

Maternal Depression in the Still-Face Paradigm: A Meta-Analysis

Katharine A. Graham^{1,2,3}, Jacqueline Blissett⁴, Evangelia E. Antoniou⁵, Maurice P. Zeegers⁶,
& Joseph P. McCleery^{1,7}

¹School of Psychology, University of Birmingham, UK

²Department of Psychology & Counselling, Newman University, UK

³Department of Psychology, University of Johannesburg, South Africa

⁴Faculty of Health and Life Sciences, Coventry University, UK

⁵Department of Clinical Psychological Science, Faculty of Psychology and Neuroscience,
Maastricht University, Maastricht, The Netherlands.

⁶Department of Complex Genetics, Cluster of Genetics and Cell Biology, NUTRIM School
for Nutrition, Toxicology and Metabolism, Maastricht University Medical Centre,
Maastricht, The Netherlands.

⁷Center for Autism Research, Children's Hospital of Philadelphia

Correspondence to:

Katharine A. Graham

School of Psychology, Newman University

Genners Lane, Bartley Green B32 3NT

United Kingdom

K.Graham@newman.ac.uk

ABSTRACT

The Still-Face Paradigm (SFP) enables researchers to examine the quality of mother-infant interactions. In typical infants, a classic still-face effect (SFE) has been confirmed whereby infants demonstrate reduced positive affect (PA), reduced gaze (GA), and increased negative affect (NA). The SFP has been used to examine the effect of maternal depression upon infant behaviour. However, the nature and consistency of the behavioural responses of infants of depressed mothers during the SFP remains unclear. In the current meta-analysis, we examined whether or not infants of depressed mothers demonstrate the classic SFE, as well as whether or not these infants display the same levels of PA, NA, and GA as their counterparts with non-depressed mothers. Results revealed that infants of depressed mothers display the classic SFE like infants of their non-depressed counterparts. However, infants of depressed mothers also demonstrated significantly higher levels of PA during the still-face episode. One potential interpretation of this finding is that infants prior experience of similar, depressed interactions with their mothers, encourages them to amplify their positive attachment signals in order to engage maternal attention and response. Alternatively, or additionally, infants of depressed mothers could be using PA in order to regulate their own NA.

KEYWORDS

Infant, Still-Face Paradigm, Depression, Mother-Infant Interaction, Maternal
Psychopathology

INTRODUCTION

The Still-Face Paradigm (SFP), designed by Tronick, Als, Adamson, Wise, and Brazelton (1978) has been used in large number of studies and is a useful paradigm which enables researchers to examine the quality of mother-infant interactions (Guesella, Muir & Tronick, 1988). In the SFP infants are typically observed in a three stage face-to-face interaction with an adult (see Mesman, Ijzendoorn, & Bakermans-Kranenburg, 2009, for review). The first stage (baseline) is a typical face-to-face interaction episode in which the adult is instructed to interact with the infant as they normally would. The second stage (still-face) involves the adult remaining in front of the infant but adopting a still face and becoming unresponsive. The third stage (reunion) involves the adult resuming normal interaction with the infant. Infants are scored throughout each stage on their positive affect (e.g., smiling, laughing), negative affect (e.g., crying, distress brow), and gaze aversion (i.e., gaze away from adult).

The SFP measures an infant's behavioural response to a reduction in responsiveness (the still face period) from a caregiver (Stanley, Murray, & Stein, 2004), and is believed to be a reliable method for inducing social-emotional stress in young infants, enabling the observation of emotion regulation and social-emotional relationships in vivo (Field, Vega-Lahr, Scafidi & Goldstein, 1986; Manian & Bornstein, 2009). The inclusion of the reunion period affords researchers the opportunity to observe infant behaviour following an unresponsive interaction with their caregiver (Mesman et al., 2009). A meta-analysis by Mesman and colleagues (2009) confirmed the existence of a classic still-face effect (SFE), which involves infants demonstrating reduced positive affect, reduced gaze, and increased

negative affect during the still-face period that is carried over into the reunion stage (Mesman et al., 2009).

The SFP has also been used to investigate the effects of maternal psychopathology on mother-infant interaction (Mesman et al., 2009), with the majority of studies focusing on maternal depression. According to the hypotheses proposed, infants who have experienced different or inconsistent interactions with caregivers as a result of parental depression may fail to show the classic still-face effect (Moore, Cohn, & Campbell 2001). Attachment theorists have further argued that the quality of day-to-day interactions between a primary caregiver and an infant help the infant to develop an internal emotional-cognitive template. This template, they suggest, underpins how the infant then interacts emotionally and behaviourally with their caregiver (Ainsworth & Bowlby, 1991; Bretherton, 1992). Significant associations have often been reported between depression and maternal behaviour during the SFP, with depressed mothers being less behaviourally sensitive and more emotionally disengaged with their infants, in addition to displaying higher levels of negative affect (Field, 1994; Field, 2002; Field, Hernandez-Reif, Diego, Feijo, Vera, Gil, et al., 2007; Rosenblum, McDonough, Muzik, Miller & Sameroff, 2002; Stanley, Murray & Stein, 2004; Weinberg, Olson, Beeghly, & Tronick, 2006). However, somewhat less consistent results have been found in relation to infant behavioural responding during the SFP (Mesman et al., 2009).

Consistent with the hypothesis described above, some authors have uncovered evidence to suggest that the SFP is less distressing for infants of depressed mothers. For example, Field and colleagues (2007) used the SFP to explore the impact of a reduction in maternal responsiveness between infants of depressed versus non-depressed mothers. Infants of depressed mothers evidenced fewer negative behaviours, less gaze aversion, and less

motor activity during the still-face period, perhaps suggesting that they found the still-face period to be less distressing. Similar results were found earlier by Field (2002), using an adapted version of the SFP. In this study, depressed and non-depressed mothers were instructed to act depressed in place of the still-face episode. Overall, infants of depressed mothers exhibited fewer positive behaviours than the infants of non-depressed mothers during the SFP. Furthermore, infants of depressed mothers also exhibited little change in behaviour from the baseline period to the depressed period. The results of a study by Pelaez-Nogueras, Field, Hossain, and Pickens (1996) also offer a degree of support for differences in infants of depressed versus non-depressed mothers. Infants of depressed mothers were found to have less negative and more positive behaviours in comparison to infants of non-depressed mothers at the reunion stage. Pelaez-Nogueras and colleagues interpreted these findings as an indication that infants of depressed mothers recover faster from the still-face period due to being less distressed initially (Pelaez-Nogueras et al., 1996). In particular, the authors suggest that infants of depressed mothers are familiar with their mother's disengaged, depressed behaviour and, therefore, are less distressed by the SFP manipulations than are their non-depressed counterparts.

