and in neutral conditions (mean difference = 121.31 ms, $p < .001$, 95% CI [100.19-142.43]). There was not a statistically significant difference in RTs in emotional non-target conditions as compared to neutral conditions (mean difference = 5.05, $p = .99$, 95% CI [-8.26-18.36]).

There was no main effect of maltreatment group ($F(1, 40) = .03, p = .86$, observed power = .05), but there was a significant interaction between face age and maltreatment group ($F(1, 40) = 7.78, p < .01, \eta_p^2 = .16$, observed power = .78), indicating that RTs in the presence of infant and adult face differed according to the experience of childhood maltreatment. Mothers who had experienced lower levels of childhood maltreatment showed significant slowed RTs to infant faces as compared to adult faces (mean difference = 72.41, $p < .001$, 95% CI [37.09-107.73]), whereas mothers who had experienced higher levels of childhood maltreatment did not show a significant difference in RTs between infant and adult faces (mean difference = 1.79, $p = .92$, 95% CI [-35.25-38.83]; see Figure 5.1).

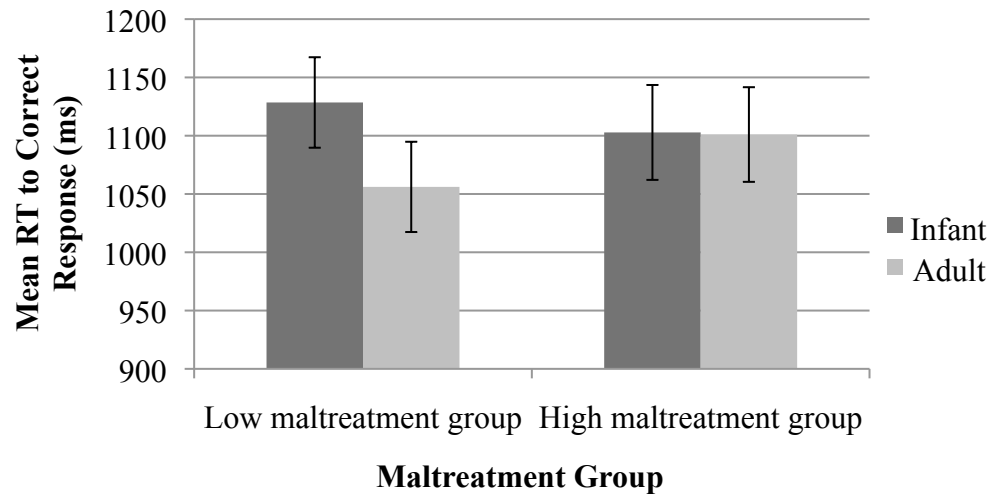


Figure 5.1. Mean RT to correct response for Low and High maltreatment groups as a function of Face Age. Error bars represented standard errors.

There was no interaction between emotion type and maltreatment group ($F(1, 40) = .02, p = .88$, observed power = .05), nor an interaction between face age and emotion ($F(1, 40) = .01, p = .91$, observed power = .05), but there was a non-significant trend for an interaction between condition and maltreatment group (Greenhouse-Geisser adjusted $F(1.6, 63.6) = 2.82, p = .08$, observed power = .48). There was an interaction between face age and condition ($F(2, 80) = 3.26, p < .05, \eta_p^2 = .08$, observed power = .61). Post-hoc comparisons (Bonferroni corrected) revealed that for adult face conditions there was no difference in RTs between emotional non-target conditions and neutral conditions (mean difference = 7.64, $p = .99$, 95% CI [-14.95-30.23]), however RTs were slower in emotional target conditions than in emotional non-target conditions (mean difference = 107.98, $p < .001$, 95% CI [81.21-134.76]) and neutral conditions (mean difference = 115.63, $p < .001$, 95% CI [88.70-142.55]). For infant faces there was a trend for RTs to be slower in neutral conditions than in emotional non-target conditions (mean difference = 17.74, $p = .07$, 95% CI [-.31-35.79]). However, RTs were slower to emotional target conditions than to emotional non-target conditions (mean difference = 144.73, $p < .001$, 95% CI [112.67-176.79]), and neutral conditions (mean difference = 126.99, $p < .001$, 95% CI [97.17-156.81]). Inspection of Figure 5.2 demonstrates that RTs appear to be particularly slow in emotional target conditions for infant faces.

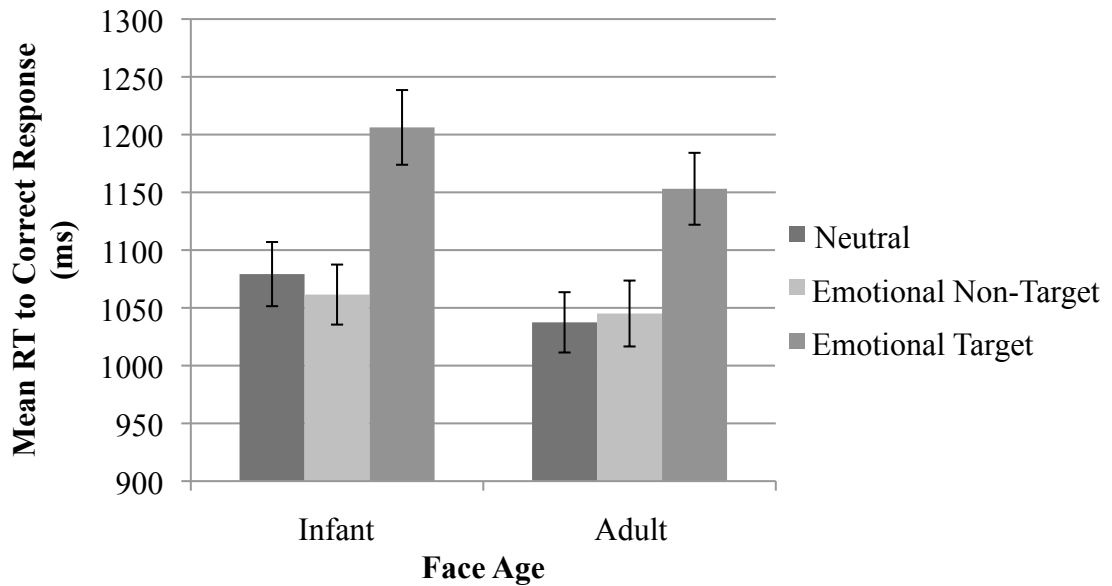


Figure 5.2. Mean RT to correct response for each experimental condition as a function of Face Age. Error bars rerepresent standard errors.

There was an interaction between emotion and condition (Greenhouse-Geisser corrected $F(1.8, 70.7) = 30.43, p < .001, \eta_p^2 = .43$, observed power = 1.00), as well as a three-way interaction between emotion, condition and maltreatment group (Greenhouse-Geisser corrected $F(1.8, 70.7) = 3.37, p < .05, \eta_p^2 = .08$, observed power = .58). Post-hoc pairwise comparisons were performed separately for low and high maltreatment groups. Mothers in the low maltreatment group showed slower RTs in happy target conditions as compared to happy non-target (mean difference = 131.92, $p < .001$, 95% CI [97.75-166.09]) and neutral conditions (mean difference = 144.70, $p < .001$, 95% CI [105.00-184.40]), and slower RTs in sad target conditions than in sad non-target (mean difference = 84.89, $p < .001$, 95% CI [42.09-127.69]) and neutral conditions (mean difference = 83.43, $p < .001$, 95% CI [50.71-116.15]). Mothers in the high maltreatment group also showed slower RTs in happy target conditions as compared to happy non-target (mean difference = 197.07, $p < .001$, 95% CI [161.01-233.12]) and neutral conditions (mean difference = 183.21, $p < .001$, 95% CI [137.52-228.89]), and slower RTs in sad target conditions than in sad non-target (mean difference = 91.55, $p < .001$, 95% CI [44.83-138.28]) and neutral conditions (mean difference = 73.90, $p < .001$, 95% CI [36.63-111.17]). Inspection of Figure 5.3 suggests that mothers in the higher maltreatment group showed more pronounced slowing of RTs for happy target faces.

