# Assessments (in the Making) of Attachment in the Making:

# Organized Patterns of Infant Regulatory Behavior in Response to the Maternal Still-Face

by

Katherine Faith Hagan

A dissertation accepted and approved in partial fulfillment of the

requirements for the degree of

Doctor of Philosophy

in Psychology

Dissertation Committee:

Jennifer Ablow, PhD, Chair

Jeffrey Measelle, PhD, Co-Chair

Dare Baldwin, PhD, Core Member

Jeffrey Todahl, PhD, Institutional Representative

University of Oregon

Summer 2024

DISSERTATION ABSTRACT

Katherine Faith Hagan

Doctor of Philosophy in Psychology

Title: Assessments (in the Making) of Attachment in the Making: Organized Patterns of Infant Regulatory Behavior in Response to the Maternal Still-Face

Infants' experiences of caregiver attunement and regulatory support in the first months of life likely shape embodied expectations about the self, the caregiver, and the extent to which the emerging attachment relationship can transform and soothe distress. Infants' biobehavioral responses to the Still-Face Paradigm (SF) offer a potential index of these emerging expectations, with potential implications for understanding precursors to later quality of attachment and the origins and malleability of these precursors in early development.

This dissertation adopts a programmatic and integrative approach to evaluating the possibility that infant responses to the Still-Face paradigm are meaningfully indicative of dyadic adjustment during the infant's first year of life and potentially prognostic of quality of attachment in the infant's second year. To this end, the introduction to the dissertation describes (1) the theoretical and empirical rationale for regarding infant SF response as a marker of the infant's interactive history and (2) the importance that identification of attachment-like regulatory patterns or precursors to later quality of attachment in the SF may have for the study of infant adaptation and long-term health. The dissertation's second chapter consists of a narrative review of existing efforts to glean attachment-like patterns or otherwise predict later quality of attachment on the basis of infants' SF response. The narrative review details discrete affective and regulatory behaviors in the SF that have received attention as possible markers of infants' attachment-related working models in-the-making; the review identifies overlap and

discrepancies among existing microanalytic findings. While modest associations between infant SF behaviors and attachment outcomes point to the promise of the SF paradigm as a source of information about dyadic adjustment and attachment in the making, discrepancies across microanalytic studies of discrete behaviors (including among infants at different ages) and differences in measurement strategies exemplify the need for programmatic, synthesizing efforts to facilitate comparison of findings between studies. The narrative review also draws on the development of the attachment classificatory system to advocate for an approach to individual differences in the SF that attends to organized patterns of regulatory behavior rather than discrete behaviors.

The subsequent chapters of this dissertation examine proximal and distal correlates to infant regulatory responses in the SF, by way of three sub-studies of a single sample of mother-infant dyads contending with socioeconomic and other psychosocial risk. Each of the three sub-studies make use of archived recordings of the SF paradigm and leverage secondary analysis of several related measures that were collected in an already-completed study that predated the dissertation. Study 1 adopts a novel but existing typological approach to identifying organized patterns of infant regulatory behavior in the SF, to in turn compare the distribution of the patterns in the present sample to that of other samples that have applied a similarly categorical approach. Study 1 also (a) examines evidence for convergent validity of the regulatory patterns by juxtaposing the patterns with more granular approaches to observing and describing infant SF behavior, and (b) evaluates the hypothesis that patterning of infant regulatory behavior reflects features of the infant's interactive history. Study 2 examines whether patterns of regulatory behavior are accompanied by differences in infants' autonomic (specifically, heart rate and respiratory sinus arrhythmia) responses to the SF stressor. Finally, Study 3 seeks to replicate an

existing finding of association between SF regulatory patterns and later organized attachment classification. Studies 1 and 2 find evidence of convergent validity of the regulatory patterns, which exhibit expected associations with more granular observations of infant behavior, maternal sensitivity to infant distress, and differential changes in infant heart rate during the SF paradigm. While several hypothesized associations between infants' SF-based regulatory patterns and concurrent measures bear out in the present study, the regulatory patterns observed in the SF paradigm in this sample at five months postpartum are not associated with later organized quality of attachment assessed in the Strange Situation Procedure one year later. Connections to current findings are discussed, as are recommendations for future study of organized patterns of regulatory behavior and attachment in the making.

CURRICULUM VITAE

NAME OF AUTHOR: Katherine Faith Hagan

GRADUATE AND UNDERGRADUATE SCHOOLS ATTENDED:

University of Oregon, Eugene
Harvard Divinity School, Cambridge
Swarthmore College, Swarthmore

DEGREES AWARDED:

Doctor of Philosophy, Clinical Psychology, 2024, University of Oregon
Master of Science, Psychology, 2019, University of Oregon
Master of Theological Studies, 2011, Harvard Divinity School
Bachelor of Arts, Linguistics and Languages, Swarthmore College

AREAS OF SPECIAL INTEREST:

Intergenerational processes
Infant mental health
Social-emotional development
Complex trauma
Dyadic intervention

PROFESSIONAL EXPERIENCE:

Predoctoral Clinical Psychology Fellow, Clinical Psychology Training Program, University of California, San Francisco Department of Psychiatry and Behavioral Sciences, 2023-2024

Graduate Teaching Fellow, Department of Psychology, University of Oregon, 2016-2023

Perinatal Mental Health Extern, Center for Family Development, Eugene, OR, 2020-2023

Psychological Assessment Extern, Private Practice in Forensic Evaluations, Eugene, OR 2021-2022

Bilingual Therapist, Centro Latinoamericano, Eugene, OR, 2020-2021

Dialectical Behavior Therapy Co-Leader, Portland DBT Institute, Salem, OR, 2020-2021

Doctoral Student Therapist, University of Oregon Psychology Clinic, 2017-2020

Group facilitator in randomized-controlled intervention study, Oregon Research Institute, Eugene, OR, 2019-2020

Spanish-Language Healthcare Interpreter, Boston, MA, Massachusetts General Hospital, 2016; Dana-Farber Cancer Institute, 2014-2016

Clinical Research Coordinator, Massachusetts General Hospital Martinos Center for Biomedical Imaging, 2012-2016

Writing Associate, Swarthmore College Writing Center, 2006-2009

GRANTS, AWARDS, AND HONORS:

Psychology Graduate Education Committee Award for Positive Change, University of Oregon, 2022

Oregon Sasakawa Young Leaders Fellowship Fund (Sylff) Graduate Fellowship for International Research, Sylff Association, 2019

Committee for an Inclusive Community Inclusivity and Diversity Professional Development Award, University of Oregon Department of Psychology, 2019

Norman D. Sundberg Fellowship, University of Oregon, 2019

Wayne Morse Graduate Research Fellowship, Wayne Morse Center for Law and Politics, 2018

Gary E. Smith Professional Development Award, University of Oregon, 2017

Janney Fellow, Swarthmore College, 2009-2011

Alejandro Reyes Award, Pan-American Association of Philadelphia, 2008

Joel Dean Summer Research Fellowship, Swarthmore College, 2008

Rubin Scholar, Office of Multicultural Affairs, Swarthmore College, 2006-2008

PUBLICATIONS:

Farzam P., Buckley, E.M., Hagan, K., Grant P.E., Inder, T.E., Carp, S.A., Franceschini, M.A. (2017). Shedding light on the neonatal brain: probing cerebral hemodynamics by diffuse optical hemodynamic methods. *Scientific Reports. 7*(15786): 1-10. 10.1038/s41598-017-15995-1

Roberts, S.B., Franceschini M.A., Krauss, A. [and 14 others, including Hagan, K]. (2017). A pilot randomized controlled trial of a new supplementary food designed to enhance cognitive performance during prevention and treatment of malnutrition in childhood. *Current Developments in Nutrition. 1*(11): 1-12. 10.3945/cdn.117.000885

Lin, P.Y., Hagan, K., Fenoglio, A., Grant, P.E., Franceschini, M.A. (2016). Reduced cerebral blood flow and oxygen metabolism in extremely preterm neonates with low-grade germinal matrix-intraventricular hemorrhage. *Scientific Reports*. (6)25903. 10.1038/srep25903.

Dehaes, M., Cheng, H. H., Buckley, E. M., Lin, P.Y., Ferradal, S. L., Williams, K., Vyas, R., Hagan, K., Wigmore, D., McDavitt, E., Soul, J. S., Franceschini, M. A., Newburger, J. W., and Grant. P. E. (2015). Perioperative cerebral hemodynamics and oxygen metabolism in neonates with single-ventricle physiology. *Biomedical Optics Express*, *6(*12). 10.1364/BOE.6.004749.

Lin, P.Y., Roche-Labarbe, N., Dehaes, M., Carp, S., Fenoglio, A., Barbieri, B., Hagan, K., Grant, P. E., Franceschini, M.A. (2013). Non-invasive optical measurement of cerebral metabolism and hemodynamics in infants. *Journal of Visualized Experiments*. *73*(e4379).10.3791/4379

ACKNOWLEDGMENTS

I would like to thank my advisors and co-directors of the University of Oregon Developmental Sociobiology Lab, Jennifer Ablow, and Jeffrey Measelle. Thank you for the chance to think with you, on many occasions and over several years, about perinatal psychology, infancy, and development in early childhood. I remember that when Jen invited me to join the graduate department under your shared mentorship, I said that I felt like I had won the lottery, and I remain truly grateful for your willingness to take me on for doctoral training. I appreciate the warm and welcoming spirit that you have both brought to my range of interests, and I wish to thank you both for your patient witness and faith in my process.

I would also like to thank my dissertation committee members, Dare Baldwin and Jeff Todahl, for your feedback on the plans for the dissertation and the culminating manuscript. I would like to extend a special thanks to Dare, whose mentorship on multiple projects has shaped my sense of myself as a developmental scientist. Dare, your combination of kindness, careful thinking and nuanced reception of my work has supported me to take a less self-deprecating stance toward my ideas and the direction of my research, even as I retain the rigor and healthy skepticism that are part of any science. And Jeff, representation from the Center for Prevention of Abuse and Neglect on this committee means more than I can say.

I am indebted to the clinical psychologists who have supervised my clinical training, including, most recently, each of the psychologists of the University of California San Francisco's Child Trauma Research Program. Your admirable example has influenced me profoundly, both personally and professionally.

I would like to acknowledge my father, Francis, who passed away in the second year of my training but who voiced many times his contented belief that I had found my "niche" when I

joined the UO Psychology Department as a graduate student. He repeatedly encouraged me to keep my sense of humor, which has indeed been an important resource. I would also like to acknowledge my mother, Flora, whose natural inquisitiveness, even in the absence of formal educational opportunities similar to my own, helped make curiosity my watchword.

I would like to extend my heartfelt gratitude to my sisters and closest friends, whose wisdom, coaching, and care packages have been a lifeline. Your friendship is one of my greatest sources of good fortune. I send related thanks to the nightshift historians of the virtual library, my sisters among them. The solidarity of this silent online co-working space has been a vital source of support to my learning and writing. Thank you for welcoming a budding psychologist among your ranks. I also thank Eugene Taiko, for taking me onto the team, helping me move out when the time came, and for gracefully abiding the fact that I often have more words than I do rhythm.

I wish to acknowledge my sweet animal friend, Roo, who has kept loyal vigil while I write, and who has taught me more in the eleven years since his adoption than I could have ever expected. I suspect he will continue to teach.

This dissertation project would not be possible were it not for the parents and infants who participated in the From Pregnancy to Parenting study. Their participation has offered a window into intergenerational processes and early dyadic relationships, in this and other studies. The leadership of the Developmental Sociobiology Lab's co-directors and the skilled efforts of many research assistants and graduate students to bring this longitudinal study to fruition were similarly indispensable. Additionally, Dr. Marina Fuertes of the University of Porto generously shared her coding manual with me and provided training in her method for describing individual differences among dyads responding to the Still-Face Paradigm. Her approach reflects many

years of work in this domain, and I thank her for her willingness to share this approach and respond to my inquiries. Finally, I wish to express my appreciation to Makena Marietta and Jesse Connor, each of whom devoted time and thorough work to applying this method with fidelity in archived video recordings of infant-caregiver interaction.

This dissertation is dedicated to F. G., with gratitude.

TABLE OF CONTENTS

Chapter Page

LIST OF FIGURES

Figure Page

LIST OF TABLES

Table Page

# CHAPTER 1

# INTRODUCTION

Infant-caregiver communication is a dynamic developmental system that reflects the contributions of both infant and caregiver and shapes the developing regulatory capacities of the infant (Beeghly et al., 2010; Bornstein, 2013). While infants and caregivers are at times able to coordinate affect and intention to share matching positive states, microanalytic observation suggests that moments of mismatch are more common than they are exceptional (e.g., Tronick & Gianino, 1986; Beebe et al., 2016). Tronick's Mutual Regulation Model (MRM) emphasizes that moments of mismatch or "messiness" are inherent to dyadic communication; the model posits further that the repeated repair of communicative mismatches (and related attenuation of physiological stress responses) affords infants an implicit, embodied expectation that relational repair can come quickly on the heels of mismatch, that negative affect can be transformed, and that physiological states can be modulated through connection with the caregiver (Tronick 2007; 2017). Chronic reparatory failure, in contrast, may imbue the infant with little confidence that soothing can be reliably found in the caregiving relationship (Tronick & Beeghly, 2011) and diminish the infant's sense of self-efficacy in enlisting regulatory support (Brazelton et al., 1974; Tronick et al., 1982; Papousek, 2007).

The structured relational stressor of the Still-Face (SF) paradigm introduces experimental mismatch in infant-caregiver communication (Tronick et al., 1978). The paradigm typically begins with a baseline interaction or *engagement* episode, during which the participating adult, typically the infant's mother or other primary caregiver, is asked to sit across from the infant and play or interact with the infant as she typically would. In the *neutral-face* episode that follows, the mother interrupts interaction with her infant at the experimenter's cue and assumes a neutral,

expressionless face for a standardized period of time, lasting (in many representative studies) for two minutes. During this neutral-face episode, the adult also refrains from touching or vocalizing to the infant. The caregiver's despondency typically evokes distress for the infant: the "signature" effects of the SF include increases in infant negative affect and gaze aversion and decreases in infant positive affect (Mesman and colleagues, 2009; Adamson & Frick, 2003). A third and final episode, the *reunion* episode, begins when the caregiver is invited to resume interaction with the infant. On average, infants exhibit less positive affect and more negative affect in the reunion episode than in the initial engagement episode, and this contrast with the initial baseline interaction is commonly construed as a carryover of the signature effects of the neutral face into the ensuing interaction (Mesman et al., 2009).

While the SF reliably elicits signature effects at the level of participating samples, there are individual differences in infant responses to the paradigm (Mesman et al. 2009; 2013). Infants' efforts to enlist the re-engagement of the expressionless caregiver, the infant's affect and use of regulatory strategies, and the extent to which the infant is able to recover during reunion are believed to reflect, in part, the interactive history of the dyad, and the ways in which the infant has tailored regulatory and communication strategies to the contingencies of the dyadic relationship (Beeghly et al., 2010). Evidence for this view includes findings that features of maternal interactive behavior, including maternal sensitivity, predict aspects of infant affect, behavior, and autonomic physiology during the Still-Face (Conradt & Ablow, 2010; McQuaid et al., 2010; Lowe et al., 2012; Braungart-Rieker et al., 2014; Speck et al., 2023; for review and meta-analysis of earlier studies, see Mesman et al., 2009).

Individual differences in infants' behavioral and physiological responses to the SF are, in turn, associated with socioemotional outcomes, including emergence and expression of behavior

problems (e.g., Moore et al., 2001; Ekas et al., 2013; Wagner et al., 2016), and adaptation within the attachment relationship (Hill & Braungart-Rieker, 2002; Ekas et al., 2013; Northrup et al., 2019). Indeed, the early ages at which the SF can be administered—as well as the possibility that infant SF responses reflect accrual of experience-based expectations of caregiver availability and responsiveness—have together led some authors to argue that infant SF behaviors are an "index" or "probe" of emerging internal working models of attachment (Cohn et al., 1991; p. 368, p. 373). Similarly, Braungart-Rieker and colleagues (2014) observe that the SF can be administered when infants are between three and eight months of age, the age at which Bowlby (1969) asserted that attachment relationships are likely "in the making."

Infant-caregiver attachment classification is typically assessed in the Strange Situation Procedure in the infant's second year of life (Ainsworth et al., 1978/2015), during a developmental window in which the infant's internal working models of the caregiver's availability are believed to have become more consolidated and less conducive (though not entirely impermeable) to change (Grossman & Grossman, 2006; Opie et al., 2013). The prospect of assessing precursors to later infant-caregiver attachment within the first postnatal year, when these models are believed to still be in the making, is an exciting and important one. Infants' security of attachment with the caregiver is a "seminal early marker of socioemotional development" and an influential antecedent to later health and functioning (McIntosh et al., 2021, p. 1). There is overwhelming evidence that early attachment experiences shape the emerging regulatory capacities of the infant and have ties to a host of later socioemotional outcomes, ranging from internalizing and externalizing difficulties to prosocial behavior and peer relationships (e.g., Sroufe, 2005). There is also strong evidence that attachment experiences calibrate the stress response system in ways that are linked to inflammatory, immunological, and

neuroendocrine processes, with implications for long-term physical health and disease (Cassidy et al., 2013; Ehrlich et al., 2016; Dagan & Sagi-Schwartz, 2020). The place of infant attachment status as an influential "initiating condition" in the course of development and its transactional contribution to a range of related biopsychosocial processes and outcomes lead Sroufe (2005) to observe that, "While it is not proper to think of attachment variations as directly causing certain outcomes…it is nonetheless the case that nothing can be assessed in infancy that is more important" (p. 362; p. 365).

Despite parallels between physical separation and reunion during the Strange Situation Procedure (SSP) and the emotional unavailability of the caregiver and subsequent resumption of interaction in the SF (Cohn, 2003), efforts to index emerging quality of infant-caregiver attachment on the basis of infants' responses to the SF paradigm have yielded mixed findings (Mesman et al., 2009). The earliest studies to assess infant SF responses as possible indicators of emerging quality of attachment did so by focusing on infants' affective communication within the neutral-face episode (Tronick et al., 1982; Cohn et al., 1991). Other studies have extended observation and characterization of infant behaviors to the paradigm's reunion episode (Kogan & Carter, 1996; Abbot, 2016) or to all three SF episodes (e.g., Kiser and colleagues, 1986; Jamieson, 2004, Braungart-Rieker et al., 2014, Barbosa et al., 2021), but the piloting of novel coding approaches in each case has hindered comparison across studies.

The overarching aim of this dissertation study is to examine the possibility that infant responses to the Still-Face paradigm are meaningfully indicative of dyadic adjustment during the infant's first year of life and prognostic of quality of attachment in the infant's second year. The dissertation extends existing efforts to this end in a programmatic manner and with attention to implications for attachment-in-the-making.

The present investigation fulfills this overarching aim, first, through detailed review of existing efforts to glean attachment-like patterns or otherwise predict later quality of attachment on the basis of infants' SF response. The narrative review, which details and synthesizes these efforts, makes up this dissertation's second chapter. The review provides evidence that associations between infant SF responses and later quality of attachment indeed exist and represent a viable area of study; and yet, discussion of discrepant microanalytic findings also illustrates the likely advantages of attending to organized patterns of behavior in lieu of discrete microanalytic measures.

In view of the case that the narrative review makes for attending to organized patterns of regulatory behavior, the three sub-studies of this dissertation examine organized patterns of infant regulatory behavior in the SF in a sample of mother-infant dyads at risk for insensitive parenting and disruption in dyadic regulation of emotion. Study 1 applies an existing but novel typology of SF regulatory patterns to archived data and compares the prevalence of the patterns in the present sample to studies that have applied a similarly categorical approach (Fuertes and Lopes-dos-Santos, 2009; Barbosa et al., 2021). Study 1 also (a) examines evidence for convergent validity of the regulatory patterns by juxtaposing the patterns with more granular approaches to observing and describing infant SF behavior, and (b) evaluates the hypothesis that patterning of infant regulatory behavior reflects features of the infant's interactive history and is distinguishable from trait-like tendencies toward negative affect. Study 2 examines whether patterns of regulatory behavior coincide with differences in infants' autonomic responding to the SF manipulation. In doing so, the study seeks to replicate and extend an existing study of similar design (Barbosa et al., 2018). Finally, and in light of an existing study that found moderate stability of regulatory patterns between three and nine months and moderate association between

these patterns and later quality of attachment, Study 3 assesses association between the regulatory patterns at five months postpartum and organization of infant-caregiver attachment one year later.

There is existing but equivocal evidence that infants' pattern of responding in the SF may manifest their emerging (though as yet unconsolidated) quality of attachment with the caregiver. A review of this evidence and approaches to date lay the foundation for the three empirical sub-studies that follow.

# CHAPTER 2

## FROM PATTERNS TO PARTICULARS AND BACK AGAIN: A NARRATIVE REVIEW OF EFFORTS TO EXAMINE INFANT STILL-FACE RESPONSE AND LATER ATTACHMENT CLASSIFICATION

The earliest efforts to glean precursors to later attachment classification from infants' response to the maternal still-face focused on potential patterns of responding within the neutral-face episode (Tronick et al., 1982; Cohn et al., 1991). In a cross-sectional study of three-, six-, and nine-month-old infants, Tronick and colleagues (1982) identified three possible patterns of response to the still-face. Infants who directed positive affect toward the still-faced mother were described as exhibiting a *positive elicit* pattern, while a *negative elicit* pattern described infants who directed negative affect toward the mother. A final, *no elicit*, pattern pertained to infants who did not address affect toward the expressionless mother in the neutral-face episode (Tronick et al., 1982). Six-month-old infants who responded to the mother's neutral face by making positively-valenced bids to re-enlist maternal engagement were described as exemplifying the positive elicit pattern, and nearly every such infant was securely attached to the mother at the end of their first year. A subsequent study similarly investigated infants' mother-directed "elicits" during the neutral-face episode as a likely predictor of attachment classification (Cohn et al., 1991); in this study, too, the presence of positive elicits during the SF neutral-face episode at six months was predictive of attachment security at one year. Furthermore, in the latter study, infants exhibiting the *no elicit* pattern with the mother at six months were more likely to be classified as avoidantly attached to this same caregiver six months later (Cohn et al., 1991). While multiple studies later examined duration of infant distress and positive affect in the SF as potential predictors of later attachment classification, it merits highlighting that these early studies emphasized not only infant affect, but also whether infants addressed emotional signals to the

mother. The presence or absence of infant mother-directed affect was conceptualized as essentially the outcome of a prediction on the part of the infant: that is, an expression of the infant's experience-based expectations about the efficacy of their own emotion communication in eliciting maternal responsiveness and regulatory support.

Further study of infant behavior during the neutral-face episode retained these previous studies' focus on (1) the positive or negative valence of infant affect and (2) the directedness of regulatory efforts to the parent or to the self (Gianino & Tronick, 1988). For example, Braungart-Rieker and colleagues (2001) conducted second-by-second coding of infant vocalization and facial expressions to glean, for each infant, a percentage of the neutral-face episode marked by positive affect and a percentage of the same episode marked by negative affect. For each five-second epoch of the neutral-face phase, they also coded whether the infant exhibited self- or other-directed regulatory behavior. Self-directed regulatory behaviors included deployment of attention (away from the mother and) towards objects or features of the environment and, separately, tactile self-comforting behaviors such as hand-mouthing and contact between the infant's feet. Parent-focused regulation was defined as present when the infant focused their gaze on the mother. Importantly, this coding approach could not evaluate earlier findings that positive bidding behavior toward the mother might be associated with later attachment security, as parent-focused gaze was analyzed apart from infant affect, and Tronick et al's (1982) observation of positive and negative "elicits" entails evaluating both affect and parent-focused gaze in tandem to see if these different modalities of communication are coordinated into a bid toward the mother.

