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DYADIC SYNCHRONY AND INFANT REGULATION OF POSITIVE AND NEGATIVE AFFECT WITH MOTHERS AND FATHERS

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ABSTRACT

This study investigated the relation between mother-infant and father-infant dyadic synchrony and infant emotion regulation in sample of 6-month-old infants (N = 137). Specifically, during a developmental period characterized by reciprocity and bi-directionality, parent-infant dyadic synchrony was predicted to be associated with infant positive and negative emotion regulation. The current study examined dyadic synchrony in free play and the reunion episodes of the Still-Face Paradigm and infant behavior thought to reflect emotion regulation, measured by gaze in the still-face and reunion episodes and peek-a-boo. Parent and infant positive affect was the most salient predictor of dyadic synchrony, infant gaze aversion was stable across contexts and with parents, and dyadic synchrony was found to relate to gaze aversion across contexts for mother-infant interactions, but not father-infant interactions. Findings are discussed with respect to the relation of gaze aversion and synchrony, the importance of positive affect, and differences in interactions with mothers and fathers.

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Chapter 1. INTRODUCTION

Parents play a central role in facilitating the development of children's emotion regulation during dyadic interactions (see review by Cole, Martin, & Dennis, 2004). Emotion regulation has been defined as "extrinsic and intrinsic processes responsible for monitoring, evaluating, and modifying emotional reactions, especially their intensive and temporal features, to accomplish one's goals" (Thompson, 1994, p. 27-28)**.** During interactions with parents, infants display both positive and negative affect and can become too aroused by either type of affect. One mechanism through which parents may help guide infants to develop the ability to regulate these emotions is dyadic synchrony, a quality of the dyadic interaction that captures coordinated patterns of parent and infant behaviors during their interactions (Cohn & Tronick, 1988; Feldman, 2003; Moore & Calkins, 2004). Dyadic synchrony with parents allows infants the opportunity to experience the coordination of biological and behavioral rhythms, mutual levels of optimal positive arousal, and a type of dyadic interaction that will presumably generalize to other interactions with the same caregiver across different contexts (Feldman, Greenbaum, & Yirmiya, 1999). After infants experience synchronous interactions repetitively with parents they may ultimately learn how to guide themselves to more optimal levels of arousal without waiting for their parent to help them do so. This mechanism is discussed in more detail in the following section.

Dyadic Synchrony and Emotion Regulation During Parent-Infant Interactions

Dyadic synchrony is a micro-level behavioral framework for examining patterns of relationships and interactions (Feldman, 2007a; Feldman, 2007b**).** Feldman (2007a) suggested that there are three different methods for measuring interactions- matching

states concurrently, measuring chains of behavior sequentially, or examining organized patterns. Synchrony reflects an organized pattern involving the dance between partners moving together over time. Examining specific patterns within one interaction may highlight repetition of behaviors, and these repetitive behaviors could presumably generalize to other interactions between the same partners.

In order for parents and infants to have synchronous interactions, both the parent and infant presumably observe his or her partner's behavior and then make adjustments in his or her own behavior to reflect her partner's behavior (Tronick, 1989). Infants by 6 months have more of a reciprocal interaction with parents and guide the interaction more so than before (Cohn & Tronick, 1987). By the age of 6 months, infants have likely established a typical pattern of interaction with each parent, and may act before their parent does in anticipation of their parents' typical response. Some of these typical patterns may include parents guiding infants who are too highly aroused to decreased levels of engagement by having less positive facial expressions and averting their gaze in response to the infant, who then presumably becomes less aroused. Parents can then help infants become more engaged once infant arousal levels appear to be at an optimal state, reflecting a synchronous interaction. Eventually infants may act in anticipation of these responses, not needing his or her parent to guide him or her to more optimal levels of arousal. The more often these patterns occur within the same type of interaction, the more likely infants presumably expect certain responses. Infants may then begin to act in the expected manner in other contexts (Calkins, 2004). With time these expectancies may guide the infant's behavior during future interactions, possibly by allowing infants to respond faster and before parents respond. Research shows that self and mutual

regulation are associated by 6 months of age, suggesting that infants are able to help themselves regulate and retain optimal levels of arousal having already had their parents guide them to optimal levels of arousal (Beebe & Lachman, 1999). Moreover, higher levels of mother-infant synchrony at 3 and 9 months were related to self-regulation at 2 years, including more compliance and longer delays to a reward (Feldman, Greenbaum, & Yirmiya, 1999). Patterns of synchronous interactions are also specific to each relationship, suggesting that these synchronous interactions are possibly dyadic (Feldman, Greenbaum, & Yirimaya, 1999). By 6 months infants appear to have the capacity to expect a response during interactions with parents that may teach them to act before their parent would act to help themselves regulate without the help of their parent.

Infants' expectations from repetitive interactions with the same parent may be related to physiological processes. During week 30-34 of the gestational period there is a shift in the development of vagal tone (measured as respiratory sinus arrythymia [RSA]) where infants who reach the gestational period have more stable baseline vagal tone (Feldman, 2006). This change reflects the capacity of infants to physiologically respond when needed. Infants who did not reach this milestone had less dyadic synchrony with parents at 3 months of age, suggesting that perhaps effective physiological regulation is related to infants' ability to learn from interactions. Moreover, mothers and infants with synchronized heart rates showed high behavioral synchrony during a free play (Feldman, 2007). A change in infants' heart rates was followed by mothers' parallel changes in heart rates within less than 1 second. Other research examined infant vagal tone during the challenging still-face episode of Still-Face Paradigm (SFP; Tronick, Als, Adamson, Wise, & Brazelton, 1978). Infants showing greater decreases in vagal tone, which is

thought to indicate more effective self-regulation, had more synchronous interactions with their mothers (Feldman, 2007; Moore & Calkins, 2004). Thus, these infant physiological mechanisms may relate to higher levels of synchrony with parents and the ability to learn from repetitive experiences in interactions with parents. Moreover, effective physiological regulation may help infants to remain at more optimal levels of positive arousal by not needing to regulate behaviorally.

In addition to physiological mechanisms, infants may learn to use certain strategies during interactions as a result of first imitating parents' behaviors. Demiris and Meltzoff (2008) suggested that imitation occurs in infancy when there is a clear goal and infants have an underlying mental state represented by their bodily action. Infants have the ability to act like another agent and the capacity to track a past response and repeat it later (Meltzoff & Moore, 1989). In support of the idea that infants repeat specific patterns of interaction, researchers found that early patterns in communication, including synchrony, were stable across the first year even as infants developed and changed (Feldman, Greenbaum, & Yirimya, 1999; Hsu & Fogel, 2003). However, it is possible that this stability is also a result of parents' repetitive behaviors or sensitivity to their children's behaviors.

During interactions with parents infants may need to regulate both positive and negative levels of arousal. Infants may display high levels of positive arousal that could be over-stimulating during social interactions and require a partner to help maintain and move to an optimal level of positive affect (Feldman, 2003). Infants showed patterns of behaviors that began with play and positive expressions and moved to averting gaze during mother-infant interactions in positive contexts (Cohn & Tronick, 1983),

suggesting that infants may need to avert gaze to regulate these positive expressions. Additionally, other research exploring parent-infant interactions during a peek-a-boo game suggests that infant gaze aversion is associated with high levels of positive arousal or a lack of stimulation (Stifter & Moyer, 1991). Infants used gaze aversion when they were showing highly positively expressions and the more they displayed these expressions the longer they used gaze aversion. These findings suggest that infants may need to regulate positive affect by looking away from mothers in order to achieve an optimal level of arousal. Perhaps infants also experience repetitive, rhythmic patterns with parents to help regulate positive affect , in addition to negative affect, so that infants ultimately form expectations and learn to help themselves to regulate high levels of positive affect.

With respect to the link between negative and positive emotion regulation, researchers examined the stability of infant positive and negative emotion regulation strategies during parent-infant interactions (Diener, Mangelsdorf, McHale, & Frosch, 2002). The authors found that infants used the same scanning or distraction strategies during the expression of both types of emotions. This suggests that, during parent interactions, infants use the same regulatory strategies when regulating both positive and negative affect. Examining dyadic synchrony in parent-infant interactions may shed light on possible differences in guiding infants to regulate different kinds of emotions, and whether interactions with high levels of synchrony may relate to less emotion regulation of both negative and positive emotions.