Authors have further suggested that infants of depressed mothers develop a passive coping style much like that of stressed infant primates (Field, 2002; Reite, Short, Seller, & Pauley, 1981). In 1981, Reite and colleagues observed infant primates and their level of control in stressful situations. The authors found that during brief moments of stress, active coping was adopted by the primate infants, reflected in increases in agitated behaviour and physiological arousal. Alternatively, during lengthened periods of stress, the primate infants passively coped, indexed through reduced physiological and physical responses. Based upon these findings, Field (2002) has argued that infants of depressed mothers may similarly

develop passive coping strategies through repeated exposure to depressed interactions with their mothers, contributing to their becoming less distressed during the SFP. Field (2002) also found that infants of depressed mothers exhibited more positive behaviours and less negative behaviours during still-face and reunion periods. Out, Bakermans-Kranenburg, and Van Ijzendoorn (2009) have suggested that infants with disorganised attachment styles (due to a range of factors including maternal insensitivity and maternal psychopathology) will attempt to minimise the expression of negative emotions in an effort to deal with stressful circumstances and to engage with their mother. Additionally, Weinberg and Tronick (1996) have suggested that PA may be an effective way for infants to deal with the still-face, effectively down-regulating the feelings of the distress it induces. It is therefore possible that infants of depressed mothers are amplifying their positive attachment signals in these circumstances in order to attract maternal attention and response, or that they have learnt to use PA in an effort to regulate their own NA.

The view that infants of depressed mothers adopt coping strategies to deal with the stress induced by the SFP has received some support in the literature (Manian & Bornstein, 2009, Moore, Cohn & Campbell, 2001). Moore et al. (2001) found infants of depressed mothers exhibited increased gaze aversion, at 4 months of age, whereby they spent significantly more time averting their gaze from their mother when compared with their non-depressed counterparts. Gaze aversion has been argued to act as an important emotion-regulation strategy in infancy, allowing the infant to disengage from the source of distress (Manian & Bornstein, 2009). Moore and colleagues (2001) suggest that the infants of depressed mothers increase their gaze aversion in a bid to manage their distress during the SFP more effectively. Manian and Bornstein (2009) have found contradictory results, however, with infants of depressed mothers averting their gaze significantly less

often than infants of non-depressed mothers. Despite the contradiction between these findings, the authors still suggest that their findings may be evidence of a coping strategy. Manian and Bornstein (2009) explain that the infants of depressed mothers in their study may have adopted self-soothing strategies as opposed to averting their gaze to regulate their distress. Alternatively, gaze aversion has also been linked to an infant's ability to process information (Field, 1977; Field 1981). Field (1981) suggests that differences in infant gaze behaviour are a reflection of differing levels of stimulation provided by a social interaction partner. For example, infants were found to show less gaze aversion with a moderately active partner in comparison to an excessively active partner. Results suggest that infants experiencing more stimulated social interactions avert their gaze more frequently in order to facilitate information processing. Therefore it may be possible that a decrease in gaze aversion in infants of depressed mothers may be the outcome of less information being available for the infant to process from the still-face of a depressed mother.

In other instances, infants of depressed mothers have been found to exhibit increased negative behaviours compared with infants of non-depressed mothers in the SFP (Forbes, Cohn, Allen, & Lewinsohn, 2004; Rosenblum et al., 2002; Weinberg et al., 2006). This finding, however, has not been consistent across age and gender of infants of depressed mothers, or in relation to current depressive symptoms of the depressed mothers. Furthermore, Forbes and colleagues (2004) observed increased negative affect only in infants who had parents with a previous diagnosis of depression in comparison to mothers who have never had a diagnosis. This study also found that negative affect was not significantly associated with current depressive symptoms. Similarly, Rosenblum and colleagues (2002), found increased negative affect solely in 3 month old infants of depressed mothers, whereas

Weinberg and colleagues found that increased negative behaviours were only evident in male infants of depressed mothers (Weinberg et al., 2006). Weinberg et al., (2006) proposed that the Mutual Regulation Model (MRM: Tronick & Weinberg, 2000) can account for this observed increase in negative behaviour. According to this model negative behaviours become more apparent and reinforced in an infant due to a cycle of negative interactions between mother and child (Weinberg et al., 2006).

It is also important to note that evidence from several studies has been produced to support the notion that infants of depressed mothers display the classic still-face effect (Moore & Calkins, 2004; Stanley et al., 2004; Weinberg, Beeghly, Olson & Tronick, 2008). For example, Weinberg et al., (2008) evaluated the interactive behaviour of depressed mothers and their infants using the SFP. Results indicated that infants of depressed mothers displayed the traditional SFE and, therefore, did not differ from infants with mothers without a clinical diagnosis. Similarly, Stanley and colleagues (2004), as well as Moore and Calkins (2004), did not find any significant group differences in the behaviour of infants of depressed versus non-depressed mothers. The authors of these studies, therefore, concluded that infants of depressed mothers find the SFP equally distressing as infants of non-depressed mothers.

Although the literature overall appears to support the hypothesis that depressed mothers interact differently with their infants in at least some ways during the SFP (Field, 1994; Field, 2002; Field et al., 2007; Rosenblum et al., 2002; Stanley et al., 2004; Weinberg et al., 2006), the true nature, consistency, and extent of any differences in the responses of infants of depressed versus non-depressed mothers during the SFP is currently very unclear. Several studies have reported that infants of depressed mothers find the SFP less distressing (Field 2002; Field 2007; Pelaez-Nogueras, Field, Hossain & Pickens, 1996), that they have increased/decreased gaze aversion (Manian & Bornstein 2009; Moore et al., 2001), or

increased negative behaviours (Forbes et al., 2004; Rosenblum et al., 2002; Weinberg et al., 2006). At the same time, however, several studies have found little to no difference in the behavioural responses of infants with depressed versus non-depressed mothers, with infants of depressed mothers displaying the classic SFE in a manner consistent with other infants (Moore & Calkins, 2004; Stanley et al., 2004; Weinberg et al., 2008; see also Mesman et al., 2009).