While parent-directed gaze (again, analyzed in isolation from infant affect) was not associated with later quality of attachment, infant affect and self-regulatory behavior in the SF

neutral-face episode at four months was associated with attachment classification at one year, and the authors' attention to subgroups or variations within the securely attached group nuanced their findings. Specifically, infants later classified as avoidant or in the B1 or B2 subgroups of securely attached infants exhibited greater self-regulation (that is, tactile self-comforting and attention to the environment) during the neutral-face episode than infants later classified as anxious-ambivalent or belonging to the B3 or B4 secure subgroups. Greater positive affect and less negative affect during the neutral-face episode also distinguished the B1 and B2 subgroups from B3, B4, and anxious-ambivalent categories. In their interpretation of the outcome of their discriminant function analyses, Braungart-Rieker and coauthors (2001) ultimately suggested that measures of maternal sensitivity at four months may discriminate between future-secure infants and future-insecure infants, and that the extent of self-directed regulatory behaviors may define both heterogeneity among securely attached infants and the form that attachment insecurity takes (with anxious-ambivalent infants exhibiting more other-directed regulatory efforts, and avoidant infants exhibiting greater use of self-comforting behaviors). Their study was the first to find four-month-olds' SF behavior to be prognostic of attachment outcome, as previous studies suggested that bidding behavior had prognostic utility at six months, but not before.

While the above studies of infant behavior in the neutral-face episode considered infant affect and gaze, and in some cases reported microanalytic measures of each (Cohn et al., 1991; Braungart-Rieker et al, 2001), both facets of infant behavior were ultimately rendered in a reduced form, either as binary variables (e.g., infant exhibited a positive elicit or did not), or as percentages of the total neutral-face episode. As a result, information about changes in infant behavior over the duration of the neutral-face episode were not reflected in these measures. Ekas et al. (2013) proposed that the temporal course of infant responding within the neutral-face

episode might differentially predict attachment outcomes. Frame-by-frame coding of infant gaze, cry-face expressions, and smiling in the neutral-face episode facilitated modeling of the within-episode time course of each behavior for each infant. Simultaneous smiling and gaze to the caregiver on the part of the infant was regarded as positive elicit behavior, and this metric also enabled authors to model changes in positive bids to the parent within the neutral-face episode. The temporal course of smiling, positive elicits, and cry-face expressions within the neutral-face episode at six months did not differ by later attachment classification. However, changes in infant gaze within the neutral-face episode at six months were associated with later attachment classification at 15 months. More specifically, infants who were classified as avoidantly attached at 15 months showed the steepest decline in gaze to the mother during the neutral-face episode at six months, followed by securely attached infants, and, in turn, infants later classified as anxious-ambivalent. Ekas and coauthors (2013) interpret this finding in view of existing theory and evidence that infants whose attachment to the caregiver is classified as avoidant in the Strange Situation inhibit the expression of attachment behaviors because their interactive history suggests that this strategy will elicit care more effectively than overt attempts to seek the caregiver's attention and proximity (Main, 1990; Kobak et al., 1993). In light of this possibility, Ekas and colleagues (2013) observe that the faster decline in mother-focused gaze among future-avoidant infants may reflect a deactivating strategy for regulating the attachment system, wherein infants with repeated experiences of maternal rejection may avert their attention and curb efforts to seek contact with the mother as a means to simultaneously maintain proximity while avoiding reproach or rejection that would otherwise exacerbate attachment threat (Main, 1990; Cassidy, 1994). Similarly, the authors suggest that the slower decline in mother-directed gaze among future-ambivalent infants may reflect a hyperactivating strategy for this subset of infants, as

infants who have experienced inconsistency in caregiver responsiveness may maximize the likelihood of eliciting care from the attachment figure by amplifying attachment signals.

In summary, two of the four studies that have focused on infant behavior in the neutral-face episode as prospective predictors of later quality of attachment have identified social bids toward the caregiver as a potential marker of (or precursor to) emerging attachment security. A subsequent study found that the extent of infants' self-comforting behaviors in the neutral-face episode was associated with later classification into attachment subtypes (A, B1, B2) defined by less proximity-seeking toward the attachment figure (Braungart-Rieker et al., 2001). The extent of infant distress in the SF at four months postpartum was also associated with twelve-month attachment classification into attachment subtypes characterized in part by heightened distress (B3, B4, C). The remaining study of this type identified rate of decline in gaze over the neutral-face episode as a candidate marker that distinguished between future-avoidant, -secure, and -ambivalent infants, but the study did not find changes in infant affect within the neutral-face episode (including positive elicits) to be predictive of later quality of attachment (Ekas et al., 2013).

**A Break From Neutrality: Inclusion of Other Episodes and Emerging Attachment**

The rationale for examining the reunion episode of the SF as a source of information about the emerging attachment relationship is largely premised on comparisons between the SF and the SSP (e.g., Abbott, 2016). It has been tentatively proposed that the SF may even be an "age-appropriate version" of the SSP (Mesman et al., 2009, p. 155), and attachment researchers classify quality of infant attachment with almost exclusive reference to infant attachment behaviors during the post-separation reunion episodes of the Strange Situation (Ainsworth et al., 1978/2015). In addition to this methodological parallel between classifying attachment according

to the SSP reunion and characterizing potential attachment-like patterns or precursors to quality of attachment on the basis of the SF reunion episode, a conceptual argument also motivates a focus on infant reunion behaviors in the study of emerging attachment organization. The reunion episode (in contrast with the initial engagement and neutral-face episodes) introduces the co-regulatory challenge of calming distress, repairing, and resuming interaction after rupture, and infant behavior during the SF reunion may therefore be an important indicator of infants' emerging strategies for modulating interaction with the mother as a means of soothing distress (Weinberg & Tronick, 1996). On these grounds, two studies have scored infant behavior in the reunion episode as potential predictors of later quality of attachment. Kogan and Carter (1996) adapted reunion behavior scales typically applied in Strange Situation coding for use in their sample of four-month-olds in the SF reunion; some of these reengagement behaviors in the SF reunion at four months postpartum were indeed predictive of analogous behaviors in post-separation reunions in the SSP at the end of infants' first year. In a later dissertation study, Abbott (2016) assigned global scores to infants' affect, attention, and protest behaviors in the SF reunion episode. She then devised a decision tree in which cut-offs and combinations of these scores formed the basis for "attachment-like" classifications of infant reunion behavior at seven months. These attachment-like classifications of reunion behavior showed significant association with quality of attachment at 14 months, though less than half of the sample retained their seven-month SF-based, ("attachment-like") classification when later classified according to the Strange Situation. While Abbott (2016) consulted infant behavior in the neutral-face episode when signs of disorganization were suspected, her method for assigning organized attachment-like classifications relied solely on global ratings of reunion behaviors.

While the above-described studies focused either exclusively or primarily on infant behavior within the reunion episode, competing approaches have included ratings of infant behaviors during each of the SF episodes to in turn examine both within-episode and between-episode differences in infant behavior as possible predictors of later attachment classification (e.g., Kiser et al., 1986; Jamieson, 2004; Mills-Koonce et al., 2012; Braungart-Rieker et al., 2014). Coding strategies in this group of studies range from frame-by-frame (Jamieson, 2004) and second-by-second (Braungart-Rieker et al., 2014) coding to ratings of infant behaviors in five- or thirty-second epochs within each episode (Mills-Koonce et al., 2012; Kiser et al., 1986). Among these studies, the most common approaches to observational measurement of behaviors entail coding of infant affect and gaze in each episode, and a minority of studies examine self-soothing tactile behaviors (Fuertes et al., 2006, 2009; Braungart-Rieker et al., 2014). Findings from these multi-episode studies differ from those of single-episode studies in some respects and overlap in others.

***Infant Positive Affect During the Neutral-Face Episode.***

A well-known meta-analysis of six studies of infants between two and nine months old reported a small but detectable ($d$ = .23) effect size for the association between infant positive affect within the SF and later quality of attachment (Mesman et al., 2009). Contributions to the meta-analytic finding include the above-mentioned studies of positive elicits among future-secure infants (Tronick et al., 1982; Cohn et al., 1991) and Braungart-Rieker et al.'s (2001) study, in which positive affect differed between future-ambivalent and some (but not all) subtypes of securely attached infants. Additional evidence for the possibility that future-secure infants are likely to exhibit more positive affect during the SF paradigm comes from a study that aggregated microanalytic measures of infants' "positive expression" across all episodes of the SF

and found that future-secure infants expressed more positive affect toward the mother than future-avoidant and future-ambivalent infants (Fuertes et al., 2006, p. 293). This was the case even when the SF was administered when the infants were only three months old, with a nine-month span between observation of infant behavior in the SF and assessment of quality of attachment in the Strange Situation.

The above findings notwithstanding, there is also counterevidence that does not support the possibility that infant positive affect within the neutral-face episode is associated with later attachment status. In two sub-studies of an unpublished doctoral dissertation, microanalytic coding in a sample of four-month-olds and a separate sample of six-month-olds found no attachment-related differences in smiling or positive vocalization during the neutral-face episode (Jamieson, 2004). Similarly, in a longitudinal study of 3-, 5-, and 7-month-old infants, second-by-second coding of infant affect for each episode of the SF did not find an association between positive affect in the neutral-face episode and later attachment classification (Braungart-Rieker et al., 2014); nor did the time course of six-month-olds' smiling and positive elicits in Ekas and colleagues' (2013) dynamic modeling of infant behavior discussed earlier.

While the extent of positive affect during the neutral-face episode is a potential avenue for examining precursors to later attachment classification, it would be a mistake to conclude from the current evidence that differences in infant affect during the neutral-face episode are stable across time, or that they reliably (and in the absence of other information) forecast attachment outcomes with any specificity. To be sure, interest in infants' positive bids to the mother as a possible index of later attachment security has a strong and appealing theoretical basis, and positive bids to the mother have been predictive of attachment security in some small samples of six-month-old infants (Tronick et al., 1982; Cohn et al., 1991). However, in these

studies, infants who exhibited a positive bid to the mother during the neutral-face episode at six months did not uniformly show signs of a secure attachment relationship with the mother at the end of their first year, and no association between positive elicits and later quality of attachment was detected in cohorts of infants who completed the SF paradigm at two, four, or nine months (Tronick et al., 1982). Tronick and coauthors (1982; p. 89) anticipated the need for "finer-grained" approaches to observing infant responses to the maternal still-face and emphasized that stability in infants' affective response in the neutral-face episode is contingent on continuity in qualities of the interactive process between the infant and the environment.

***Infant Negative Affect During the Neutral-Face Episode***

The same meta-analysis that reported a modest association between infant positive affect in the still-face and later quality of attachment reported a similarly modest association between negative affect in the SF and later attachment classification ($d$ = .24; Mesman et al., 2009). Infants' "negative elicits" in the earliest studies of the neutral-face episode were not predictive of later quality of attachment (Tronick et al., 1982; Cohn et al., 1991), but a separate (above-mentioned) study's second-by-second ratings of negative affect suggested that future-ambivalent infants exhibited more negative affect in the neutral-face episode than some subtypes of future-secure infants (Braungart-Rieker et al., 2001), and each of these findings is reflected in the meta-analysis. The meta-analytic finding also reflects the microanalytic coding of negative expressions across the SF paradigm by Fuertes and colleagues (2006) and the subsequent finding that future-ambivalent infants exhibited significantly more negative expression than future-avoidant infants, and marginally more negative expression when compared to future-secure infants. In a study that did not meet inclusion criteria for Mesman et al.'s (2009) meta-analysis, future-secure infants were less distressed during the neutral-face episode than future-ambivalent infants, though

neither group differed from future-avoidant infants on this measure of distress (Kiser et al., 1986). Jamieson's unpublished (2004) dissertation findings further suggest that affect in four-month-olds during the neutral-face episode may differ in ways that depend on (or are otherwise associated with) emerging quality of attachment, as four-month-old infants who were later classified as securely attached emitted negative vocalizations for less of the neutral-face episode than future-ambivalent infants and grimaced less than both future-ambivalent and future-avoidant infants. Furthermore, future-secure infants who participated in the SF at the age of six months also showed less grimacing than their future-insecure counterparts (Jamieson, 2004), though neither the presence nor the absence of differences in negative vocalization is reported in the six-month sample.

Two studies that have been published in the time since Mesman et al.'s (2009) meta-analysis contrast somewhat with findings that future-secure infants exhibit less distress or negative affect during the neutral-face episode. Changes in cry-face expressions within the neutral-face episode did not differ by later quality of attachment in one six-month-old sample (Ekas et al., 2013); this measure, however, differs from measures of intensity or total duration of negative affect. In the other contrasting study, ratings of negative affect for each five-second epoch of the neutral-face episode at three, five, and seven months did not differ by later attachment classification (Mills-Koonce et al., 2012). However, infants' negative affect in the neutral-face episode was predictive of their negative affect in the reunion episode, which was in turn predictive of later quality of attachment.

### *Infant Positive Affect During Reunion*

Infants' positive affect in response to the reunion episode's return to interaction has not been the subject of meta-analytic study, but two studies suggest that future-avoidant infants may

exhibit more positive affect than both future-ambivalent and future-secure infants in the reunion episode at six months of age (Kiser et al., 1986; Jamieson, 2004). In one sample of six-month-old infants, future-avoidant infants enjoyed less positive mutuality with the mother during the initial engagement period before the neutral-face, but these infants nevertheless exhibited more positive affect than both future-ambivalent and future-secure infants in the reunion episode (Kiser et al., 1986). These findings in six-month-old infants converge with later frame-by-frame findings from six-month-old (but not four-month-old) infants that indicated that future-avoidant infants smiled more in the reunion episode than both future-ambivalent and future-secure infants did (Jamieson, 2004). Findings of greater positive affect among future-avoidant infants in the SF reunion episode may be an early manifestation of the deactivation strategy attributed to avoidantly-attached infants, in which infants minimize expression of distress and inhibit attachment behavior in the presence of the attachment figure (Main, 1990; Cassidy, 1994). In contrast with future-avoidant infants, six-month-old future-ambivalent infants in Jamieson's (2004) study had the lowest duration of smiling during the reunion episode, which differed from that of both future-avoidant infants and future-secure infants. While infants' later attachment classification was associated with behavioral differences in the SF reunion at six months, no attachment-related differences in positive vocalization, total smiling, or latency to smile were found during the reunion episode when the SF was administered at four months (Jamieson, 2004).

The evidence that future-avoidant infants exhibit greater positive affect in the SF reunion comes from two samples of six-month-olds, and one might infer from the absence of any such differences in four-month-olds that attachment-related differences in positive affect in the SF reunion episode become detectable between four and six months. However, Braungart-Rieker et al.'s (2014) longitudinal sample of infants who completed the SF at three, five, and seven months

offers no indication that future-avoidant infants, future-ambivalent, or future-secure infants differ from one another in terms of their total expression of positive affect within the reunion episode. This said, the study's coding of positive affect across all three episodes of the SF and across multiple ages within the first year form the basis for important observations concerning future-ambivalent infants and positive affect. More specifically, infants later classified as anxious-ambivalent exhibited a slower increase of positive affect from the neutral-face to the reunion episode than other infants did (Braungart-Rieker et al., 2014). Additionally, the sample of infants as a whole grew in their overall extent of positive affect over the span between three and seven months, and greater parental sensitivity was associated with greater increases in infants' positive affect over this time. Remarkably, however, future-ambivalent infants showed a slower increase in positive affect over this time than their future-secure and future-avoidant counterparts. The authors cite evidence that positive affect is not only orthogonal to negative affect but also more amenable to environmental influence (Baker et al., 1992), and they suggest on this basis that the slower growth of positive affect among future-ambivalent infants may reflect their interactive history in the attachment relationship. This finding and interpretation resonate with the view, advanced by Tronick and colleagues (1982; p. 83), that "a background emotional state or mood becomes stabilized" in infants that is an "accumulated distillate" of emotions that infants have experienced again and again in their interchanges with the caregiver.

The above findings regarding positive affect during reunion and later attachment insecurity are somewhat difficult to reconcile with findings from two studies that have also reported on infant reunion behavior and later attachment but differed widely in design (Abbott, 2016; Kogan & Carter, 1996). The algorithmic approach to assigning attachment-like classifications to seven-month-old infants held that future-secure and future-avoidant infants

would have comparable ratings for positive affect (Abbott, 2016), with the proviso that possible affect ratings for future-secure infants would include the highest-possible, "actively happy" rating, while the otherwise comparable range of affect ratings for future-avoidant infants does not include this more effusive option. Importantly, this algorithmic or decision-tree approach did not emphasize distinctions in affect to differentiate between future-secure and future-avoidant infants; rather, the avoidant-versus-secure distinction hinged largely on differing levels of infant attention to the mother. Nevertheless, the estimation in the decision-tree that future-secure infants might exhibit higher positive affect than future-avoidant infants departs from some of the above microanalytic findings on this front. Interestingly, while the decision-tree yielded attachment-like classifications at seven months that were associated with four-way attachment classification at fourteen months, the decision tree was less effective in identifying future-avoidant infants than it was in predicting other attachment classifications (Abbott, 2016). More specifically, an assignment to the avoidant-like classification based on affect and parent-directed attention in the SF reunion did not significantly predict assignment to the avoidant classification in the Strange Situation, though the odds of later avoidant classification in the SSP for infants assigned to an avoidant-like classification in the SF did approach significance.

In Kogan and Carter's (1996) study of infant reunion behaviors, global ratings of infants' reengagement behaviors during reunion were analyzed in connection with later *continuous* measures of infant attachment behaviors in the SSP, but not in connection to later attachment *category*. Additionally, the study included coding of positive affect on a second-by-second timescale but did not explore associations between this coding of positive affect in the SF reunion and later attachment outcomes. Instead, only the concurrent association between infant positive affect and the more global SF reunion reengagement ratings were reported. These

differences between the Kogan and Carter (1996) design on the one hand, and studies that have, on the other hand, focused on infant positive affect in the SF as an antecedent to later attachment, complicates somewhat any conclusions about infants' affect in the SF reunion and later attachment outcomes in the Kogan and Carter sample. This said, associations between Kogan and Carter's (1996) microanalytic measure of positive affect and concurrent, SF-based reengagement codes yield some clues about the potential association between infants' positive affect in the SF reunion and later attachment. For example, the duration of infants' positive affect during the reunion episode was positively correlated with the more global score of infants' efforts to maintain the mother's attention in the SF reunion; that is, the more positive affect that infants exhibited during the SF reunion episode, the more initiative they showed in maintaining her attention through reaching, smiling, looking at her, and vocalizing during this same episode. The global score for infant attention-seeking was in turn predictive of the infant's contact maintenance scores in the Strange Situation eight months later, meaning that infants who actively sought and sustained the mother's attention in the SF reunion also showed more initiative in maintaining physical contact to the mother through (for example) active clinging, clambering up, or sinking into her embrace following separation in the SSP (Kogan & Carter, 1996; Ainsworth, 1978/2015). Infants who took longer to show positive affect in the reunion episode (i.e., those who showed longer latencies to positive affect), had lower attention-seeking scores, and lower attention-seeking scores in the SF reunion predicted lower SSP contact maintenance scores in turn. While infants' positive affect in the SF reunion was associated with their reengagement behaviors, the reengagement codes encompass more than infant affect, and Kogan and Carter (1996; p. 364) point out that the reengagement codes they devised were "consistent" but "not redundant" with microanalytic measures of infant affect in their sample.

### *Infant Negative Affect During Reunion*

Findings on the potential association between infant negative affect during reunion and later quality of attachment are equivocal. Some studies have suggested that higher negative affect in the SF reunion episode portends later ambivalent attachment. In one such study, ratings of infant negative affect for every five seconds of the reunion episode showed that future-ambivalent infants exhibited more negative affect in this episode at six months of age than their future-secure and future-avoidant counterparts (Mills-Koonce et al., 2012). Mills-Koonce and coauthors (2012) point to two competing interpretations of this finding: the possibility, on the one hand, that future-ambivalent infants are showing signs of emerging ambivalent attachment that is already underway at six months, and the competing possibility, on the other hand, that difficulties with soothing at this time point reflect a precursor in a developmental cascade that later contributes to (or otherwise confers risk for) insecure-ambivalent attachment, but that is fundamentally different from insecure-ambivalent attachment. Importantly, infant negative affect in the reunion episode, while associated with negative affect during the preceding episode, was not associated with maternal report of infant dimensions of temperament that are typically deemed "difficult," including fearfulness, (low) soothability, and distress to limitation (Mills-Koonce et al., 2012).

Findings of higher negative affect among future-ambivalent infants in the SF reunion resonate with findings from Kogan & Carter's small (1996) sample, in which infants' negative affect in the reunion episode was associated with more resistance behaviors in this same reunion, such as fussing, escalating upset in response to the mother's attempts to interact, and postural protest (e.g., back-arching and squirming). These resistance behaviors in the SF were in turn marginally predictive of similar behaviors in the SSP reunion in later infancy (Kogan & Carter,

1996). Similarly, Abbott's (2016) assignment of attachment-like classifications to seven-month-olds largely hinged on infants' angry protest behaviors (in combination with medium-to-high attentiveness to the mother) to assign an ambivalent attachment-like classification at seven months. Infants who received the ambivalent attachment-like classification on the basis of these SF reunion behaviors were significantly more likely to be classified as ambivalently attached in the Strange Situation at the age of fourteen months (Abbott, 2016).

Contrasting evidence comes from Braungart-Rieker et al.'s (2014) longitudinal study of 3-, 5-, and 7-month-old infants, which did not find attachment-related differences in negative affect. Likewise, neither grimacing nor negative vocalization within the reunion episode differed by later attachment classification in Jamieson's (2004) sample of four-month-olds. It is possible that timing or intensity of infant negative affect in the reunion episode, rather than total duration, would be more telling of the infants' confidence in the attachment figure as a source of soothing. Additionally, it is possible that a more specific expression of negative affect—such as angry protest—is more predictive of later ambivalent attachment than negative affect more generally.

***Self-Oriented Regulatory Behavior in the Neutral-Face Episode***

The measure of self-regulation (as opposed to parent-focused regulation) in Braungart-Rieker et al. (2001) reflects a combination of self-comforting tactile behaviors together with focused visual attention away from the mother. Braungart-Rieker et al.'s (2001) distinction between self-regulation and parent-focused regulatory behavior is an important one, as is the possibility that the extent of self-oriented (including self-comforting) behaviors in the SF neutral-face episode at six months differs not only between future-avoidant and future-ambivalent infants, but also between future-secure infants for whom different subtype designations reflect differing degrees of proximity-seeking and other behaviors. The absence of any exact analogue

to this microanalytic measure of self-oriented regulation in later studies of infants in the neutral-face episode hampers conclusions as to whether this finding in four-month-old infants generalizes to other samples or other ages. Measures of infants' self-oriented regulatory behavior in two samples come notably close to Braungart-Rieker et al.'s (2001) approach, however. In Braungart-Rieker et al.'s (2014) longitudinal study of infants, tactile self-comforting behaviors (this time measured separately from focused visual attention away from the mother) did not differ by later attachment classification when these behaviors were examined within the neutral-face period, but future-ambivalent infants did exhibit a greater increase in self-comforting behaviors from the neutral-face episode to the reunion episode than their future-secure and future-avoidant counterparts.

Self-oriented regulatory behavior was also coded in two separate analyses of a single sample, in which Fuertes and colleagues (2006; 2009) applied the Infant Regulatory Scoring System (Tronick & Weinberg, 1990) before generating second-by-second self-directed coping scores to reflect combinations of self-comforting touch (e.g., clasping or mouthing hands) and averting gaze from the mother by looking elsewhere or closing the eyes. Fuertes and colleagues (2006; 2009) combined scores across the length of the SF (without regard for episode) and reported that self-directed coping at three months corrected gestational age in a sample born prior to term was predictive of later avoidant attachment at one year.

***Infant Gaze During the Neutral-Face Episode***

Direction and focus of infant gaze together form part of the infant's regulatory repertoire (Field, 1981; Hunnius, 2007), and one aspect of the average or "classic" still-face effect is a decrease in gaze to the mother in response to the neutral-face episode (Mesman et al., 2009). Neither Braungart-Rieker et al. (2001) nor Jamieson (2004) found attachment-related differences

in total duration of infants' visual attention to the mother during the neutral-face episode, but other measures of infant gaze behaviors in Jamieson's (2004) studies at four and six months did show differences by later attachment classification.