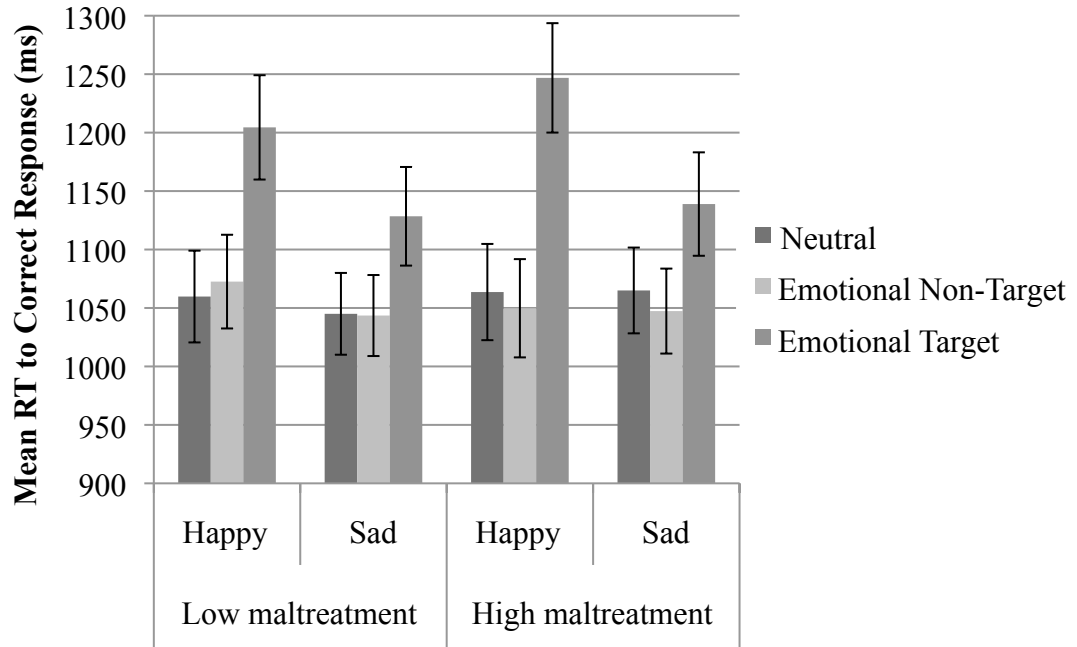


Figure 5.3. Mean RT to correct response for each Search condition as a function of Emotion and maltreatment group. Error bars represent standard errors.

There was no significant three-way interaction between face age, emotion, and maltreatment group ($F(1, 40) = .22, p=.64$, observed power=.08), nor between face age, condition, and maltreatment group ($F(2, 80) = .57, p=.57$, observed power=.14), nor between face age, emotion, and condition ($F(2, 80) = .55, p=.58$, observed power=.14). There was also no four-way interaction between face, emotion, condition and CTQ group ($F(2, 80) = 1.95, p=.15$, observed power=.39).

5.3.2.1. Including depression as a covariate

The repeated measures ANOVA was re-run with total BDI score (log transformed) as a covariate in order to explore whether individual differences in depression symptoms could account for the interaction between face age and CTQ group. There was no main effect of BDI score on RTs ($F(1, 39) = 1.13, p=.30$, observed power=.18), BDI score did not interact with any other variables and the interaction between face age and CTQ group remained significant ($F(1, 39) = 7.43, p<.01, \eta_p^2=.16$, observed power=.76).

5.3.3. *Errors*

Errors rates were low (5.5% of total trials). As errors were rare and non-normally distributed, comparisons reported here use non-parametric statistics and median percent errors are reported. Errors differed between face age conditions (2.9% Adult, 4.2% Infant, $p<.05$), and between search conditions (1.6% neutral, 1% emotional non-target, 1% emotional target, $p<.01$), but errors did not differ between different emotion conditions (happy = 1%, sad = 1.2%, $p=.98$). Furthermore, mothers in the low and high maltreatment groups did not differ in total error rate (2.9% low maltreatment group, 4.9% high maltreatment group, $p=.21$). For completeness, error rates for all conditions are reported in Table 5.4.

Table 5.4. *Median percent error for all trial conditions for mothers in the low and high maltreatment groups.*

	Low maltreatment group (N=22)				High maltreatment group (N=20)			
	Infant		Adult		Infant		Adult	
	Median	Range	Median	Range	Median	Range	Median	Range
Happy Target	1	0-7	1	0-6	1	0-7	1.5	0-8
Happy Non-Target	1	0-4	1	0-3	1	0-6	1	0-5
Neutral within Happy Blocks	1.5	0-10	1	0-10	2	0-10	2	0-10
Sad Target	1	0-4	0	0-9	2	0-8	1	0-4
Sad Non-Target	1	0-6	0	0-10	1.5	0-7	1	0-6
Neutral within Sad Blocks	2	0-5	1	0-9	3	0-9	2	0-9

5.4. Discussion

The current study investigated whether differing levels of childhood maltreatment were associated with individual differences in attentional processing of infant emotional faces in mothers. As in the previous three Chapters, it was found that RTs were slower in the presence of infant faces as compared to adult faces, particularly in emotional target conditions. However, mothers who reported higher levels of maltreatment did not appear to show the “bias” for infant faces (indexed by slower RTs to infant as compared to adult faces), while mothers with lower levels of maltreatment did show this bias, as reported in previous chapters (Chapters 2 and 3), in pregnant women (Pearson et al., 2010), and in adults without children (Chapters 2 and 3; Brosch et al., 2007, 2008). This altered pattern of attentional processing associated with maltreatment experience was still present when current symptoms of depression were controlled for. This pattern of findings suggests that mothers’ attentional engagement with infant faces as compared to adult faces is associated with the experience of maltreatment during their childhood.

5.4.1. *Effects of Childhood Maltreatment on Infant Face Processing*

The primary finding reported in this chapter is that mothers who scored higher on a self-report measure of childhood maltreatment showed similar RT performance when processing both adult and infant faces, whereas mothers reporting lower levels of maltreatment appeared to differentiate between adult and infant faces. One possibility is that infant faces may not hold the same salience or incentive value for women who have experienced a difficult childhood. Such a suggestion is in line with studies suggesting that parents with histories of maltreatment show less involvement with their children (Driscoll & Easterbrooks, 2007; Lyons-Ruth & Block, 1996; Moehler et al., 2007).

However, it is also possible that women who experienced maltreatment show a similar amount of attention towards infant faces as those with fewer maltreatment experiences, but fail to differentially allocate attention between infant and adult faces. Inspection of the RTs for both groups suggest that adult faces may appear more salient, slowing RTs in adult face conditions in the higher maltreatment group contributing to a similar performance for both infant and adult stimuli. Such increased salience of adult

faces may be due to the perceived likelihood of threat from an adult face, given the findings from previous research reporting threat biases in maltreated children and adults with histories of maltreatment. A third possibility is that women in the high maltreatment group are less able to make subtle discriminations between different aged faces, similar to the deficits seen in maltreated children when trying to discriminate facial expressions (Pollak et al., 2000). These women may also differ from the women in the low maltreatment group in their perception of the emotional valence, arousal, and vulnerability of the face stimuli. Unfortunately, the women who participated in this study did not rate the stimuli used in the attention task, so it was not possible to investigate whether the groups differed in their ratings of the stimuli. Future research is required to discriminate between these possible accounts.

Regardless of the specific process at play, mothers who have experienced maltreatment in childhood appear not to preferentially allocate attention to infant compared to adult faces. This finding raises the possibility that the general tendency seen in parents to prefer and orient toward infant faces may be disrupted in those who have received poorer parenting themselves. This absence of enhanced attentional allocation towards infant faces may have implications for parenting behaviour, such as a relatively decreased sensitivity to an infant's communicative signals, which may result in inappropriate, ineffective caregiving responses (McElwain & Booth-LaForce, 2006; Pearson et al., 2010, 2011a; Swain, 2011; Swain et al., 2007).