To date, only one meta-analysis exploring maternal depression and infant affect during the SFP has been conducted. This meta-analysis was carried out by Mesman et al. (2009) as part of a review which explored mother-infant interaction and the SFP. The meta-analysis did not find any significant differences between PA and NA for infants of depressed mothers and infants of non-depressed mothers. However, it can be argued that the existing meta-analysis is not a true representation of the SFP literature in regards to maternal depression and infant affect. As acknowledged by Mesman et al. (2009), the meta-analysis did not apply strict criteria for inclusion and only explored infant NA and PA during the still-face episode of the SFP. Some included studies used a modified SFP where toys and separations between episodes were allowed. Furthermore, data from incomplete studies was not sought so only one study out of eight included complete data from the SFP. Therefore, the aims of the current meta-analysis were to determine whether or not infants of depressed mothers display the classic SFE, as well as to investigate whether or not infants of depressed mothers display the same levels of behaviour (positive affect, negative affect, and gaze aversion) as their non-depressed counterparts, for each episode of the SFP. To these ends, an initial meta-analysis was conducted on the infants of the non-depressed mothers in order to confirm or disconfirm the existence of a classic SFE in this comparison control group. Then, the SFE for the infants of depressed and non-depressed mothers was directly compared. It

was hypothesised that the initial meta-analysis would confirm the classic SFE in the non-depressed group, because the SFE in typical infants is widely accepted within the literature and was confirmed in a meta-analysis by Mesman (2009). The second meta-analysis was then performed in order to directly compare changes in positive affect (PA), negative affect (NA), and gaze aversion (GA) in infants of depressed versus non-depressed mothers between each of the stages of the still-face paradigm (baseline, still-face, reunion). The purpose of this analysis was to determine whether infants of depressed mothers display the same changes in pattern of behaviour across episodes as the infants of the non-depressed mothers. Finally, a third meta-analysis was conducted in order to directly compare the levels of behaviours of infants of depressed versus non-depressed mothers during each of the stages of the SFP. The aim was to see if levels of behaviour displayed by infants of depressed mothers differed from infants of non-depressed mothers for each individual stage of the SFP. Specifically, we directly compared levels of Positive Affect (PA), Negative Affect (NA), and Gaze Aversion (GA) between the groups for each stage of the SFP. Due to the mixed findings within the literature, described above, several hypotheses were formed. Firstly, we hypothesized that infants of depressed mothers would display increased levels of negative behaviour at each stage, as this finding has been supported by the results of several studies (Forbes et al., 2004; Rosenblum et al., 2002; Weinberg et al., 2006). Another supported possible outcome would be that infants of depressed mothers would show differences in their gaze at each stage due to the potential employment of gaze aversion as a coping strategy (Moore et al., 2001; Manian et al., 2009). Lastly, it was hypothesised that infants of depressed mothers would show an increase in positive behaviours during the Still-Face and Reunion episodes (Field, 2002; Field, 2007; Pelaez-Nogueras et al., 1996).

METHOD

Selection of studies

Studies were identified using online databases (Psycarticles: <http://www.apa.org/pubs/databases/psycarticles>; PubMed: <http://www.ncbi.nlm.nih.gov/pubmed>; Web of Science: <http://wok.mimas.ac.uk>) and entering keywords and phrases (*infant, *depression, *still-face paradigm or *face to face interaction). Online databases were last searched on 01/06/2017 to ensure inclusion of all relevant literature prior to publication. Further to this, additional studies were found by examining references in the relevant papers, including the Mesman et al. (2009) review. Studies were selected for inclusion in the current meta-analyses if they presented data using the still-face paradigm with infants of mothers with depression. Data from groups of infants with non-depressed mothers were used as control groups in all of the included papers. However, for the meta-analysis designed to examine and confirm the existence of the classic SFE, a study was not required to have a control group for inclusion.

In regards to measures, for a study to be included it needed to have reported infant behaviours which could be grouped into PA, NA, or GA. This ensured that direct comparisons could be made for the behaviour of infants of depressed versus non-depressed mothers at each stage of the SFP. Furthermore, studies had to report either the average portion of time or the average percent of time infant behaviour occurred in each episode. For the current study, all behaviours were converted to the average percent of time behaviour occurred, providing a consistent measurement of infant behaviour to be used in the meta-analyses. Finally, standard deviation or standard error data had to be available in order for a study to be included, as this statistical information was required for the meta-analyses. In

cases where this information was not available, the corresponding author was contacted and was requested to supply this information (Moore & Calkins, 2004; Moore et al., 2001; Weinberg et al., 2008). Chart 1 provides an overview of the study selection process as outlined by Moher, Liberati, Tetzlaff, Altman and The PRISMA Group (2009). A final seven studies were identified for the meta-analyses, as shown in Table 1.

Meta-analytic Procedures

Three meta-analyses were conducted. The initial meta-analysis was performed on the non-depressed groups to confirm or disconfirm the classic SFE before the infants of depressed mothers' behaviour was directly compared to the infants of non-depressed mothers. A second meta-analysis was conducted to directly compare changes in PA, NA, and GA across the SFP in infants of depressed and non-depressed mothers. The final meta-analysis also compared levels of PA, NA, and GA between the infants of depressed and non-depressed mothers' but for each stage of the SFP separately. All meta-analyses were performed using STATA 11 software (StataCorp: College Station TX).

Meta-analysis 1: The Still-Face Effect in infants of non-depressed mothers

The aim of the first meta-analysis was to investigate whether the classic still-face effect was present in the infants of non-depressed mothers, before direct comparisons were made with the data of infants of depressed mothers. Therefore, changes in PA, NA, and GA between each of the still-face episodes in the control groups (infants of non-depressed mothers) were examined with an initial meta-analysis.

Collapsing behaviours

Percentage of time behaviours occurred was calculated for each study to ensure the measure of infant behaviour was the same for each included study (Forbes 2004, Moore et al., 2001 & 2004). Mean differences and standard errors were calculated for changes in each behaviour, between each stage. For example: smiling (baseline) - smiling (still-face), smiling (baseline) - smiling (reunion) and smiling (still-face) - smiling (reunion). This allowed us to see changes in behaviour across each stage of the paradigm.

Many studies included several infant behaviours, for example PA may have been represented by smiling and positive vocalisations (see Table 2). These variables were combined using a fixed effects model as it was assumed that the variation in a study's sample would be consistent for behaviours within that study (Lipsey & Wilson, 2001). Values for the average percentage of time PA, NA and GA occurred were computed for infants of depressed mothers. Upper and lower confidence intervals (CIs) were also generated for each study and behaviour. Pooled standard errors were estimated based on CIs. Nine meta-analyses were performed using a random effects model.