Jamieson (2004) reported that future-secure infants exhibited less latency to look away from the mother during the neutral-face episode than both future-avoidant and future-ambivalent infants at four months, and latency to avert gaze from the mother did not vary by episode for future-secure infants in the way that it did for future-insecure infants. Future-avoidant and future-ambivalent infants showed a relative hastening to look away in the neutral-face and reunion episodes, as evidenced by shorter latencies to gaze aversion for these two episodes (when compared to the baseline interaction episode) in each of the two future-insecure groups. In a subsequent study with six-month-old participants, no such attachment-related differences in gaze latency were reported for six-month-old infants (Jamieson, 2004), but a significantly lower level of visual exploration among future-ambivalent infants in the neutral-face episode differentiated future-ambivalent infants from their future-secure and future-avoidant counterparts, and future-ambivalent infants exhibited significantly lower levels of visual exploration in comparison to other infants during the other two episodes of the SF as well.

The latter finding suggests that future-ambivalent infants may not deploy visual attention to objects or features of the environment to the same extent as future-secure and future-avoidant infants, even when doing so (in the case of the neutral-face episode) may have a self-regulatory effect. Low levels of visual exploration among future-ambivalent infants in the SF paradigm (as reported by Jamieson, 2004) accords with Braungart-Rieker and colleagues' (2001) finding that future-ambivalent infants in the neutral-face episode exercised less self-directed regulatory behavior than future-avoidant and subgroups of future-secure infants in this same episode. The

finding of lower visual exploration among future-ambivalent infants in the neutral episode at six months also coheres with Ekas et al.'s (2013) report that future-ambivalent infants in the neutral-face episode decreased their gaze to the mother more gradually than future-secure and future-avoidant infants. Furthermore, the faster rate at which future-avoidant infants decreased their gaze to the mother during this episode, and the fact that future-secure infants differed but followed next in line in terms of the rate at which they decreased their mother-directed gaze together suggests that there may be a gradient of self-regulatory behavior along which future-ambivalent, future-secure, and future-avoidant infants differ from one another when faced with maternal impassivity or a similar stressor.

***Infant Gaze During Reunion***

Braungart-Rieker et al (2014) found differences in parent-directed gaze as a function of age, level of parental sensitivity, and SF episode, but they did not find differences by later attachment classification. In Kogan and Carter's (1996) coding scheme, gaze to the mother at four months was positively correlated to attention-seeking, while gaze away from the mother was (by extension) negatively correlated to attention-seeking. This measure was then associated with later contact maintenance in the Strange Situation at one year. Abbott's (2016) decision-tree approach suggested that infants with either a secure or ambivalent attachment-like classification in the reunion episode were those who showed moderate-to-high attention to the mother in the reunion episode, while infants assigned to the avoidant-like classification from the SF reunion exhibited attention to mother for less than half of the episode (Abbot, 2016).

In the dissertation sub-study of six-month-old infants, Jamieson's (2004) coding of infant gaze suggested that trajectories were similar in and between the initial engagement episode and the neutral-face episode, but comparisons between the initial engagement episode and the

reunion period revealed contrasts between future-secure, future-avoidant, and future-ambivalent groups. All three groups of infants (1) gazed to the mother for similar durations of the pre-SF free play episode, (2) showed similar decreases in duration of gaze to the mother during the neutral-face episode, and (3) looked more to the mother in the reunion episode than they did in the neutral-face episode. This said, future-avoidant infants looked to the mother more in the reunion episode than they had in the pre-SF engagement episode. In contrast, future-resistant infants exhibited less looking to the mother in the reunion episode than they did in the pre-SF engagement episode. While changes in future-resistant infants' gaze to the mother were consistent with a carryover effect from the reunion episode, future-avoidant infants exhibited no such carryover effect (and indeed, something akin to the opposite of a carryover effect). Unlike future-avoidant infants, future-secure infants did exhibit a carryover effect in duration of gaze to the mother, which increased from the neutral-face episode to the reunion but did not reach the extent of mother-directed gaze observed in the baseline interaction episode. However, future-resistant infants exhibited the highest carryover effect (as indexed by gaze) and the least amount of looking to the mother during the reunion episode relative to future-secure and future-avoidant infants. The absence of a carryover effect (and something like its opposite) among future-avoidant infants is reminiscent of findings that future-avoidant infants exhibit higher positive affect in the reunion episode relative to other infants.

**Takeaways From Microanalytic Research**

While the measurement of discrete behaviors (in the form of frequency of behavior or proportion of time during which a behavior is exhibited) has the benefit of being both readily quantifiable and conducive to high interrater reliability, the measurement of discrete behaviors may belie the function of these behaviors and their membership in a constellation of affective

communication and self-regulatory strategies (Weinberg & Tronick, 1994). Stated differently, rendering isolated behaviors in terms of total time or frequency may inadvertently divorce these behaviors from context—both in terms of the stimuli that evoke the observed behaviors, the concurrence of complementary or contradicting behaviors, and the arc or trajectory of behavior onset and offset.

Insights from the development of the attachment classification system are relevant to current and ongoing efforts to characterize individual differences in infant SF responses, and to understanding the antecedents and implications of these individual differences. Importantly, in Ainsworth and colleagues' (1978/2015) articulation of the attachment classification system, its development, and its usefulness for describing individual differences in infant interactive behaviors in the Strange Situation and the home environment, there is emphasis on the advantages of identifying *patterns* to the ways in which behaviors are organized, instead of enumerating the frequency of discrete behaviors. Ainsworth and coauthors (1978/2015; p. 50) pointed out that individual behaviors may differ in form but serve the same (for example, proximity-seeking) function, and that if such behaviors are indeed "interchangeable" or functionally equivalent but measured in isolation, observations of discrete behaviors "may well fail to reflect the true state of affairs."[1] Furthermore, Ainsworth and colleagues introduced the

[1] Waters and Sroufe (1977; p. 1188) advance a similar argument for attending to the organization of behaviors rather than quantification of discrete behaviors, and they provide an illustrative example: "As an alternative to the simple frequency counter/duration of response approach to assessment, behaviors may be viewed as exemplars of categories or classes, and the manner in which behaviors are *organized* across situation and across individuals may be assessed…since multiple behaviors can have similar meanings (serve the same function or have the same or equivalent outcome), the prediction becomes not that behavior A will be correlated with behavior A across situation or time, but rather that behavior A, as a member of class X, will predict the occurrence of behaviors in class X in that same context. Babies who vocalize and show a toy in one reunion episode may smile in another; both are positive greetings. Similarly, babies who seek proximity on reunion at one age may smile and vocalize when they are older; both are ways of reestablishing contact." Compared to individual behaviors, the patterning or organization of behaviors is not only more likely to be stable across developmental time; they are also more reflective of the function of behaviors and of underpinning working models (embodied, experienced-based expectations) of the self and others.

attachment classificatory system as an observational tool, rather than an unequivocal and exhaustive account of reality. They emphasized that the classification system is amenable to revision, and that its descriptions of organized patterns of behavior—which they framed as provisional—lend themselves to inquiry into the (evolutionary, interpersonal, and intra-personal) ontogeny of such patterning. Attachment researchers stress that it is the organization of behaviors—rather than the behaviors per se—that are, in stable conditions, likely to exhibit stability over time and predict later functioning (Sroufe & Waters, 1977; Ainsworth et al., 1978/2015). Much the same could be said in favor of seeking organized patterns of regulatory behavior in the SF. Indeed, in the first study to explore infant SF response and later quality of attachment, Tronick and colleagues (1982) characterized infants' positive elicits, negative elicits, or absence of elicits as *patterns* of adaptation. In this way, more recent calls for evidence-based identification of *patterns* of regulatory behavior in the SF and related adoption of person-centered (as opposed to variable-centered) approaches, represent a kind of coming full circle, rather than a departure from original attempts to anticipate quality of attachment from SF response.

**Seeing the Forest *and* the Trees: The Transition (and Return) to Patterns of Adaptation**

Given that isolated, discrete measures of infant behavior in the SF have shown only modest association with security of attachment assessed in the SSP (Mesman et al., 2009), some SF researchers have called for a transition from "variable-driven" to "person-centered" approaches (Qu & Leerkes, 2018, p. 710; Safyer, 2019). Microanalytic measures have been subjected to cluster analyses (Montirosso et al., 2015) or latent profile analysis (Qu & Leerkes, 2018) to detect possible response patterns that take multiple measures into account. There has been some convergence in the regulatory patterns that have been gleaned from these approaches,

even when the underlying coding strategies have differed (e.g., Fuertes, 2005; Montirosso et al., 2015; Safyer, 2019). The observed patterns may form a viable typology for characterizing differences in infant affect, behavior, and (implicit) expectations of the attachment relationship.

### *Three-Pattern Typologies*

The Coding System for Regulatory Patterns in the SF has its origins in person-centered analysis of microanalytic observations of infant behavior (Fuertes, 2005; Fuertes & Lopes-dos-Santos, 2009; Barbosa et al., 2021). The coding system integrates observation of infant regulatory behavior across the three episodes of the SF to categorize the infant's behavior as pertaining to one of three mutually exclusive regulatory patterns.

The *social-positive oriented* pattern is defined in part by moderate-to-high levels of positive and reciprocal interaction in the SF's initial engagement episode. Reponses to the neutral-face episode within the social-positive oriented pattern can range from a (mere) decrease in positive engagement to immediate and pronounced distress at the onset of the still-face. Positive bids to the caregiver in response to the start of the neutral-face episode can contribute to assignment of the social-positive oriented pattern to describe the infant's regulatory behavior, but this positive bidding is not a requirement for this regulatory category. In contrast, one defining feature of the social-positive oriented pattern is infants' recovery and return to reciprocal interaction during the reunion episode. Within the social-positive oriented pattern, there are subpatterns that differ in large part according to how promptly or, conversely, how gradually the infant recovers within the reunion episode, though features of the engagement and neutral-face episodes may also inform subpattern assignment.

A second higher-order pattern of regulatory behavior in the SF is the *distressed-inconsolable* pattern, which is characterized by less positive interaction in the engagement

episode, pronounced negative affect in reaction to the still-face episode, and maintenance or increase of this negative affect throughout the recovery episode (Fuertes & Lopes-dos-Santos, 2009; Barbosa et al., 2018; Barbosa et al., 2021).

Finally, the *self-comfort-oriented pattern* describes infants who show conspicuous gaze aversion away from the mother and low-intensity protest or self-comforting behaviors in response to the mother's efforts to get the infant's attention during the engagement episode; these infants appear to relax in response to the onset of the neutral-face episode and then resume evident but muted signs of distress through grimacing, gaze aversion, and tense posturing when the mother resumes interactions. For this subset of infants, self-comforting regulatory behaviors (including tactile behaviors and deployment of gaze away from the mother) predominate across all episodes of the SF (Fuertes & Lopes-dos-Santos, 2009; Barbosa et al., 2018; Barbosa et al., 2021).

The three regulatory patterns delineated by the Coding System for Regulatory Patterns bear striking similarity to patterns of SF responding that have emerged from similar harnessing of either microanalytic data (Montirosso et al., 2015; Qu & Leerkes, 2018) or more global ratings (Safyer, 2019) into person-centered or typological approaches. Each of these typological approaches has distilled observations into descriptions of classes, which may represent patterns or summaries of infants' response trajectories, profiles, or prototypes. Montirosso and colleagues (2015) independently arrived at patterns similar to those identified by Fuertes and Lopes-dos-Santos (2009) to summarize individual differences in infant SF behavior. Cluster analysis of microanalytic observations within the SF initial engagement episode suggested three groups: a *socially engaged* group, a *negatively engaged* group, and a *disengaged* group (Montirosso et al., 2015). These groups were gleaned from the initial engagement episode, and group membership

gleaned from the engagement episode predicted different response profiles in the remaining episodes. Relative to the disengaged and negatively engaged groups, infants who were socially engaged in the initial engagement episode responded to the neutral-face episode with greater visual monitoring of the mother, and visual monitoring in this group was accompanied by looks of interest or neutral affect on the part of positively engaged infants. This higher social monitoring of the mother among socially engaged infants in the neutral-face episode also characterized their behavior in the reunion episode. In contrast, the negatively engaged group responded to the neutral-face episode with more distress than disengaged and socially engaged infants and made less use of distraction than the other two groups. These differences between the negatively engaged group on the one hand, and disengaged and socially engaged infants on the other, persisted into the reunion episode, in which negatively engaged infants continued to exhibit more distress and make less use of attention to the environment. Additionally, infants who belonged to the disengaged cluster in the engagement episode made the most use of attention to objects and the environment in the neutral face episode. On reunion, they showed more negative engagement and less positive engagement and social monitoring than socially engaged infants but less negative engagement and more attention to the environment than infants in the negatively engaged group (Montirosso et al., 2015).

### *Four-Pattern Typologies and Their Compatibility with a Three-Pattern Approach*

Two studies identified four patterns instead of the three patterns outlined above (Qu & Leerkes, 2018; Safyer, 2019). Safyer (2019) assigned global ratings to infant positive and negative affect for each of the three episodes of the SF and subjected these episode-by-episode scores to latent profile analysis. She identified four profiles, three of which she equated to the social-positive oriented, distressed-inconsolable, and self-comfort oriented regulatory patterns

defined by the Coding System for Regulatory Patterns in the SF (Fuertes and Lopes-dos-Santos, 2009). Safyer (2019) posited that a fourth pattern of responding to the SF is distinct from the social-positive oriented, distressed-inconsolable, and self-comfort oriented patterns, and that this fourth pattern instead reflects the classic still-face effect, with hallmark decreases in positive affect, increases in infant negative affect, and gaze aversion and carryover of these signature effects into the reunion, with gradual or partial recovery (Adamson & Frick, 2003; Mesman et al., 2009; Safyer, 2019**)**.

At first glance this fourth, "classic still-face effect" pattern identified by Safyer (2019) may appear to be missing from Fuertes & Lopes-dos-Santos' (2009) three-pattern coding system. However, the differences between the three-pattern typology and the four-pattern typology are arguably reconciled by the existence of subpatterns within the social-positive oriented group. In the Fuertes & Lopes-dos-Santos (2009) system, there are three subpatterns within the higher-order, summary category of social-positive oriented responding. The first subpattern within the social-positive category is defined by a decrease in positive affect and mild perturbation in response to the neutral-face episode, and this same subpattern is also defined by relatively quick recovery and return to reciprocal interaction within the first thirty seconds of the reunion episode. This trajectory of responding may be thought of as a prototypical social-positive response, but the mild decrease in positive affect during the neutral-face episode and prompt recovery on reunion form only one version of the social-positive regulatory pattern. The two remaining subpatterns within the higher-order, summary designation of "social-positive oriented" allow for (and anticipate) a greater increase of negative affect in the neutral-face episode and a slower climb to recovery. Stated differently, there is room for a classic still-face effect subgroup within the social-positive oriented category, and the room is in subpattern form.

While the four-profile solution proposed by Safyer (2019) separates social-positive oriented responding from the classic still-face effect, infants who exhibit the still-face effect but ultimately return to positive and reciprocal interaction would, in the three-typology approach, be described as social-positive oriented in their response (Fuertes and Lopes-dos-Santos, 2009).

Safyer's (2019) identification of four patterns of infants' affective responding to the SF parallels four patterns identified by Qu & Leerkes (2018). Qu & Leerkes (2018) completed microanalytic ratings of infant affect in each of episode of the SF and combined observations of infant affect with a physiological index of concomitant parasympathetic regulation aggregated for every 15-second epoch of the SF paradigm. Profiles synthesized behavioral observations and physiological monitoring to identify a *resilient-to-distress* group, a *highly distressed, but regulating* group, an *under-regulated* pattern, and an *over-regulated* pattern. The *resilient-to-distress* pattern appears to parallel the first subpattern within the social-positive oriented category identified by Fuertes and Lopes-dos-Santos' (2009) line of work, as infants who were deemed "resilient-to-distress," just like infants in the first of the social-positive subpatterns—had low levels of negative affect across the SF, with a mere decrease in positive affect in the neutral-face episode and recovery to their affective baseline during the reunion episode. The "highly distressed, but regulating" group may be comparable to Safyer's (2019) "classic still-face effect" group. If such infants exhibit a pronounced increase in negative affect in response to the neutral-face episode but ultimately return to reciprocal interaction in the reunion episode, their response trajectory would be in keeping with the social-positive oriented pattern, and subpattern assignment would index their more marked distress and gradual recovery (Fuertes and Lopes-dos-Santos, 2009). The "under-regulated" pattern bears resemblance to the distressed-inconsolable group in Fuertes and Lopes-dos-Santos' (2009) three-pattern typology, as infants

deemed “under-regulated” in Qu and Leerkes’ (2018) sample, like infants described by the distressed-inconsolable pattern, exhibited high levels of negative affect throughout the SF paradigm; Qu and Leerkes’ addition of physiological measurement revealed that this group did not show parasympathetic braking on sympathetic arousal despite the high levels of behavioral distress the infants exhibited. Finally, the over-regulated pattern described by Qu and Leerkes (2018) may parallel the self-comfort oriented pattern identified in the Fuertes and Lopes-dos-Santos (2009) line of work. “Over-regulated” infants in Qu & Leerkes’ sample showed a high level of physiological regulation, even as the (low) level of negative affect exhibited by these infants remained within a narrow range compared to other infants.

***Patterns of Responding to the Still-Face and Attachment Outcomes***

Of the studies that have identified patterns or profiles of infant responding to the SF paradigm, only three have examined the possibility that response patterns in the SF are predictive of responses and related quality of attachment in the Strange Situation (Barbosa et al., 2018; Safyer, 2019; Qu & Leerkes, 2018). Application of the Coding System for Regulatory Patterns in the SF at three and nine months found moderate stability in infants’ organized patterns of behavior, with nearly 84 percent of the sample retaining their three-month classification following a second administration of the SF at nine months (Barbosa et al., 2018). Infants who exhibited a social-positive oriented regulatory pattern at three or nine months were more likely to be classified as securely attached in the Strange Situation at one year; infants whose behavior pattern in the SF was described as distressed-inconsolable in the SF were more likely to be classified as ambivalently attached, and infants who showed the self-comfort oriented pattern were more likely to be classified as avoidantly attached at the year’s end (Barbosa et al., 2021). Additionally, there was stronger association between SF regulatory pattern and later quality of

attachment among the subset of infants who retained the same SF regulatory pattern between the SF administrations at three and nine months (Barbosa et al., 2021).

Safyer's (2019) four-profile approach did not find longitudinal stability in profile memberships between separate administrations of the SF at three and seven months, and membership in the social-positive, classic still-face effect, distressed-inconsolable, and self-comfort-oriented profiles at three months was not associated with attachment classification at fourteen months. However, membership in these four profiles at seven months was associated with quality of attachment as assessed in the SSP. The social-positive oriented pattern predominated at both three and seven months, and about two-thirds of the infants who were classified as securely attached at fourteen months of age had been described as social-positive oriented in the SF at seven months. Interestingly, 8 of the 13 infants who were characterized as exhibiting the "classic still-face effect" at seven months went on to be classified as securely attached, while five of these infants were later classified as anxious-ambivalent. This observation—that some infants described as exhibiting the "classic still-face effect" became securely attached, and that others were later classified as ambivalently attached—suggests that the pattern that Safyer (2019) identified as a still-face effect pattern may sit near the dividing line between social-positive and distressed-inconsolable patterns of responding, in much the same way that commonalities exist between infants who are classified in the Strange Situation as secure B3 and B4 infants and those who are classified as C/anxious-ambivalent infants.

The four patterns identified by Qu & Leerkes's (2018) were also associated with later attachment outcomes, and the nature of this association in their study supports the view that resilient-to-distress infants and highly-distressed-but-regulating infants (or in Safyer's labelling of her profiles, infants exhibiting a social-positive-oriented pattern and those exhibiting the

classic still face effect) might show commonalities that justify their being grouped—in the Fuertes and Lopes dos Santos (2009) system—under the same social-positive oriented umbrella. In Qu & Leerkes' (2018) longitudinal study of infants in the SF at six months and the SSP at 14 months, both the group of infants deemed resilient-to-distress and the group of infants deemed highly-distressed-but-regulating (again, categories likely encompassed in the three-typology approach by the social-positive pattern) showed less avoidance in the SSP at 14 months than the group that was over-regulated at six months postpartum. The under-regulated group in Qu & Leerkes' (2018) sample, which is a possible analogue to the distressed-inconsolable pattern in the three-pattern approach adopted in this dissertation's upcoming sub-studies, showed higher resistance in the SSP than their counterparts who were previously either over-regulated or highly distressed but regulating.

In sum, the patterns of regulatory behavior identified by the Coding System for Regulatory Patterns have analogues in the small number of other studies that have described patterns of infant regulatory response to the SF. In the three studies that have examined associations between patterns of regulatory responding in the SF and later attachment outcomes, SF response patterns described at 3, 6, 7, and 9 months were associated with individual differences in attachment assessed in the SSP.

# CHAPTER 3

## STUDY 1. PATTERNS OF REGULATORY BEHAVIOR, THEIR PSYCHOSOCIAL CORRELATES, AND SOURCES OF CONVERGENT VALIDITY

Convergent evidence has coalesced around three to four organized profiles or patterns for describing individual differences in infant responses to the SF paradigm. Studies have typically identified these patterns in a bottom-up manner, using either latent profile or cluster analysis (Montirosso et al., 2015, Qu & Leerkes, 2018; Safyer, 2019). Few studies have gone on to translate these profiles into a priori, top-down descriptions for categorical or typological classification of infant SF behavior. The Coding System for Regulatory Patterns is an exception to this rule, in that it invites the user to consider the trajectory of infant responding across the three episodes of the SF in order to assign a categorical pattern of regulatory behavior that encapsulates the infant's SF response. The organized pattern approach to observing regulatory behavior in the SF has several arguable advantages over microanalytic approaches. Even as heuristic tools, organized patterns capture configurations of individual differences in ways that may be more readily and intuitively understood than reports of multiple discrete behaviors studied in isolation. In the case of organized patterns of attachment, Ainsworth and colleagues (1978/2015) argued that attention to organized patterns of infant behavior—and the study of individual differences in these patterns—bring to the fore inquiry into "why and how the patternings arose" (Ainsworth et al., 1978/2015, p. 57). A potential drawback, of course, is the judgment required to apply a less granular and more typological approach to observation (Chorney et al., 2015). The current study evaluated the feasibility of bringing the typological pattern approach to bear in the present sample and sought to identify sources of convergent validity and potential determinants of organized patterns of infant regulatory behavior.

### *Distribution of Regulatory Patterns in Existing Studies*

In studies that have identified infant response profiles or patterns in the SF, the distribution of these patterns differs from study to study. When the Coding System for Regulatory Patterns was brought to bear in a modest ($n$ = 48) Portuguese sample of healthy preterm infants who completed the SF at three months corrected gestational age, just over half of the infants (55.1%) were classified as social-positive oriented; about a third of the sample was classified as distressed inconsolable (34.7%), and the small remaining fraction of the sample was classified into the self-comfort oriented category (10.2%; Fuertes et al., 2014, as cited in Barbosa et al., 2019). In a later sample of three-month-old infants, the distribution of these same regulatory patterns was similar, with just over half (53.6%) classified as social-positive oriented, a third of the sample classified as distressed-inconsolable, and the remaining (12.5%) of the sample classified as self-comfort oriented. While Safyer (2019) did not apply the Coding System for Regulatory Patterns in her Michigan-based sample of three-month-olds, her labelling of variable-driven, affect-based clusters of infants indicated that a social-positive oriented group made up two-thirds (66%) of the sample. The "classic still-face effect" group, (which, in the three-typology system, would likely be divided between the social-positive and distressed inconsolable groups) made up 21% of the sample, and smaller percentages of infants made up the distressed-inconsolable (8%) and self-comfort oriented (5%) clusters.

***Maternal Sensitivity and SF response***

Narrative and systematic reviews have found that maternal interactive behaviors are associated with individual differences in infants' responses to the SF stressor (Mesman et al., 2009; Gavalgno et al., 2021), and meta-analytic synthesis of several studies has found a medium effect size ($d$ = .45) for the association between positive features of maternal interactive behavior (e.g., sensitivity) and infant positive affect within episodes of the SF task (Mesman et al., 2009).