5.4.2. Attention Towards Emotional Faces

As in the previous studies reported in this thesis, the current study found, regardless of maltreatment group, an effect of search condition such that RTs were particularly slow when an emotional expression appeared on adult and infant target faces. Also as reported before, responses for all participants appeared to be particularly slow when emotion was present on a target infant face. It should also be noted that unlike the previous findings reported in this thesis, this study did not find an effect of slowed RTs to emotional non-target faces, suggesting that the women in this study were more able to effectively ignore emotional information on a non-target face. It is not immediately clear why this might be. This group of women may have differed from the previous groups due to possible demographic differences (such as IQ, social disadvantage, ethnicity) or due to the presence of the women who were reporting high

levels of maltreatment in this study. One possibility is that those women who experienced maltreatment did not recognise that the non-target faces were emotional or different to the neutral target face, as previous studies have shown deficits in the ability to discriminate discrete emotional expressions (Pollak et al., 2000; Pollak & Kistler, 2002; Pollak & Sinha, 2002). It may also be that the neutral target face was itself distracting, as those with a history of maltreatment may have found the neutral face ambiguous or perceived it as threatening (Fani et al., 2011; Pollak et al., 2000; Pollak & Kistler, 2002). However, these suggestions are not readily reconciled with the lack of slowed RTs to emotional non-targets seen for all participants, not just those in the high maltreatment group.

It is equally possible that this group of women was initially more focused on the feature-based search of finding the correct eye colour and “used-up” their attentional resources on this first stage of the task, leaving no room for emotion to capture attention. Studies have shown that under conditions of high perceptual load people are more able to ignore distracting information (Lavie, 2005, 2010). However, these women may have still been distracted by emotional target faces as the emotion was clearer to them when making the more holistic judgment about face tilt direction (Horstmann & Becker, 2008, Thompson-Booth et al., 2013 [Chapter 2]). It is also possible that the differences in ethnicity between this sample and the previous samples could account for the differences; all participants in previous samples were Caucasian, whereas 38% of the participants in this study were non-Caucasian. This may have affected attention towards the faces in this task as all of the stimuli were Caucasian faces, and there is evidence to suggest that people are better at recognising and discriminating own-race faces (Meissner & Brigham, 2001).

Another discrepant finding in the current study is that unlike the study reported in Chapter 2 of this thesis, this study found that RTs were slower to happy faces than sad faces, an effect that was qualified by an interaction between emotion, condition and CTQ group. Although many studies show negative emotions capture attention more effectively (e.g. Eastwood et al., 2001, 2003), other studies have shown search advantage for both negative and positive emotions (Williams et al., 2005), and greater interference effect by happy non-target faces (Preston & Stansfield, 2008). Furthermore, the three-way interaction between emotion, condition and CTQ group suggested that this effect seemed to be more enhanced in those who had experienced

higher levels of maltreatment. This is in line with a study in adults with maltreatment histories, which found attentional biases to happy faces but not threatening faces (Fani et al., 2011). It is possible that those who have experienced maltreatment may interpret happy or neutral faces as masks for more malevolent emotions, and so allocate more attention towards them (Pollak et al., 2000). Such individuals may allocate more attention towards happy faces and less towards sad faces in an effort to avoid negativity (Fani et al., 2011). Finally, it may be the case that those with histories of maltreatment do not consistently recognise sad faces as showing sadness (Pollak et al., 2000).

5.4.3. Effects of Depression

Unlike previous studies in pregnant women (Pearson et al., 2010), but similar to findings reported in Chapter 2 of this thesis, current symptoms of depression were not found to have an effect on attention towards infant faces. There is a strong evidence base suggesting that depression is associated with attentional biases towards negative emotional stimuli, so it is somewhat surprising that symptoms of depression were not associated with task performance in the current study (e.g. Mathews & MacLeod, 2005). However, it should be noted that a study of maltreated and non-maltreated children also found that while trait-rumination (a risk factor for depression) was associated with increased attention towards sad faces, this bias was not associated with current symptoms of depression and was still evident when controlling for depressive symptomatology (Pollak & Romens, 2012). Similarly, the current study found that differential attentional processing of infant as compared to adult faces between the low and high maltreatment groups still remained when controlling for symptoms of depression. It is possible that symptoms of depression did not affect task performance in the current study as few of the participants had clinically significant symptoms of depression (only 5 participants had BDI scores above 13, indicating mild depression, and no participants had scores in the “severe depression” range; Beck et al., 1996) and the sample size was small. Future studies may wish to further investigate further the possible associations between childhood maltreatment, depression, and attention towards infant and adult distress in larger samples, or in those with elevated levels of depressive symptomatology.

5.4.4. Limitations and Future Directions

There are several limitations to note in this exploratory study of the effects of childhood maltreatment on attentional processing of infant cues. Due to time constraints in recruitment and testing, the two maltreatment groups are not pair-wise matched, and they differ on a number of features, notably in number of years in education. Although number of years in education did not correlate with task performance, it would still be preferable to match the samples on all demographic variables. However, maltreatment is associated with an increased risk for other negative socio-demographic, environmental, and psychological outcomes, and so it will be challenging (although possible) for a future study to ensure that those with and without maltreatment histories are matched on these domains. There may be other variables not measured in this current study that may differ between the maltreatment groups which could potentially account for some of the findings observed, such as low social support, ongoing trauma and victimisation, and deprivation (Coid et al., 2001, 2003). Furthermore, the sample was too small to enter demographic variables in as covariates in the analyses. It is therefore difficult to tease apart the “pure” effects of maltreatment from the other risk factors that are commonly associated with maltreatment experience.

Another limitation already noted is that only Caucasian face stimuli were used in this study, whereas the participants varied in their ethnicity. The use of stimuli that were not matched to participant race may have influence performance, as previous research has shown that individuals are better at recognising and discriminating own-race faces (Meissner & Brigham, 2001), and own-race infant faces appear to preferentially attract attention, whereas other-race infant faces do not (Hodsoll et al., 2010). However, as race did not significantly differ between maltreatment groups, it is unlikely to account for the differences seen as a function of maltreatment experience. It may, however, go some way to explaining the differences observed in certain aspects of task performance between the participants in the current study and those in the previous studies reported in this thesis. In future, studies should create versions of task with stimuli matched to participant ethnicity.

It should also be noted that the information on experiences of childhood maltreatment is limited to self-report in this study, and therefore may be subject to recall or response biases. Also, although the CTQ asks questions about experiences of

abuse and neglect “in my family” it does not specifically ask about who the perpetrator of the maltreatment was. Furthermore, while CTQ can provide some information about the frequency of maltreatment, it is not a comprehensive measure of the severity or length of time of the maltreatment, both of which can affect later outcomes (Hildyard & Wolfe, 2002). Future studies may wish to include a battery of assessments of childhood maltreatment and adversity, ideally referencing contemporaneous and independent sources of information, such as that recorded in social work files.

5.5. Conclusions

This study has shown that mothers who have experienced comparatively high levels of childhood maltreatment do not preferentially allocate attention to infant compared to adult faces. By comparison, mothers who have experienced lower levels of childhood maltreatment, consistent with the pattern found with both mothers and fathers in the previous chapters of this thesis, show an attentional bias to infant faces over adult faces. This effect remained significant even after controlling for current levels of depression, a factor previously been shown to have effects on attention to emotion, and attention to infant cues. These results tentatively suggest that early experience may disrupt the preferential allocation of attention to infant faces, and this may in turn serve to compromise later parenting behaviour.

Chapter 6: General Discussion

6.1. Overview

Early childhood experiences of parenting have implications for later development, with “better quality” care and secure infant-parent attachments associated with more positive outcomes (Ainsworth et al., 1978; Bowlby, 1969/1982, 1973, 1980; Cassidy & Shaver, 2008; De Wolff & Van IJzendoorn, 1997). Effective parenting response involves the detection of and engagement with infant signals, correctly recognising the messages being communicated by the child, and responding to them in an appropriate and timely manner (Ainsworth et al., 1978; McElwain & Booth-LaForce, 2006; Mills-Koonce et al., 2007; Swain et al., 2007). During infancy, children are only able to communicate their needs or emotional states through crying or through body and facial movements; thus, infant facial expression represents a critical means of non-verbal communication between infants and their parents. In order for a parent to rapidly prepare to respond to their infant’s needs, they must first identify that their infants are conveying signals to them and identify them appropriately, despite many other environmental stimuli competing for attention. Thus, the ability to selectively attend to infant facial cues may facilitate caregiving responses (Brosch et al., 2007; Pearson et al., 2010, 2011; Thompson-Booth et al., 2013; Strathearn et al., 2009; Swain, 2011). Responding appropriately to infant signals is believed to be crucial for the infant’s learning about relationships between their communication and the care they can expect to receive, as well as providing a consistent context for the child’s social and emotional development (Beeghly et al., 2011; Belsky, 1997; Tronick, 1989).