Factors Influencing Dyadic Synchrony

Dyadic synchrony is one behavioral measure through which we can examine patterns of interactions that promote optimal levels of positive arousal and effective regulation. Yet, there may be essential factors that influence the achievement of dyadic synchrony, either through infant or parent behaviors.

Infant temperament. One issue for consideration of dyadic synchrony concerns various individual differences that may influence infant behavior during dyadic interactions, including child temperament. Temperament refers to individual differences in reactivity and self-regulation that are largely influenced by an individual's biological makeup, but that may also be influenced by experience (Rothbart, 1981). Infants with certain temperaments may be more effective at forming expectations and learning following a typical pattern of interaction to reach levels of optimal arousal, possibly affecting levels of dyadic synchrony. Achieving dyadic synchrony may also reflect parents' consideration and accommodation of infant temperament. Parents of infants with difficult temperaments may need to exert more effort to achieve dyadic synchrony with their infants, or may use more techniques to help these infants reach an optimally positive arousal state than parents of infants with less difficult temperaments. However, other analyses of the current data set found that parent report of temperament was unrelated to infant or parent behavior in the Still-Face Paradigm. This may be a result of measuring temperament with parent perceptions. Parent report of temperament at such a young age may not be entirely accurate, and may mask any possible links between temperament and the SFP. Although temperament does contribute to differences in infant emotion

regulation and possibly dyadic synchrony during interactions, these types of individual differences are beyond the scope of the current study.

Parental Depression. Another factor that may affect dyadic synchrony and consequently children's regulatory abilities is parental depressive symptoms. Parental depressive symptoms have been suggested to adversely affect children's development through factors such as affective expression and synchrony (Cicchetti, Rogosch, & Toth, 1998). In a study that examined mother-infant interaction during free play with 3-month-old infants, the authors found that a greater amount of time was spent for both infants and depressed mothers in negative states than positive states, with more reciprocity of negative affect (Field, Healy, Goldstein, & Guthertz, 1990). This was not the case for non-depressed mothers and their infants, who spent more time in shared positive states than negative states. Mothers with more depressive symptoms also had fewer shared states overall with their infants than did mothers with less depressive symptoms and their infants, potentially affecting coordinated patterns of interaction. This evidence suggests that parents' abilities to achieve dyadic synchrony with infants could be negatively affected by depression. If parents are not positive during interactions they may not be able to help guide infants to states of optimal arousal during interactions so levels of dyadic synchrony may be lower. These infants may not have a rhythmic pattern of interaction with their parent, and may not be able to form expectations to help themselves regulate using effective techniques. Infants with depressed parents may not have a model of effective regulation to learn from and use for themselves.

Another study examined child emotion regulation strategies in children age 4-7 who had mothers with child-onset depression, and found that these children showed

cognitive and behavioral impairments in emotion regulation (Silk, Shaw, Skuban, Oland, & Kovacs, 2006). Specifically, daughters of child-onset depressed mothers tended to use more passive regulatory strategies, such as passively waiting, than daughters of non-depressed mothers who used more active strategies, such as distraction. The authors asserted that the passive emotion regulatory strategies are more likely to result in adjustment problems later in life. This evidence supports the possibility that parental depression is associated with less effective child emotion regulation, and it is possible that dyadic synchrony is one of the mechanisms through which depression influences emotion regulation. Dyadic synchrony could be affected by the lack of coordinated positive affect between the parent and infant as a result of parental depression, which could prevent the infant from experiencing effective regulatory strategies with parents to guide behavior later, as well as having less mutual regulation of optimal positive arousal to promote effective regulation.

Mother/father differences in interactions. Dyadic synchrony may be different between interactions with mothers and fathers, possibly due to differences in dyadic affective displays during interactions with each parent. It is well established that mothers and fathers show different intensities of affective expressions and display different types of behaviors during interactions with children (e.g., Feldman, 2003). Generally, mothers display more positive affect than fathers, yet fathers are more likely than mothers to engage in physical play with infants. (Belsky, Gilstrapp, & Rovine, 1984; Clarke-Stewart, 1978; Lamb, Frodi, Hwang, Frodi, & Steinberg, 1982**;** Roopnarine, Talukder, Jain, Joshi, & Srivastav, 1990; Weintraub & Frankel, 1977). Another study showed that infants also responded more positively to play initiated by fathers than mothers (Lamb, 1977).

Feldman (2003) examined parental differences during positive parent-infant interactions. She asserted that father-infant interactions are less stable, have higher levels of positive arousal, and are often characterized as "frequent, intense bursts of positive arousal and contain quick buildups and declines from peaks of emotional excitement (p. 16)". Feldman concluded that mothers presented socially oriented affective signals while fathers used high-intensity spurts of positive arousal. Infant arousal with mothers was characterized by low and medium states of arousal, whereas infant arousal with fathers was characterized by several peaks of high intensity. This evidence suggests that mothers and fathers display different intensities of positive affect during play with infants and infants respond differently to parents. If parents display high levels of positive affect infants may be too aroused and not at an optimal level of positivity. As a result, infants could show different levels of affect to regulate during interactions with mothers and fathers, and these different patterns of affect and behavior during the interaction might lead to different levels of dyadic synchrony, presumably relating to different patterns of regulation.

Although research exists on parental differences in affective interactions with infants, little research has examined infant emotion regulation with different parents. In one study infant regulation of negative affect was examined in parent-infant interactions and the authors suggested that mothers who had more positive interactions with their infants allowed infants to develop regulatory skills for distress as well as prevented or decreased future infant distress (Belsky, Fish, & Isabella, 1991). Another study found that infants used the same emotion regulation strategies of either scanning or distraction and had the same emotional expressions with both fathers and mothers during a

distressing task (Diener, Mangelsdorf, McHale, & Frosch, 2002). This evidence supports the notion that infant emotion regulation could be stable across positive and negative parent-infant interactions for both mothers and fathers, but may be different between interactions with mothers and fathers. It is possible that this difference is due to a difference in synchrony in mother-infant and father-infant interactions, possibly resulting from different patterns and intensity of affect between parents. Furthermore, patterns of synchrony are specific to each relationship and dyad (Feldman, 2007a), so it would be reasonable for them to be affectively and/or behaviorally different.

Infant sex differences in interactions. Another factor possibly related to dyadic synchrony and infant emotion regulation is infant sex. There is little agreement in the modest amount of research on infant sex differences in dyadic synchrony during parent-infant interactions. Some studies have examined the differences in mother-daughter and mother-son dyadic interactions, and have found that mothers and sons have more coordinated behaviors than mothers and daughters, indicating more synchrony (Malatesta & Haviland, 1982; Tronick & Cohn, 1989). Weinberg, Tronick, Cohn, and Olson (1999) also found that during free play mothers and 6-month-old sons had more synchrony than mothers and daughters. Yet, Feldman (2003) concluded that same-sexed pairs with 5-month-old infants had more synchrony during a free play dyadic interaction than opposite-sexed pairs, consistent with other research (Bettes, 1988; Feldman, Greenbaum, & Yirmiya, 1999; Rochat & Striano, 1999). Thus, research findings on sex differences in dyadic synchrony with mothers and fathers are unclear.

With respect to emotion regulation and infant sex differences during interactions several studies showed contradictory findings. Weinberg et al. (1999) found that 6-

month-old boys showed more anger and negative expressions than girls, fussed more often, and tried to be picked up or escape more often during the SFP, presumably because they were having a harder time maintaining regulation than girls. These findings were consistent with those of Osofsky and O'Connell (1977) who found that newborn males had a higher reactivity score measured by excitement, irritability, rapid buildup, and lability during a challenging interaction than females and showed more frequent peaks of excitement. This is contradictory to another study that found that 3 month-old female infants responded more negatively to mothers during the SFP than males with more disorganized behavior including showing more distress and appearing out of control and inconsolable (Mayes & Carter, 1990). Yet little research has specifically studied the differences in the relation between mothers' and fathers' synchrony with infants and the regulation of affect in boys compared with girls. The current study sought to clarify contradictory research findings with respect to dyadic synchrony with mothers and fathers and infant emotion regulation.