Meta-analysis 2: Direct comparison of behavioural changes across episodes

The second meta-analysis directly compared changes in behaviour (PA, NA, and GA) across each episode of the SFP between the infants of depressed and non-depressed mothers. Values for the collapsed behaviours and pooled standard errors were computed the same way for the infants of depressed mothers as they were in the first meta-analysis (Table 2 indicates collapsed behaviours).

Mean differences for the infants of depressed mothers were subtracted from the mean differences of the infants of non-depressed mothers. Standard errors were computed accordingly for the final mean difference values. Nine meta-analyses using the mean differences and pooled standard errors were performed using a random effects model. A direct comparison of infants of depressed and non-depressed mothers were made by looking at changes in PA, NA and GA between each still-face episode (baseline-still-face, still-face-reunion and baseline-reunion). Combined *p*-values, effect sizes (*d*) and 95% CIs were generated. Positive effect sizes reflected a higher occurrence of behaviour in the control groups and negative effect sizes reflected a higher occurrence of behaviour in the depressed groups.

Meta-analysis 3: Direct comparison of behaviour for each episode

The third meta-analysis directly compared levels of behaviours (PA, NA, GA) for the infants of depressed and non-depressed mothers for each episode of the SFP (baseline, still-face and reunion).

The percentage of time infant behaviours occurred at each episode and their corresponding standard errors were entered into a fixed effect model. As before, this allowed behaviours to be collapsed into the PA, NA and GA categories for each study (see Table 2 for collapsed behaviours).

Mean percentage of time of PA, NA and GA for the depressed groups were subtracted from the mean percentage of time of PA, NA and GA for the control groups in each of the still-face episodes. Standard errors for each study and behaviour were computed. Nine meta-analyses using the mean differences and the pooled standard errors were performed using a random effects model, combined *p*-values, effect sizes (*d*) and 95% CIs were generated.

Positive effect sizes reflected a higher occurrence of behaviour in the control groups and negative effect sizes reflected a higher occurrence of behaviour in the depressed group.

RESULTS

Meta-Analysis 1: The Still-Face Effect in infants of non-depressed mothers

The purpose of this meta-analysis was to determine whether infants of non-depressed mothers showed the classic SFE as confirmed throughout the larger literature (Mesman et al., 2009). The initial meta-analysis confirmed the classic SFE in the infants of mothers without depression (i.e., the control group). Positive affect significantly reduced from the baseline to the still-face episode ($p < 0.01$) with significantly lower positive affect at the reunion episode in comparison to baseline ($p < 0.05$). Negative affect ($p < 0.01$) and gaze aversion ($p < 0.01$) significantly increased from baseline to still-face. In addition, negative affect was significantly higher at the reunion episode in comparison to the baseline episode ($p < 0.05$). Table 3 shows the 95% confidence intervals (CIs) and effect sizes for the analysis.

Meta-analysis 2: Direct comparison of behavioural changes across episodes

The second meta-analysis directly compared changes in PA, NA, and GA across each stage of the SFP between infants of depressed and non-depressed mothers. The purpose was to establish whether infants of depressed mothers display the classic SFE by comparing changes in PA, NA, and GA through all the episodes of SFP to those of the non-depressed groups. No significant differences were found for changes in PA from the baseline to still-face episodes ($p = 0.84$), still-face to reunion episodes ($p = 0.15$) or baseline-to reunion episodes

($p=0.33$) between the depressed and non-depressed groups. There were also no significant differences in NA from the baseline to still-face episodes ($p=0.97$), still-face to reunion episodes ($p=0.48$) or baseline-to reunion episodes ($p=0.09$). Further to this, the groups did not differ significantly in changes in GA from the baseline to still-face episodes ($p=0.87$), still-face to reunion episodes ($p=0.79$) or baseline-to reunion episodes ($p=0.28$). 95% CIs and effect sizes for this analysis are shown in Table 3.

Meta-analysis 3: Direct comparison of behaviour for each episode

The third meta-analysis directly compared infants of depressed and non-depressed mothers amount of behaviour (PA, NA, & GA) displayed at each stage. The aim was to see if levels of behaviour displayed by infants of depressed mothers differed from infants of non-depressed mothers for each episode of the SFP. The depressed group displayed significantly higher levels of PA during the still-face episode in comparison to the control group ($p<0.01$). PA did not differ significantly for the baseline ($p=0.75$) or reunion episodes ($p=0.59$). The infants of depressed mothers did not significantly differ from infants of non-depressed mothers for levels of NA displayed at the baseline ($p=0.14$), still-face ($p=0.85$) and reunion episodes ($p=0.31$). Similarly, no significant differences were revealed for GA during the baseline ($p=0.39$), still-face ($p=0.79$) and reunion episodes ($p=0.79$). For further information on CIs and effect sizes please view Table 3.

DISCUSSION

To date, the nature and consistency of the behavioural responses of infants of depressed mothers during the SFP has remained unclear in the extant literature (Mesman et al., 2009). In the current meta-analysis, we therefore examined whether or not infants of depressed mothers demonstrate the classic still-face effect. Furthermore, we also explored whether or not these infants display the same levels of PA, NA, and GA as their counterparts with non-depressed mothers. Results revealed that infants of depressed mothers display the classic SFE. However, these infants also demonstrated significantly greater levels of PA during the still-face episode than did infants of non-depressed mothers. These findings suggest that despite prior experience of maternal unresponsiveness, infants of depressed mothers find the SFP equally as distressing as their non-depressed counterparts. Increased PA during the still-face episode, however, implies that infants of depressed mothers are employing coping strategies in order to regulate their distress. The emergence of coping strategies in infants of depressed mothers may be a result of prior exposure to reduced maternal responsiveness.

As hypothesised, the initial meta-analysis confirmed the SFE in infants of non-depressed mothers. This finding is consistent with the current literature (Mesman et al., 2009) and indicates that this effect is present in the comparison control sample used in the current study. Following from this analysis, data from the groups of infants of depressed versus non-depressed mothers were then directly compared in the subsequent meta-analyses, in order to examine whether and how behaviour differed between these two groups of infants. To this end, the second meta-analysis directly compared changes in PA, NA, and GA across each episode of the SFP between the maternal depression and control groups. Results revealed that infants of depressed mothers did not differ from those of non-depressed mothers in regards to the magnitude of changes in PA, NA, or GA between the various stages of the SFP. In other

words, infants of depressed mothers exhibited the classic SFE during the SFP. Just like infants of non-depressed mothers, the infants of depressed mothers demonstrated reduced positive affect from their baseline state, in addition to increased gaze aversion and negative affect, which continued into the reunion episode. This finding is consistent with studies which suggest that infants of depressed mothers find the SFP equally distressing as infants of non-depressed mothers (Stanley et al., 2004; Weinberg et al., 2008), and contradicts other studies that have found that infants exhibit increased/decreased GA (Manian & Bornstein 2009; Moore et al., 2001) or increased negative behaviours (Forbes et al., 2004; Rosenblum et al., 2002; Weinberg et al., 2006).