However, aberrant childhood experiences, such as growing up in the context of abuse or neglect, or having a parent with emotional difficulties such as those seen in depression, anxiety, and high stress, are associated with poorer parent-child relationships and outcomes during childhood and throughout life (Cicchetti & Toth, 1995, 2005; Deater-Deckard, 1998; Goodman, 2004; Kaitz et al., 2010; Murray, Fiori-Cowley, et al., 1996). It has been theorised that the experience of childhood maltreatment disrupts the development of effective emotional information processing and regulation strategies, leading to the development of abnormal and potentially maladaptive attentional processes (Cicchetti & Toth, 2005; Gibb et al., 2009; Fani et al., 2011; McCrory et al., 2013; Pollak, 2008; Pollak, 2012). These may have implications for later mental health; information-processing biases are thought to be

one element underlying emotional difficulties (Bar-Haim et al., 2007; Gotlib & Joorman, 2010; Mathews & MacLeod, 2005; Pollak, 2008; Pollak, 2012). In turn, parents with histories of maltreatment or their own psychological difficulties appear to show less sensitive parenting behaviours (Baer & Martinez, 2006; Bailey et al., 2012; Berlin et al., 2011; Newcomb & Locke, 2001). Given that maltreatment histories and certain psychological difficulties are associated with difficulties in emotion processing, it may be that these parents also have difficulties in the cognitive processes underlying sensitive parenting behaviour, such as paying attention to infant facial cues and discriminating facial expressions requiring response.

6.2. Research Questions Addressed in This Thesis

There has been a relative dearth of behavioural studies in the attention literature investigating whether adults in general, and parents in particular, differentially process infant facial cues as compared to adult faces. This thesis set out to investigate individual differences in attentional engagement with infant faces, according to parental status, sex, symptoms of psychological distress, and childhood history of maltreatment. Variations of the same attention paradigm were used throughout these studies; this paradigm allowed the investigation of attention processing of stimuli that differed in age and emotion by varying the faces presented on screen while participants performed an un-related search task. By assessing differences in response times to the search target in the presence of different aged faces and different emotional conditions (emotional facial expressions present or absent), inferences about attentional engagement with the face stimuli on screen were able to be made. The research presented in this thesis endeavoured to answer five key questions: 1) Do emotional and non-emotional infant faces confer greater attentional engagement than older faces? 2) Do other young faces, such as that of pre-adolescent children, also engage attention to a greater degree than older faces? 3) Do mothers show particularly enhanced attentional allocation to infant faces as compared to non-mothers? 4) Do fathers show enhanced attentional allocation towards infant faces as compared to non-fathers? 5) Do symptoms of psychological stress and/or a history of childhood maltreatment impact

attentional processing of infant faces for mothers? The findings in relation to each of these questions will be considered in the sections below.

6.2.1. Attention Towards Infant Faces

In each of the empirical chapters in this thesis it has been established that infant faces engage attention to a greater degree than adult faces, as well as than pre-adolescent and adolescent faces, in different samples of women and men (Chapters 2-5). Although infant faces appeared to engage greater attention in both emotional and neutral search arrays, this effect was particularly enhanced when infant faces displayed emotional (happy and sad) facial expressions. These results are consistent with previous behavioural research using attention paradigms, which observed attentional biases towards neutral infant faces as compared to adult faces in college students (Brosch et al., 2007, 2008), as well as attentional biases to neutral and emotional infant faces as compared to adult faces in pregnant women (Pearson et al., 2010).

Electrophysiological and neuroimaging studies have also demonstrated that there might be enhanced neural responses, indicative of increased processing, towards infant as compared to adult face stimuli, with indications that these neural responses originate from regions of the brain associated with visual processing, face perception, and reward and motivation (Brosch et al., 2008; Glocker et al., 2009; Kringelbach et al., 2008; Noll et al., 2012; Proverbio et al., 2006, 2011). Some of these studies have also found that emotional infant faces elicit larger neural responses than neutral infant faces, with these responses originating from regions associated with reward processing (Noriuchi et al., 2008; Montoya et al., 2012; Proverbio et al., 2006, 2011; Swain et al., 2007). The finding that infant faces activate visual and face-specific regions early after their presentation is suggestive of increased allocation of attentional resources towards infant faces. This may allow emotional cues to be “tagged” as relevant early on, allowing rapid preparation of appropriate responses (Kringelbach et al., 2008). Meanwhile, the activation of reward and motivation circuits, even when infant faces present with distress, suggests that infant faces are rewarding stimuli that provide incentive for continued engagement and motivation for care-giving responses (Proverbio et al., 2011; Swain, 2008, 2011; Swain et al., 2007).

Taken together, this set of studies suggests that infant faces are particularly salient stimuli for adults. It has previously been proposed that infant faces have

intrinsic qualities that signify their young age and vulnerability, and that elicit positive emotions and care-taking responses from adults (Lorenz, 1943, 1971). Indeed, ratings of the stimuli used in the studies reported in this thesis (see Chapters 2 and 3) indicate that the infant faces were rated as more emotionally arousing and vulnerable than older faces. Furthermore, Brosch and colleagues (2007) demonstrated that attentional biases towards infant faces correlated with the arousal ratings of the faces presented. Given that infants are completely dependent on adults for their survival, such a mechanism by which infants can automatically attract care-giving behaviour would be evolutionarily advantageous (Bowlby, 1982/1969; Darwin 1872/1904; Lorenz, 1943, 1971). There has been plenty of research demonstrating that other socially significant stimuli, such as emotional facial expressions more generally, have privileged access to attention as they provide information about possible threat and affiliation that may require behavioural responses (e.g. Eastwood et al., 2001, 2003; Hansen & Hansen, 1988; Pinkham et al., 2010; Vuilleumier, 2005). It is theorised that those stimuli that are evaluated as important to immediate goals, wellbeing and survival, demand increased allocation of attention and processing at the expense of other environmental information (Field & Cox, 2008; Mogg et al., 2007; Sander et al., 2005). Therefore, it appears that infant faces, particularly when expressing emotional facial expressions but also when neutral, may be evaluated as significant stimuli and selectively attended to. This process may allow infant cues to be prioritised for recognition and response, which may then facilitate sensitive care-giving responses.

6.2.2. Attention Towards Pre-adolescent Child Faces

While infant faces appear to be particularly salient social stimuli, it is less clear whether faces of pre-adolescent children should also capture attention. Pre-adolescent children also require high levels of parental care and sensitive parenting responses are likely to also be important outside of the infancy period (Belsky & Fearon, 2002; Belsky, 1984; Sroufe, 1988; Thompson, 2000; Waters et al., 2000). Previous studies had reported some preference for pre-adolescent faces as compared to older faces, but these effects were less strong than those observed for infant-face preferences (Luo et al., 2011; Proverbio et al., 2011). The studies reported in Chapters 3 and 4 of this thesis found that pre-adolescent child faces do receive enhanced attentional engagement as compared to adolescent and adult faces, but only when they display negative affect

(although it should be noted that this effect appears to be weaker in men; see Chapter 4). It is possible that sad affect in pre-adolescent children indicates enhanced vulnerability and need for care, compared to expressions of sad affect in older individuals. Indeed, ratings of the pre-adolescent stimuli (see Chapter 3) indicated that pre-adolescent child faces were rated as more emotionally arousing and vulnerable when displaying sad affect as compared to adult and adolescent faces. It should also be noted that ratings of perceived vulnerability of sad pre-adolescent faces were not statistically different to ratings of sad infant faces, suggesting that signs of distress increase potential vulnerability of pre-adolescent faces and may solicit care.