Parent – Infant Interaction in Varying Contexts

There are certain contexts of parent-infant interaction that are particularly well-suited to examine dyadic synchrony and infant emotion regulation. One common procedure used to examine infant regulation of positive and negative emotions within parent-infant interactions is The Still Face Paradigm (SFP) which was developed by Tronick et al. (1978) and consists of three episodes. First, the mother is asked to interact naturally with her infant (free play), then is told to stay neutral and not speak to or touch her infant (still-face episode), and finally is instructed to resume normal interaction

(reunion episode). This paradigm is unique because mothers presumably respond in an atypical manner to infants during the still-face episode in a way that is not synchronous.

Research suggests that infants react to the SFP with fewer facial expressions of joy, more neutral expressions, and less gazing at the mother (Toda & Fogel, 1993; Weinberg & Tronick, 1996). When mothers are not responsive to infants in the expected manner, infants avert gaze presumably to regulate emotions. During challenging contexts designed to elicit negative affect infants show behaviors that both signal unresponsive parents and regulate affect (Adamson & Frick, 2003). This evidence suggests that parent behavior is related to infant regulation during challenging interactions. Dyadic synchrony may be an important quality contributing to the degree of infant emotion regulation during these challenging dyadic interactions, based on varying affective displays of both parents and infants during the interaction. More dyadic synchrony presumably should relate to less behavioral regulation.

Recently, the reunion episode has been examined as a central component of the SFP. The reunion is a unique context because it emphasizes the affective and dyadic regulation in parent-infant interactions by observing parents and infants during a context that creates the need to repair the interaction when parents violate the infants' expectancy (Weinberg & Tronick, 1996). Dyadic synchrony may be a mechanism through which parents repair this relationship, by using established patterns of interactions to teach infants effective regulatory strategies that they can use in different, unexpected contexts, such as the SFP. Evidence shows that in the reunion episode infants had high levels of negative affect and negative expressions (sadness, anger, and stress) as well as high levels of positive affect and gazing at the mother (Weinberg & Tronick, 1996). However,

this could be the result of a carryover of emotion from the still-face episode. This context allows the parent to display sensitive behaviors with the infant following a negative situation, possibly helping to repair the relationship and guide the infant to effectively regulate in different ways resulting in a synchronous interaction.

Issues in Measurement

There are notable challenges to studying complex concepts such as dyadic synchrony and emotion regulation. Dyadic synchrony has been used to describe a quality of the interaction reflecting mutual engagement and components of parental sensitivity. In the infancy literature synchrony and other constructs tend to be used interchangeably and appear to describe a similar quality of the parent-infant interaction, yet may be measured differently and related to different aspects of the interaction. Some of the terms associated with these measures include sensitivity, attunement, matched affect, engagement, bi-directionality, reciprocity, and shared states (Harrist & Waugh, 2002). Currently, the literature has not made clear distinctions among these terms. Although related, these measures may be independent and may tap into different dimensions of parent-infant interaction. The current study uses dyadic synchrony based on its use in various studies (i.e. Feldman, 2003) as a measure of the coordinated movement of parent and infant affect and gaze across the interaction and is measured as the zero order correlation between the parent and infant states of engagement at every second.

Moreover, in the literature synchrony has been discussed as presumably reflecting a positive quality of the interaction. It is unclear what "negative synchrony" may relate to during an interaction. Negative synchrony would reflect a parent-infant interaction where both partners display patterns of coordinated negative affect. It has been shown that

negative affect is negatively related to mother-infant synchrony and could possibly hinder dyadic synchrony (Feldman, 2003; Feldman, Greenbaum, & Yirmiya, 1999). Feldman speculated that positive affect is important in establishing the cyclic nature of mother-infant interactions and that negative emotionality may disrupt these cycles, possibly more so with mother-infant interactions than father-infant interactions. To date, there is little other empirical evidence showing the degree to which synchrony is related to positive or negative affect, particularly in the infant. This study will investigate the relation between dyadic synchrony and positive and negative affect during parent-infant interactions.

In addition to issues with defining and measuring dyadic synchrony, emotion regulation is also a complex, dynamic process that has been measured in so many different ways that its utility has been questioned (Cole, Martin, & Dennis, 2004). The current study chose to measure emotion regulation behaviorally, based on gaze aversion. From a young age infants use attentional processes including gaze aversion to regulate emotions (Kopp, 1982). Unlike younger infants, infants at the age of 4 months begin to shift gaze from one location to another, such as looking away from mothers more often during interactions (Rothbart, Ziaie, & O'Boyle, 1992). The development of this response is thought to regulate arousal. Additionally, infants increase gaze aversion from the mother from 2 to 6 months of age presumably as a strategy for regulating positive and negative emotions during face-to-face interactions (Moore, Cohn, & Campbell, 2001). Thus, a change in attention through gaze aversion appears to be one of the most common strategies for emotion regulation in six-month old infants.

The Proposed Study

This thesis explored relations between dyadic synchrony and infant emotion regulation in parent-infant interactions that typically elicit positive and negative emotions. Dyadic synchrony was examined during a free play episode as well as in the reunion episode of the SFP. To better understand these constructs, infant and parent variables, such as parental depression and parent and infant sex differences, were also examined in relation to synchrony within these contexts to investigate the different predictors of dyadic synchrony. Synchrony is, by nature, a dyadic construct but it is questionable which variables are the strongest predictors of dyadic synchrony, and if these variables are being contributed in larger part by the parent or infant.

The study also examined infant emotion regulation, measured by gaze aversion, in four contexts: a free play interaction, which typically elicits moderate levels of positive affect, a structured game of peek-a-boo, which typically elicits high levels of positive affect and arousal, the still-face episode of the SFP, which typically elicits moderate levels of negative affect and arousal, and the reunion episode of the SFP, which elicits low to moderate levels of both negative and positive affect and arousal. The nature of these contexts allowed for comparison of gaze aversion (i.e., emotion regulation) across different types of interactions. Gaze aversion in the peek-a-boo, still-face, and reunion episodes served as the outcome variables when being compared to dyadic synchrony during free play.

Preliminary analyses included the examination of the stability of infant positive and negative affect and infant gaze aversion across contexts as well as the relations among these infant variables.

The specific questions and hypotheses tested were as follows:

1. What factors contribute to individual differences in dyadic synchrony during free play and the reunion episode?

1a. What are the relative contributions of infant affect and gaze, parent depressive symptoms, and parent affect in predicting dyadic synchrony during free play and the reunion episode?

- Both infant and parent variables will predict dyadic synchrony in free play and the reunion, yet given the dyadic nature of the construct of dyadic synchrony it is unclear if any variables will have more predictive power than any others. However, because parents tend to be positive often, infants may contribute more variance due to their more frequent changes in behavior and affect than parents.

1b. Do mother-infant dyads and father-infant dyads have different levels of dyadic synchrony in free play or the reunion episode? Do same-sexed or opposite-sexed pairs of parents and infants differ in dyadic synchrony in free play or the reunion episode?

- Mother-infant dyads and father-infant dyads will have significant differences from each other in dyadic synchrony in free play. Fathers have been found to have more intense bursts of positive affect with infants, yet mothers have been found to use more positive affect and be more responsive to infants. Since there is contradictory evidence across this research it is not clear in which direction these differences will be, or whether or not these differences will be the same for positive and negative contexts.

- Due to the conflicting research on the differences between same-sex and opposite-sex parent and infant pairs during interactions, it is unclear if there will be significant differences between these dyads with respect to dyadic synchrony during free play or the reunion episode.

2. How does dyadic synchrony in free play and the reunion episode relate to infant gaze aversion in a positive interaction (peek-a-boo) and challenging interactions (the still-face and the reunion episodes)?

    - Dyadic synchrony should negatively relate to infant gaze aversion across both negative and positive contexts. Higher levels of dyadic synchrony should decrease gaze aversion for infants, as evidence from studies shows that higher levels of synchrony relates to better self-regulation (Feldman, 2007; Feldman, Greenbaum, & Yirmiya, 1999; Moore & Calkins, 2004).

Chapter 2. METHOD

Participants

One hundred and thirty-seven families composed of mothers, fathers, and their 6-month-old infants (48% males) were participants. These participants originally were part of a representative community sample of 1,709 adolescents who were selected from nine high schools in urban and rural districts of western Oregon at age 14 to 18 years for a study of adolescent depression. Participants from this study were recruited when they were pregnant with their first child for a study of infant development (the Infant Development Study, P.I.s Lewinsohn, Cohn, & Allen).