Our third and final meta-analysis directly compared the maternal depression group and control group for levels of behaviours (PA, NA, & GA) displayed separately at each stage of the SFP. Interestingly, and somewhat contradictory to the results of the second meta-analysis, this analysis revealed that infants of depressed mothers exhibited significantly greater PA during the still-face episode in comparison to their counterparts with non-depressed mothers. One possible explanation for the relatively higher PA could be, as Field (2002) has suggested, that the infants of depressed mothers have become accustomed to their mother's depressed behaviour and, therefore, are less distressed when their mother displays emotional disengagement towards them during the still-face episode. This finding appears to provide support for previous studies which suggest that infants of depressed mothers find the SFP less distressing (Field, 2002; Field et al., 2007; Pelaez-Nogueras et al., 1996). However, this third meta-analysis also revealed that the depressed groups did not differ from the infants of non-depressed mothers on levels of NA. This finding strongly suggests that the infants are, in fact, finding the SFP as distressing as the non-depressed infants. One plausible explanation

for the increase in PA in the third meta-analysis, then, may be that infants of depressed mothers are adapting their behaviour in order to cope with their own distress.

Attachment theorists have found that an infant's response to their mother in any given situation is based upon previous experience and interactions with her (Ainsworth & Bowlby, 1991; Bretherton, 1992). Therefore, due to the infant's prior experience with their mother's disengaged behaviour, these infants may be employing coping strategies during the still-face episode in an effort to cope with their distress, such as amplifying positive attachment signals in an attempt to engage maternal attention and support (Out et al., 2009). This viewpoint is consistent with proposals by a number of authors who agree that infants of depressed mothers adopt coping strategies during the SFP (Field, 2002; Manian & Bornstein, 2009; Moore et al., 2001; Weinberg & Tronick, 1996). Alternatively, Field (2002), for example, has argued that infants of depressed mothers adopt passive coping strategies. However, the current results do not support this proposal. Infants did not produce a passive interaction style during the SFP and mirror their mother's depressive behaviour as Field suggested. In addition, the current analyses did not produce evidence to suggest that infants of depressed mothers display an increase in GA or employ self-soothing techniques in order to cope with their distress, as other authors have suggested (Manian & Bornstein, 2009; Moore et al., 2001).

Overall, the results of the current study provide a degree of support for Weinberg and Tronick's hypothesis (1996), which states that PA may help infants to down-regulate feelings of distress. The authors have speculated that PA is a coping strategy adopted by infants because it acts as a buffer against distress and NA. Given that greater PA was observed during the still-face episode in infants of depressed mothers, this could be indicative of these infants adopting this strategy as a method via which they can better cope with the stress induced by the SFP.

The current study provides critical grounding for the still-face literature, documenting consistencies in findings across studies related to both similarities and differences in behaviour between infants of depressed and non-depressed mothers. However, the current meta-analytic results only provide an insight into how infants of depressed mothers react in the SFP towards their mother, and do not address whether the behaviour observed in infants is continuous with other caregivers and strangers. As attachment theorists have noted (Ainsworth & Bowlby, 1991; Bretherton, 1992), an infant's reaction to a caregiver is based on the quality of interactions the infant has experienced with that particular individual. Infants of depressed mothers may become accustomed to their mothers depressed behaviour as Field (2002) suggests, and react in a way they deem appropriate with her (i.e., adopting increased PA either as a coping strategy to reduce distress from previous experience of disengaged interactions or to better engage support from their depressed parent). A future direction for this field of research, then, should be to investigate whether behaviour observed during the SFP in infants of depressed mothers is reflected in the behaviour of the infants when they are interacting with other individuals. For example, do infants of depressed mothers still display greater PA than infants of non-depressed mothers when interacting with individuals with whom they have no prior experience, or with other caregivers who do not have a depressed interaction style? It is possible that the observed difference in PA may only be evident in interactions with their mothers. If this were true it would suggest that infants of depressed mothers are adapting their behaviour accordingly as a way of reengaging the mother as Out et al. (2009) have proposed. Alternatively, they may be exhibiting greater PA as a means for coping with the withdrawn behaviour displayed by their mother (Weinberg & Tronick, 1996).

A limitation of the current study is the potential for publication bias as data from four studies that met inclusion criteria were unable to be included.. Unfortunately, within the psychological field requests to share data are commonly ignored or denied (Vanpaemel, Vermorgen, Deriemaecker, & Storms, 2015). There is high demand within the discipline for open access to published study data for an increased confidence in research findings and for the preservation of data (Piwowar, Day, & Fridsma, 2007; Vision, 2010). Suggestions have been made regarding journals adopting policies on open access in a bid to increase data availability (Vanpaemel et al., 2015). The advancement of open access data within the psychological field would be beneficial to help address the challenges faced regarding data availability in the current study. However, despite four studies not being included in the analyses, a visual examination of the included studies' findings did not reveal a bias in the overall results. For example, some studies reported infants of depressed mothers display the classic SFE (Moore & Calkins, 2004; Stanley et al., 2004; Weinberg et al., 2008), others reported that infants of depressed mothers find the SFP less distressing (Field, 2007; Pelaez-Nogueras et al., 1996) whilst others reported increased/decreased GA in infants of depressed mothers (Manian & Bornstein, 2009; Moore et al., 2001). Another potential limitation of the current meta-analysis is that only published studies were included in the analysis which could bias findings as a result of the file drawer problem. The file drawer problem refers to a bias within published literature, whereby significant results are more likely to be published (Rosenthal, 1979). This problem therefore gives rise to the possibility that literature within a given field is not representative of the behaviour it is reporting. Within the current study, it is worth noting that three of the seven included studies did not find a significant difference between infant affect for infants of depressed mothers and their non-depressed counterparts (Moore & Calkins, 2004; Stanley et al., 2004; Weinberg et al., 2008). As a result, non-

significant results were taken into account in the current meta-analyses. To address publication bias and file drawer issues, inclusion of all studies within the SFP depression area would be beneficial in a future meta-analysis to ensure findings are reliable and representative.