While pre-adolescent children are more self-sufficient than infants and are able to verbalise their needs more easily, they still require parental support to regulate emotional distress and promote emotional development (Belsky, 1984; Grolnick & Farkas, 2002; Kopp, 1989; Lengua, 2002; Mathis & Bierman, 2012). However, pre-adolescent child faces did not engage attention to a greater degree than adolescent or adult faces when expressing neutral affect, suggesting that the general saliency of child faces diminishes as they age. Once children are able to speak, they are less likely to rely solely on facial cues to communicate their needs, and so facial expressions that do not indicate immediate threat or distress for the child may be less pertinent to sensitive parental responses for this age group. Furthermore, as children grow older the strength of their *Kindchenschema* characteristics declines, which may have implications for their potential to elicit attentional prioritisation when not expressing emotions as compared to older faces (Alley, 1981; Enlow, 1982; Hildebrandt & Fitzgerald 1979; Lorenz, 1971; Luo et al., 2011; Struhsaker, 1971).

6.2.3. *Attention Towards Infant Faces For Mothers of Infants*

Although neuroimaging and electrophysiological studies have made comparisons between parents and non-parents when viewing infant faces, behavioural studies employing attention paradigms have not made such comparisons. It has been found that mothers show greater ERP responses when viewing infant faces as compared to non-mothers, and that this neural response appeared to be influenced by infant emotion for mothers only (Proverbio et al., 2006, 2007; although see Noll et al., 2012). It has also been found that mothers show increased activation in brain regions associated with empathy when viewing infant facial expressions as compared to non-

mothers, although no differences were found between these groups when viewing adult faces (Nishitani et al., 2011). Consistent with these research findings, the studies reported in Chapters 2 and 3 demonstrate that while both mothers and non-mothers were more engaged with infant faces than adult faces, this effect was particularly pronounced for mothers. Furthermore, the study reported in Chapter 3 found that while mothers allocated more attention to infant faces than to adult, adolescent and child faces, non-mothers only showed differences between infant and adult face conditions, suggesting that they did not allocate more attention towards infant faces than to child or adolescent faces.

Infant faces are likely to be a particularly salient stimulus for mothers as selectively attending to infant cues may help promote care-giving responses. There are several possible explanations for the difference in responding to infant faces between mothers and non-mothers. Firstly, mothers may be more familiar and thus “experts” at viewing infant faces in attempts to discriminate facial expressions and provide adequate care according to the child’s needs. Although the non-mothers recruited for Chapters 2 and 3 all had some childcare experience, they did not live with or work with infants and so would have had less exposure to infant faces and thus may be less likely to develop such a specialised response to infant faces. There is evidence to suggest that attentional engagement with certain stimuli is associated with the degree of “real-life” engagement with that stimuli (Field & Cox, 2008), and so non-mothers may not show such heightened attentional engagement due to not having to engage with infants in “real-life”.

Secondly, behavioural changes in processing infant cues may develop over the course of pregnancy and be associated with the biological changes that occur during the antenatal and post-natal period (Pearson et al., 2010, 2009). Pregnancy and childbirth are associated with a cascade of changes in neuroendocrine systems (e.g. dopamine-reward and oxytocinergic systems), which have been hypothesized to prepare women for motherhood by initiating maternal thoughts and behaviours (Brunton & Russell, 2008; Kinsley & Amory-Meyer, 2011; Numan, 2007; Strathearn et al., 2009; Swain, 2011). It has been found that the ability to discriminate between different emotional expressions becomes enhanced from early to late pregnancy (Pearson et al., 2009). Furthermore, Pearson and colleagues demonstrated that an attentional bias towards distressed infant faces was present during pregnancy and also associated with mothers’ ratings of her relationship with her infant after birth (Pearson

et al., 2010, 2011). It has also been found that pregnant women's self-reports of stronger attachment towards their unborn infants are associated with sensitive parental responding after birth (Shin, Park, & Kim, 2006; Siddiqui & Hägglöf, 2000). It would be advantageous for mechanisms underlying maternal responding to develop over pregnancy so that they are in place from the moment the infant is born, as newborns are completely helpless and depend entirely on parental care.

Finally, given that viewing infant stimuli (particularly own infant face) is associated with activation in reward and empathy networks, it may be that mothers' attentional engagement with infant stimuli is driven by an empathic response (Bartels & Zeki, 2004; Nitschke et al., 2004; Nishitani et al., 2011; Noriuchi et al., 2008; Strathearn et al., 2009; Swain et al., 2007). Swain and colleagues (2007) report that even distressed infant faces activate reward-processing circuits in mothers; finding distressed infant faces rewarding may provide motivation to engage with and respond to infants rather than treat infant distress as aversive and withdraw from it (Swain et al., 2007).

6.2.4. Attention Towards Infant Faces for Fathers of Infants

Father-infant relationships are far less well researched than mother-infant relationships, despite father-infant attachment and paternal sensitivity also having implications for child outcomes (e.g. Atzaba-Poria & Pike, 2008; Bretherton, 2010; Cowan, 1997; Lamb, 2010; Main & Weston, 1981). The study reported in Chapter 4 found that men appear to show preferential allocation of attention towards infant faces as compared to adult, adolescent, and pre-adolescent faces, although this only appeared to be the case for fathers. Furthermore, comparisons of fathers' responses with those from the mothers who took part in the study reported in Chapter 3 did not reveal any differences in this "attentional bias" for infant faces between fathers and mothers. This suggests that both mothers and fathers of infants show greater attentional engagement with infant faces than older faces. This finding is consistent with neuroimaging work showing that both fathers and mothers show increased activation in the amygdala and interconnected limbic regions in response to infant cries as compared to men and women without children (Seifritz et al., 2003). Other studies have reported preliminary findings suggesting that both fathers and mothers activate reward networks when viewing their own infants' faces (Swain et al., 2011). These activations may reflect

adaptive changes in the brain as a result of becoming a parent that may be necessary for providing adequate parental care and sufficient parent-infant bonding (Seifritz et al., 2003). Although neuroplastic changes in mothers' brains relevant for maternal response are hypothesised to occur during pregnancy (Kinsley & Amory-Meyer, 2011, 2012), research has also shown that new fathers also show similar changes in hormonal levels to mothers around the birth of their infants (Storey et al., 2000; Storey & Walsh, 2012). Therefore, maternal and paternal roles may share underlying physiological mechanisms (Swain et al., 2011; Storey & Walsh, 2012).

There is also evidence from electrophysiological and neuroimaging studies suggesting that mothers and fathers show similarities as well as differences in neural processing when viewing infant faces. For example, Proverbio and colleagues (2006) noted that at early stages in visual processing mothers and fathers differed in their ERP response towards infant faces, however by around 200ms after stimulus onset mothers and fathers showed similar responses to infant faces, which were greater than neural responses observed for non-parents (Proverbio et al., 2006). At this point in processing, parents showed stronger activation in response to negative infant facial expressions than non-parents, suggesting that both mothers and fathers are more sensitive to differences in the intensity of infant distress. However, the same study reported that at later stages in processing mothers again showed greater activation than fathers, although fathers still showed more activation than non-parents. In a study of mothers and fathers from the same couple, Atzil and colleagues (2012) found that both fathers and mothers showed similar activations in social-cognitive networks implicated in empathy and social cognition when viewing their own infant's face as compared to an unknown infant. However, mothers showed more activation in limbic regions than fathers, whereas fathers showed more activation in social cognitive circuits than mothers, which Atzil and colleagues suggest may reflect the differences in parenting behaviours observed for mothers and fathers (Atzil et al., 2012). These studies suggest that while fathers also show parent-specific neural responses to infant faces, there may also be some subtle mother-father differences. However, it appears from the current study that any subtle neural differences in early visual processing did not manifest at the behavioural level when allocating attention to infant faces. Furthermore, it should be noted that Proverbio's study recruited fathers and mothers with children who were not necessarily infants; it may be that attentional engagement with infant facial cues are particularly pronounced for first-time mothers and fathers of infants, who were

recruited for the studies reported in Chapter 3 and 4. Taking these studies together, it seems that basic processes such as automatic attentional allocation towards infant faces are likely to characterise the parenting response more generally, consistent with a common enhanced sensitivity in parents compared to non-parents.

6.2.5. Depressive Symptoms, Parenting Stress, Maltreatment and Attention to Infant Faces

In Chapter 2 and Chapter 5 of this thesis mothers were assessed for individual differences in attentional engagement with infant faces according to symptoms of depression, parenting stress (Chapter 2), and history of childhood maltreatment (Chapter 5).