The mean age of the parents was 26 years (SD = 2.42) for mothers and 28 years (SD = 3.33) for fathers. Mothers' ethnicity was 94% Caucasian and fathers' was 87% Caucasian and 8% Hispanic. There was range of income levels for families. With respect to education, 53% of mothers and 52% of fathers had a high school degree, 33% of mothers and 30% of fathers had a 2-year or 4-year college degree, and 3% of mothers and 2% of fathers had a graduate degree.

Procedures

Parent-infant interactions. Families came into the laboratory where face-to-face parent-infant interactions were conducted as part of a larger battery of procedures. Only data from the SFP were examined in the proposed study. Whenever possible, both parents were observed with their infant on the same day. A modified SFP was conducted that included a 3 minute episode of free play, a 40 second game of peek-a-boo, a 2 minute still-face episode, and a 2 minute reunion episode. Instructions for the SFP were given beforehand. Families were told that each parent independently would have the infant in

an infant seat facing him/her and parents received prompts for each episode over an intercom. Parents were instructed to play with their children for three minutes without any toys. They were then asked to play peek-a-boo with their children for 40 seconds. They were instructed to cover their faces with their hands and say "baby" and then to open them and say "peek-a-boo." Following this they were instructed to turn around for 15 seconds and then turn back with an expressionless face to their children for two minutes (still-face episode). They were asked not to speak to or touch their children during this time. Parents were then instructed to turn around again for 15 seconds, turn back, and play with the child again for two minutes for the reunion. The interaction was cut short if the baby was too fussy or would not cooperate. The interactions were videotaped for later coding and a time stamp was added.

Parental Depression. The Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977), a 20-item standardized self-report screening instrument of depressive symptom severity, was used to screen current parental depressive symptoms. Items are rated on a 4-point scale based on the frequency with which the item has been experienced in the previous week, and are added together to create an overall symptom rating for screening. A score of 16 or higher signifies the possibility of clinical depression. The CES-D has been shown to be reliable and valid for different demographic groups (Radloff, 1977). It has inter-item reliability estimates of .80s to .90s, test-retest reliability coefficients of .40s to .70s, and correlations to the BDI of > .80 (Roberts, 1980; Mahard, 1988). The CES-D has also been used in previous studies of parent-infant interaction (Diego et al., 2002; Diego et al., 2004).

Coding

Affect and gaze. For free play and the reunion episode, infant and parent affect and direction of gaze were coded on a second-by-second basis. For peek-a-boo and the still-face episode only infant affect and gaze was coded because parent behavior was considered to be neutral. Affect was coded according to a system based on Tronick's monadic phases (Tronick, Als, & Brazelton, 1980) and Izard's Affex System (Izard, Dougherty, & Hembree, 1983) following Cohn, Campbell, Matias, and Hopkins, 1990. Videotapes were viewed in real time. Coders were able to rewind the tape to establish to the nearest second when a change in behavior occurred. Infant affect at each second was coded into the mutually exclusive categories of positive, neutral, or negative. Infant gaze was also coded as either looking away or looking toward the parent. Parent affect was coded second by second during the free play and reunion episodes. Facial expressions of parents were coded into the mutually exclusive categories of negative, neutral, low positive, high positive, surprise, or empathy. Gaze to or away from the infant was also coded. Parent affect was later collapsed into positive, neutral, and negative categories to be consistent with infant coders. Positive affect consisted of low positive, high positive, surprise, and empathy.

Coding of videotapes was conducted by observers trained to a minimum reliability of $\kappa = .70$ and 80% agreement. Separate coding teams coded infant and parent behaviors and within each team the same person never coded both parents or the infant with both parents. In addition, 20% of the parent tapes and 20% of the infant tapes were coded by more than one coder to assess inter-coder reliability. Positive and negative affect are the focus for this study. Parents rarely showed negative affect so reliability

could not be computed for parent negative affect. Kappa's were .82 for parent positive affect and ranged from .71-.83 for infant positive and negative affect.

Data Reduction

Parent and infant affect. In order to operationalize the variables of parent and infant positive affect and negative affect, the amount of time parents and infants were in a positive state and a negative state were calculated as a percentage of valid interaction time separately for each of the four contexts (peek-a-boo, free play, still-face, reunion).

Parent and infant gaze aversion. Infant and parent gaze aversion was calculated as a percentage of valid interaction time parents or infants gazed away from the other separately for each of the four contexts (peek-a-boo, free play, still-face, reunion).

Dyadic synchrony. To compute parent-infant synchrony during free-play and the reunion phases of the SFP, following Cohn and Tronick (1988) and Moore and Calkins (2004) we first created a positive engagement score for each parent and child separately at each second of the episode. This computation combined information from affect and gaze to index the degree of positive engagement of the individual ranging from low (1) to high (6). A score of 1 was assigned for negative affect and gaze away from the other, 2 was negative affect with gaze toward the other, 3 was a neutral expression with gaze away from the other, 4 was a neutral expression and gaze toward the other, 5 was positive affect and gaze away from the other, and 6 was positive affect and gaze towards the other. These scores were computed for both infants and parents in the same way. Parents were typically more engaged than infants and had little negative affect, therefore parent positive engagement scores were typically restricted to a range of 3 - 6.

For each parent-infant dyad, a dyadic synchrony score during free-play and the reunion episodes were measured by computing the Pearson correlation coefficient between the time-series of parent and infant *positive engagement scores* at each second across the entire free-play and reunion episodes separately, following previous research (e.g. Moore & Calkins, 2004).

Dyadic synchrony variables were transformed prior to analyses using a Fisher R to Z transformation because they were correlation coefficients.

Chapter 3. RESULTS

Descriptive information about the major variables are presented in Table 1, including infant positive affect, negative affect, gaze, parent positive affect, parent CES-D ratings, and dyadic synchrony.

With respect to the CES-D, 12.4% percent of mothers scored above the cutoff of 16, which was considered to reflect a high probability of Depression, and 5.4% of fathers scored above the cutoff. Several studies have also used a cutoff as low as 12 for depression (i.e. Stewart, Rao, Emslie, Klein, & White, 2005). Using this cutoff, 21.7% of mothers and 9.3% of fathers scored above the cutoff. Paired t-tests were conducted to examine differences in CES-D ratings between mothers and fathers, and they were significantly different ($t(148) = 3.30$, $p < .001$), with mothers having higher ratings of depressive symptoms than fathers. Correlation analyses were also performed examining the relation between CES-D ratings and parent and infant affect, and no significant relations among these variables were found.

Preliminary analyses were performed to examine the relation of demographic variables to mother and father synchrony and infant gaze aversion, the primary dependent variables. Correlation analyses were performed with these variables and mother and father age, education level, and household income level, with values ranging from $r = -.09$ to $r = .15$, p = n.s.. One way ANOVAs were also performed with race and dyadic synchrony, with values ranging from $F = .30$ to $F = .86$, p = n.s.

Relations Among Infant Variables Within and Across Contexts

Correlation analyses were performed to examine the relation between infant gaze aversion and infant positive and negative affect for interactions with mothers and fathers (See Tables 2 and 3). With respect to mother-infant interactions, more positive affect in free play related to less gaze aversion during free play and the still-face episode, more positive affect in peek-a-boo was related to less gaze aversion in peek-a-boo and the reunion episode, and more positive affect during the reunion episode was related to less gaze aversion during the still-face episode. Furthermore, more negative affect during the still-face related to less gaze aversion during free play and the still-face episode for mother-infant interactions. For fathers-infant interactions, more positive affect during free play related to less gaze aversion during free play, more positive affect during the still-face episode related to less gaze aversion during the still-face episode, and more positive affect during the reunion related to less gaze aversion during free play and the still-face episode. Furthermore, more negative affect during free play related to more gaze aversion during free play for father-infant interactions. Additionally, infant positive and negative affect was negatively related within every context, with values ranging from $r = -.23$ to $r = -.44$, $p < .01$.