In one sample, maternal sensitivity at three months was correlated with a continuous microanalytic measure of positive-other directed coping behaviors in the SF, while maternal control in free play was positively correlated with self-directed coping (Fuertes et al., 2011). A closely related line of work has examined whether infants' membership in regulatory patterns reflects differences in maternal sensitivity or other features of the infants' interactive history in the caregiving relationship (Fuertes et al., 2011; Barbosa et al., 2019). For example, mothers of infants in a class of infants deemed "social-positive oriented" on the basis of affective rating trajectories across the SF had more successful positive engagement with their infants than mothers of infants in the distressed-inconsolable cluster, and this was the case for infants at both three months and seven months (Safyer, 2019). In a separate sample, mothers of four-month-olds who were characterized as "negatively engaged" exhibited more social monitoring and less positive engagement in the SF (Montirosso et al., 2015).

In a study that specifically applied the Coding System for Regulatory Patterns in the SF and examined potential predictors of the system's three regulatory patterns, maternal sensitivity during a five-minute, unstructured free-play interaction was higher among infants who exhibited the social-positive pattern than it was for either distressed-inconsolable infants or self-comfort oriented infants (Barbosa et al., 2019). Social-positive oriented infants also had mothers who exhibited less controlling behavior in the same free-play task (Barbosa et al., 2019). Maternal sensitivity was similarly predictive of the social-positive pattern in samples of Brazilian and Portuguese infants who completed the SF at three months postpartum (Fuertes et al., 2021). These findings are consistent with the view that repeated positive experiences of attunement and reparation of communicative mismatch in the caregiving relationship may scaffold and support regulatory resilience in the infant (DiCorcia & Tronick, 2011).

### *Infant temperament and SF response*

Some studies have explored the possibility that individual differences in infant temperamental negative reactivity account for differences in infant responses to the SF paradigm. Limited evidence of a potential association between parental report of infant temperamental negative affectivity and infant SF response has so far stemmed from study of discrete variables or behaviors. For example, one study found that "low-negative" infants, or those in the lowest thirty percent of the sample for maternal report of negative reactivity, engaged in protest and withdrawal behaviors for a lower percentage of the reunion episode than "high-negative" infants (that is, those in the top thirty percent of the sample) did (Yoo and Reeb-Sutherland, 2013). Importantly, however, the "high-negative" group of infants and "low-negative" group did not differ in their trajectories or extent of visual monitoring of the caregiver, social positivity, or self-directed regulatory behaviors (i.e., distraction and tactile self-soothing). A similarly representative example of the mixed findings in this area comes from a longitudinal study of infants at three time points between the ages of three and seven months (Planalp & Braungart-Rieker, 2015). The authors expected to corroborate an earlier finding that parent-reported negative affectivity on the part of the infant would be associated with lower use of distraction and self-comforting behaviors (Braungart-Rieker et al., 1998) but found no such association between parent-reported negative temperament and observation of infants' self-directed regulatory behaviors.

If infant patterns of regulatory behavior in response to the SF are indicative, in part, of their experiences and expectations within the caregiving relationship (and not merely a reflection of constitutional disposition), some independence between infant temperament and pattern of regulatory behavior would be expected (Abbot, 2016). This prediction—that infant pattern of

regulatory behavior in the SF would not merely reflect infant negative affectivity—bore out in a study that applied regulatory pattern coding to a sample of three-month-olds (Barbosa et al., 2019). Maternal report of "difficult" temperament did not differ among social-positive infants, distressed-inconsolable infants, and self-comfort oriented infants, who all shared similar scores on the parental report measure (Barbosa et al., 2019). Similarly, maternal report of infants' "difficult" temperament was not predictive of continuous scores of social-positive, negative other-directed, and self-directed coping in an earlier sample of infants born prior to term (Fuertes et al., 2011).

**The Present Study**

The present study had four aims. To this author's knowledge, the Coding System for Regulatory Patterns in the SF (Fuertes and Lopes-dos-Santos, 2009) has never before been applied outside of the research environment in which it was first developed, and a first aim of the present study was to assess whether researchers unconnected to the development of the coding system could apply the approach with fidelity to the method in a high-risk sample. Indeed, the existing report of association between SF regulatory patterns and later quality of attachment in a Portugal-based sample characterized by low socioeconomic risk is accompanied by a call for replication and extension to other "geographic and sociodemographic contexts," including to samples characterized by socioeconomic and other sources of psychosocial risk (Barbosa et al., 22021, p. 14).

A second aim was to evaluate the convergent validity of the regulatory patterns in the present sample by assessing whether the regulatory patterns are consistent with more granular measures of infant affect and interactive behavior in the SF paradigm. This was done, first, by assessing whether existing second-by-second coding of infant distress in each of the interaction

episodes differed by regulatory patterns in ways that cohere with the regulatory patterns, and second, by examining whether independently-coded global ratings of infant reengagement behaviors during the reunion period differed by regulatory pattern in ways that are similarly congruent with features of the social-positive, distressed-inconsolable, and self-comfort oriented categories.

A third aim was to assess for potential associations between maternal report of infant temperament and infant regulatory pattern in the SF, as an association (or conversely, independence) between infant temperament and the regulatory patterns would have important implications for the possibility that organized patterns of regulatory behavior index infants' interactive history and experience-based expectations of an attachment figure during the attachment-in-the-making phase.

A fourth and final aim of the present study was to examine whether infant SF regulatory patterns are associated with concurrent measures of maternal sensitivity in the SF initial engagement and reunion episodes.

In service of the above aims, the present study made use of archived recordings of previous administrations of the SF in an existing sample.

**Hypotheses**

It was hypothesized that the social-positive oriented pattern would predominate in the present sample. In samples in which the Coding System for Regulatory Patterns has been applied, approximately half or more of infants have been described as social-positive oriented (e.g., Fuertes et al., 2014; Barbosa et al., 2018). Additionally, labeling of affect-based clusters in a Michigan-based sample estimated that approximately two-thirds of infants in the sample were social-positive oriented in their response to the SF (Safyer, 2019), even as analysis in this sample

separated out infants who exhibited the classic still-face effect (i.e., infants whose behavior might, in the three-pattern paradigm, still pertain to the social-positive pattern). These prior findings informed the hypothesis that two-thirds or more of infants in the present study would exhibit behavior consistent with the social-positive oriented pattern.

It was hypothesized that measures of infant distress would differ according to regulatory pattern, such that distress would be higher among distressed-inconsolable infants than among social-positive oriented infants. It was also expected that global ratings of infant reengagement behaviors in the SF reunion episode would cohere with the regulatory patterns, and that this convergence would be evidenced by higher resistance ratings among distressed-inconsolable infants, higher attention-seeking ratings among social-positive infants, and higher avoidance ratings among infants who exhibited a self-comfort-oriented pattern of regulatory behavior in the SF.

Given that maternal report of infants' "difficult" temperament did not differ among the regulatory patterns in an earlier study (Barbosa et al., 2019), it was hypothesized that maternal report of infant negative affectivity would not differ by regulatory pattern.

Finally, the possibility that infant patterns of regulatory behavior reflect infants' interactive history with the caregiver informed the hypothesis that the regulatory patterns would be linked to differing levels of maternal sensitivity. More specifically, and in view of long-standing literature that has linked maternal sensitivity to attachment security (e.g., De Wolff & Van Ijzendoorn, 1997; Madigan et al., 2024), it was hypothesized that the social-positive oriented pattern of regulatory behavior (as a possible precursor to later attachment security or index of its emergence) would be associated with higher measures of maternal sensitivity in both the initial engagement episode of the SF and the reunion episode. Given the likelihood that maternal

sensitivity to distress may be particularly predictive of attachment security (e.g., Leerkes, 2011; Cassidy et al., 2013), it was expected that maternal sensitivity during the reunion episode would be more strongly associated with infant regulatory pattern than maternal sensitivity during the baseline engagement episode.

## Method

### Participants

Primiparous women were invited to take part in a prospective longitudinal study concerning the perinatal transition to parenting among first-time parents. Recruitment sought to reach expectant individuals via local social service agencies, childbirth classes, and hospitals. The study aimed to examine intergenerational processes among mother-infant dyads at risk for parenting problems and difficulties in dyadic emotion regulation (see, for example, Oppenheimer et al., 2013; Ostlund et al., 2017). For this reason, eligibility criteria included a minimum score of 11 (out of a possible score of 25) on the Screening Scale for Problems in Parenting (SSPP; Avison et al., 1986) and a minimum score of 12 (out of a possible 36) on the Center for Epidemiological Studies-Depression scale (CES-D; Radloff, 1977). Expectant women who met eligibility criteria and wished to participate were enrolled during their third trimester of pregnancy and completed a prenatal lab visit ($n$ = 105).

Participants in the prenatal component of the study were similarly invited to subsequent longitudinal follow-up visits, including when their infants were approximately five months old and again one year later, when the infants approached the age of seventeen months. Both lab visits included an array of interaction tasks as well as completion of paper-and-pencil questionnaires. Analysis in the present study relies on secondary analysis of data collected at these two (that is, the five-month postnatal and seventeen-month postnatal) timepoints. Of the

105 participants who enrolled during pregnancy, 97 women returned with their infants for the five-month post-partum assessment. Attrition of eight participants between the prenatal visit and the postpartum assessment was attributable to the following: four participants could not be reached for follow-up, two participants had moved too far away to participate, one participant consented only to the prenatal component of the study, and one remaining mother lost her infant to illness. The subset of participants who completed the post-partum lab visit did not differ from the original prenatal sample in terms of maternal age, maternal education, marital status, or household income (Conradt & Ablow, 2010). All 97 participants in the postnatal visit had signed a consent form for the prenatal study, agreed to be contacted for postnatal assessment, and signed a consent form to document their consent to the post-natal study visit. Consent forms and study protocols for each lab visit were approved by the University of Oregon Committee for the Protection of Human Subjects.

Of the 97 mother-infant dyads who attended the post-partum lab visit, complete recordings of the Still-Face (SF) paradigm were available for 90 participants. Fussiness in two infants precluded their completion of the Still Face task. For two infants, the parent's departure from SF instructions invalidated the SF for the present purposes. A final subset of three infants did not have SF videos available for coding of regulatory patterns due to error in video recording or in digitization of existing recordings. The resulting sample of mother-infant dyads with valid Still-Face recordings (amenable to analysis) totaled 90 dyads.

**Procedures**

At the time of the postnatal assessment, the participating mothers completed demographic questionnaires and self-report measures on a range of constructs, including maternal mood and trauma symptoms and maternal perception of child temperament. Physiological monitoring

equipment collected ongoing measures of maternal and infant heart rate and respiration throughout a series of interactive laboratory tasks, including the Still-Face Paradigm.

***Still-Face Paradigm***

The defining feature of the Still-Face (SF) paradigm is a neutral-face episode, during which the adult does not respond to the infant (Tronick et al., 1978). The neutral-face episode is preceded by a baseline interaction episode and followed by a reunion episode. For the purpose of the SF paradigm, infants sat in a highchair, with the chair positioned so that mother and infant could comfortably face one another from a distance of approximately 18 inches. To initiate the two-minute baseline free play episode, an experimenter told the parent via intercom that she could play with her infant. During these two minutes, mothers interacted with their infants without toys. The experimenter then asked the mother via intercom to play "peekaboo" with her infant. Following thirty seconds of "peekaboo," the experimenter asked the mother to turn to her left. The experimenter waited for a span of 15 seconds before asking the mother to turn back to her infant and to maintain a neutral face. The ensuing neutral-face episode lasted for two minutes. The neutral-face episode was discontinued if the infant exhibited continuous distress for more than 15 seconds. Following the neutral-face episode, mothers were again asked to turn to their left for a span of 15 seconds, after which they were invited to resume play with their infant. The invitation to resume interaction marked the beginning of the reunion episode, which lasted for one minute. The one-minute reunion episode and the incorporation of "peekaboo" immediately before the onset of the neutral-face episode each reflect this study's adoption and modification of Lewinsohn's (1996) SF procedure, which is detailed further in Forbes and colleagues' (2004) publication. A second SF procedure followed immediately on the heels of the first and consisted of a second two-minute neutral-face episode and a second reunion episode.

This addition of a second neutral-face episode and second reunion were the innovation of Haley and Stansbury (2003). The second neutral-face episode is believed to elicit greater stress for the infant (Haley & Stansbury, 2003; DiCorcia et al., 2016).

Video recording of the SFP made use of two cameras, with one camera positioned to focus on the mother and another camera positioned to focus on the infant. A split-screen generator integrated recordings from the two cameras to enable researchers to simultaneously observe both mother and infant behaviors.

**Measures**

***Coding of infant response to the Still-Face paradigm***

Three separate coding strategies were used to characterize infant responses to the Still-Face paradigm. The first two strategies were applied prior to the start of the present study and were available to this author as archival data. These included (1) microanalytic coding of infant distress and (2) global ratings of infants' reengagement behaviors during the SF reunion episode. The latter coding strategy was devised by Kogan and Carter (1996); it characterizes infant reengagement behavior in the reunion episode by way of three continuous scales, each of which have analogues in the Strange Situation behavior rating scales (Ainsworth et al., 1978/2015). Kogan and Carter's (1996) Post-Still-Face Reengagement Behavior Codes were applied to the first reunion episode. The final coding strategy consisted of the Coding System for Regulatory Patterns in the Face-to-Face Still Face (Fuertes and Lopes-dos-Santos, 2009), which requires that coders consider the trajectory of infant behaviors across the length of the baseline interaction, neutral-face episode, and reunion episode. Despite the administration of a second neutral-face and second reunion episode following the first SF sequence, this study focused on the first full SF sequence without regard for the second SF sequence, with one exception. Application of the

Fuertes and Lopes-dos-Santos (2009) approach was confined to the first instantiation of the SF (and did not extend to the second neutral-face episode and reunion), except in a subset of videos for which information in the first reunion period did not suffice to select the best-suiting regulatory pattern. Scenarios that necessitated review of the second neutral-face and reunion episodes are described below.

**Microanalytic Coding of Infant Distress.** Observation of infant behavior recorded the presence or absence of infant distress on a second-by-second basis in the baseline engagement episode and the reunion episode. The total seconds of infant distress in each episode were then rendered as a percentage of the total duration of the episode (Conradt & Ablow, 2010). Coding of infant distress preceded the start of the current study, and details of infant distress coding are documented by Conradt and Ablow (2010).

**Post-Still-Face Reengagement Behavior Codes.** Kogan and Carter (1996) proposed three scales to characterize infant emotion regulation during the reunion episode of the SFP. The coding scheme consisted of three dimensions of interest, each of which were coded on a four-point scale that ranged from a minimum of 0 to a maximum of 3. *Avoidance* ratings described the extent to which the infant averted her gaze or actively withdrew or turned away from her mother. *Resistance* ratings described the extent to which infant protest behaviors (including fussing, squirming, and arching) persisted in the presence of infant gaze to the mother and/or increased in the presence of maternal efforts to reengage and soothe the infant. Finally, ratings of *attention-seeking* behaviors, devised as an analogue to later contact-maintenance ratings in the Strange Situation, described the extent to which the infant exhibited initiative by reaching toward the mother and/or addressing gaze, vocalization, and smiles in her direction. In the case of all ratings, higher scores indicated a higher level of the behavior in question.

The application of the Post-Still-Face Reengagement Behavior Codes in this sample is described in Conradt and Ablow (2010). As reported there, coders assigned avoidance, resistance, and attention-seeking scores to infant behavior during the first 20 seconds of the reunion episode and then assigned scores of these same dimensions for the remaining 40 seconds of the reunion episode. Subsequent paired samples *t*-tests demonstrated that reengagement codes from the first 20 seconds did not differ from reengagement codes from the latter 40 seconds (all *p*s>.19; Conradt & Ablow, 2010). For this reason, the two scores for a given dimension (i.e., the score for the first 20 seconds and for the latter 40 seconds) were averaged to glean a single score for the length of the reunion episode. In sum, each infant ultimately had three scores to represent their reengagement behaviors across the length of the reunion episode: an avoidance score, a resistance score, and an attention-seeking score. Conradt and Ablow (2010) previously evaluated the interrater reliability of the reengagement codes by selecting a random subset of 15 reunion recordings for double coding. Intraclass correlations among independent coders suggested excellent agreement (.930 for avoidance scores, .949 for resistance scores, and 961 for attention-seeking; Conradt & Ablow, 2010). Among the present subset of 90 infants, avoidance, resistance, and attention-seeking scores ranged from 0 to 3, indicating that coders made use of the full range of each scale. The mean avoidance score was 1.74 (*SD* = 0.79); the mean resistance score was 1.13 (*SD* = 1.16), and the mean attention-seeking score was 1.24 (*SD* = 0.86).

**Coding System for Regulatory Patterns in the Still-Face Paradigm**. The Coding System for Regulatory Patterns in the Face-to-Face Still Face (Fuertes and Lopes-dos-Santos, 2009) introduces six different profiles or sub-patterns of infant regulatory behavior as these relate to the three episodes of the SF paradigm. The six sub-patterns belong, in turn, to three higher-order "summary" patterns (Barbosa et al., 2021, p. 4). For each of the six sub-patterns, the

system provides an episode-by-episode account of the behaviors that define the given sub-pattern and distinguish it from the others. Multiple features of infants' responses to the SF form the basis for assignment of their SF behaviors to a (descriptive) regulatory sub-pattern. These include: (1) the quality of dyadic interaction in the baseline free-play episode, including the extent to which mother-infant interaction in the baseline episode is positive and reciprocal, the level of infant attention to the mother, and degree of negative engagement in this same episode (e.g., the duration of any bouts of infant distress or efforts to retreat from the face-to-face interaction), (2) the infant's response to the mother when she assumes the neutral face, including the timing, type and intensity of infant affect at the onset of the neutral-face episode, whether the infant elicits maternal re-engagement, and predominant behaviors during the length of maternal non-responsiveness, and (3) the trajectory of infant recovery (or non-recovery) during the reunion episode (Fuertes and Lopes-dos-Santos, 2009; Barbosa et al., 2018). The higher-order patterns (into which the six sub-patterns are further organized) are social-positive oriented, distressed-inconsolable, and self-comfort oriented (Barbosa et al., 2018, 2020). A seventh sub-pattern does not pertain to any of the three higher-order categories but is instead reserved for dyads in which the infant exhibits extremely limited interaction with the mother or shows no differentiated reactions to the episodes of the SF (Fuertes and Lopes-dos-Santos, 2009).

This study's author contacted the developer of the Coding System for Regulatory Patterns in the Face-to-Face Still Face and underwent the developer's didactic training on the coding approach before providing instruction and the coding manual to two coders. The two coders were blind to the study's aims and hypotheses. They were also not advised of the organization of the seven sub-patterns into the three higher-order patterns and were asked to assign the best-fitting of the seven sub-patterns according to the first baseline interaction, neutral-face, and reunion

sequence. In keeping with guidelines for implementing a novel coding system (Chorney et al., 2015), the two coders independently coded sample observations from a subset of pilot videos to demonstrate preparedness to proceed with review and coding of the videos from the study sample.

Pilot coding confirmed both coders' command of the coding system and identified two adaptations needed to apply the coding approach to the existing SF videos. In the pilot subset, each trainee coders' selection of codes was compared against the codes assigned by this study's author, who functioned as the "gold standard" for the present investigation. The subset of pilot videos was limited to four videos. Coder 1's selections from among the seven-subpattern system were identical to selections by the gold-standard coder. The only departure between Coder 2's test codes on the one hand, and those of Coder 1 and the gold-standard coder on the other, rested on a discrepancy between the SF protocol in the present sample and the SF protocol as administered by developers of the Coding System for Regulatory Patterns approach (Fuertes and Lopes-dos-Santos, 2009). Existing studies that have applied the Coding System for Regulatory Patterns reported that the coding system was applied to reunion episodes that were two minutes in duration (Barbosa et al., 2018, 2021). In contrast, the reunion episode in the current study lasted for only one minute before a second neutral-face episode. Given that the coding system's distinction between two of the system's sub-patterns hinges in part on the presence or absence of infant recovery in the second minute of a two-minute reunion episode, the study team faced a dilemma about the application of the coding system in this sample, for which the reunion episode lasted only one minute. The study team adapted the coding system for application in this sample by determining that coders would review the second neutral-face and reunion episodes in the case of those infants for whom behavior in a longer reunion episode would be decisive for their

subpattern assignment. Because the second reunion episode coincided with the end of the lab task, coders were able to observe infant recovery during a longer reunion episode following the second neutral-face episode. For infants for whom a second minute of recovery time was key to selecting the most suiting subpattern, coders referenced the second reunion episode to make a determination about infant recovery, which in turn informed assignment of the infant's regulatory behavior to one of the regulatory sub-patterns. Additionally, coders excluded from consideration the "peekaboo" segment between the baseline interaction and neutral-face episodes.

All 90 videos were double-coded by Coders 1 and 2, with disagreements resolved through review by Coder 3. Coders 1 and 2 proceeded with coding for the first half of the sample by submitting their respective codes to Coder 3 for five videos at a time. In this half of the sample, any disagreements between coders' selection of codes (from among the seven regulatory subpatterns) were addressed through weekly conferencing and video review with Coder 3, with final codes decided by discussion and consensus. Within this subset of videos, approximately half of the videos (that is, 23 out of 45) required consensus coding in order to reach agreement on assignment to one of the seven subpatterns. Importantly, however, the majority (specifically, 17) of (23) discrepancies in subpattern selection concerned distinctions between closely related subpatterns within the same higher-order summary pattern. Stated differently, consensus coding to address discrepancies between trainee coders' respective (and independent) selection of subpatterns was decisive for identification of the higher-order summary pattern in only 6 of the 45 videos in this subset. Thereafter, Coder 3 resolved any discrepancies in subpattern codes that would result in different assignment at the level of the higher-order patterns. This was the case (i.e., review by Coder 3 was decisive for higher-order pattern assignment) for 7 of the remaining 45 videos in the sample.

In keeping with Barbosa and colleagues (2018, 2020), the three higher-order regulatory patterns—that is, the social-positive oriented, distressed-inconsolable, and self-comfort-oriented categories—were retained for analysis. It merits repeating that trainee coders selected sub-patterns, without the information that these sub-patterns were further organized into (or cleaved by) the higher-order patterns. Without inclusion of the "test" videos, intercoder agreement (prior to consensus coding) was 83.5% for the three-category distinction. Cohen's kappa coefficient for intercoder agreement was 0.63, indicating moderate (McHugh, 2012) to substantial (Cohen, 1960) agreement prior to consensus coding.

***Coding of maternal behaviors in interaction episodes of the SF paradigm***

**Maternal sensitivity.** The Global Ratings of Mother-Infant Interaction (Murray et al., 1996) were previously used to score maternal behavior in the SF play and reunion episodes in this same sample (Conradt & Ablow, 2010), and archived maternal sensitivity data was therefore available for each of the mother-infant dyads in the present study. The Global Ratings of Mother-Infant Interaction include, among others, five 5-point scales to characterize maternal behavior towards the infant on dimensions of acceptance, demandingness, responsiveness, sensitivity, and warmth (Murray et al., 1996). Conradt and Ablow (2010) previously assessed inter-rater reliability via intra-class correlations and reported that intra-class correlations for the five maternal behavior scales ranged from .77 to .94 for the SF play episode and from .88 to .93 for the reunion episode (Conradt & Ablow 2010, p. 255). Within each of the two episodes, high intercorrelation among the five scales justified aggregating the five scores into a single maternal sensitivity score (Conradt & Ablow 2010). For each mother in the pre-SF play episode, the demanding scale was reverse-scored and averaged with acceptance, responsiveness, sensitivity, and warmth to yield a single maternal sensitivity score for the play episode. Separately, the five

scores pertaining to the reunion episode were similarly averaged to generate a reunion-based maternal sensitivity score for each mother (Conradt & Ablow 2010). In the present sample, maternal sensitivity scores ranged from 1.20 to 4.80 ($M$ = 3.69, $SD$ = 0.678) in the initial engagement episode. Maternal sensitivity scores in the reunion episode had the same range and were moderately correlated with sensitivity during the pre-SF free play ($r(88) = .455$, $p < .001$). However, maternal sensitivity scores during reunion were lower, on average, than the free-play sensitivity scores ($M$ = 2.98, $SD$ = 0.957, $t(88) = 7.60$, $p < .001$).