6.2.5.1. Depressive Symptoms

In both Chapter 2 and Chapter 5, symptoms of depression as measured by the BDI were not found to be associated with performance on the attention task. This is somewhat surprising given that previous studies have demonstrated that depression can affect attentional engagement with emotional facial expressions for generally (Joorman & Gotlib, 2010; Mathews & MacLeod, 2005). Furthermore, it has been found that symptoms of depression in pregnant women reduce attentional biases towards infant distress, and that CBT treatment can increase these biases to the level of healthy women (Pearson et al., 2010, 2013). There are several possible explanations for these discrepant findings. The first is that none of the women in the study reported in Chapter 2 were currently diagnosed or receiving treatment for depression, and very few women in either the study in Chapter 2 or Chapter 5 had clinically significant levels of depressive symptoms. It is possible that the effects of depression on attentional engagement with infant faces are only evident in clinically depressed (or more severely depressed) samples, or that there was not enough variability in the levels of depression or statistical power in these small samples in order to detect the effects of depression on attentional processing. Another possibility is that depression has more severe implications for attentional biases towards infant faces in pregnant women rather than women who are already mothers; during pregnancy attentional processes involved in recognising and discriminating infant cues may still be developing and thus more vulnerable to the effects of depression. This hypothesis would require further

investigation. It is also possible that the association between depression and attention to infant faces might be stronger when women are presented with faces of their own children rather than infant faces more generally, as observational studies suggest that post-natal depression is associated with impaired sensitivity and poorer interactions with one's own infant (Brockington, 2004; Cohn, Matias, Tronick, Connell, & Lyons-Ruth, 1986; Murray, Fiori-Cowley, et al., 1996).

6.2.5.2. Parenting Stress

The study reported in Chapter 2 observed a negative correlation between responses to infant faces and scores on the Distress subscale of the PSI. This suggests that levels of parental distress are associated with attentional engagement with infant faces, such that mothers experiencing higher levels of parental distress show less engagement with infant faces. Given the small sample size and the relatively modest correlation coefficient, this should be considered a preliminary finding that requires further investigation. Nonetheless, this finding suggests that mothers experiencing higher levels of parental distress may be less sensitive to infant faces than parents who experience lower levels of parental distress. This is consistent with studies showing that parenting stress is associated with reduced parental sensitivity and poorer attachment quality (e.g. Barry et al., 2005; Deater-Deckard, 1998; Huth-Bocks & Hughes, 2008; Jarvis & Creasey, 1991; Pereira et al., 2012; Taylor et al., 2009; Teti et al., 1991).

It should be noted that only the parental distress subscale appeared to be associated with task performance in the study reported in Chapter 2; this may be because the parental distress subscale measures stress experienced by the parent within the parenting role, whereas the other PSI subscales measure stresses within the parent-child relationship. It may be that the stresses measured by the other PSI subscales are more specific to mothers' own children, rather than responding to infants' faces more generally. It should also be noted that it is not possible to delineate the causal nature of this association between parental distress and attentional engagement with infant faces. It may be that mothers who allocate less attentional resources to infant faces consequently experience higher levels of parental distress, as they may feel that infant signals are more ambiguous (cognition to parental distress effect). Alternatively, higher

levels of parental distress may cause difficulties in processing infant cues, perhaps due to problems in emotion regulation (parental distress to cognition effect).

6.2.5.3. Childhood maltreatment

The study reported in Chapter 5 found that mothers who had experienced comparatively high levels of childhood maltreatment did not appear to preferentially allocate attention to infant compared to adult faces. By comparison, mothers who had experienced lower levels of childhood maltreatment showed heightened attentional engagement with infant faces over adult faces, consistent with the results found for mothers and fathers in Chapters 2-4. The difference in attention allocated to infant as compared to adult faces observed between the low and high maltreatment groups was still observed when controlling for current symptoms of depression, suggesting that this difference was not driven by higher levels of depression in the higher maltreatment group.

It is not yet clear what may drive this lack of preferential attentional engagement with infant faces. As discussed in Chapter 5, it is possible that infant faces may not hold the same salience or incentive value for women who have experienced a difficult childhood. Such a suggestion is in line with studies suggesting that parents' with histories of maltreatment show less involvement with their children (Driscoll & Easterbrooks, 2007; Lyons-Ruth & Block, 1996; Moehler et al., 2007). Preliminary findings from an fMRI study have suggested that mothers with histories of childhood maltreatment showed enhanced activations in the anterior cingulate cortex in response to viewing faces of their own children, which has been hypothesised to possibly reflect negative evaluation of infant facial cues (Barrett et al., 2009). Another fMRI study found that mothers' attachment styles may be associated with neural responses to their infants' faces, such that mothers with insecure attachment styles showed less activation of reward processing regions of the brain (Strathearn et al., 2009). Although these mothers did not necessarily have histories of maltreatment, this study suggests that attachment representations formed in childhood may impact on later neural responses to infant faces. This reduced reward circuit activation may reflect reduced engagement with infant signals, which may then have implications for parental responses (Strathearn et al., 2009).

However, it is also possible that women who experienced maltreatment show a similar amount of attention towards infant faces as those with fewer maltreatment experiences, but fail to differentially allocate attention between infant and adult faces. It is possible that adult faces are particularly salient for people with histories of more severe maltreatment due to the perceived possibility of threat from an adult face (e.g. Pollak, 2008, 2012). Another possibility is that women in the high maltreatment group are less able to make subtle discriminations between different aged faces, similar to the deficits seen in maltreated children when trying to discriminate facial expressions (Pollak et al., 2000).

Again, it should be noted that this is a preliminary finding in a relatively small sample and requires further investigation, but it does provide tentative evidence that early adverse childhood experiences may disrupt the development of attentional biases towards infant faces as compared to adult faces. This absence of enhanced attentional engagement with infant faces may have implications for parenting behaviour, such as decreased sensitivity to an infant's communicative signals, which may heighten the possibility of failing to detect an infant's cues.

6.3. Limitations

As noted in each of the empirical chapters, there are some limitations in the research reported in this thesis that future studies should address. Firstly, the research is limited by a number of sampling issues, not least the relatively small sample sizes. For example, the participants recruited for Chapters 2-4 were generally middle-to-high income, university educated participants with low or no symptoms of psychological problems. Only first-time parents were recruited for Chapters 2-4, as well as only including women who had breast-fed their child. Furthermore, all of the fathers recruited for the study reported in Chapter 4 were still living with their partner and child, which again is not necessarily the case for fathers more generally. Secondly, there is a related issue pertaining to controlling (or not controlling) for a range of parenting characteristics. For example, while it may be advantageous to control for demographic aspects such as number of children, singleton pregnancy, and history of breastfeeding, as these factors may impact parenting sensitivity (Kim et al., 2011;

Pearson, Lightman, & Evans, 2011b; Swain, 2011), such an approach may have generated a sample that is not in fact representative of parents more generally. Conversely, there are also several other variables that may potentially impact parenting sensitivity, and thus possibly affect attentional engagement with infant faces, that were not controlled for, such as method of birth, social support, and other symptoms of psychopathology (Brockington et al., 2006; Goldstein, Diener, & Mangelsdorf, 1996; Swain et al., 2008).

Thirdly, in relation to the stimuli employed, it is worth noting that Caucasian stimuli were used, notably in Chapter 5 where a mixed race sample of participants was recruited. As discussed this may be problematic given that previous research has shown that individuals are better at recognising and discriminating own-race faces (Meissner & Brigham, 2001), and own-race infant faces appear to preferentially attract attention, whereas other-race infant faces do not (Hodsoll et al., 2010). However, similar effects were found in Chapter 5 as those reported in earlier chapters, despite having a sample of women who were more heterogeneous in terms of socio-demographic variables, ethnicity, and number of children. This suggests that the results reported in Chapters 2-4 may still be generalisable to other parents.