Stability of Infant Variables

Pearson correlation analyses were performed to examine the stability of infant gaze, infant positive affect, and infant negative affect across contexts. Infant gaze was correlated across almost all contexts and with both parents, where the majority of correlations were above .25, ranging from $r = .17$ to .86, where $p < .01$ for almost all correlations (Table 4). Infant positive affect was moderately correlated across contexts

and between parents, ranging from r = .06 to .59, where $p < .01$ for the majority of correlations (Table 5). Infant negative affect was more variable across contexts, showing moderate correlations across contexts and parents (Table 6). Correlations ranged from r = -.14 to .56.

Furthermore, dyadic synchrony was also correlated within the same dyad, where mother-infant dyadic synchrony was related across contexts (r = .27, $p < .01$) as was father-infant dyadic synchrony (r = .20, $p < .05$). There were no significant relations between father-infant and mother-infant dyadic synchrony within or across contexts, with values ranging from r = -.10 to r = .05, p = n.s.

Relation Between Dyadic Synchrony and Infant Variables

Correlation analyses were performed to examine the relation between dyadic synchrony variables and infant gaze aversion in peek-a-boo, the still-face episode, and the reunion episode. As hypothesized, greater mother-infant dyadic synchrony was related to less infant gaze aversion in peek-a-boo and the reunion episode with mothers (r = -.19, $p < .05$ and r = -.22, $p < .05$, respectively). However, father-infant synchrony was unrelated to infant gaze aversion in any contexts, with values ranging from r = -.04 to r = -.10, p = n.s.

Mother-infant dyadic synchrony was positively related to infant positive affect in the still-face episode (r =.17, $p < .05$), but was unrelated to infant positive or negative affect in other contexts. Father-infant synchrony was unrelated to infant positive or negative affect in any context, with values ranging from r = -.13 to r = .15, p = n.s.

Factors Predicting Dyadic Synchrony

Regression analyses were performed to examine the relative contributions of infant and parent variables to dyadic synchrony during free play and the reunion episodes separately for each parent, with 4 regressions performed in total (see Table 7). Included in the regression models were infant positive and negative affect, infant gaze, parent positive affect during free play and the reunion, and parent depressive symptoms. The overall fit of the model for mother-infant interaction during free play was significant ($F(132,5) = 11.22$, Adjusted $R^2 = .27$, $p < .001$, Cohen's $f^2 = .43$). Dyadic synchrony in mother-infant pairs during free play was predicted by higher levels of infant positive affect and lower levels of mother positive affect ($\beta = .38$, $p < .001$ and $\beta = -.50$, $p < .001$, respectively). The overall fit for the model for father-infant interaction during free play was significant ($F(114,5) = 5.12$, Adjusted $R^2 = .15$, $p < .001$, Cohen's $f^2 = .22$). Dyadic synchrony in father-infant pairs during free play was predicted by higher infant positive affect, less infant gaze away from fathers, and lower father positive affect ($\beta = .30$, $p < .01$; $\beta = -.20$, $p < .05$; $\beta = -.25$, $p < .01$), respectively. Infant negative affect was unrelated to dyadic synchrony, as were parent depressive symptoms for both mothers and fathers.

The overall fit for the model for mother-infant dyadic synchrony during the reunion episode was not significant ($F(109,5) = 1.63$, Adjusted $R^2 = .03$, Cohen's $f^2 = .08$). Dyadic synchrony in mother-infant pairs during the reunion episode was predicted by higher levels of infant positive affect ($\beta = .27$, $p < .05$) and lower levels of mother positive affect ($\beta = -.22$, $p < .05$). The overall fit for the model for father-infant dyadic synchrony during the reunion episode was not significant ($F(93,5) = 2.00$, Adjusted $R^2 = .05$, Cohen's $f^2 = .11$. Dyadic synchrony in father-infant interactions during the reunion

episode was predicted by higher levels of infant positive affect ($\beta = .29$, $p < .05$). No other variables predicted dyadic synchrony in the reunion episode for mother-infant or father-infant interactions.

Post-hoc analyses were performed to examine the relation of the proportion of positive affect between the parent and infant with dyadic synchrony and infant gaze to explore the possibility that positive affect could be driving the relation between synchrony and gaze aversion. For mother-infant interactions, the proportion of mother-infant positive affect during free play was positively related to dyadic synchrony in free play($r = .36$, $p < .01$) and negatively related to gaze aversion during free play ($r = -.23$, $p < .01$), and the proportion of mother-infant positive affect in the reunion episode was positively related to dyadic synchrony in free play ($r = .19$, $p < .05$) and positively related to gaze aversion during peek-a-boo and the reunion ($r = .22$ and $r = .21$, $p < .05$). For father-infant interactions, the proportion of positive affect during free play was positively related to dyadic synchrony during free play ($r = .19$, $p < .05$) and negatively related to gaze aversion during free play ($r = -.18$, $p < .05$). The proportion of father-infant positive affect during the reunion was negatively related to gaze aversion in free play, the still-face, and the reunion episode ($r = -.27$, $p < .01$; $r = -.21$, $p < .05$; $r = -.20$, $p < .05$, respectively).

Additional correlations analyses were conducted to determine if parents only scoring with a cutoff or 16 or above on the CES-D had ratings that related to dyadic synchrony. Relations remained non-significant, despite including only parents that scored above the cutoff.

Sex Differences in Dyadic Synchrony

Paired t-tests were conducted to examine mean differences in parent and infant dyadic synchrony between mothers and fathers. There were no sex differences in parent-infant dyadic synchrony, with values ranging from t = -.*43 to* t = .25, p = n.s.

Differences in Infant Variables Between Parents

Paired t-tests were conducted to examine mean differences in infant gaze aversion across contexts with mothers and fathers. Infants had higher levels of gaze aversion with fathers than mothers during the reunion episode (t[93] = 2.18, $p < .05$). There were no differences in infant gaze during other contexts, including free play, with values ranging from t = -1.80 to t = 1.12, p = n.s.

There were no differences in infant positive or negative affect with parents across contexts, with values ranging from t = -1.67 to t = .76, p = n.s.

Table 1.

Means and Standard Deviations of Variables Across Episodes

Infant Positive Affect	Mother	Father
Episode	Mean (SD) Range	Mean (SD) Range
Free Play	.25 (.21) 0 - .93	.22 (.19) 0 -.76
Peek-a-boo	.43 (.28) 0 – 1.00	.43 (.27) 0 - 1.00
Still-face	.07 (.12) 0 - .84	.07 (.09) 0 - .43
Reunion	.22 (.21) 0 - .89	.22 (.22) 0 - .84
Infant Negative Affect	Mother	Father
Episode	Mean (SD) Range	Mean (SD) Range
Free Play	.08 (.13) 0 - .78	.09 (.18) 0 -.96
Peek-a-boo	.06 (.15) 0 - .86	.04 (.13) 0 - .82
Still-face	.20 (.26) 0 – 1.00	.16 (.24) 0 - .96
Reunion	.21 (.29) 0 - 1.00	.18 (.28) 0 – 1.00
Infant Gaze Aversion	Mother	Father
Episode	Mean (SD) Range	Mean (SD) Range
Free Play	.43 (.24) .02-.98	.43 (.24) .05 -1.00
Peek-a-boo	.80 (.22) 0 - .91	.83 (.18) 0 - .87
Still-face	.24 (.23) 0-1.00	.22 (.20) .27 – 1.00
Reunion	.84 (.19) 0 - .92	.86 (.15) 0 - .83
Parent Positive Affect	Mother	Father
Episode	Mean (SD) Range	Mean (SD) Range
Free Play	.58 (.22) .06 – 1.00	.51 (.26) .02 - .99
Reunion	.52 (.24) .01 - .98	.52 (.23) 0 – 1.00
Parent C-ESD Ratings	Mother	Father
	Mean (SD) Range	Mean (SD) Range
	8.00 (6.74) 0 -32	5.95 (6.09) 0 - 36
Dyadic Synchrony	Mother-Infant	Father-Infant
Episode	Mean (SD) Range	Mean (SD) Range
Free Play	.29 (.14) -.08 - .67	.29 (.17) -.27 - .71
Reunion	.27 (.22) -.44 - .75	.30 (.22) -.32 - .80

Table 2.