***Maternal report of infant negative affectivity***

**Infant temperament.** The Infant Behavior Questionnaire-Revised (IBQ-R; Gartstein & Rothbart, 2003) elicited maternal impressions of infant temperament by way of 191 items, which ask the mother to consider her infant's behavior over the preceding week (for some scales) or fourteen days (for others). Items are organized into domains (e.g., feeding) and inquire about the frequency with which the infant displayed specific behaviors during the relevant time span (e.g., "During feeding, how often did the baby wave arms?"). Response options range on a 7-point scale from "Never" to "Always" and allow the respondent to otherwise indicate if the behavior or scenario does not apply. Combinations of items yield scores for fourteen scales, five of which are Activity Level, Distress, Fear of Novelty, Smiling, and Soothability. In keeping with Haley and Stansbury (2003), Conradt and Ablow (2010) subtracted the (Smiling + Soothability) sum from (Activity Level + Distress + Fear of Novelty) to calculate an overall index of negative temperament. Negative temperament scores in the present sample ranged from 3.13 to 6.67 ($M$ = 4.82, $SD$ = .688).

**Data Analysis Plan**

*Aim 1:* This study's first aim was to apply the regulatory pattern coding to the present sample and describe the distribution of the infant regulatory patterns among five-month-old infants contending with risk. In service of this aim, univariate frequency analysis was conducted.

*Aim 2:* This study's second aim was to evaluate whether the regulatory profiles were consistent with more granular measures of infant affect and behavior. To this end, one-way analyses of variance (ANOVAs) were planned to assess (a) whether second-by-second coding of infant distress in each of the interaction episodes differed by regulatory patterns in ways that cohere with the regulatory patterns, and second by examining (b) whether the more global ratings of infant reengagement behaviors differed by regulatory pattern.

*Aim 3:* This study's third aim was to assess for potential association between maternal report of infant temperament and infant regulatory pattern in the SF task, in order to evaluate the capacity of regulatory pattern coding to differentiate between infant responses to the SF and infant propensity toward negative affect more generally. A one-way ANOVA was planned to evaluate whether mean-level negative affectivity scores differed between groups of infants grouped by regulatory pattern.

*Aim 4*: The final aim of the present study was to evaluate the construct validity of infant patterns of regulatory behavior as a potential measure of attachment in the making, by exploring whether infant patterns of regulatory behavior in the Still-Face are associated with concurrent differences in maternal sensitivity as observed in the same paradigm. Two separate one-way, univariate analyses of variance (ANOVAs) were planned to assess for between-group differences in maternal sensitivity scores among social-positive oriented, distressed inconsolable, and self-comfort-oriented infants. The first planned ANOVA assessed for between-group differences in scores of maternal sensitivity in the free-play engagement episode that marks the outset of the SF

paradigm. The second ANOVA made use of coding of maternal sensitivity scores used to describe maternal interactive behaviors during the reunion episode.

Each one of the planned ANOVAs was accompanied by an assessment of the prerequisite assumptions for ANOVA. When assumptions were not met, alternative tests of between-group differences (Welch's ANOVA and/or the non-parametric Kruskal-Wallis test) were conducted as follow-up, to address risk of Type I error incurred by violation of the test's assumptions and to confirm that the ANOVA-based findings were robust to choice of statistical test. For each of the above tests, the analysis plan also held that a significant omnibus test statistic would cue appropriate post-hoc pairwise comparisons.

## Results

### *Sample Characteristics*

Descriptive demographic information for participants in the first postnatal lab visit are detailed in Table 1. At the time of the first postnatal visit, infants ranged in age from 16 to 32 weeks ($M$ = 20.97 weeks, $SD$ = 2.55). Fifty-three of the 90 infants were female (58.9%). Maternal age at this time point ranged from 18 to 38 years ($M$ = 23.96 years, $SD$ = 4.66). A majority of participating mothers indicated that they were married (40%) and/or residing with their partner (43.3%). Fifty percent of the sample reported a household income of less than 20,000 dollars, and 41.1% reported a household income between 21,000 and 40,000 dollars. Approximately one third (33.9%) of the participating mothers reported completing a four-year college degree (17.6%) or schooling beyond college (16.3%). Just over half (54%) of mothers reported completing either some college (37.8%) or a two-year degree (16.2%). The remaining 12.2% of mothers in the sample either earned a high school degree or equivalency diploma (9.5%) or discontinued secondary education prior to receiving a high school degree or equivalent

(2.7%). A majority of mothers in the sample identified themselves as White and not of Hispanic origin (81.1%).

**Table 1**

*Participant Demographics*

| Variable | % or *M* (SD) | Range |
|---|---|---|
| Age | | |
| Mother (years) | 23.96 (4.66) | 18-38 |
| Infant (weeks) | 20.97 (2.55) | 16-32 |
| Infant gender | | |
| Boys | *n* = 53 | - |
| Girls | *n* = 37 | - |
| Household income | | |
| Less than $9,999 | 20% | |
| $10,000-20,000 | 31.1% | |
| $21,000-40,000 | 41.1% | |
| $41,000-60,000 | 4.4% | |
| Greater than $61,000 | 3.3% | |
| Maternal highest level of education | | |
| Some high school | 2.2% | |
| High school diploma or equivalent | 7.8% | |
| Two-year degree/Some college | 44.4% | |
| Four-year college degree | 14.4% | |
| Some school beyond college | 7.8% | |
| Graduate degree | 5.6% | |
| Not reported | 17.8% | |
| Maternal ethnicity | | |
| White, and not of Hispanic origin | 81.1% | |
| Hispanic or Latino | 4.4% | |
| American Indian | 4.4% | |
| Black or African-American | 3.3% | |
| Another group | 6.7% | |
| Maternal marital status | | |
| Single | 16.7% | |
| Living with partner | 43.3% | |
| Married | 40.0% | |

### *Descriptive Statistics*

Of the 90 infants for whom SF regulatory patterns were coded, a preponderance of the videos (74.4%, $n = 67$) received the social-positive oriented classification. Eighteen of the 90 videos (20%) were coded as distressed-inconsolable, and only five (that is, 5.6%) of the videos were coded as self-comfort oriented. The descriptive statistics for other study variables are reported in Table 2.

**Table 2**

*Descriptive statistics of infant regulatory patterns, dyadic engagement behaviors, and infant temperament*

| Variable | % or *M* (SD) | Range |
|---|---|---|
| Infant SF Regulatory Pattern | | |
| Social-positive oriented | 74.4% ($n = 67$) | |
| Distressed-inconsolable | 20.0% ($n = 18$) | |
| Self-comfort oriented | 5.6% ($n = 5$) | |
| Infant Global Reengagement Codes | | |
| Attention-seeking | 1.24 (0.86) | 0 - 3 |
| Resistance | 1.13 (1.16) | 0 - 3 |
| Avoidance | 1.74 (0.79) | 0 - 3 |
| Percentage of episode marked by infant protest or distress | | |
| Initial engagement episode | 8.57% (16.65) | 0 – 95% |
| Reunion of episode | 25.11% (33.59) | 0 – 100% |
| Maternal sensitivity | | |
| During initial engagement episode | 3.69 (0.68) | 1.20 – 4.80 |
| During reunion episode | 2.99 (0.95) | 1.20-4.80 |
| Infant temperament | | |
| Surgency | 4.82 (0.69) | 3.13 – 6.67 |
| Orienting | 5.11 (0.57) | 3.49 - 6.39 |
| Negative affectivity | 3.04 (0.58) | 1.70 – 5.37 |

***Inferential statistics***

*Are the regulatory patterns consistent with microanalytic measures of infant distress?*

As an assessment of convergent validity of the SF regulatory pattern coding in the present sample, a one-way univariate ANOVA tested whether the regulatory patterns coincided with group-level differences in the extent of infant distress during the baseline interaction episode. Infant distress during the baseline interaction differed by regulatory pattern ($F(2, 87) = 14.01$, $p < 0.001$, $\eta_p^2 = 0.244$). Effect size was large. On average, infants in the distressed-inconsolable group exhibited distress during 24.77% of the baseline interaction episode ($SD = 27.11$, range = 0.00-95.00). Among infants in the self-comfort-oriented group, the mean percentage of the baseline interaction period marked by infant distress was 9.00% ($SD = 11.86$, range = 0.00 – 26.67), and the difference between self-comfort oriented and distress-inconsolable infants in this indicator of distress during the baseline episode approached significance in post-hoc pairwise comparisons ($p = 0.090$). As a group, infants classified as social-positive oriented had the lowest duration of distress during the baseline interaction period per the distress measure ($M = 4.19\%$, $SD = 9.20$, range: 0.00 - 44.17). While the extent of distress among social-positive oriented infants differed significantly from that of distressed-inconsolable infants ($p < 0.001$), the extent of distress did not differ between social-positive-oriented and self-comfort-oriented infants ($p = 0.759$). These comparisons are summarized in Table 3.

Assessment of the prerequisite assumptions for a traditional one-way ANOVA detected violation of the homogeneity-of-variances assumption.[2] For this reason, a robust Welch's ANOVA was also conducted, which confirmed between-group differences in infant distress during the initial engagement episode ($F(2, 87) = 21.3$, $p < .001$). Post-hoc Games-Howell's

[2] Levene's test for homogeneity of variances detected evidence against this assumption ($F(2, 87) = 21.3$, $p < .001$).

tests, which (like the robust Welch's ANOVA, are similarly robust to unequal variances among groups, confirmed that social-positive oriented infants exhibited distress during a significantly lower percentage of the initial engagement episode than distressed-inconsolable infants did ($p$ = .014). A non-parametric Kruskal-Wallis test similarly found similar between-pattern differences in median distress values ($\chi^2(2) = 18.6$, $p < .001$), and post-hoc pairwise comparisons confirmed that social-positive oriented infants and distressed-inconsolable infants differed significantly in in the extent of distress they exhibited in the initial engagement episode ($W$ = 6.01, $p < .001$). In sum, infants who exhibited a distressed-inconsolable pattern in the SF exhibited distress for a significantly greater percentage of the engagement period than social-positive oriented infants did, and this finding was robust to selection of statistical test.

Infant distress during the reunion episode also differed according to the regulatory patterns, and in ways that cohere with defining features of the regulatory patterns ($F(2, 87 = 47.27$, $p < 0.001$, $\eta_p^2 = 0.521$). Effect size was larger for distress during the reunion episode than it was for the baseline interaction episode. On average, distressed-inconsolable infants exhibited distress during the majority ($M$ = 73.24%) of the reunion episode ($SD$ = 26.42, range: 10.00-100.00), and this extent of distress exceeded that in both the social-positive and self-comfort-oriented groups ($p$s < 0.001). Infants assigned to the social-positive oriented category exhibited distress during an average of 13.51% of the reunion period ($SD$ = 23.09, range: 0.00-88.33), and infants in the self-comfort-oriented category spent an average of 7.33% of the reunion episode exhibiting distress ($SD$ = 16.40, range: 0.00-36.67). The average percentage of the reunion period marked by distress did not differ between the social-positive and self-comfort-oriented groups ($p$ = 0.838).

A Welch's ANOVA was not conducted to confirm the results of the traditional ANOVA, as evaluation of the homogeneity-of-variances assumption for a traditional ANOVA did not find evidence against this assumption.[3] The outcome of a non-parametric Kruskal-Wallis test confirmed between-group differences in the extent of infant distress during the reunion episode ($\chi^2(2) = 37.0$, $p < .001$), with distress in the distressed-inconsolable group exceeding distress in both the self-comfort oriented group ($W = 4.55$, $p = .004$) and the social-positive oriented group ($W = 8.37$, $p < .001$).

**Table 3**

*Infant Regulatory Patterns and Percentage of Interaction Episodes Marked by Distress*

| | | Five-month regulatory pattern | | |
|---|---|---|---|---|
| | ANOVA $F(2, 87)$ | Social-positive oriented | Distressed-inconsolable | Self-comfort oriented |
| Percent of engagement episode marked by distress | 14.01*** | 4.19 (9.20) [a] | 24.77 (27.11)[b] | 9.00 (11.86) |
| Percent of reunion episode marked by distress | 47.3*** | 13.51 (23.1)[a] | 73.24 (26.4)[b] | 7.33 (16.4)[a] |

*Note*. Within each row, means with different subscripts denote statistically significant differences between the means. For example, social-positive oriented infants exhibited distress during less of the engagement episode, on average, than distressed-inconsolable infants.
*$p < .05$ **$p < .005$; ***$p < .001$.

*Do global reengagement codes (unique to the reunion episode) differ by infant regulatory patterns?*

To evaluate the convergent validity of the SF regulatory patterns with concurrent global ratings of infant reunion behaviors, a one-way multivariate ANOVA was planned to assess whether the SF regulatory patterns predicted differences in reengagement codes (that is, avoidance, resistance, and attention-seeking scores). A one-way multivariate analysis of variance

[3] Levene's test for homogeneity of variances retained the assumption of homogeneity of variances across groups ($F(2, 87) = 0.97$, $p – 0.38$). Shapiro-Wilk's test for normality suggested that the distress values were not normally distributed ($W = 0.826$, $p < .001$).

indicated that the reengagement scores indeed differed significantly on the basis of the regulatory patterns (Wilks' $\Lambda = 0.522$, $F(6, 166) = 10.64$, $p < 0.001$, $\eta_p^2 = 0.278$). The effect size was large. Assessment of the assumptions for a traditional one-way multivariate ANOVA detected violations of these assumptions,[4] so the more robust Welch's analysis of variance was adopted to further examine potential between-group differences. Three Welch's ANOVAs indicated that the attention-seeking, resistance, and avoidance scores each differed among infants assigned to different patterns of regulatory behavior (Table 4). First, infants' attention-seeking scores differed according to regulatory pattern ($F(2, 11.2) = 33.3$, $p < .001$). Post-hoc Games-Howell tests, robust to unequal variances between groups, indicated that attention-seeking scores were higher in social-positive oriented infants than in distress-consolable infants ($p < .001$). Stated differently, infants who were assigned to the social-positive regulatory pattern based on an assessment of their response to the three episodes of the SF had higher attention-seeking scores in the reunion episode than infants assigned to the distressed-inconsolable regulatory pattern; this means that social-positive infants were independently rated by a separate coding team as showing more initiative in looking toward the mother, vocalizing to her, and reaching and/or smiling in her direction.

[4] Shapiro-Wilk's tests indicated that reengagement scores were not normally distributed in the majority of cells (associated *p*-values ranged from <.001 to .814). Tests for multicollinearity between dependent variables indicated that correlations between engagement scores, while significant, did not exceed the conventional cut-off (of $r = .90$) for excessive multicollinearity. A Box's test of equality of covariance matrices was consistent with homogeneity of variance-covariances matrices ($p = .09$). Levene's test was consistent with between-group homogeneity of variances for avoidance scores ($p = .22$) and resistance scores ($p = .28$) but detected heteroscedasticity of between-group variances of the attention-seeking score across levels of the independent variable ($p = .037$). This latter finding of between-group variances in attention-seeking scores is a violation of the homogeneity-of-variances assumption for a traditional univariate ANOVA and therefore risks inflating Type I error. The robust Welch's ANOVA was used to address this risk.

**Table 4**

*Global reengagement codes by infant regulatory patterns*

| | | SF reunion reengagement scores | | |
|---|---|---|---|---|
| | | Attention-seeking | Resistance | Avoidance |
| Five-month regulatory pattern | Social-positive oriented | 1.50 (0.81)[a] | 0.80 (0.95)[b] | 1.55 (0.75)[a] |
| | Distressed-inconsolable | 0.35 (0.39)[b] | 2.62 (0.76)[a] | 2.38 (0.60)[b] |
| | Self-comfort oriented | 0.80 (0.57) | 0.40 (0.65)[b] | 2.20 (0.57) |

*Note.* Within each column, means with different subscripts denote statistically significant between-pattern differences in the mean score for the reengagement score in question.

Reunion-based resistance scores also differed among infants assigned to differing regulatory patterns ($F(2, 11.2) = 37.1$, $p < .001$). Specifically, resistance scores among distressed-inconsolable infants significantly exceeded those of both social-positive ($p < .001$) and self-comfort oriented infants ($p < .001$). Relative to infants described as social-positive or self-comfort oriented, infants who exhibited the distressed-inconsolable pattern received higher ratings of protest behaviors from an independent team of coders.

Finally, reunion-based avoidance scores also differed by regulatory pattern ($F(2, 10.9) = 12.2$, $p = .002$). Distressed-inconsolable infants received higher avoidance ratings than social-positive oriented infants ($p < .001$), meaning that they withdrew or turned away from the mother more and/or averted their gaze from the mother more during the SF reunion than social-positive oriented infants did.

Results of non-parametric Kruskal-Wallis tests were consistent with the outcome of the parametric ANOVAs and again suggested that between-group differences were robust to choice of statistical test.[5]

[5] As in the parametric ANOVA analyses, non-parametric Kruskal-Wallis tests found that ratings of attention-seeking ($\chi^2(2) = 27.8$, $p < .001$), resistance ($\chi^2(2) = 30.7$, $p < .001$), and avoidance each differed by regulatory pattern ($\chi^2(2) = 18.6$, $p < .001$). Post-hoc pairwise comparisons similarly confirmed that these differences resided between the social-positive oriented and distressed-inconsolable groups, with infants who exhibited the social-positive pattern

*Do concurrent measures of maternal sensitivity differ according to infant regulatory pattern?*

A one-way analysis of variance (ANOVA) assessed for between-group differences among the regulatory patterns in maternal sensitivity scores during the initial engagement episode (Table 5). The ANOVA did not yield evidence that maternal sensitivity during the free-play episode differed by infant regulatory pattern ($F(2, 87) = 1.45$, $p = .24$, $\eta_p^2 = 0.032$). Given that maternal sensitivity scores were not normally distributed,[6] a non-parametric Kruskal-Wallis Test was conducted to confirm that the distributions of free-play maternal sensitivity scores were indeed comparable across the three regulatory patterns ($\chi^2(2) = 2.19$, $p = .33$). The observational measure of mothers' sensitivity and warmth toward the infant in the initial engagement episode did not differ among infants classified as social-positive oriented in regulatory pattern, those classified as distressed inconsolable, and those classified as self-comfort oriented.

A separate one-way ANOVA was conducted to test for between-group differences among the regulatory patterns in maternal sensitivity scores during the reunion episode. The parametric test indicated that the mean level of maternal sensitivity differed significantly between two or more of the three regulatory patterns ($F(2, 86) = 4.42$, $p = .015$, $\eta_p^2 = 0.093$). Post-hoc Tukey tests suggested that the mean maternal sensitivity score for the reunion episode was higher among social positive infants ($M = 3.13$, $SD = 0.844$) than for distressed-inconsolable infants ($M = 2.39$, $SD = 1.14$), and that this difference was statistically significant ($p = .011$). Post-hoc comparisons did not identify statistically significant differences between reunion-based maternal

receiving lower ratings of resistance ($W = 7.60$, $p < .001$) and avoidance ($W = 5.75$, $p < .001$) and higher global ratings of attention-seeking ($W = 7.17$, $p < .001$).

[6] A Shapiro-Wilk's test indicated that maternal sensitivity scores during the engagement episode were not normally distributed within the social-positive oriented category ($W = .912(17)$, $p = .004$). While violation of the normality assumption (in combination with unequal number of observations among groups) in the setting of an ANOVA is more likely to lead to Type I error than it is to Type II error, a non-parametric test was conducted to confirm that the null finding was robust to type of test. A Levene's test did not detect violation of the homogeneity of variances assumption ($F(2, 87) = 0.453$, $p = 0.63$), and for this reason a Welch's ANOVA was not conducted.

sensitivity in self-comfort-oriented infants ($M$ = 2.92, $SD$ = 1.137) and social-positive oriented infants ($p$ = .87) or between self-comfort-oriented infants and their distressed-inconsolable counterparts ($p$ = .50). Given that maternal sensitivity scores were not normally distributed,[7] the non-parametric Kruskal-Wallis test was conducted to address risk of inflated Type I error in the parametric one-way ANOVA. Results of the Kruskal-Wallis test were congruent with the results of the one-way ANOVA. Median maternal sensitivity scores differed significantly between two or more of the three regulatory patterns in the reunion episode ($\chi^2(2) = 7.79$, $p$ = .02). Pairwise comparisons confirmed that differences resided between the distressed-inconsolable and social-positive oriented patterns, and that maternal sensitivity scores were lower among distressed-inconsolable infants when compared to the social-positive group ($W$ = - 3.89, $p$ = .017).

To summarize, between-group comparisons of mean-level sensitivity in the initial engagement episode suggested that, on average, infants in the social-positive oriented, distressed-inconsolable, and self-comfort oriented groups enjoyed similar levels of maternal warmth and sensitivity during the baseline free-play interaction of the initial engagement episode. However, similar between-group comparisons of maternal sensitivity scores in the reunion episode suggested that mothers of infants who exhibited a social-positive oriented pattern of regulatory behavior showed more sensitivity to their infants during this episode than mothers of infants who exhibited a distressed-inconsolable pattern.

[7] Shapiro-Wilk's tests and inspection of histograms detected non-normal distribution of maternal sensitivity scores in the reunion episode in both the social-positive ($W(67) = .943$, $p$ = .004) and distressed-inconsolable ($W(17) = .874$, $p$ = .026) groups. Neither logarithmic nor square-root transformations of the scores yielded normal distribution of values within each of the comparison groups. The violation of the normality assumption together with the unequal distribution of observations across comparison groups risks inflation of Type I error, and a non-parametric test was conduct to address this risk. A Levene's test did not detect violation of the homogeneity of variances assumption ($F(2, 86) = 1.57$, $p$ = 0.21), and for this reason a Welch's ANOVA was not conducted.

**Table 5**

*Maternal sensitivity scores by infant regulatory patterns*

| | ANOVA | Five-month regulatory pattern | | |
|---|---|---|---|---|
| | | Social-positive oriented | Distressed-inconsolable | Self-comfort oriented |
| Sensitivity in pre-SF engagement | $F(2, 87)= 1.45$, n.s. | 3.76 (0.62) | 3.47 (0.85) | 3.56 (0.65) |
| Sensitivity in reunion episode | $F(2, 86)= 4.42$* | 3.13 (0.84)[a] | 2.39 (1.14)[b] | 2.92 (1.14) |

*Note*. Within each row, means with different subscripts denote statistically significant differences between the means; For social-positive infants, maternal sensitivity was significantly higher during the reunion episode that it was for distressed-inconsolable infants.
* $p<.05$

*Are infant regulatory patterns associated with maternal report of infant negative temperament?*

A one-way ANOVA was conducted to test for differences in temperamental negative affectivity scores among infants assigned to different regulatory patterns. There was no statistically significant differences in mean negative temperament score between infants classified as social-positive oriented, self-comfort oriented, or distress-inconsolable ($F(2,87) = 1.26$, $p = .29$). Given that Shapiro Wilk's test detected non-normality in distribution of negative temperament scores among social-positive oriented infants, a non-parametric Kruskal-Wallis test was performed to confirm that the comparability of negative temperament scores across regulatory patterns was robust to choice of test. The distribution of negative temperament scores did not differ significantly between infants assigned to different patterns of regulatory behavior ($W(2) = 2.87$, $p =. 24$). Post-hoc, exploratory analyses confirmed that the distribution of infant temperament scores for surgency and (separately) orienting were conducive to between-group comparisons using univariate ANOVA. Maternal report of infant surgency did not differ among the social-positive, distressed-inconsolable, and self-comfort oriented groups ($F(2, 87) = 2.02$, $p = 0.14$), and neither did maternal report of infant orienting ($F2, 87) = 1.36$, $p = 0.26$). The

absence of between-pattern differences in maternal report of all three dimensions of infant temperament suggested that coding of regulatory patterns reflected in infants' responses to the SF perturbation rather than constitutional or trait-like differences among infants.

## Discussion

Application of the Coding System for Regulatory Patterns in the SF Paradigm identified a preponderance of the social-positive oriented pattern in the present sample. That is, nearly three-fourths of infants in the sample enjoyed moderate to high levels of positive and reciprocal interaction in the initial engagement episode, exhibited a decrease in positive engagement and/or evident perturbation during the neutral-face episode, and showed signs of recovery and return to positive and reciprocal interaction in the reunion episode.