Fourthly, detailed reports on how much time participants spent with their children were not collected. For instance, while all of the fathers who participated in the study reported in Chapter 4 were living at home with their child and partner and were in full-time employment, details were not collected on how much time they spend interacting with their infants and what types of parenting tasks they perform. Furthermore, details were not collected about whether the mothers who participated in these studies had returned to employment. Also, while all non-parents reported at least some childcare experience but not living or working with children, it is still not clear exactly how much and what kinds of childcare experience these non-parents had. Future studies may wish to collect more detailed information regarding quantity and quality of childcare experiences for both parents and non-parents. It would be of interest to recruit groups of non-parents who have more extensive experience of caring for children, such as nursery workers or teachers, in order to see if expertise has an effect on attentional engagement with infant facial cues. It should also be noted that while participants were excluded for current pregnancy, details were not collected regarding menstrual cycle stage or the use of hormonal contraceptives, which may also impact perception of infant faces (Perrett et al., 2010; Sprengelmeyer et al., 2009).

Fifthly, all of the experiments reported in this thesis involved showing participants photographs of faces of adults and children who were unknown to them. An important step for future behavioural research will be to include photographs of mothers' and fathers' own children, as it is likely that own child faces will be of particular interest to parents. Indeed, there is a growing set of neuroimaging and electrophysiological studies that suggest that neural responses towards infant faces are particularly pronounced for one's own child, with enhanced activations observed in areas associated with reward and motivation, theory of mind, and empathy (Bartels & Zeki, 2004; Strathearn et al., 2008; Leibenluft et al., 2004; Lenzi et al., 2009; Noriuchi et al., 2008; Ranote et al., 2004; Swain, 2011; Swain et al., 2007). Activation in neural circuits involved in empathy and reward suggest that parents are likely to find their own children more rewarding than other children and are more motivated to provide their care (Swain, 2011; Swain et al., 2007). Increased attentional allocation to one's own child over other children may thus have stronger ties to a sensitive parenting response, as parents are likely to find their own child's face rewarding, and attentional biases towards one's own child are likely to ensure parents focus on the child for which they are responsible. It is also important to keep in mind that children also contribute to the parent-child relationship (e.g. Atzaba-Poria & Pike, 2008; Bornstein, Hendricks, Haynes, & Painter, 2007; Kiff, Lengua, & Zalewski, 2011; Laukkanen, Ojansuu, Tolvanen, Alatupa, & Aunola, 2013). Parents who have fussy or difficult children may have a more negative relationship with them, which may be reflected in their attention and response to own child faces. It may therefore be helpful to collect concurrent data on individual own-child temperament.

Finally, it should be noted that in Chapters 2 and 3 it was found that mothers had slower task performance overall than non-mothers, while in Chapter 4 there was a non-significant trend for fathers to be slower than non-fathers (with parents slower than non-parents when collapsed across genders). Although it is possible that the slower responses seen in parents reflects an increase in attention to social stimuli in general for parents as compared to non-parents, it was not possible to investigate this hypothesis directly with the attention task used throughout these studies. It may also be the case that parents have slower responses to reaction time based tasks more generally, perhaps due to cognitive changes associated with having a child (e.g. Eidelman, Hoffmann, & Kaitz, 1993; Parsons & Redman, 1991) or due to factors such as tiredness. Future studies should include additional tasks to measure reaction times to

non-social stimuli as this may elucidate whether parents are indeed more engaged with facial stimuli more generally than non-parents.

6.4. Implications and Future Directions

While there are a great number of studies that have investigated sensitive parenting by observing parent-child interactions, relatively little is known about to what degree variation in parental behaviours are due to differences in sensitivity at the more basic sensory level. Individual differences in information processing, such as attention towards and accurate recognition of socially salient stimuli, have been hypothesised to underlie psychological disorders and arise as a possible consequence of early childhood experiences. The ability to prioritise infant signals early in attentional processing may be important for developing appropriate care-giving responses, and understanding variations in these skills may go some way to explaining successes and difficulties in parenting behaviours. However, while detecting and prioritising infant facial stimuli has been the focus of this thesis, it is only one component of the parenting response. There are likely to be several other distinct components involved in processing infant signals, which may include recognition and discrimination of emotional states and the ability to regulate one's own emotional response, in order to provide sensitive caregiving. It will be important for future studies to systematically investigate these components and look at whether individual differences in parental status, childhood experiences, and psychopathology impact these processes.

A speculative information-processing model of parental responding is illustrated in Figure 6.1. It is suggested that parental processing of infant communicative signals may be characterised by a number of stages, including detection, recognition and discrimination, and emotional regulation, before a caregiving response can be generated. The current thesis has focussed only on the first stage (detection).

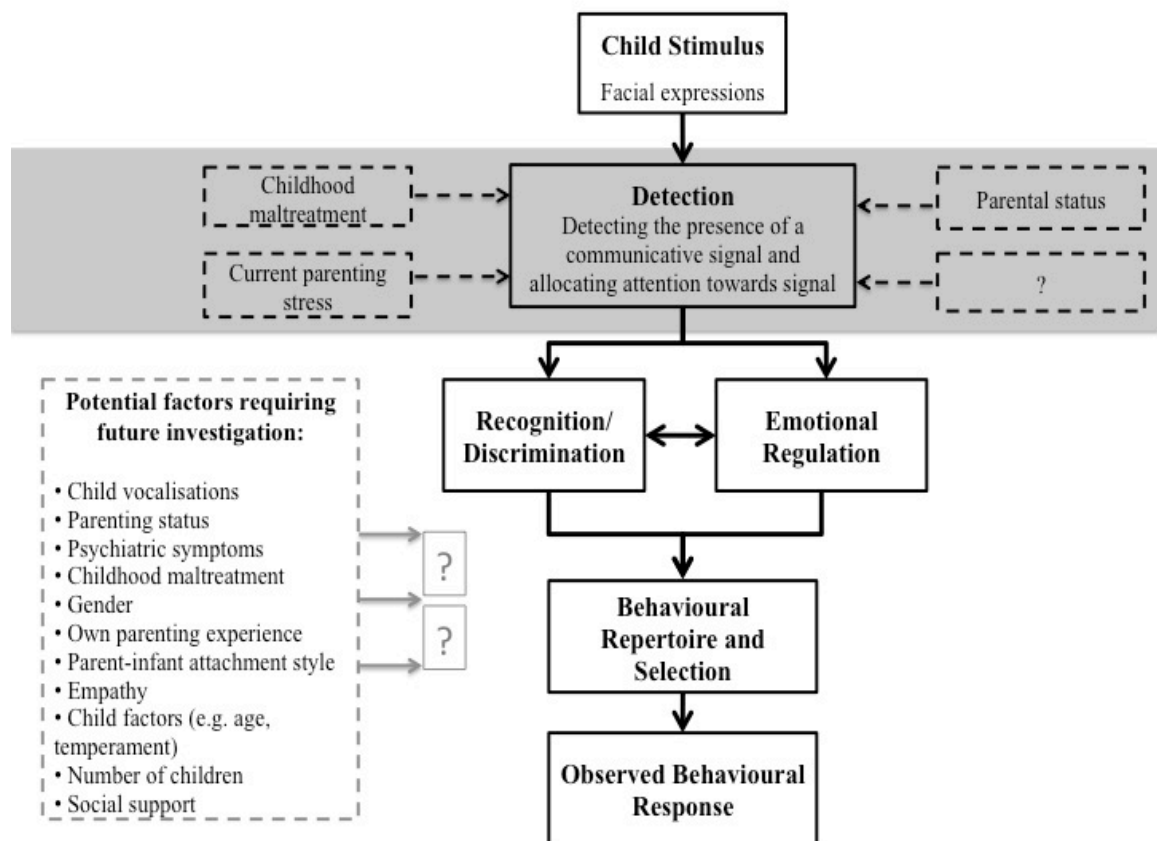


Figure 6.1. Information-processing model of parental responding when viewing infant faces.

In this initial detection stage the parent allocates additional attentional resources towards the infant, prioritising the infant's signal over other concurrent environmental stimuli. In the next stage of processing, the parent must decide that the emotion being expressed is sadness or distress (or another emotion). They must also be able to regulate their own emotional response to this signal in order to prevent becoming overwhelmed or frustrated, for example. Finally, based on their labelling of the signal (as well as other factors such as memory of previous responses to this type of signal, knowledge of their child's temperament, etc.), the parent will generate a response to the infant's signal, such as comforting the infant or attending to his needs. The ability to generate an optimal response will also relate to the repertoire of caregiving behaviours that have been learnt by the parent.