Studies included in the current meta-analyses differed in their measures of depression (from self-report to clinical diagnosis) and in mothers duration, severity and timing of depression. Samples also differed in terms of their social economic status, ethnicity and country of origin. However, due to the number of studies included in the meta-analyses it was not possible to perform moderator analyses to explore the impact of these variables. This limitation was also recognised by Mesman et al. (2009) who were also unable to perform moderator analyses due to the small number of studies currently within the maternal depression and SFP field. It would be beneficial for a future meta-analysis to include moderator analyses to explore the impact of different variables such as co-morbidity of diagnosis, measure of depression and duration of maternal depression on infant affect during the SFP. Depression is highly co-morbid with other disorders such as anxiety (Kaitz, Maytal, Devor, Bergman, & Mankuta, 2010) and personality disorders (Hirschfeld, 1999). Literature has demonstrated differences in infant responses in the SFP in regards to maternal anxiety (Kaitz et al., 2010) and maternal borderline personality disorder (Hobson, Patrick, Crandell, Garcia-Perez, & Lee, 2005). Furthermore, variations in severity, duration and timing of maternal depression have been associated with behavioural differences in children of depressed mothers (Bernard-Bonnin, 2004). Despite this limitation, a visual examination of the included studies characteristics did not reveal any patterns in regards to infant affect and co-morbidity, measure of depression or duration of maternal depression. As the literature within this area increases, it would be beneficial to perform moderator analyses to explore the identified variables and others which

could potentially impact infant behaviour in regard to maternal depression. This would help determine whether the current study's findings are representative of infant affect in relation to maternal depression during the SFP, or whether findings are impacted by other potential moderators such as co-morbidity and duration of maternal depression. However, it is worth noting that the last publication relating to maternal depression and the SFP was conducted in 2009 by Manian and Bornstein. This potentially could be related to literature which suggests that repeated exposure to the SFP could have long-term negative effects for the infant (Tronick & Beeghly, 2011). Due to ethical constraints, fewer studies may not be conducted within this area which could impact future exploration of the still-face phenomenon in infants of depressed mothers.

In summary, the current meta-analyses revealed that infants of depressed mothers do become distressed during the SFP. This finding indicates that, despite prior experience of reduced maternal interaction, infants of depressed mothers do not become fully desensitised to maternal unresponsiveness. Instead, infants of depressed mothers appear to adopt unique coping strategies to deal with stressful situations. Specifically, these infants displayed significantly higher levels of PA during the still-face episode compared with infants of mothers without depression. One potential explanation for these findings is that, due to their prior experience of similar, depressed interactions with their mothers, infants of depressed mothers amplify their positive attachment signals in an effort to engage maternal attention and response. Alternatively or additionally, they may use PA as a means of coping with the withdrawn behaviour displayed by their mother. Regardless, it appears that infants of depressed mothers are using PA in an effort to regulate their distress during the still-face stage.

The results of this study provide convincing evidence to suggest that the SFP is useful not only for understanding typical infant-mother relationships, but also for understanding the impact of maternal psychopathology on these interactive social-emotional relationships. Furthermore, future research using this paradigm more extensively with other interactive partners, such as other caregivers and unfamiliar strangers, can be expected to provide further critical insights into infant social-emotional functioning, regulation, and interpersonal development and relationships.

REFERENCES

- Ainsworth, M. D. S., & Bowlby, J. (1991). An ethological approach to personality development. *American Psychologist*, *46*, 333–341. doi:10.1037//0003-066X.46.4.333
- Bernard-Bonnin, A. C. (2004). Maternal depression and child development. *Paediatrics & Child Health*, *9* (8), 575–583.
- Bretherton, I. (1992). The origins of attachment theory: John Bowlby and Mary Ainsworth. *Developmental Psychology*, *28*, 759-775. doi: 10.1037//0012-1649.28.5.759
- Field, T. (1984). Early interactions between infants and their postpartum depressed mothers. *Infant Behavior & Development*, *7*, 527–532.
- Field, T. (1994). The effects of mother's physical and emotional unavailability on emotion regulation. *Monographs of the Society for Research in Child Development*, *59*, 208–227. doi: 10.2307/1166147
- Field, T. (2002). Early interactions between infants and their postpartum depressed mothers. *Infant Behavior & Development*, *25* (1), 25-29. doi: 10.1016/S0163-6383(02)00089-

Field, T., Hernandez-Reif, M., Diego, M., Feijo, L., Vera, Y., Gil, K., et al. (2007). Still-face and separation effects on depressed mother–infant interactions. *Infant Mental Health Journal*, 28, 314–323. doi: 10.1002/imhj.20138

Field, T., Vega-Lahr, N., Scafidi, F., & Goldstein, S. (1986). Effects of maternal unavailability on mother–infant interactions. *Infant Behavior & Development*, 9, 473–478. doi: 10.1016/0163-6383(86)90019-6

Forbes, E. E., Cohn, J. F., Allen, N. B., & Lewinsohn, P. M. (2004). Infant affect during parent- infant interaction at 3 and 6 months: Differences between mothers and fathers and influence of parent history of depression. *Infancy*, 5, 61–84. doi: 10.1207/s15327078in0501_3

Gusella, J. L., Muir, D., & Tronick, E. Z. (1988). The effect of manipulating maternal behavior during an interaction on three- and six-month-olds' affect and attention. *Child Development*, 59, 1111–1124. doi: 10.2307/1130278

Hirschfeld, R. M.A. (1999). Personality disorders and depression: Comorbidity. *Depression and anxiety the official journal of ADAA*, 10, 142–146.
doi:10.1002/(SICI)15206394(1999)10:4<142::AID-DA2>3.0.CO;2-Q.

Hobson, P. R., Patrick, M., Crandell, L., Garcia-Perez, R., & Lee, A. (2005). Personal relatedness and attachment in infants of mothers with borderline personality disorder. *Development and Psychopathology, 17* (2), 329-347.
doi:10.1017/S0954579405050169.

Kaitz, M., Maytal, H.R., Devor, N., Bergman, L., & Mankuta, D. (2010). Maternal anxiety, mother-infant interactions, and infants' response to challenge. *Infant Behavior & Development, 33* (2), 136-48.