Correlations Matrix of Infant Gaze and Positive and Negative Affect Within and Across Contexts With Mothers

Context	FP Gaze	PAB Gaze	SF Gaze	Reun Gaze
Free Play Pos	-.35**	-.13	-.22*	-.10
Peek-a-boo Pos	.12	-.21*	.07	-.20*
Still-Face Pos	.10	.12	-.16	.07
Reunion Pos	-.12	-.05	-.19*	-.09
Free Play Neg	-.01	.06	.09	.01
Peek-a-boo Neg	-.06	.02	-.01	.07
Still-Face Neg	-.18*	-.14	-.24**	-.05
Reunion Neg	-.03	-.06	-.16	.14

*p < .05, **p < .01

Table 3.

Correlations Matrix of Infant Gaze and Positive and Negative Affect Within and Across Contexts With Fathers

Context	FP Gaze	PAB Gaze	SF Gaze	Reun Gaze
Free Play Pos	-.44**	-.08	-.04	-.15
Peek-a-boo Pos	-.06	-.15	-.17	-.15
Still-Face Pos	.00	-.02	-.19*	.00
Reunion Pos	-.27**	-.15	-.19*	-.17
Free Play Neg	.28**	.03	.04	.18
Peek-a-boo Neg	.14	.10	.08	.10
Still-Face Neg	.12	-.07	-.07	.07
Reunion Neg	.05	.00	.04	.14

*p < .05, **p < .01

Table 4.

*Correlation Matrix of **Infant Gaze Aversion** Across Contexts*

Context	FP Mom	PAB Mom	SF Mom	Reun Mom	FP Dad	PAB Dad	SF Dad	Reun Dad
Free Play Mom	----							
Peek-a-boo Mom	.46**	----						
Still-Face Mom	.49**	.40**	----					
Reunion Mom	.42**	.89**	.35**	----				
Free Play Dad	.45**	.23*	.26**	.21*	----			
Peek-a-boo Dad	.28**	.37**	.19*	.35**	.41**	----		
Still-Face Dad	.35**	.17	.30**	.20	.52**	.46**	----	
Reunion Dad	.27**	.36**	.18	.39**	.40**	.86**	.39**	----

*p < .05, **p < .01

Table 5.

*Correlation Matrix of **Infant Positive Affect** Across Contexts*

Context	FP Mom	PAB Mom	SF Mom	Reun Mom	FP Dad	PAB Dad	SF Dad	Reun Dad
Free Play Mom	----							
Peek-a-boo Mom	.27**	----						
Still-Face Mom	.24**	.28**	----					
Reunion Mom	.59**	.31**	.40**	----				
Free Play Dad	.38**	.12	.09	.32**	----			
Peek-a-boo Dad	.26**	.35**	.16	.36**	.28**	----		
Still-Face Dad	.21*	.14	.28**	.18	.13	.36**	----	
Reunion Dad	.38**	.12	.06	.40**	.32**	.36**	.26**	----

*p < .05, **p < .01

Table 6.

*Correlation Matrix of **Infant Negative Affect** Across Contexts*

Context	FP Mom	PAB Mom	SF Mom	Reun Mom	FP Dad	PAB Dad	SF Dad	Reun Dad
Free Play Mom	----							
Peek-a-boo Mom	.56**	----						
Still-Face Mom	.34**	.43**	----					
Reunion Mom	.18*	.12	.62**	----				
Free Play Dad	.01	-.08	-.14	.07	----			
Peek-a-boo Dad	.11	.07	-.06	-.02	.34**	----		
Still-Face Dad	.04	.03	.10	.06	.35**	.15	----	
Reunion Dad	.11	.03	-.07	.13	.27**	.09	.46**	----

*p < .05, **p < .01

Table 7.

Regression Analyses Predicting Dyadic Synchrony

Model Regressor	R^2	F	df	ΔR^2	F	df	B	SE B	ß
Mother-Infant Dyadic Synchrony in Free Play									
1 Infant Positive Affect	.09	4.58*	(3,134)	.09	4.58*	(3,134)	.26	.06	.38**
1 Infant Negative Affect	.09	4.58*	(3,134)	.09	4.58*	(3,134)	.14	.09	.13
1 Infant Gaze	.09	4.58*	(3,134)	.09	4.58*	(3,134)	.00	.05	-.01
2 Parent CES-D ratings	.09	3.42*	(4,133)	.00	.04	(1,133)	.00	.00	-.01
3 Parent Positive Affect	.30	11.22**	(5, 132)	.21	38.57**	(1,132)	-.32	.05	-.50**
Model Regressor	R^2	F	df	ΔR^2	F	df	B	SE B	ß
Mother-Infant Dyadic Synchrony in Reunion									
1 Infant Positive Affect	.03	1.19	(3,111)	.03	1.19	(3,111)	.29	.12	.28*
1 Infant Negative Affect	.03	1.19	(3,111)	.03	1.19	(3,111)	.02	.08	.02
1 Infant Gaze	.03	1.19	(3,111)	.03	1.19	(3,111)	-.03	.12	-.02
2 Parent CES-D ratings	.03	.90	(4,110)	.00	.05	(1,110)	.00	.00	.02
3 Parent Positive Affect	.07	1.63	(5, 109)	.04	4.47*	(1,109)	-.21	.10	-.22*
Model Regressor	R^2	F	df	ΔR^2	F	df	B	SE B	ß
Father-Infant Dyadic Synchrony in Free Play									
1 Infant Positive Affect	.12	5.09**	(3,116)	.12	5.09**	(3,116)	.27	.09	.30*
1 Infant Negative Affect	.12	5.09**	(3,116)	.12	5.09**	(3,116)	.08	.09	.08
1 Infant Gaze	.12	5.09**	(3,116)	.12	5.09**	(3,116)	-.14	.07	-.20*
2 Parent CES-D ratings	.13	4.40**	(4,115)	.02	2.16	(1,115)	.00	.00	-.13
3 Parent Positive Affect	.18	5.12**	(5, 114)	.05	7.08**	(1,114)	-.19	.07	-.25*
Model Regressor	R^2	F	df	ΔR^2	F	df	B	SE B	ß
Father-Infant Dyadic Synchrony in Reunion									
1 Infant Positive Affect	.07	2.41	(3,95)	.07	2.41	(3,95)	.28	.11	.29*
1 Infant Negative Affect	.07	2.41	(3,95)	.07	2.41	(3,95)	-.11	.09	-.14
1 Infant Gaze	.07	2.41	(3,95)	.07	2.41	(3,95)	.13	.17	.08
2 Parent CES-D ratings	.07	2.41	(4,94)	.00	1.79	(1,94)	.00	.00	-.02
3 Parent Positive Affect	.10	2.41	(5, 93)	.03	1.97	(1,93)	-.16	.10	-.19

*p < .05, **p < .01

Chapter 4. DISCUSSION

This study aimed to understand the relations between the quality of parent-infant interaction and infant emotion regulation. Dyadic synchrony with parents allows infants the opportunity to experience the coordination of biological and behavioral rhythms, mutual levels of optimal positive arousal, and a type of dyadic interaction that will presumably generalize to other interactions with the same caregiver across different contexts (Feldman, Greenbaum, & Yirmiya, 1999). After infants experience synchronous interactions repetitively with parents they may ultimately learn how to guide themselves to more optimal levels of arousal without waiting for their parent to help them do so. With regard to the results, parent and infant positive affect were the most salient predictor of dyadic synchrony, infant gaze aversion was stable across contexts and with parents, and dyadic synchrony was found to relate to gaze aversion across contexts for mother-infant interactions, but not father-infant interactions. Additional findings and the implications for these results are discussed further.

Dyadic Synchrony

In order to better understand the construct of dyadic synchrony, parent and infant predictors were examined. It appears that both infant and parent positive affect were important predictors of synchrony for both mother-infant and father-infant interactions. Positive affect was a significant predictor of dyadic synchrony during both free play and the reunion episode for mothers, fathers, and infants. This finding is consistent with prior research suggesting that synchrony is a mechanism with which to build and maintain positive affect (Feldman, 2003; Feldman, Greenbaum, & Yirmiya, 1999). The more positive that infants were and the less positive parents were the more dyadic synchrony

the interaction had. Further investigation of the importance of positive affect in these interactions showed that the proportion of parent-infant positive affect was related to more dyadic synchrony and less gaze aversion within an episode for mother and father-infant interactions. Additionally, within a given context (free play or the reunion episode) dyadic synchrony was unrelated to infant or parent positive affect in other contexts, suggesting that it may be a balance of parent and child positive affect in the moment that describes dyadic synchrony. Together, these findings support the notion that infants may achieve an optimal level of positive arousal during interactions to reach and experience synchrony with parents, which could allow infants to expect and learn effective rhythms of interaction that could promote internal regulation, and that might not require as much behavioral regulation. The ability to reach this state appears to reflect a delicate balance of positive affect from parents and infants.