The studies reported in this thesis have focused on the detection stage of this process, showing that parental status, the presence of facial emotion, childhood experience of maltreatment, and symptoms of parenting stress are associated with attentional engagement with infant faces as compared to other-aged faces. By contrast, participant gender and symptoms of depression do not appear to have an effect on this early stage of processing. Nonetheless, gender and depression may impact processing at other stages. For example, it was found in the study reported in Chapter 4 that men did not show slowed responses to emotional non-target faces whereas women did (Chapters 2 and 3), suggesting that women were more distracted by the emotional content of non-target faces than men. It has also been found that women are superior at recognising emotions from facial cues and are more sensitive to subtle differences in facial expressions (Babchuk et al., 1985; Hall & Matsumoto, 2004; Hampson et al., 2006; Lobmaier et al., 2010; Merten, 2005; Proverbio et al., 2007; Rotter & Rotter, 1988; Sprengelmeyer et al., 2009; Thayer & Johnsen, 2000). Other studies suggest that men and women may also differ in emotional regulation strategies, such as cognitive reappraisal (Gross & John, 2003; McRae, Ochsner, Mauss, Gabrieli, & Gross, 2008; Weinberg, Tronick, Cohn, & Olson, 1999). Studies have also reported that individuals with depression show deficits and biases in accurately recognising emotional and neutral facial expressions (Carton et al., 1999; Gollan et al., 2008; Gotlib & Joormann, 2010; Gur et al., 1992; Joormann & Gotlib, 2006; Leppänen et al., 2004). It may then be that differences in responding to child cues according to gender and/or symptoms of depression are explained in part by differences in accurately discriminating emotional cues and regulating own emotions, but this requires investigation.

Experiences of maltreatment and parenting stress, as well as other aspects of parenting and functioning not measured in this thesis, may also impact these later stages. For example, the experience of maltreatment has been associated not just with attention to emotion but also with impaired abilities to recognise and discriminate between emotional information (Cicchetti, 2002; Gibb, 2002; Pollak 2008, 2012; Pollak & Kistler, 2002; Pollak & Sinha, 2002). It is possible that differences between parents and non-parents will not manifest at the stage of emotional recognition, as the studies reported in Chapters 2-4 suggest that both parents and non-parents show increased attentional engagement with emotional target faces as compared to neutral faces, as well as both showing particularly heightened attentional engagement with infant emotional faces. However, as the task used in the studies reported in this thesis

did not explicitly measure discrimination between emotional expressions nor emotional regulation or reactivity, further investigation is needed using more explicit emotional recognition and discrimination tasks, as well as tasks assessing emotional regulation and reactivity in response to infant signals (particularly infant distress). As an example, future studies could use tasks measuring speed and/or accuracy of identifying infant emotional expressions in order to index emotion recognition. In order to assess emotional regulation processes, future studies could measure physiological reactivity and mood ratings before, after, and during the viewing of infant faces displaying varying levels of distress. Although the model proposed in Figure 6.1 is purely speculative at this point, it suggests interesting directions for future research.

It will also be important to investigate whether attentional engagement with infant faces observed in behavioural studies is associated with real life parenting performance. While the studies reported in Chapter 2 and 5 suggest that parenting stress and history of maltreatment, which are known risk factors for poorer parent-child relationships, might be associated with less engagement with infant facial cues, it is not currently clear how attenuated attentional biases might relate to actual parenting performance. It is hypothesised that prioritising infant facial cues, particularly emotional cues, is one factor underlying sensitive parental responding, but this is yet to be correlated with observations of mother-infant interactions. Furthermore, attentional engagement with infant facial cues is only one possible aspect of sensitive parenting behaviour; future studies should also assess sensitivity towards infant vocalisations.

It may also be interesting to consider whether attentional biases for infant faces might be altered in parents with more than one child. The studies reported in Chapters 2-4 recruited first-time parents who currently had infant children. It may be that having more than one child increases attentional engagement with infant faces due to some element of expertise. Conversely, it might be that attentional biases are particularly important for first-time parents as they are learning about ways to respond to children, and once in place these attentional processes may not differ according to parity. Furthermore, as previously discussed, it may also be the case that parents who have older children show attentional biases towards older child faces, as this is the age range currently relevant to their parental behaviour. For example, one neuroimaging study found increased neural activation for faces of children aged 5-12 years old than adult

faces; however, mothers in this study had children in this age range (Leibenluft, et al., 2004).

It will also be important for future studies to use prospective longitudinal designs to follow up children at-risk for maltreatment throughout life and into adulthood in order to tease apart the directional nature of the effects of maltreatment on the formation of particular attentional biases, how these may relate to developing psychological difficulties, and how each of these factors relates to sensitive parenting behaviour in adulthood. Such studies could use a multi-faceted battery of assessments, such as observational techniques, neuroimaging methodology, physiological measures, and attention paradigms in order to understand further the impact of particular information processing styles on parenting behaviour. It will also be valuable to be able to assess whether childhood maltreatment has effects on later parenting behaviour over and above current sociodemographic risk factors. As an example, a parent who experienced a difficult childhood may have a poor relationship with their family that persists in to adulthood, which may cut them off from a critical source of social support when becoming a parent (e.g. Dench & Ogg, 2002; Lavers & Sonuga-Barke, 1997). Those with experiences of childhood maltreatment are also at risk for outcomes that could in turn impact parenting behaviour, such as teenage parenthood, lower income, lower educational attainment, and current victimisation (Coid et al., 2001, 2003; Gilbert et al., 2009).

Finally, if further research supports an association between attenuated attentional engagement with infant facial cues at the sensory level and poorer mother-infant relationships, it may be of interest to develop attentional bias modification paradigms in order to improve attentional engagement with infant faces and more accurate discrimination of infant emotional cues. Attentional bias modification paradigms have been developed to help alleviate symptoms of anxiety disorders, with some success (Bar-Haim, 2010; Hakamata et al., 2010). Furthermore, there are existing parent-baby programs and interventions which aim to improve parental sensitivity, which often include elements regarding understanding and engaging with infant cues such as crying, and which have been found to improve parent-child interactions (e.g. Bakermans-Kranenburg et al., 2003; Jung, Short, Letourneau, & Andrews, 2007; Kalinauskiene et al., 2009; Moss et al., 2011). Further understanding of the underlying cognitive mechanisms that may lead to impaired care-giving responses could potentially inform and improve such interventions.

6.5. Conclusions

Parents of infants are limited in the communications they receive from their young children and so facial cues signalling the infant's affective state become particularly important. Infant faces are thus highly salient social stimuli that are believed to elicit intuitive care-giving behaviours. Allocating attentional resources towards infant faces may be an important prerequisite for accurate identification of infant cues and appropriate parental responding. The studies reported in this thesis employed a behavioural paradigm to measure attentional engagement with infant faces, finding that infant faces received heightened allocation of attention as compared to pre-adolescent, adolescent, and adult faces, regardless of emotional expression but particularly when expressing happiness or sadness. Furthermore, both mothers and fathers showed enhanced attentional engagement with infant faces as compared to non-parents. It was also found that faces of preadolescent children also received greater attentional engagement than adolescent and adult faces, but only when these faces expressed distress, suggesting that emotional content may heighten the perceived vulnerability of child faces outside of infancy. However, symptoms of parenting stress or a history of experiences of childhood maltreatment appeared to attenuate attentional engagement with infant faces as compared to adult faces, which may be associated with less sensitive responding to infant facial cues.

The findings reported in this thesis support the hypothesis that infant faces are particularly salient stimuli, and also suggest that parenthood is associated with increased attention to infant faces. It may be that increased attentional engagement with infant faces reflects part of a wider set of adaptive behavioural changes associated with becoming a parent. However, these changes may be modulated by early or current adverse life experiences, which may affect normative attention and reward processes involved with viewing and discriminating infants cues, and may also have implications for the parental response. The findings in this thesis propose that parenting responses may be associated with more basic cognitive mechanisms involved in processing emotional information. Further understanding the attentional processing of infant facial cues, as well as vocalisations, may help delineate these basic cognitive mechanisms that contribute to parental sensitivity and may help inform clinical interventions for parents at risk for poorer parenting behaviour.

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