Distribution of the regulatory patterns in this sample paralleled existing reports of the distribution of regulatory patterns in other samples in that the social-positive oriented pattern predominated and was followed by the distressed-inconsolable category and the self-comfort-oriented category in turn. While the percentage of infants identified as social-positive oriented was somewhat higher in the present study than in other studies that applied the three-pattern system (50.9% to 55.1%; Barbosa et al., 2018; Fuertes et al., 2014, as cited in Barbosa et al., 2019), the percentage of social-positive oriented infants this sample (74.4%) more closely approximates the 66% of infants in Safyer's (2019) Michigan-based sample who were labelled as social-positive oriented on the basis of their affective trajectories across the SF task, and membership in the social-positive oriented pattern in the Michigan-based sample may have reached three-fourths of the sample but not for the parsing out of infants who exhibited the "classic" still-face effect. While Safyer's (2019) Michigan-based study provides a precedent of sorts for the extent of social-positive oriented responding detected here, the earlier study did not

apply the Coding System for Regulatory Patterns in the SF, and the Michigan sample differed from the present sample in multiple respects.

This study also found that coding of regulatory patterns was consistent with more granular measures of infant affect and interactive behavior in the SF paradigm. More specifically, infants whose regulatory behavior followed the social-positive oriented pattern showed less distress during baseline interaction with their mothers than distressed-inconsolable infants did. The coding system anticipates that infants who exhibit a distressed-inconsolable pattern will have less positive and reciprocal interaction with the parent during the initial engagement episode than social-positive infants, and micro-coding of infant distress suggested that these expected differences between distressed-inconsolable and social-positive infants held true in the engagement episode. Furthermore, a defining feature of the distressed-inconsolable pattern is infant distress within the neutral-face episode that does not remit and/or further intensifies during the reunion episode. Second-by-second coding of infant distress also corroborated coders' assignment of the distressed-inconsolable pattern to infants for whom this was the case, as differences between the extent of distress among distressed-inconsolable infants and that expressed by other infants increased further during reunion. In sum, the organized patterns of regulatory behavior coincided with differences in detailed coding of infant distress in ways that cohere with defining features of the reunion behavior. The reader may recall that when Kogan and Carter (1996; p. 364) devised their global ratings of infant reengagement behavior, they observed that their global ratings were "consistent" but "not redundant" with concurrent microanalytic measures of infant affect, and the same could be said of the organized patterns of regulatory behavior and microanalytic distress measures here.

Independent, global ratings of infant reengagement behaviors during the reunion episode also provided encouraging evidence of convergence between the regulatory pattern coding and another existing method for observing infant SF behavior. It warrants emphasizing that the Kogan and Carter (1996) reengagement codes describe infant behaviors during the reunion episode, and these same behaviors (and the reunion episode) form only part of the profiles or trajectories of infant regulation that determine coders' assignment of infant behaviors to a regulatory pattern in the Coding System for Regulatory Patterns. This said, the Kogan and Carter's reengagement codes were a strong source of independent corroboration of the regulatory pattern coding in this study, as coding of infant reengagement behaviors was not conducted by the same coding team or at the same time as the regulatory pattern coding and nevertheless differed as a function of regulatory patterns. The constellation of mean reengagement codes for the social-positive group suggests that this group's reunion behavior is characterized by moderate levels of attention-seeking and avoidance and moderately low levels of resistance. While the moderate levels of avoidance in the social-positive group may seem unexpected at first glance, it is possible that moderate levels of attention-seeking directed to the mother combined with moderate levels of visual exploration of the environment and/or turning away from the caregiver in social-positive infants indexes something akin to attachment-exploration balance in pre-locomotor infants.

The pattern of differences in social-positive oriented infants and distressed-inconsolable infants in terms of their reengagement behaviors not only offers evidence of the regulatory patterns' convergent validity with a distinct but related observational tool, but also lends further credence to the possibility that regulatory patterns may be early probes of attachment in the making. Social-positive oriented infants engaged in more attention-seeking behaviors in the

reunion episode than distressed-inconsolable infants did, and infants who exhibited a social positive pattern also exhibited less avoidance and resistance than distressed-inconsolable infants. While quality of attachment in the Strange Situation is not assigned in an algorithmic fashion, some differences would be expected between securely attached and anxious-ambivalent infants that parallel the differences observed here between social-positive and distressed-inconsolable infants here. The small number of self-comfort oriented infants ($n$ = 5) limits power to detect differences between self-comfort oriented infants and the other two regulatory patterns. However, the mean-level reengagement scores in this small subset of infants tentatively suggest that self-comfort oriented infants exhibited low resistance and attention-seeking and moderately high avoidance on the three-point point rating scales. A similar constellation of interactive behaviors would be expected in infants classified as avoidantly attached in the Strange Situation.

Marked differences in the extent of distress exhibited by distressed-inconsolable infants relative to infants in the social-positive group and the self-comfort oriented group might compel the reader to wonder if this group's unremitting distress in the reunion episode reflects infant-level temperamental characteristics, rather than features of the dyad's interactive history and shared ability at the five-month time point to co-regulate and reach a place of repair following the experimental mismatch (or separation of sorts) that the neutral-face episode represents. However, infants in the social-positive, distressed-inconsolable, and self-comfort oriented groups received comparable scores in maternal report of infant negative affectivity. The independence of regulatory pattern classification from this measure of temperamental negative reactivity lends evidence to the possibility that organized patterns of regulatory behavior have antecedents in the attachment relationship (and the infant's history of communication with the caregiver) and are not a proxy for temperament or other trait-like characteristics inherent to the infant.

Further evidence for the possibility that organized regulatory patterns reflect infants' emerging working models of attachment (and not infant-level, trait-like characteristics) also comes from the finding, in the present study, that mothers of social-positive oriented infants exercised more sensitive responding in the reunion episode than mothers of infants who exhibited a distressed-inconsolable regulatory pattern. While it was expected that organized regulatory patterns would coincide with differences in maternal sensitivity in both the initial engagement episode and the reunion episode, between-group differences were only detected in the reunion episode. The absence of pattern-related differences in free-play sensitivity departs from Barbosa et al.'s (2019) finding that maternal sensitivity in a free-play task was higher for three-month-old social-positive infants than for distressed-inconsolable and self-comfort oriented infants. This said, a line of research suggests that maternal sensitivity in the face of distress (rather than free-play sensitivity) may be especially influential in the formation of attachment security (e.g., Leerkes, 2011), and evidence of significantly greater maternal sensitivity among mothers of social-positive oriented infants in the reunion episode (even in the absence of such differences in the initial engagement episode) is in keeping with theory and findings that caregiving responses in distress are more predictive of infant outcomes than response to non-distress (for review, see Cassidy et al., 2013).

Given the socioeconomic and psychosocial risk that characterized the present sample, the overwhelming predominance of the social-positive oriented pattern in this same sample is arguably remarkable. Infants' social-positive responding is posited as a potential byproduct of sensitive caregiving, and yet the social-positive oriented pattern predominated, even as poverty-related stressors, maternal depressive symptoms (which constituted one component of enrollment criteria), maternal endorsement of parenting beliefs that are empirically associated with parenting

problems, and other psychosocial sources of risk introduced potential compromise to the same caregiving sensitivity that is believed to shape infants' social-positive responding. The prevalence of the social-positive oriented pattern in this high-risk sample may reflect the contributions of protective factors. Though not assessed in the present study, protective factors may have nevertheless buffered infant-mother dyads from risks that might otherwise impinge on the relationship. The finding that infants who exhibited the social-positive oriented pattern had mothers who showed greater sensitivity to distress during the reunion episode favors the view that sources of resilience potentially supported maternal sensitivity and (in tandem) the emergence of the social-positive oriented pattern in the majority of the sample, even in the face of considerable risk. It is similarly possible that socioeconomic disadvantage and other sources of adversity are either less salient or not yet detectable in early infancy, and that the risks that these stressors introduce instead accumulate and/or exact effects on the infant-caregiver relationship in later infancy, when infants' increasing individuation and the onset of walking introduce demands and caregiving challenges that differ from those of the first half of the postnatal year. An additional possibility is that sources of risk to the caregiving relationship (e.g., socioeconomic stressors, depressive symptoms) are indeed at work in the early caregiving relationship at four and five months postpartum, including in the present sample, but that infants' patterns of regulatory behavior do not yet reflect experiences of caregiver insensitivity and related expectations. If infant regulatory patterns indeed probe attachment-related working models, a strong divorce between environmental risk (and caregiving behavior) and infant regulatory patterns at this age could suggest that attachment-related internal working models are not quite in-the-making, or that these models remain so receptive to additional input at this age

that they take existing experiences into account but are not yet tailored with precision to the contingencies of the caregiving relationship.

A number of strengths and limitations in the present study merit mention. The study is novel in its exercise of the Coding System for Regulatory Patterns outside of the research environment in which the coding system was developed. Double-coding of regulatory patterns to consensus was a strength of this study, as was rigorous evaluation of the validity of the regulatory patterns through juxtaposition of the patterns alongside independently coded and more granular observations of the same infants' SF behavior. The description of the distribution of regulatory patterns in a sample contending with socioeconomic and other psychosocial risks is also among this study's strengths and contributions.

One limitation of the present study is the modest number of infants in the sample who exhibited a self-comfort oriented regulatory pattern. This study did not detect differences in maternal sensitivity, infant reengagement scores, or negative temperament to distinguish the self-comfort oriented pattern from the remaining regulatory patterns. However, low representation of the self-comfort oriented pattern in the present study should constrain conclusions about this regulatory pattern. In the future, larger sample sizes may afford greater statistical power and further opportunities to identify correlates to the self-comfort oriented pattern of regulatory behavior.

An additional limitation is the brevity of the reunion episode in the present study's administration of the SF paradigm. Given that this reunion episode differed in duration from reunion episodes in which the coding system had previously been applied, coders consulted a second neutral-face episode and second reunion episode to evaluate infant recovery in a longer, second reunion episode when needed. This was a provisional remedy, and further standardization

of SF procedures across studies in the future will benefit replication efforts. Additionally, with the exception of maternal report of infant temperament, the present study focused on observations of mother, infant, and dyadic behaviors and their organization. Future study of the regulatory patterns in the SF should examine possible antecedents and correlates of the regulatory patterns at other levels of analysis.

# CHAPTER 4

## STUDY 2. PATTERNS OF REGULATORY BEHAVIOR AND CONCOMITANT PHYSIOLOGY

The organized patterns of infant regulatory behavior in the SF (Fuertes and Lopes-dos-Santos, 2009) are coded on the basis of observed behavior but have been examined alongside physiological measures in a single study that found that heart-rate responses to the SF varied as a function of regulatory behavior patterns (Barbosa et al., 2018). More specifically, three-month-old infants who exhibited behavior pertaining to the social-positive oriented pattern showed an increase in heart rate during the neutral-face episode and subsequent return of heart rate to baseline during the reunion phase. Infants who were characterized as either distressed-inconsolable or self-comfort oriented also showed acceleration of heart rate during the neutral-face episode, but they did not show the recovery of heart rate during reunion that set the social-positive pattern apart (Barbosa et al., 2018). Similar differences in heart-rate responses to the SF were associated with the regulatory patterns when infant regulatory patterns and heart rate were reassessed six months later.

While the above study made use of heart-rate measures, evaluation of the Coding System for Regulatory Patterns in the SF has not yet included study of infant vagal reactivity and recovery. Infant respiratory sinus arrhythmia (RSA) has been used as a measure of parasympathetic (specifically, vagal) modulation of sympathetic arousal, and studies of vagal response in the SF (and meta-analytic synthesis of these studies) have observed decreases in RSA amplitude in response to the neutral-face that are consistent with withdrawal of parasympathetic regulation and mobilization of a stress response episode (e.g., Weinberg & Tronick, 1996; Bazhenova et al., 2001; see Sacrey et al., 2021 for recent meta-analysis). On

average, the reunion episode is expected to bring infant RSA to baseline-like levels during the reunion phase (Bazhenova et al., 2001; Moore & Calkins, 2004),

A large body of research has identified psychosocial correlates to individual differences in infant vagal response and recovery during the SF. Representative examples include findings that infants' exposure to interparental conflict is associated with individual differences in infant vagal response and recovery in the SF (Moore, 2010), and that vagal regulation in the SF differs as a function of maternal sensitivity (Haley & Stansbury, 2003; Ham & Tronick, 2006). There is evidence from the present sample that infants' reengagement behavior and maternal sensitivity within the reunion episode is associated with vagal recovery from the neutral-face to the reunion episode (Conradt & Ablow, 2010). Patterns of regulatory behavior may be similarly associated with variation in vagal recovery in response to the mother's return to interaction in the reunion episode. Infants who exhibit different patterns of regulatory in the SF may also differ in vagal reactivity in response to the neutral-face episode. Physiological correlates to SF regulatory patterns in the present sample would be a source of convergent validity for the identified patterns and point to biological embeddedness of socioemotional experiences in the first year.

**The Present Study**

The first aim of this study was to determine whether infant regulatory patterns predicted differential heart rate responses to the Still-Face stressor, and whether any detected differences converged with those reported in Barbosa et al.'s (2018) study of similar design. The second aim was to extend the existing study of physiological concomitants to the regulatory patterns by assessing whether the organized patterns of infant regulatory behavior were associated with differences in parasympathetic regulation across the SF as indexed by respiratory sinus arrythmia (RSA) in each of the three episodes.

**Hypotheses**

Infant heart rate responses to the SF were expected to vary as a function of regulatory pattern. The SF manipulation typically exacts an increase in sympathetic arousal (e.g., Haley & Stansbury, 2003; Moore and Calkins, 2004), and Barbosa et al. (2018) reported that infants in each of the three regulatory patterns exhibited an increase in heart rate in response to the neutral-face episode. A similar increase in cardiac arousal was expected for each of the regulatory patterns here. In Barbosa et al.'s study of the organized regulatory patterns, social-positive infants exhibited physiological recovery from the stressor of the neutral-face episode that was evidenced by heart rate in the reunion episode that was either lower than that of the neutral-face episode or comparable to heart rate in the initial engagement episode. It was hypothesized that social-positive oriented infants would exhibit similar evidence of physiological recovery here. Additionally, distressed-inconsolable infants exhibited higher levels of sympathetic arousal relative to other infants in this earlier study (Barbosa et al., 2018). Similar differences between distressed-inconsolable infants and infants in the self-comfort oriented and social-positive patterns were expected in the present study.

Vagal withdrawal in response to the neutral-face episode, indexed by a decrease in respiratory sinus arrhythmia (RSA), has previously been established in the sample as a whole (Conradt & Ablow, 2010). It was hypothesized that the extent of vagal withdrawal (again, indexed by a decrease in RSA) would vary as a function of behavioral regulatory patterns. Given Barbosa et al.'s (2018) earlier finding that average heart rate in the neutral-face episode was higher among distressed-inconsolable infants than for social-positive and self-comfort oriented infants (Barbosa et al., 2018), it was hypothesized that vagal withdrawal in response to the neutral face would be greatest among distressed-inconsolable infants, and present but less

pronounced among self-comfort-oriented infants. The heart rate findings in Barbosa et al.'s earlier study also informed the hypothesis that social-positive oriented infants would exhibit vagal recovery during the SF reunion period, which would be indicated by an increase in RSA between the neutral-face episode and the reunion episode. This hypothesis also reflects the fact that recovery from distress and return to positive and reciprocal interaction forms an important part of the criteria for assignment of infants' observable behavior to the social-positive oriented pattern. It was expected that distressed-inconsolable and self-comfort oriented infants would not exhibit this same increase in RSA in the reunion episode, which would signal a return of the parasympathetic brake on sympathetic arousal. Furthermore, withdrawal of the vagal brake on sympathetic arousal was expected to persist for distressed-inconsolable infants in the reunion period, such that heart rate would increase between the neutral-face and reunion episodes in this subset. Self-comfort oriented infants were expected to exhibit an increase in vagal control of sympathetic arousal over the reunion period, but to a lesser extent than in social-positive-oriented infants.

## Method

### Participants and Procedure

Participants and procedures in the present study are the same as those described in Study 1. Briefly, participants were 97 mother-infant dyads who attended a lab visit when infants were approximately 21 weeks old ($M$ = 20.97, SD = 2.55). Mothers and infants underwent physiological monitoring during a series of lab tasks that included the SF paradigm. Complete recordings of the SF paradigm were available for 90 of the participants who attended the postnatal visit at approximately five months postpartum, and these recordings were reviewed by two coders and this study's author for the purpose of assigning organized patterns of regulatory

behavior (Fuertes and Lopes-dos-Santos, 2009). For detailed description of recruitment procedures, sample characteristics, and application of the regulatory pattern approach, please see Study 1.

## Measures

### *Physiological data*

Placement of electrodes from a Bioamplifier (model JCA-09) with 21 channels to the infant's chest and back enabled continuous monitoring of infant heart rate and respiration for the length of the SF paradigm. Details of electrode placement are described by Conradt and Ablow (2010). High-pass filtering at .03 Hz and low-pass filtering at 1000 Hz were applied to continuous sampling of the physiological channels. Outlier points in the physiological data were identified and replaced according to conventions described by Conradt and Ablow (2010) and Graham, Ablow, and Measelle (2010). The calculation of infant heart rate and RSA and treatment of movement artifacts are also documented in these earlier studies. In the present study, mean-level heart rate and RSA were calculated for each infant within each episode of the SF task.

## Analytic Plan

*Aim 1:* Evaluate whether infant regulatory patterns are associated with variation in heart rate responses to the Still-Face manipulation. A two-way, 3-by-3 mixed (between-subjects and repeated-measures) analysis of variance was planned and conducted to examine possible moderation of changes in infant heart rate across the baseline interaction, neutral-face, and reunion episodes by infant regulatory pattern. Each of the three episodes of the SF formed a level of a three-level, within-subject factor (episode), and the infants' regulatory pattern classification

variable formed a three-level, between-subjects factor. This two-way, 3-by-3 design paralleled that of Barbosa and colleagues (2018).

*Aim 2:* Evaluate whether infant regulatory patterns are associated with pattern-related differences in mean-level infant RSA in the three episodes of the SF. As with *Aim 1*, a two-way, 3-by-3 mixed (between-subjects and repeated-measures) analysis of variance was planned and conducted. In the analysis for *Aim 2*, assessment of possible moderation of infant physiological response according to infant regulatory pattern made use of mean-level RSA values for each infant and for each SF episode.

**Treatment of Potential Outliers**

**Heart rate values.** Preliminary analysis of heart rate values was conducted to evaluate the assumptions for the planned analysis of variance. Studentized residuals in excess of ±3 were used to signal potential outliers, and review of the studentized residuals confirmed that there were no significant outliers in cells pertaining to the baseline and reunion episodes (all residuals within ±3). Within the neutral-face episode, review of the studentized residuals detected a single outlier.[8] While this observation would not constitute an outlier at the level of the sample, it was an outlier in the (social-positive oriented pattern by neutral-face episode) cell. The value was assessed to be an informative reflection of variability within the group (i.e., not outside of the range of typical heart values or otherwise implausible for infants at the age of five months) and was retained. Variability in heart rate values within each regulatory pattern and SF episode are

[8] The studentized residual value of the outlying observation was 3.47, which reflected a mean-level heart rate of 185.69 beats per minute. Examination of the Shapiro-Wilk's test suggested that the value in the cell skewed the distribution within the cell, as heart-rate values within the neutral-face episode were not normally distributed for social-positive oriented infants ($W(58) = .959$, $p = 0.048$). This appeared to be attributable to the outlier, as the Shapiro-Wilk test no longer identified evidence of non-normality in this subset once the outlying observation was removed ($W(57) = .981$, $p = .495$). Shapiro-Wilk's tests for each remaining combination of regulatory pattern and SF episode did not identify evidence of non-normality in the related cells ($ps > .05$, range: .124=.996).

visualized for the reader's assessment in Figure 1. Though not reported in detail here, a follow-up ANOVA was conducted to assess the influence of the potentially outlying value on ANOVA outcome, and omission of the potentially outlying value did not alter statistical conclusions, which suggested that the influence of the observation was limited and not unduly decisive for test outcome and interpretation.

**Mean RSA values.** As with preliminary analysis of heart rate values, studentized residuals of infant RSA values were assessed for potential outliers within each cell of the design, with a threshold of ±3 to signal potential outliers. Five outlying observations stemmed from the same two participants. These values were winsorized through replacement of the outlier with the value that coincided with the 97$^{th}$ percentile of the corresponding distribution (Hampel et al., 1986) Though not reported in detail here, follow-up analyses examined the influence of the outliers. Retaining the outliers without treatment altered the outcome of the ANOVA, but omission of the outliers and winsorization to the 90$^{th}$, 95$^{th}$, and 97$^{th}$ percentile of the distributions all yielded the same statistical conclusions.

**Review of Test Assumptions**

Assessment of assumptions for ANOVA included evaluation of the assumption of homogeneity of variance among the underlying populations estimated by the groups. Levene's test of equality of error variances suggested that equal variances among groups could not be assumed ($p$s < .05, range: .002 - .69). Given the violation of this assumption for the traditional ANOVA and the unequal distribution of observations among regulatory patterns, two additional approaches were consulted to ensure that violation of the assumption for ANOVA did not drive test outcome for each of the two aims. While not further detailed here, robust Welch's ANOVAs yielded results consistent with results of the two traditional mixed (between-subjects and

repeated-measures) ANOVA analyses detailed below. A linear mixed effects model was also used to predict mean heart rate (and separately, mean RSA) by SF episode and infant regulatory pattern, and consultation of these two models—also robust to unequal variances among groups—also yielded statistical conclusions in keeping with those of the two traditional mixed ANOVAs. The planned ANOVA approach facilitated comparison to a previous study of similar design, and results are relayed below.

## Results

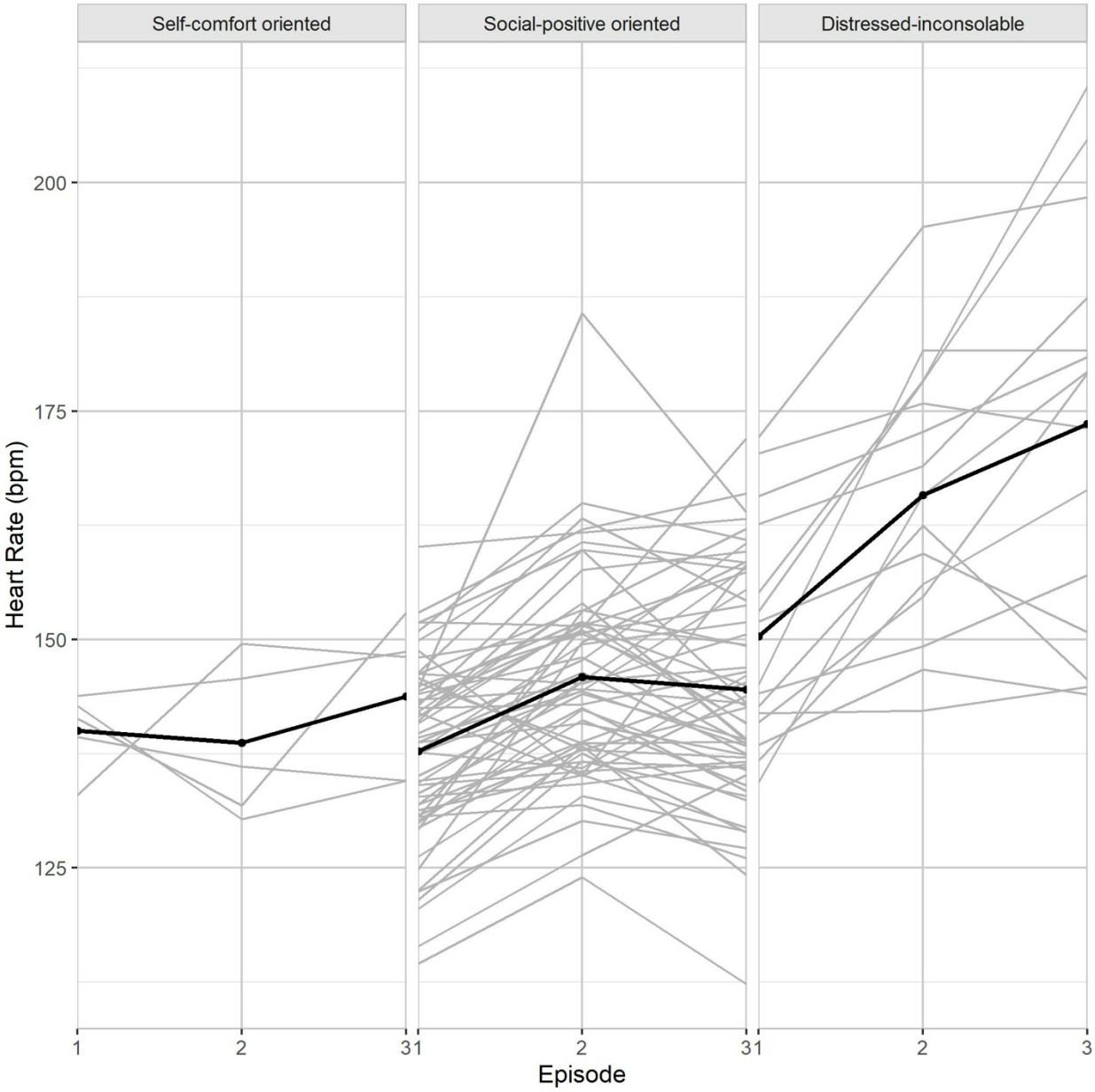
### Infant Heart Rate Responses to the SF and Patterns of Regulatory Behavior

*Do infant patterns of regulatory behavior predict differences in heart rate across SF episodes?*

Patterns of regulatory behavior interacted with SF episode to predict heart rate ($F(4, 150) = 8.54$, $p < .001$, $\eta_p^2 = 0.186$). That is, heart rate varied differently across the SF episodes depending on the infants' regulatory pattern. Please see Figure 1 for individual infants' heart-rate trajectories across the SF organized within each of the three regulatory patterns, and a summary line that aggregates observations within each group. Figure 2 provides a visual summary and snapshot of between-group differences in heart-rate response trajectories in the SF task.