The current findings also suggest that infants' and parents' positive affect may contribute equally and more importantly to dyadic synchrony than other variables. Even in the reunion episode, a challenging interaction that presumably needs to be repaired after the disruption of the still-face, positive affect appeared to be more important for both parents and infants than negative affect in contributing to dyadic synchrony. It is notable that these findings were consistent for both free play and reunion episodes, where infants showed the same proportions of positive affect. Despite the fact that parents were positive for the majority of the interactions, and this finding may be, in part, a function of the lack of negative affect from parents, infants do show negative affect during these interactions. Although coordinated negative affect between parents and infants could reflect synchrony, it appears that coordinated positive affect is more important for

synchrony. Dyadic synchrony was also unrelated to negative affect across contexts. This further highlights the importance of infant positive affect as opposed to negative affect in interactions with parents, consistent with previous research (Cohn & Tronick, 1983; Kahana-Kalman & Walker-Andrews, 2001). These findings also provide evidence that synchrony is a dyadic quality of the interaction that parents and infants co-create, instead of infants or parents driving the interaction. This evidence lends support to the idea that synchrony may not be simply based on the infant's temperament or typical affective displays, but that it depends on both the infants' and the parents' behaviors to determine what a synchronous interaction will be. However, this study did not measure infant temperament directly and future research would benefit from examining relations between temperament and synchrony

The relation between dyadic synchrony and gaze aversion is slightly more complicated, and appears to be dependent on parent sex. In regard to infant gaze as a predictor of dyadic synchrony within an episode, infant gaze aversion predicted dyadic synchrony in interactions only with fathers during free play, where less gaze aversion during the free play interaction was associated with higher levels of dyadic synchrony in free play. With respect to the relation between dyadic synchrony in free play and gaze aversion in other contexts, dyadic synchrony measured during the free play episode was related to less gaze aversion in peek-a-boo and the reunion episode, but only in mother-infant interactions. So for interactions with fathers, gaze aversion appears to be important in reaching dyadic synchrony, but for interactions with mothers gaze aversion was not predictive of synchrony within an episode. Instead, dyadic synchrony with mothers may reflect established patterns that infants may have learned to expect and repeat. Infants

engaged in highly synchronous interactions may form expectations about the way their mothers guide them to optimal levels of arousal and ultimately learn to guide themselves to optimal levels of positive arousal in later interactions. It appears that infants who are engaged in synchronous interactions with their mothers avert gaze less often in both positive and negative contexts, presumably needing to avert gaze less often. While they may need to avert gaze occasionally, it is possible that infants participating in highly synchronous interactions with mothers may be able to maintain a more optimal level of arousal during interactions that typically elicit positive emotion. Previous research has suggested that gaze aversion helps infants to reach an optimal level of positive arousal (Stifter & Moyer, 1991), and the current study has shown that infants avert gaze in different contexts more often when their previous interactions are not as synchronous with mothers. Perhaps infants who are averting gaze in these contexts are not reaching optimal levels of positive affect with mothers, potentially from not establishing a pattern of interactions with mothers that allowed stay at optimal levels of arousal.

However, this relation between dyadic synchrony and gaze aversion did not hold for father-infant interactions. Instead, it may be that infant gaze is important for establishing synchrony with fathers at 6 months. It may be more difficult for infants and fathers to achieve repetitive, coordinated interactions than infants and mothers, at least as measured by dyadic synchrony. Thus, infants may not be learning to expect the same patterns of interactions with fathers that they are with mothers, and not regulating with the same patterns. Feldman (2003) showed that infant arousal with mothers was centered on low and medium states of arousal, whereas infant arousal with fathers was centered on several peaks of high intensity. Fathers' behaviors may be more unpredictable so infants

react by looking away more often from fathers than from mothers to regulate this unpredictability (Feldman, 2003), not having established an anticipated pattern fathers at this age. Findings of the current study that infants averted gaze from fathers more often than from mothers were consistent with those of Feldman (2003). Perhaps rhythms between fathers and infants are still developing at 6 months, not yet allowing infants to expect and learn effective regulatory patterns with fathers. This is consistent with research suggesting that patterns of interaction are different based on each dyadic interaction (Feldman, Greenbaum, & Yirmiya, 1999). Infants and fathers may use a different mechanism for reaching dyadic synchrony than infants and mothers that is not as cyclic or repetitive, so infants may not yet have developed the link between established patterns of interaction and effective regulation to stay at optimal levels of arousal.

In addition to infant variables, parental depressive symptoms were expected to relate to dyadic synchrony during parent-infant interactions. Yet, depressive symptoms did not predict dyadic synchrony when considering other parents and infant variables. Although previous research has found that depressed mothers had fewer shared states with infants (e.g. Field, Healy, Goldstein, & Gutherz, 1990), many of these studies used parents showing higher levels of depression. The current sample used depressive symptoms as a screening tool, and the majority of parents were not at the cutoff of a high likelihood of clinical depression at the time of the study. Although the relation between dyadic synchrony and clinically-relevant CES-D ratings was still not significant, there were only a small number of parents included in the study with ratings reflecting a high probability of depression that might not allow for enough power to show the relation. Thus, it is possible that in order for depression to have an effect on parent-infant

interactions many parents in the study need to be at a higher level of depressive symptoms. An alternative interpretation is that dyadic synchrony does not measure shared affective states, and previous research has found that depression negatively affects matched states, particularly shared positive affect (Field, Healy, Goldstein, & Guthertz, 1990). Perhaps depressive symptoms do not actually affect dyadic synchrony directly, and only affect interactions measuring concurrent behaviors. The current study did not have the methods to examine this possibility.

Gaze Aversion as a Measure of Emotion Regulation

In addition to exploring the construct of dyadic synchrony, this study sought to better understand infant gaze as a mechanism of emotion regulation. Gaze aversion was found to be stable across contexts, consistent with previous research showing that infants use similar regulatory strategies for positive and negative affect and with both mothers and fathers (Diener, Mangelsdorf, McHale, & Frosch, 2002).. It is important to note that infants used gaze aversion at 6 months during contexts designed to elicit both positive and negative affect to regulate arousal. Much research has supported the idea that infants need to regulate negative emotions (i.e., Adamson and Frick, 2003; Toda & Fogel, 1993; Weinberg & Tronick, 1996), but less research has argued for the need of infants to regulate positive emotion. Current findings suggest that 6-month-old infants can use gaze aversion to regulate positive affect, and gaze, an attentional mechanism, has already been understood as one of the most effective strategies for infants to regulate negative emotions (Kopp, 1982; Moore, Cohn, & Campbell, 2001). Thus, it appears that this regulatory skill can be extended into both positive and negative situations, even at 6 months. It is also notable that infants' gaze aversion was stable between interactions with

mothers and fathers. Although mothers and fathers may socialize infants differently (Belsky, Gilstrapp, & Rovine, 1984), infants appear to use the same strategy with both parents to regulate both positive and negative emotions. This evidence suggests that although interactions are different between mothers and fathers, infants use gaze aversion as a strategy across both interactions. Perhaps gaze aversion is a more primitive, ingrained mechanism that infants use more automatically with both parents and other types of internal, physiological, or more complex behavioral regulatory mechanisms arise from these early patterns of interactions with parents. This view is consistent with research suggesting that attentional mechanisms in young infants are simply antecedents to development of more sophisticated self-regulation (Kopp, 1982). The stability of gaze across contexts could also reflect an underlying infant temperament, where certain regulatory strategies are more trait-like, and certain infants use this strategy more than others with both parents.