Lipsey, M. W., & D.B. Wilson. (2001). *Practical meta-analysis*. Thousand Oaks, CA: Sage

Manian, N., & Bornstein, M. H. (2009). Dynamics of emotion in infants of clinically depressed and nondepressed mothers. *Journal of Child Psychology and Psychiatry, 50*, 1410-1418. doi: 10.1111/j.1469-7610.2009.02166.x

Mesman, J., Van IJzendoorn, M. H., & Bakermans-Kranenburg, M. J. (2009). The many faces of the still-face paradigm: A review and meta-analysis. *Developmental Review, 29*, 120-162. doi: 10.1016/j.dr.2009.02.001

Mimas. (2013). Web of Science Service for UK Education. Retrieved from:

<http://wok.mimas.ac.uk/>

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & The PRISMA Group

(2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *Open Medicine*, 3 (3), 123-130.

Moore, G. A., & Calkins, S. D. (2004). Infants' vagal regulation in the still-face paradigm is related to dyadic coordination of mother–infant interaction. *Developmental Psychology*, 40, 1068–1080. doi: 10.1037/0012-1649.40.6.1068

Moore, G. A., Cohn, J. F., & Campbell, S. B. (2001). Infant affective responses to mother's still face at 6 months differentially predict externalizing and internalizing behaviors at 18 months. *Developmental Psychology*, 37, 706–714. doi: 10.1037//0012-1649.37.5.706

Out, D., Bakermans-Kranenburg, M.J., & Van IJzendoorn, M.H. (2009). The role of disconnected and extremely insensitive parenting in the development of disorganized attachment: Validation of a new measure. *Attachment & Human Development*, 11, 419-443. doi: 10.1080/14616730903132289

Peláez-Nogueras, M., Field, T. M., Hossain, Z., & Pickens, J. (1996). Depressed mothers' touching increases infants' positive affect and attention in still-face interactions. *Child Development*, 67, 1780–1792. doi: 10.2307/1131731

Piwowar, H. A., Day, R. S., & Fridsma, D. B. (2007). Sharing detailed research data is associated with increased citation rate. *PLoS ONE* 2, e308. doi: <http://dx.doi.org/10.1371/journal.pone.0000308>

Reite, M., Short, R., Seller, C., & Pauley, J. D. (1981). Attachment, loss and depression. *Journal of Child Psychology and Psychiatry*, 22, 141-169. doi: 10.1111/j.1469-7610.1981.tb00539.x

Rosenblum, K. L., McDonough, S., Muzik, M., Miller, A., & Sameroff, A. (2002). Maternal representations of the infant: Associations with infant response to the Still Face. *Child Development*, 73, 999–1015. doi: 10.1111/1467-8624.00453

Rosenthal, R. (1979). The file drawer problem and tolerance for null results. *Psychological Bulletin*, 86 (3), 638-641. doi: 10.1037/0033-2909.86.3.638

Stanley, C., Murray, L., & Stein, A. (2004). The effect of postnatal depression on mother–infant interaction, infant response to the still-face perturbation, and performance on an instrumental learning task. *Development and Psychopathology*, 16, 1–18. doi: 10.1017/S0954579404044384

STATA (Version 11) [Software]. (2010) College Station TX: Statacorp.

Tronick, E., Als, H., Adamson, L., Wise, S., & Brazelton, T. B. (1978). Infants response to entrapment between contradictory messages in face-to-face interaction. *Journal of the American Academy of Child and Adolescent Psychiatry, 17*, 1–13. doi: 10.1016/S0002-7138(09)62273-1

Tronick, E., & Weinberg, M. K. (2000). Gender differences and their relation to maternal depression. Paper presented at 15th Symposium on Stress, Coping, and Depression in Miami.

Vanpaemel, W., Vermorgen, M., Deriemaecker, L., & Storms, G. (2015). Are We Wasting a Good Crisis? The Availability of Psychological Research Data after the Storm. *Collabra, 1*, 1-5. doi: 10.1525/collabra.13

Vision, T. J. (2010). Open data and the social contract of scientific publishing. *BioScience, 60*, 330-331. doi: <http://dx.doi.org/10.1525/bio.2010.60.5.2>

Weinberg, M.K., Beeghly, M., Olson, K.L., & Tronick, E.Z. (2008). Effects of maternal depression and panic disorder on mother-infant interaction in the Face-to-Face Still-face paradigm. *Infant Mental Health Journal, 29* (5), 472-491. doi: 10.1002/imhj.20193

Weinberg, M. K., Olson, K. L., Beeghly, M., & Tronick, E. Z. (2006). Making up is hard to do, especially for mothers with high levels of depressive symptoms and their infant sons. *Journal of Child Psychology and Psychiatry*, *47*, 670–683.

Weinberg, M. K., & Tronick, E. Z. (1996). Infant affective reactions to the resumption of maternal interaction after the still-face. *Child Development*, *67*, 905–914. doi: 10.2307/1131869