**Figure 1**

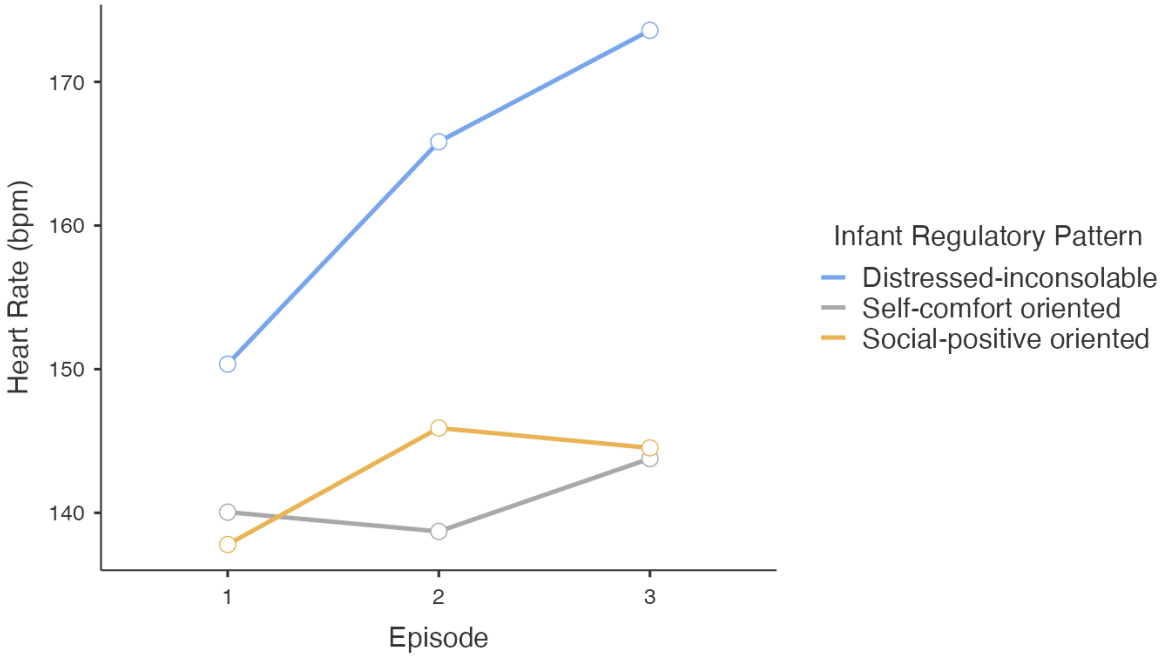
*Individual Infant Heart Rate Trajectories Across the Still-Face, by Regulatory Behavior Pattern*




*Note*. Each gray line traces an individual infant's mean-level heart rate in the initial engagement episode (Episode 1), neutral-face episode (Episode 2), and reunion episode (Episode 3). Each bold line averages the individual observations within the regulatory pattern in question.

**Figure 2**

*Between-Group Comparison of Mean-Level Heart Rate in Each of Three SF Episodes*




Simple main effects of the regulatory patterns within each episode of the SF were examined (please see Figures 1 and 2 for visual reference, and Table 6 for summary statistics). Within the baseline interaction episode, there were statistically significant differences in mean heart rate between two of the three infant regulatory patterns ($F(2, 75) = 9.32$, $p < .001$, $\eta_p^2 = 0.199$). Post-hoc Tukey comparisons indicated that infants in the social-positive oriented category had lower mean-level heart rate in the baseline interaction period than their counterparts assigned to the distressed-inconsolable classification, ($p < .001$); this difference in heart rate between social-positive infants and distressed-inconsolable infants remained when equal variances were not assumed and a Games-Howell comparison was used in lieu of Tukey HSD ($p = .005$). Mean heart rate in the baseline interaction episode did not differ significantly between social-positive oriented and self-comfort oriented infants ($p = .88$); nor did heart rate in the

baseline episode differ between infants who received a distressed-inconsolable classification and those classified as self-comfort oriented ($p = .12$).

**Table 6**

*Infant Heart-Rate Response to Still-Face Episodes, Within and Between Regulatory Patterns*

| Variables | Baseline (a) *M* (*SD*) | Still-face (b) *M* (*SD*) | Reunion (c) *M* (*SD*) | Within-pattern comparisons between episodes*** |
|---|---|---|---|---|
| Social-positive oriented (d) | 137.79 (9.67) | 145.91 (10.96) | 144.52 (12.31) | a < b, c |
| Distressed-inconsolable (e) | 150.35 (12.43) | 165.83 (14.75) | 173.59 (21.80) | a < b, c |
| Self-comfort oriented (f) | 140.05 (4.29) | 138.71 (8.54) | 143.78 (8.61) | a = b = c |
| Within-episode comparisons between patterns*** | e > d | e > d, f | e > d, f | |

****$p < .001$

In the neutral-face episode, too, heart rate again differed between regulatory patterns (Figure 2, Table 6; $F(2,75) = 19.62$, $p < .001$, $\eta_p^2 = 0.344$). Effect size for between-group differences was larger in the neutral-face episode than in the initial engagement episode. As with the baseline interaction episode, post-hoc Tukey comparisons for the neutral-face episode indicated that mean heart rate among distressed-inconsolable infants exceeded that of infants in the social-positive ($p < .001$) group. Within the neutral-face episode, heart rate among distressed-inconsolable infants also exceeded that of self-comfort oriented infants, and significantly so ($p < .001$). The more conservative Games-Howell comparison also detected this same difference between distressed-inconsolable and social-positive oriented infants ($p <.001$) as well as between distressed-inconsolable and self-comfort oriented infants ($p < .001$). Heart rate in the neutral-face

episode did not differ significantly between self-comfort oriented infants and social-positive oriented infants ($p$ = .39).

Additional heart rate differences between regulatory patterns were identified in the reunion episode (Figure 2, Table 6; $F(2, 74) = 24.74$, $p$ <.001, $\eta_p^2 = 0.398$). Post-hoc Tukey tests indicated that in the reunion episode, mean heart rate in distressed-inconsolable infants again exceeded that of social-positive oriented ($p$ <.001) and self-comfort oriented infants ($p$ < .001). Suspending the equal variance assumption and using the Games-Howell comparison did not change the result; by this measure, too, mean heart rate was higher for distressed-inconsolable infants in the reunion episode than it was for social-positive oriented ($p$ < .001) and self-comfort oriented infants ($p$ = .001). As was the case in the neutral-face episode, there was not evidence of a statistically significant difference in mean heart rate between social-positive and self-comfort oriented infants ($p$ = .99).

Analysis probed simple main effects of each episode of the SF within regulatory patterns. Three omnibus ANOVAs were used to examine between-episode differences in heart rate for each of the three regulatory patterns (see Table 6 for summary of main effects of SF episode within the three regulatory patterns).

Infants in the social-positive oriented group had mean-level heart rates that differed by SF episode (Figure 2, Table 6; $F(2, 114) = 25.61$, $p$ < .001, $\eta_p^2 = 0.310$). Among social-positive oriented infants, mean-level heart rate in the baseline interaction period ($M$ = 137.79, $SD$ = 9.67) was lower than mean-level heart rate in the neutral-face episode ($M$ = 145.91, $SD$ = 10.96, $p$ < .001) and similarly lower than in the reunion episode ($M$ = 144.52, SD = 12.31, $p$ < .001). Mean-level heart rate among social-positive oriented infants did not differ between the neutral-face and reunion episodes ($p$ = .73). This increase in heart rate between the baseline interaction

and the neutral-face episode in social-positive oriented is consistent with a still-face effect on sympathetic arousal, and the absence of any significant difference in mean-level heart-rate between the neutral-face and the reunion episode is evidence of a carryover of heart-rate acceleration into the reunion.

For infants in the distressed-inconsolable pattern, there was a simple main effect of SF episode (Figure 2, Table 6; $F(2, 28) = 18.90$, $p < .001$, $\eta_p^2 = 0.574$).[9] For infants who exhibited a distressed-inconsolable pattern, mean-level heart rate was lower in the baseline free-play episode ($M = 150.35$, $SD = 12.43$) relative to the neutral-face episode ($M = 165.83$, $SD = 14.75$) and the reunion episode ($M = 173.59$, $SD = 21.80$), and this difference between the baseline episode compared to each of the two subsequent episodes was statistically significant ($p$s < .001). Among distressed-inconsolable infants, mean heart rate did not differ between the neutral-face episode and the reunion episode ($p = .13$). Like social-positive oriented infants, distressed-inconsolable infants showed an increase in sympathetic arousal in response to the neutral-face episode, and this increase in sympathetic arousal (relative to baseline) persisted in the reunion episode. While both social-positive oriented and distressed-inconsolable infants exhibit increases in heart rate in response to the neutral-face episode, mean-level heart rate is higher in distressed-inconsolable infants than it is for social-positive oriented infants in each episode of the SF.

Infants in the self-comfort oriented group did not exhibit statistically significant episode-related differences in heart rate (Figure 2, Table 6; $F(2, 8) = .647$, $p = .55$, $\eta_p^2 = 0.139$).

To summarize, the consequence of face-to-face interaction, the neutral-face manipulation, and the resumption of mother-infant interaction for infant heart rate differed according to

[9] While a Mauchly's test warranted rejection of the sphericity assumption for the analysis ($W = .565$, $\chi^2(2) = 7.432$, $p = .024$), adjustments to degrees of freedom using Greenhouse-Geisser and (separately) Huynh-Feldt epsilon yielded the same $F$-statistic and $p$-value reported when sphericity was assumed.

regulatory pattern. Heart-rate differences were present between distressed-inconsolable infants and social-positive infants during the baseline free-play interaction episode, and prior to the onset of the neutral face. In the neutral-face episode, differences in heart rate between distressed-inconsolable and social-positive infants increased further, even as social-positive oriented infants themselves exhibited an increase in heart rate between the initial engagement and neutral-face episodes. Heart-rate differences between distressed-inconsolable infants and their social-positive counterparts persisted in the reunion episode. While there were not statistically significant differences in heart rate between social-positive and self-comfort oriented infants in any of the three episodes of the SF paradigm, differences in heart rate between self-comfort oriented infants and distressed-inconsolable infants emerged in the neutral-face episode, when heart rate increased in distressed-inconsolable infants. This difference between self-comfort oriented and distressed-inconsolable infants was also evident in the reunion episode, in which the heart rate of distressed-inconsolable infants remained elevated in response to the mother's return to interaction.

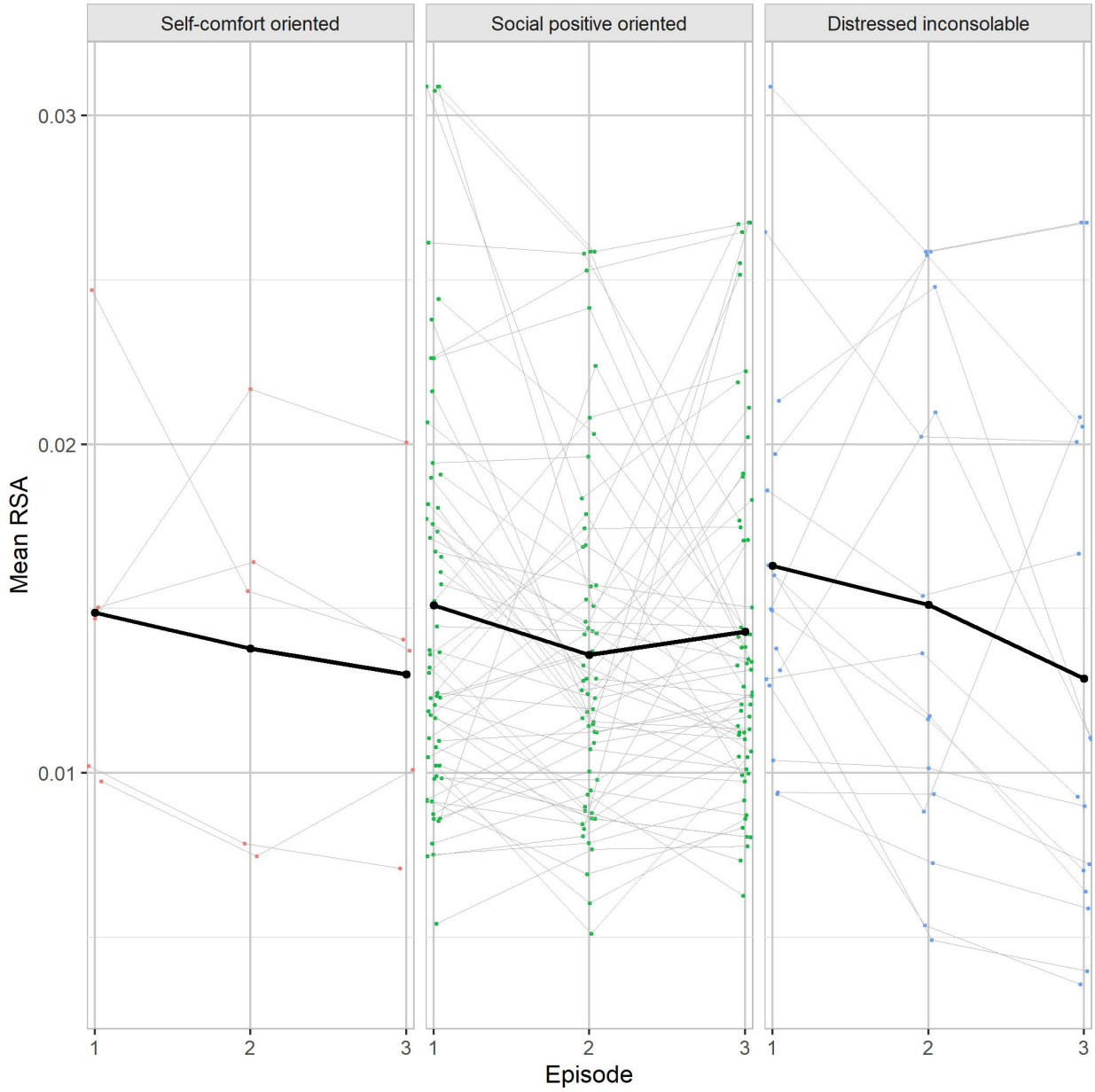
**Infant RSA Responses to the SF and Patterns of Regulatory Behavior**

*Do infant patterns of regulatory behavior predict differences in RSA within and across SF episodes?*

There was not a statistically significant interaction between patterns of regulatory behavior and SF episode to predict mean-level RSA ($F(4, 154) = 1.17$, $p = .33$, $\eta_p^2 = 0.03$). Stated differently, the effect of SF episode on mean-level RSA did not depend on the infants' regulatory pattern. Please see Figure 1 for individual infants' RSA trajectories and the aggregation of these observations within each group.

**Figure 3**

*Infant Mean-Level RSA by Still-Face Episode and Regulatory Pattern*



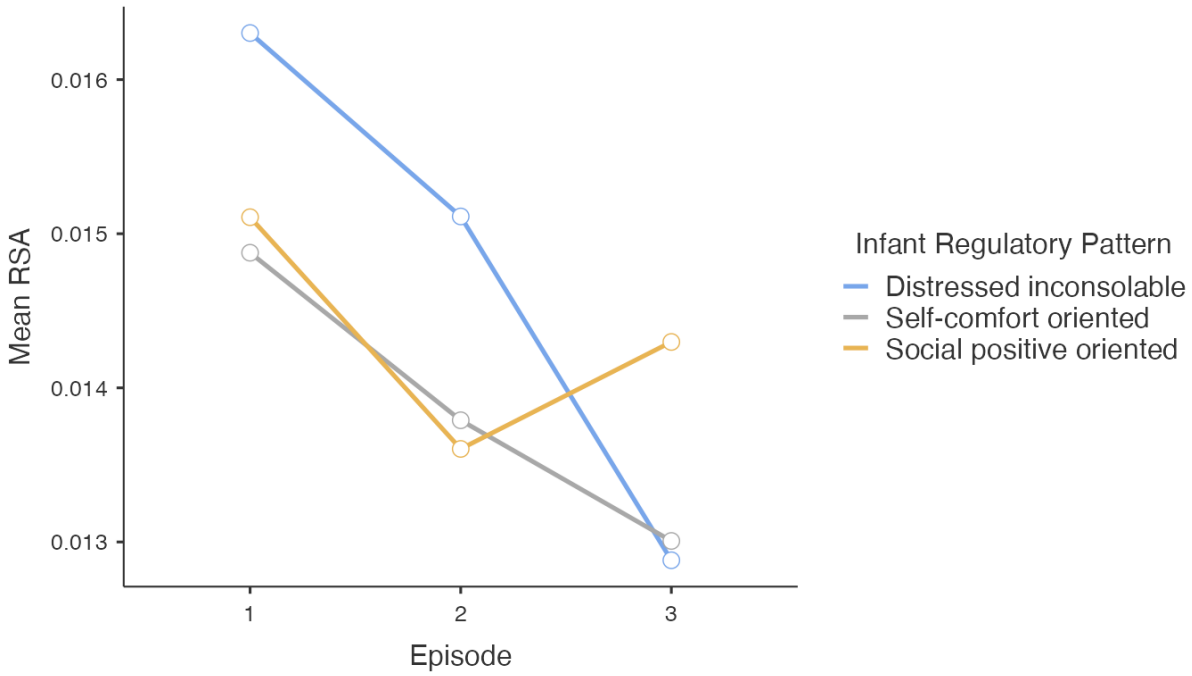

*Note*. Each gray line traces an individual infant's mean-level RSA in the initial engagement episode (Episode 1), neutral-face episode (Episode 2), and reunion episode (Episode 3). Each bold line averages the individual observations within the regulatory pattern in question.

Despite the absence of an interaction effect, simple main effects of the regulatory patterns were nevertheless examined within each episode of the SF in an exploratory manner, in order to

better understand what appeared (visually, but not formally) to be patterning of means within and between groups (Figure 4; Table 7).

**Figure 4**

*Between-Group Comparison of Mean-Level RSA in Each of Three SF Episodes*




Within the baseline interaction episode, differences in mean-level RSA by infant regulatory pattern did not trend toward significance ($F(2, 77) = .24$, $p = .79$). Raw differences between social-positive oriented, self-comfort oriented, and distressed-inconsolable infants in the neutral-face episode did not approach significance ($F(2, 77) = .43$, $p = .65$), and mean-level differences in RSA were not detected between the regulatory patterns in the reunion episode ($F(2, 77) = .42$, $p = .66$).

Exploratory analysis also probed for any trend toward simple main effects of each episode of the SF within regulatory patterns. Three omnibus ANOVAs were used to examine between-episode differences in mean-level RSA for each of the three regulatory patterns.

**Table 7**

*Infant Mean-Level RSA by Still-Face Episodes and Regulatory Patterns*

| Variables | Baseline (a) *M* (*SD*) | Still-face (b) *M* (*SD*) | Reunion (c) *M* (*SD*) | Within-pattern comparisons between episodes |
|---|---|---|---|---|
| Social-positive oriented (d) | .0151 (.006) | .0136 (.005) | .0143 (.005) | a approaches† > b |
| Distressed-inconsolable (e) | .0163 (.006) | .0151 (.008) | .0129 (.008) | a approaches† > c |
| Self-comfort oriented (f) | .0149 (.006) | .0138 (.006) | .0130 (.005) | a = b = c |
| Within-episode comparisons between patterns | d = e = f | d = e = f | d = e = f | |

† $p < .10$

For infants in the social-positive oriented group, mean-level RSA did not differ significantly by SF episode, but between-episode differences approached statistical significance ($F(2, 116) = 2.39$, $p = .096$, $\eta_p^2 = 0.040$). Among social-positive oriented infants, mean-level RSA in the baseline interaction period ($M = .051$, $SD = .006$) was marginally higher than mean-level heart RSA in the neutral-face episode ($M = .0136$, $SD = .005$, $p = .051$). Pairwise comparison between mean-level RSA in the neutral face episode and the reunion episode did not approach significance ($p = .98$), nor did comparison between the baseline interaction period and the reunion episode ($p = .84$). There is evident heterogeneity in individual trajectories of RSA within each of the regulatory behavior patterns (Figure 3). However, pairwise, between-episode comparisons of group-level RSA means as well as visual inspection of individual trajectories across the SF together suggest that the modal RSA response in the social-positive group may consist of withdrawal of the parasympathetic brake on sympathetic arousal in response to the neutral-face episode. The fact that the social-positive group's mean RSA in the reunion episode

falls between the group's mean RSA in the initial engagement episode and the group's mean RSA in the neutral-face suggests that there is, at the level of the subgroup, a partial but incomplete return to the infants' initial engagement RSA (Figure 4; Table 7).

For infants in the distressed-inconsolable pattern, there was not a statistically significant simple main effect of SF episode on RSA ($F(2, 30) = 3.08$, $p = .061$, $\eta_p^2 = 0.17$), but between-episode differences in mean-level RSA again approached significance. Importantly, the between-episode comparison that approached statistical significance among distressed-inconsolable infants is different from the between-episode comparison that approached significance among social-positive oriented infants. For infants who exhibited a distressed-inconsolable pattern, the differences in mean-level RSA (although marginal and below the threshold for statistical significance) resided between the baseline free-play episode ($M = .0163$, $SD = .006$) and the reunion episode ($M = .0151$, $SD = .008$); this difference approached statistical significance in this small subset of infants ($n = 17$, $p = 0.073$). Among distressed-inconsolable infants, there was no evidence of a difference between the baseline free-play episode and the neutral-face episode approaching significance ($p = .99$), nor did pairwise comparisons point to any difference between the neutral-face episode and the reunion episode ($p = .99$). While there is considerable variability of RSA trajectories within the distressed-inconsolable pattern (Figure 3), group-level means and visual inspection of individual trajectories suggest that there is a considerable subset of distressed-inconsolable infants for whom parasympathetic regulation decreases between the baseline interaction episode and the neutral-face episode, and further decrease in parasympathetic regulation in this subset of infants during the reunion episode further distinguishes the reunion episode from the baseline episode and nearly registers as a difference between engagement RSA and reunion RSA at the level of the subgroup.

Infants in the self-comfort oriented group did not exhibit statistically significant episode-related differences in mean-level RSA, and episode-related differences in this small subset of infants did not approach statistical significance ($F(2, 8) = .364$, $p = .71$, $\eta_p^2 = 0.08$).