This study also examined the relation of infant gaze aversion to infant affect. More gaze aversion was related to less positive affect within free play in both mother-infant and father-infant interactions. This pattern suggests that infants who were presumably at optimal levels of positive affect did not need to regulate positive affect during free play. The current analyses measured infant behaviors in terms of the proportions of affect and gaze expressed across each episode of the SFP, so it is difficult to know the temporal order of affect and gaze or the link between them to conclude causality. Moreover, more gaze aversion was related to less positive affect within the still-face episode for father-infant interactions. Since father-infant interactions have been shown to be less cyclic with more intense displays of positive affect perhaps infants

displaying positive affect were accustomed to changes in fathers' emotional displays during interactions, so were not as surprised by the still-face and did not need to look away to regulate their emotions. Additionally, infants may not have experienced high levels of positive arousal since fathers had a neutral expression and did not assist in positively arousing them, so infants presumably did not need to regulate this positive affect. In addition, more positive affect in one episode related to less gaze aversion across later episodes for mother-infant interactions. This supports the idea that infants at optimal levels of positive arousal do not need to use behavioral regulation as often during interactions with mothers.

It was assumed that infant gaze aversion was an index of emotion regulation, and the relation between gaze and affect lends support to the idea that when infants become too aroused they may avert gaze to regulate these emotions. Infant gaze aversion was also related to infant negative affect, in addition to positive affect. More negative affect in free play was related to more gaze aversion in free play for father-infant interactions. This finding suggests that the more negative infants were during free play, the more they had to look away, presumably to regulate. However, less negative affect during the still-face episode was related to more gaze aversion for mother-infant interactions. When infants' expectancies are challenged they may change their behavior to evoke a response from their parent. Since mother-infant interactions have been found to be cyclic and stable, infants may expect to successfully get their mothers' attention and therefore look at them for help regulating during this challenge instead of attempting to regulate on their own. Consequently, negative affect may not necessarily reflect more gaze aversion in this context. It is also possible that infants looked away to regulate distress during the still-

face episode and this gaze aversion was effective in preventing the experience and display of negative affect, although the current study was not able to examine this possibility.

Sex Differences

Another goal of this study was to examine sex differences in mother-infant and father-infant interactions. It was predicted that mothers and fathers would interact with infants differently, showing different levels of dyadic synchrony. In this study, mothers and fathers did not have different levels of dyadic synchrony with infants. Previous research has shown that there are differences in the way mothers and fathers interact with infants, especially during positive contexts (i.e., Feldman, 2003). While it is accepted that parents interact with infants very differently, it may be that these different methods for interacting are the most effective ways to achieve dyadic synchrony for each parent specifically. Mothers tend to be more stable in their interactions, whereas fathers are more variable and unexpected (Feldman, 2003). Both types of interactions may relate to higher levels of dyadic synchrony when considering the infants' needs and way of interacting with each parent. It appears that as long as both the parent and infant can find a balance of positive affect, they will have higher levels of dyadic synchrony and perhaps how they achieve this positive affect does not matter. However, dyadic synchrony may reflect an established pattern of interactions for mothers, relating to more effective emotion regulation, but potentially not for interactions with fathers.

In addition to the lack of sex differences between parents, there were no infant sex differences in dyadic synchrony with either parent in free play or the reunion episode. This finding is not surprising given the contradictory findings on sex differences at six

months during interactions with parents. This study suggests that there seems to be no pattern with respect to infant sex in parent-infant interactions at 6 months, at least for the current sample. Perhaps at 6 months infants are not yet being differentially socialized based on sex, but there may be differences in parent-infant interactions as children get older.

Although there were no sex differences in dyadic synchrony between parents and infants, there were differences in infant gaze aversion with mothers and fathers. Infants used more gaze aversion with fathers during the reunion episode and peek-a-boo. This suggests that infants may react differently to the ways that parents interact with them. This also may support research suggesting that fathers use higher intensities of positive arousal with infants, forcing infants to look away and regulate their own positive arousal more so than with mothers, although the intensity of positive affect was not examined in the study. This evidence further supports the notion that perhaps infants may not have yet established patterns with fathers that are conducive to expecting repetition of interaction and learning behavioral mechanisms for self-regulation, and so infants need to use gaze aversion more often with fathers than with mothers.

Despite differences in gaze aversion with parents there were no differences in the amount of infant positive or negative affect with parents. Although infants do have inherent, temperamental traits, infants may function differently when interacting with mothers and fathers. For example, infants may show more positive affect with mothers on a more stable basis, but may show higher intensities with fathers sporadically. Or they may show longer displays of positive affect with mothers with more pauses in between,

but may show increased, quicker displays with fathers with fewer pauses. Due to limited methods, this study could not examine this possibility.

Limitations and Future Directions

The current study examined dyadic synchrony during parent-infant interactions. Although dyadic synchrony has been measured behaviorally in the past (i.e. Feldman, 2003) research has recently began to examine physiological measures of synchrony, such as cardiac measures (Feldman, 2007; Ham & Tronick, 2006). Previous research has suggested that early infant physiological patterns may contribute to dyadic synchrony, at least between mothers and infants (e.g. Feldman, 2006). Therefore, it may be important to examine physiological measures of dyadic synchrony in addition to behavioral measures to better understand possible mechanisms accounting for the patterns of the dyad during the interaction. These physiological indicators may highlight further links between dyadic qualities of the interaction and infant emotion regulation. Moreover, there are many other qualities of the interaction that have been linked to the idea of mutual responsiveness, such as contingent responsiveness, affect attunement, and flexibility, measured in ways other than simple patterns of interaction across time. While this study did not have the methods available to sort out possible differences among these different qualities of interactions, it may be important to focus on different ways to do so. Using different methods to measure and examine dyadic qualities may better help to explain the processes during parent-infant interactions and what the most important aspects of the exchanges may be. Using measures of concurrent, contingent, and coordinated patterns of interactions may shed light on the essential components of the interaction that promote effective infant regulation.

In addition to using one type of dyadic quality of the interaction, this study used one measure of emotion regulation, gaze aversion. While attentional mechanisms such as gaze aversion have proved to be one of the most common processes through which infants regulate emotions (i.e., Kopp, 1982), it may be that infants are using other strategies as well, such as self-soothing behaviors or more internal, physiological mechanisms. Future studies should examine different emotion regulatory strategies and their relation to dyadic qualities of the interaction as well as differences in the use of these strategies between interactions with mothers and fathers. Furthermore, emotion regulation is a complicated process and while infants may be regulating while they are averting gaze, it is important to empirically support this regulation. Gaze aversion has been shown to help infants regulate negative emotions, but only few studies have shown this to be the case with positive emotions. Future studies should examine the effectiveness of gaze aversion in regulating positive emotions and explore different strategies and ways to regulate this high positive arousal with both mothers and fathers by using sequential analyses and measuring contingencies of affect and behavior. Moreover, the current study looked at the regulation of positive and negative emotions in general, as opposed to differences in discrete negative emotions. Prior research has shown that different strategies may be more effective at regulating different negative emotions (Buss & Goldsmith, 1998) so further research should look at regulation of more discrete emotions and dyadic synchrony. This study also did not examine levels of intensity of each emotion, and doing so could shed light on further explanations for the different findings in mother-infant and father-infant interactions.

Finally, one of the most basic questions being examined in the current study concerns the level of contribution of parents compared to infants to measures of synchrony during the dyadic interaction. While it appears that both parents and infants bring their own traits to the interaction, future studies should continue to sort out the different contributions. Examining infant temperament and parent personality may shed light on the specific traits driven by each partner, whereas affect may just be a proxy for some of these more established traits. For example, one study found that infant affective displays and behaviors during the still-face at 6 months were related to ratings of internalizing and externalizing behaviors a year later (Moore, Cohn, & Calkins, 2001). Studies should also examine the differences in the impact of mothers' and fathers' personality, as well as sex differences in temperament during these interactions.

Summary and Conclusion

This study sought to understand the relation between dyadic synchrony and infant gaze aversion across contexts and between parents as well as to examine different predictors of dyadic synchrony during free play and the reunion episode of the SFP. It appears that dyadic synchrony is related to gaze aversion across mother-infant interactions but is not related to gaze aversion during infant interactions with fathers. However, gaze aversion is important for reaching dyadic synchrony for father-infant interactions within an interaction. Additionally, positive affect, but not negative affect, proved to be an important contribution to dyadic synchrony, and for both mother-infant and father-infant interactions. Although mothers and fathers may use different techniques for reaching dyadic synchrony with infants, they both seem to reach the same level of synchrony with infants. Future studies should examine other dyadic qualities of the

interaction, different types of regulatory strategies, and more sophisticated methods for understanding these processes.

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