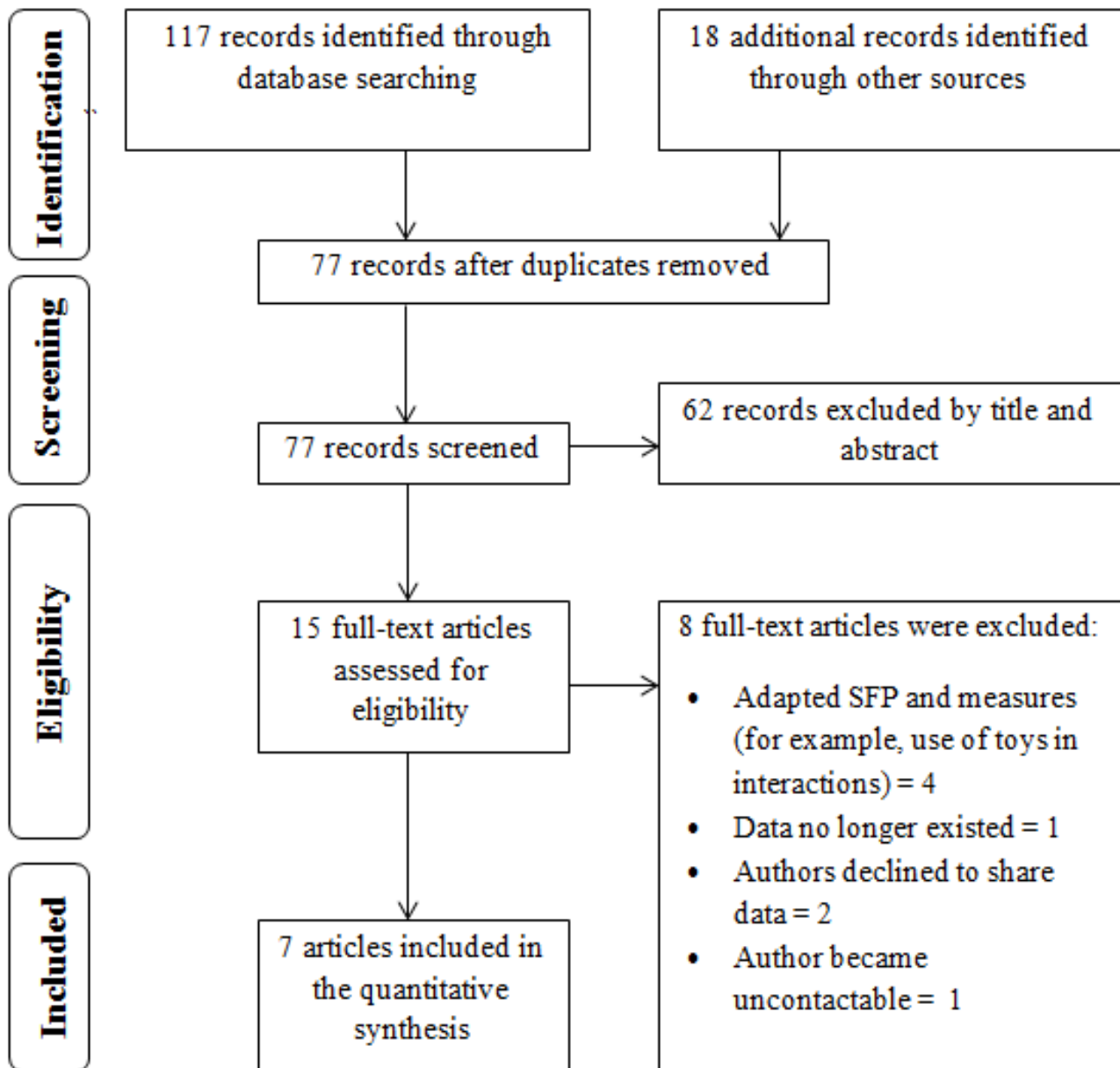


Chart 1. Moher, Liberati, Tetzlaff, Altman and The PRISMA Group (2009) flow chart illustrating selection of studies

Table 1

Included studies, number of infants and mean age by depressed and non-depressed groups

Study	Non-Depressed		Depressed	
	Number of Infants	Mean Age (months)	Number of Infants	Mean Age (months)
Stanley et al. 2004	50	3	72	3
Manian & Bornstein 2009	68	5	48	5
Moore & Calkins 2004	60	3	13	3
Moore et al. 2001	62	4	67	4
Field 2007	16	4	16	4
Pelaez-Nogueras et al. 1996	16	3	16	3
Weinberg et al. 2008	48	3	33	3

Table 2

This table shows each study that contributed to the meta-analyses along with their corresponding ID numbers. Behaviours are listed for each study, which were subsequently collapsed in the initial stages to provide individual scores for PA, NA and GA for each episode of the SFP. The table indicates where behaviours did not need to be collapsed and where data was not available

Studies	Positive Affect			Negative Affect			Gaze Aversion		
	Baseline	Still-Face	Reunion	Baseline	Still-Face	Reunion	Baseline	Still-Face	Reunion
Stanley et al. (2004)	Complete data	Complete data	Complete data	Protest to mother Dysregulation Avoidance of mother	Protest to mother Dysregulation Avoidance of mother	Protest to mother Dysregulation Avoidance of mother	Complete data	Complete data	Complete data
Manian & Bornstein (2009)	Complete data	Complete data	Complete data	Wary Negative Affect	Wary Negative Affect	Wary Negative Affect	Complete data	Complete data	Complete data
Moore & Calkins (2004)	Complete data	Complete data	Complete data	Complete data	Complete data	Complete data	Complete data	Complete data	Complete data
Moore et al. (2001)	Complete data	Complete data	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available
Field (2007)	Smile Vocalisations	Smile Vocalisations	Smile Vocalisations	Distress Brow Crying	Distress Brow Crying	Distress Brow Crying	Complete data	Complete data	Complete data
Pelaez-Nogueras et al. (1996)	Smile Gaze Vocalisations	Smile Gaze Vocalisations	Smile Gaze Vocalisations	Grimace Crying	Grimace Crying	Grimace Crying	Complete data	Complete data	Complete data
Weinberg et al. (2008)	Complete data	Complete data	Complete data	Complete data	Complete data	Complete data	Complete data	Complete data	Complete data

Table 3

95% Confidence intervals (CIs) and effect size (*d*) for each meta-analysis by PA, NA, GA and episode.

Meta-analysis 1: The Still-Face Effect in infants of non-depressed mothers					
<i>Positive Affect</i>					
Baseline to Still-Face		Still-Face to Reunion		Baseline to Reunion	
95% CIs	<i>d</i>	95% CIs	<i>d</i>	95% CIs	<i>d</i>
11.59, 17.74	14.66	-17.01, -4.36	-10.68	0.13, 9.58	4.86
<i>Negative Affect</i>					
-8.86, -1.47	-5.17	-15.86, 6.68	-4.59	-20.14, -2.33	-11.24
<i>Gaze Aversion</i>					
-26.25, -4.90	-15.57	-1.18, 21.39	10.11	-0.86, 1.13	0.13
Meta-analysis 2: Direct comparison of behavioural changes across episodes					
<i>Positive Affect</i>					
Baseline to Still-Face		Still-Face to Reunion		Baseline to Reunion	
95% CIs	<i>d</i>	95% CIs	<i>d</i>	95% CIs	<i>d</i>
-5.08, 6.23	0.57	-1.72, 11.16	4.72	-3.12, 9.29	3.09
<i>Negative Affect</i>					
-12.31, 13.68	0.68	-30.13, 14.17	-7.98	-17.18, 1.31	-7.93
<i>Gaze Aversion</i>					
-2.78, 3.28	0.25	-2.95, 3.85	0.45	-5.43, 1.62	-1.91
Meta-analysis 3: Direct comparison of behaviour for each episode					
<i>Positive Affect</i>					
Baseline		Still-Face		Reunion	
95% CIs	<i>d</i>	95% CIs	<i>d</i>	95% CIs	<i>d</i>
-4.99, 6.90	0.95	-1.32, -0.60	-0.96	-4.58, 7.96	1.69
<i>Negative Affect</i>					
-1.57, 0.23	-0.67	-13.89, 11.56	-1.15	-4.03, 12.55	4.26
<i>Gaze Aversion</i>					
-0.91, 2.33	0.71	-1.95, 2.54	0.29	-2.95, 3.85	0.45