## Discussion

The first aim of this study was to evaluate whether infant patterns of regulatory behavior in the SF are accompanied by differences in heart rate response to the Still-Face manipulation, and analysis indeed found pattern-related differences in this marker of sympathetic arousal. On average, infants whose behavior in the SF was characterized as distressed-inconsolable had higher heart rate than social-positive oriented infants during the initial episode of unstructured interaction with the mother, and heart rate in distressed-inconsolable infants increased further in the neutral-face episode and reunion episodes to distinguish sympathetic response profiles in distressed-inconsolable infants from that of both social-positive and self-comfort oriented infants. While both social-positive and distressed-inconsolable infants exhibited a still-face effect on sympathetic arousal and carryover of sympathetic arousal into the reunion episode, heart rate was higher among distressed-inconsolable infants than for social-positive oriented infants in every episode of the SF task. In the reunion episode, neither social-positive oriented nor distressed-inconsolable infants showed a group-level return of heart rate to levels observed during the initial engagement episode.

The second aim of this study was to evaluate whether measures of infant RSA, as an index of parasympathetic regulation of sympathetic arousal, would differ across the SF in ways that map onto (or otherwise accord with) the trajectories of observable behavior that define the regulatory patterns. Within each of the regulatory patterns, heterogeneity of RSA response trajectories is considerable, and statistically significant differences among the regulatory patterns

in terms of their RSA trajectories were not detected. However, close attention to RSA trajectories within each pattern suggested that infants in the social-positive oriented pattern (or a predominant subset within the pattern) showed withdrawal of the vagal brake on sympathetic arousal in response to the neutral-face episode and a partial return of vagal control in the reunion episode. In contrast, marginally significant differences between engagement-episode RSA and reunion-episode RSA among distressed-inconsolable infants suggested that, for infants who exhibit the distressed-inconsolable pattern, withdrawal of the vagal brake that begins in the neutral-face episode may not only persist into the reunion episode, but intensify. While this study's one-minute reunion episode provided only a narrow window for physiological recovery, autonomic indices suggested that social-positive oriented infants were on their way toward attenuation of the physiological stress response, while these same indices in distressed-inconsolable infants were consistent with maintenance and/or further amplification of the stress response.

The small number of infants in the self-comfort oriented pattern should caveat any conclusions about autonomic physiology in this subgroup. However, the present study did not detect changes in sympathetic arousal or parasympathetic regulatory effort in response to the SF manipulation in this group. This said, visual inspection of individual heart rate trajectories in this group suggests that heart rate in fact decreases in the neutral-face episode for 3 of the 5 infants in this group. This is especially interesting in light of the coding system's instruction that some self-comfort oriented infants appear to be more relaxed during the neutral-face episode than during the interaction episodes, and a decrease in heart rate for a subset of self-comfort oriented infants is congruent with this behavioral observation.

This study's findings converge in some respects with those of Barbosa et al (2018). Barbosa et al (2018) examined infant regulatory patterns and heart-rate responses to the SF when infants were three months old, and again when infants reached the age of nine months. They found more within-episode differences among the regulatory patterns at nine months than at three months, and both time points are relevant reference points to the present study of five-month-olds. In Barbosa and colleagues' administration of the SF and coding of regulatory patterns among three-month-olds, mean HR during reunion was higher among distressed-inconsolable infants than it was among self-comfort oriented infants. In the administration of the SF and re-coding of regulatory patterns among nine-month-olds, Barbosa et al. (2018) found that distressed-inconsolable infants had average higher heart rate than social positive and self-comfort-oriented infants in both the neutral-face and reunion episode. Higher heart rate among distressed-inconsolable infants in the neutral-face and reunion episodes is also among the present study's findings, which suggests, first, that acceleration of heart rate in the neutral-face episode and maintenance of this acceleration during the reunion episode may be a physiological marker of the distressed-inconsolable pattern, and second, that this marker may emerge between three and five months after birth.

While the present study found differences between distressed-inconsolable infants' and social-positive infants' engagement-episode heart rate, Barbosa et al. (2018) found no such difference in the engagement episode, and instead found that engagement-episode heart rate in distressed-inconsolable infants exceeded that of self-comfort oriented infants at the age of nine months. Additionally, Barbosa et al (2018) reported that three-month-old and nine-month-old self-comfort oriented infants had lower heart rate in the engagement episode than they did in the remaining episodes, and the present study found no such episode-dependent changes in heart rate

among self-comfort oriented infants. The small number of self-comfort-oriented infants in this five-month-old sample may account for this discrepant finding; the decrease in heart rate among some self-comfort oriented infants in the present study, however, is consistent with relative relief in the neutral-face episode, and perhaps future study will treat the possibility of subgroups within the self-comfort oriented pattern that share the same pattern of regulatory behavior but differ in their physiological response profiles.

A final difference between this study's findings and those of Barbosa et al. (2018) is of theoretical importance but likely attributable to differences between the two studies' respective administrations of the SF. Barbosa et al. (2018) reported that each of the regulatory patterns in their sample exhibited an increase in heart rate in response to the neutral-face, and that social-positive oriented infants were the only group for whom this increase in sympathetic arousal abated in the reunion episode. Social-positive oriented infants, who are defined in part by signs of behavioral recovery and return to positive and reciprocal interaction in the reunion episode, did not show this sign of physiological recovery in the present study. Importantly, however, the reunion episode was briefer here than in Barbosa et al.'s administration, and evidence from the present study's one-minute reunion hints to the possibility that physiological recovery was partial for social-positive infants but indeed underway.

In the current study, the higher heart rate among distressed-inconsolable infants (relative to social-positive infants) in the initial engagement episode suggests that features of communication with the mother (e.g., mis-attunement or unintended intrusiveness on the part of the parent) may induce stress in ways that shape the distressed-inconsolable pattern. An alternative (but not incompatible) possibility is that higher baseline levels of sympathetic arousal

may be part of a more pervasive sociobiological backdrop in infants who exhibit a distressed-inconsolable pattern of regulatory behavior.

Heightened sympathetic arousal in infants who exhibit the distressed-inconsolable pattern in the SF is also evocative of the hyperactivating strategies attributed to infants who are classified in later infancy as anxious ambivalent (discussed here in Chapter 2; Main, 1990; Cassidy, 1994). Similarly, the absence of episode-dependent changes among this study's self-comfort oriented infants could be a plausible correlate or early precursor to the deactivating strategies for proximity-seeking described in infants classified as avoidant with respect to attachment.

Physiological correlates to the SF regulatory patterns in the present sample are an additional a source of convergent validity for the identified patterns. Given that maternal sensitivity to distress is among the possible antecedents to the organization of infants' regulatory behavior patterns, the differences in sympathetic arousal between patterns in the present study points to the possibility that socioemotional experiences in the first months of life become biologically embedded in ways that may in turn shape and be shaped by other experiences downstream.

This study replicated, in part, an existing study of stress physiology and infant regulatory patterns in the SF. It also extended the study of the infant regulatory patterns by assessing vagal functioning in the SF as a possible concomitant to the observed patterns of regulatory behavior. The study's programmatic approach to replication and extension of an existing line of research is a strength of the present study, as is the integration of multiple levels of analysis to examine the development of infants' relational and regulatory capacities.

While the present study replicated an existing study of similar design, the one-minute reunion episode limits, to a modest extent, the present study's ability to draw conclusions about the regulatory patterns and infants' physiological recovery in response to the mother's return to interaction. While this study shares with other studies the essential elements of the SF, future study would benefit from further standardization of administration of the SF in order to facilitate comparison across studies. Within the current sample, future study could "zoom in on" the reunion episode in order to model changes to sympathetic arousal and parasympathetic regulation over the course of the reunion episode with greater precision, rather than using aggregate indices of each for the length of the episode. This approach would allow for a more nuanced assessment of attenuation of physiological stress response during a period when dyads are working toward co-regulation and repair.

# CHAPTER 5

## STUDY 3. PATTERNS OF INFANT REGULATORY BEHAVIOR IN THE STILL-FACE AND QUALITY OF ATTACHMENT IN THE STRANGE SITUATION

In the single existing study to examine possible associations between Fuertes and Lopes dos Santos' (2009) patterns of regulatory behavior in the Still-Face and later organized quality of attachment, nearly all (i.e., 93.2%) of the three-month-old infants classified as social-positive oriented in the SF were classified as securely attached at one year (Barbosa et al., 2021). When regulatory patterns were reassessed during a second administration of the SF at nine months, a similar majority (94.6%) of infants who exhibited the social-positive oriented pattern in the SF were later classified as securely attached in the SSP. While this overwhelming majority of social-positive oriented infants who were later classified as securely attached introduces the possibility of a link between social-positive oriented responding in the SF and later attachment security in the SSP, there was less evidence for across-time ties between (1) the distressed-inconsolable pattern in the SF and later anxious ambivalent attachment in the SSP, and (2) the self-comfort oriented pattern in the SF and later attachment classification into the avoidant category. More specifically, only approximately half of infants who exhibited a distressed-inconsolable pattern in the SF—48.6% of those who did so at the three-month time point and 53.5% of those assigned to the distressed-inconsolable pattern at nine months—were later classified in the SSP as anxious-ambivalent with respect to attachment (Barbosa et al., 2021). These percentages pale, of course, in comparison to the more than 90% of social-positive oriented infants who were later classified as securely attached. Among infants who exhibited a self-comfort oriented pattern in the SF, the more modest percentage to be later classified as avoidantly attached in the SSP also suggested that any ties between the self-comfort oriented pattern in the SF and later avoidant attachment classification are less compelling than for social-positive oriented infants and later secure

attachment classification. To be more specific, 41.7% of infants assigned to the self-comfort oriented pattern on the basis of their SF response at three months of age were ultimately classified as avoidantly attached in the SSP at the end of their first year. A greater percentage (55.6%) of infants who were assigned to the self-comfort oriented pattern at nine months were ultimately classified as avoidantly attached in the SSP. These percentages of self-comfort oriented infants who went on to exhibit avoidant attachment in the SSP were lower, of course, than the 93.2% and 94.6% of social positive oriented infants who were later securely attached.

Contingency analysis evaluated whether membership in each of the three regulatory patterns was associated with differential classification into each of the three organized attachment patterns. This analysis found moderate (overall) association between the regulatory patterns and organized attachment categories. Attention to the attachment outcomes of infants within each regulatory pattern above suggests that the association may be stronger or more specific for some pairings of regulatory patterns and attachment categories than for others.

**The Present Study**

The present study evaluated the possibility that infant regulatory patterns in the SF at the age of five months would be associated with quality of attachment one year later, when infants reached the approximate age of seventeen months. A secondary aim was to evaluate the prognostic utility of the infant regulatory patterns in the SF alongside Kogan and Carter's (1996) more granular approach to characterizing infant reunion behavior in the SF via global reengagement codes. The reengagement codes were modestly predictive of attachment outcomes in a single study (Kogan & Carter, 1996) that itself warrants replication. The auxiliary assessment, in the current study, of whether the more granular (and reunion-focused) approach is

predictive of attachment outcomes provides a reference point for assessment of the performance or prognostic utility of the regulatory patterns in this respect.

**Hypothesis**

This study's hypothesis was that the overall association between organized SF regulatory patterns and later organized attachment classification would be comparable to associations reported by Barbosa and colleagues (2021). In keeping with this hypothesis, it was expected that a majority of infants who exhibited a social-positive oriented pattern to the caregiver in the SF at five months would demonstrate attachment security with this same caregiver one year later. Furthermore, it was expected that approximately half of distressed-inconsolable infants, for whom distress without recovery predominates in the SF, would exhibit anxious-resistant attachment at seventeen months. Additionally, it was expected that approximately half or less of the subset of infants who exhibited a self-comfort oriented pattern during the SF would be classified as avoidant in the SSP. This hypothesis drew on the percentage (41.7%) of three-month-old, self-comfort oriented infants who exhibited later avoidant attachment in Barbosa et al.'s sample. It also rested on the premise that patterns that have been regarded as a potential early analogue (or precursor) to the attachment-avoidant classification have been the least predictive of attachment outcome in existing studies (Abbott, 2016; Barbosa et al., 2021), and theory suggests that parent-child interaction behaviors (and in tandem, internal working models that arguably underpin and transact with these behaviors) may be most likely to change when existing behaviors are dissatisfying to one of both members of the dyad (for related discussion, see Bowler, 2020).

A final hypothesis on the basis of Barbosa et al.'s (2021) existing finding was that infants' regulatory pattern in the SF would be associated with between-pattern differences in

avoidance ratings and resistance ratings during the SSP reunion episodes one year later. More specifically, in Barbosa et al.'s (2021) sample, infants who were social-positive oriented in the SF went on to have lower resistance ratings in the Strange Situation reunions than infants who exhibited the distressed-inconsolable pattern in the SF. Additionally, infants who were social-positive in the SF within the first year also exhibited lower avoidance ratings than their self-comfort oriented counterparts when both groups completed the Strange Situation Procedure at the year's end. The ratings of interactive behavior in the reunions of the SSP provide an additional index of attachment outcomes that are continuous rather than categorical, and the SF regulatory patterns in the present sample were expected to be similarly associated with these later interactive behavior ratings in the Strange Situation.

Assessment of whether Kogan and Carter's (1996) reengagement codes were predictive of later attachment outcomes is a secondary aim of the present study and in service to assessment of the regulatory patterns. Hypotheses regarding whether the reengagement codes would predict attachment outcomes relied on the findings of Kogan and Carter's original (1996) study in a sample of low-income mothers and their infants. Kogan and Carter (1996) found that four-month-olds' reunion-based resistance and attention-seeking scores in the SF reunion were predictive of ratings of contact maintenance in the SSP reunions at one year, and these same scores were marginally predictive of resistance ratings in the SSP. The SF reengagement codes were not predictive of the remaining interactive behavior ratings in the SSP: specifically, later proximity-seeking or avoidance scores. Similarly modest associations between infants' attention-seeking and resistance behaviors in the SF reunion and later contact maintenance and resistance in the SSP were expected in the present sample.

## Method

### Participants

This study relied on data collected during a postnatal lab visit that mother-infant dyads completed at approximately five months postpartum, and a subsequent follow-up visit one year later (Please see Study 1 for recruitment details and full sample characteristics). Of the 90 mother-infant dyads for whom Still-Face data was available, 82 attended the subsequent longitudinal visit one year later and completed the Strange-Situation Procedure at this latter timepoint. Among the toddlers who completed the Strange Situation, 59.8% ($n$ = 49) were female. At the time of this second postnatal visit, toddlers were 17 months old ($M$ = 17.6 months, $SD$ = 1.76). There were no significant differences in demographic characteristics of those mother-infant dyads who completed the second postnatal visit and those who did not.

### Procedures

#### *Strange-Situation Procedure*

The Strange-Situation Procedure (SSP) entails a structured, standardized sequence of eight episodes that begin with the introduction of the infant and a primary attachment figure to an unfamiliar (but otherwise innocuous) room (Ainsworth et al., 1978). During two of the eight episodes, the attachment figure exits the room at the experimenters' cue, for a period lasting no longer than three minutes (for a full account of the procedure, see Ainsworth et al., 1978). These two separations, though brief, aim to activate the infant's attachment system and "instigate" attachment behaviors (Ainsworth et al. 1978, p. *xl*). The separations between the infant and the attachment figure are interspersed with reunion episodes in which the attachment figure returns and greets the infant. The infant's behavioral responses to reunion with the caregiver are the primary grounds for classification of the infant's quality of attachment with the participating

caregiver (Ainsworth et al., 1978). The procedure was recorded to enable review and characterization of mother-infant attachment. Administration of the SSP formed part of a separate study that predated this dissertation.

## Measures

### *Coding of infant response to the Still-Face paradigm*

**Post-Still-Face Reengagement Behavior Codes.** The present study made use of Kogan and Carter's (1996) coding scheme for characterizing infant reengagement behaviors during the SF reunion episode. Infants were assigned global ratings on each of three scales that were devised as analogues to interactive behavior rating scales in the reunion episodes of the SSP (Ainsworth et al., 1978/2015). The three rating scales characterize the extent of infant behaviors along three dimensions of interest: avoidance, resistance, and attention-seeking. For further description of the coding scheme and assessment of inter-rater reliability in the present sample, please see Study 1 (Chapter 3).

**Coding System for Regulatory Patterns in the Still-Face Paradigm**. The Coding System for Regulatory Patterns in the Face-to-Face Still Face (Fuertes and Lopes-dos-Santos, 2009) was also applied for the purposes of the present study, and infants' responses to the SF were assigned to one of three higher-order regulatory patterns: social-positive oriented, distressed-inconsolable, or self-comfort oriented. For a full account of the coding approach, its application, and inter-rater reliability in the present sample, please see Study 1 (Chapter 3).

### *Classification of mother-infant quality of attachment*

SSP videos were previously reviewed and coded to consensus by E. Carlson and L. A. Sroufe at the University of Minnesota. In the present study, secondary analysis made use of archived attachment classifications and related ratings detailed below. Two-thirds (67%) of

infants in the sample were classified as secure with respect to the participating attachment figure. Eight percent of infants were classified as insecure-avoidant, and 5% were classified as insecure-resistant. Twenty percent of infants were classified as disorganized; these infants also received a secondary, organized, classification. Additionally, infant reunion behavior was rated according to Ainsworth and colleagues' (1978) four continuous behavior rating scales for each of the two reunion episodes. For each of the seven-point scales, a single point indicates the absence of the behavior (e.g., no resistance), while the maximum on the seven-point scale indicates active, marked, and (for three of the four scales) persistent expression of the behavior (for scoring system details, see Ainsworth et al., 2015/1978, Appendix III). Finally, the extent of disorganized behavior exhibited by each infant was also rated on Main and Solomon's (1990) nine-point scale, ranging from, "no signs of disorganization/disorientation" to "strong, frequent, or extreme" indicators of attachment disorganization (Main & Solomon, 1990, pp. 152-153). Descriptive statistics for the interactive behavior ratings and disorganization scale are reported in Table 8.

**Table 8**

*Descriptive Statistics of Strange Situation Behavior Ratings*

| Variable | *M* (SD) | Range |
|---|---|---|
| Interactive behavior ratings for first reunion | | |
| Proximity-seeking | 3.26 (1.42) | 1.00-6.00 |
| Contact maintenance | 1.87 (1.41) | 1.00-6.00 |
| Resistance | 1.57 (1.21) | 1.00-5.00 |
| Avoidance | 3.18 (1.48) | 1.00-6.00 |
| Rating scales for second reunion | | |
| Proximity-seeking | 3.84 (1.34) | 1.00-6.00 |
| Contact maintenance | 3.57 (1.55) | 1.00-6.00 |
| Resistance | 2.20 (1.50) | 1.00-7.00 |
| Avoidance | 2.23 (1.38) | 1.00-6.00 |
| Disorganized behavior on nine-point rating scale | | |
| Disorganization/disorientation | 3.70 (1.62) | 1.00-9.00 |

**Analysis Plan**

*Aim 1*: This studies first aim was to assess the prognostic utility of the five-month regulatory patterns for predicting three-way (i.e., organized) attachment classification one year later, and in doing so, to evaluate the generalizability in the present sample of Barbosa and colleagues' (2021) findings of associations between SF regulatory patterns and later attachment classification. In service of this aim, a three-way cross-tabulation was performed. Given that this aim endeavored to replicate Barbosa and colleagues' (2021) measures of association between infant regulatory patterns and organized attachment classifications, the analytic approaches were planned to replicate those of the earlier study, and cross-tabulation analysis was therefore confined to the subset of the sample that received an organized attachment classification. In keeping with the statistical approach of existing studies that have evaluated either infant patterns of regulatory behavior (Safyer, 2019; Barbosa et al., 2021) or attachment-like categories (Abbott, 2016) in the Still-Face paradigm as predictors of later attachment classification, a chi-squared test for independence was planned to assess for associations between the five-month regulatory patterns and seventeen-month organized attachment categories. To foster comparison with Barbosa et al.'s existing (2020) assessment of associations between regulatory patterns and organized attachment classification, the analysis plan also included calculation of Cramér's V as a measure of effect size for the chi-squared test (Barbosa et al., 2021). Cohen's kappa was calculated as an additional metric of potential association between regulatory patterns and organized attachment categories. To this end, the social-positive oriented regulatory pattern was treated as equivalent to the secure attachment category. Stated differently, the co-occurrence of the social-positive oriented pattern and attachment security was treated as an instance of inter-observer agreement by assigning matching codes to each (Barbosa et al., 2021). Similarly, the distressed-inconsolable

designation was treated as equivalent to the insecure-resistant attachment classification, and the self-comfort oriented regulatory pattern was treated as equivalent to an insecure-avoidant attachment classification. Finally, and in similar parallel to the original Barbosa et al. (2021) study, Goodman and Kruskal's tau coefficient was calculated as an index of proportional reduction in prediction error in predicting organized attachment classification in the presence of regulatory pattern (Goodman & Kruskal, 1954; Bishop et al., 2007).

In order to further assess the generalizability of Barbosa and colleagues' (2021) findings to the current sample, a multivariate ANOVA was planned to test whether the continuous interactive behavior rating scales in the Strange Situation at seventeen months differed as a function of five-month regulatory pattern.

*Aim 2:* A secondary aim was to evaluate the prognostic utility of the infant regulatory patterns alongside Kogan and Carter's (1996) more granular approach to characterizing infant reunion behavior via global reengagement codes. To this end, the same analytic approach in the original Kogan and Carter (1996) study was brought to bear on the current sample. Kogan and Carter (1996) observed that a minority of their sample was classified as attachment-insecure, and they selected the continuous interactive behavior ratings over attachment classification as the measure of attachment outcome for this reason. Kogan and Carter (1996) summed the interactive behavior ratings across the two reunion episodes of the Strange Situation and treated these interactive behavior ratings as the dependent variable in four separate multiple regression analyses, for which avoidance, resistance, and attention-seeking scores from the SF reunion were evaluated as potential predictors of interactive behaviors ratings in the reunion episodes of the Strange Situation. In the present study, steps were taken to address multicollinearity among the predictor variables, as avoidance scores and attention-seeking scores were strongly negatively correlated

($r(88) = -0.863$, $p < 0.001$). Following Conradt and Ablow (2010), SF avoidance scores were reverse-scored; the reversed avoidance scores were then averaged with the attention-seeking scores to render a composite that was interpreted as attention to the mother.

## Results

*Are infants' SF regulatory patterns associated with later organized attachment classification?*

It was hypothesized that association would exist between infants' regulatory patterns and later organized attachment classification, such that infants assigned to the social-positive oriented patterns would predominate among securely attached infants, distressed-inconsolable infants would be overrepresented in the insecure-resistant attachment classification, and self-comfort-oriented infants would be more likely to receive the insecure-avoidant attachment classification. A three-way cross-tabulation was conducted to examine possible association between regulatory patterns at five months and organized attachment classification at seventeen months (Table 9). In the context of crosstabulation analysis, expected frequencies are derived from row and column totals and represent the values that would be expected in each interior cell of the contingency table if row and column categories are independent of one another (McHugh, 2013; Agresti, 2019). A prerequisite for the chi-squared test is that expected frequency values exceed 5 in at least 80 percent of the interior cells, and that they not be less than 1 in any of these same cells. Given that the observations were unevenly distributed within the contingency table and expected frequencies were less than one in 3 out of 9 cells and indeed less than 5 in an additional 3 of the 9 cells, the chi-squared test for independence and calculation of related effect size measure Cramér's V (which relies on the chi-squared distribution) were contraindicated (Larntz, 1978; Kearney, 2017; McHugh, 2013; Agresti, 2019). A small-sample procedure, the Fisher's exact test, was instead conducted.

**Table 9**

*Crosstabulation of Regulatory Patterns with Organized Attachment Classification*

| | | Attachment classification at 17 months | | | |
|---|---|---|---|---|---|
| | | Secure | Ambivalent | Avoidant | Total |
| Regulatory pattern | Social-positive oriented | 39 (**84.8%**) 0.1 | 2 (4.3%) -0.2 | 5 (10.9%) 0.0 | 46 |
| | Distressed-inconsolable | 12 (85.7%) 0.1 | 1 (**7.1%**) 0.5 | 1 (7.1%) -0.5 | 14 |
| | Self-comfort oriented | 4 (80.0%) -0.3 | 0 (0.0%) -0.5 | 1 (**20.0%**) 0.7 | 5 |
| Total | | 55 | 3 | 7 | 65 |

*Note*. With the exception of row and column totals, remaining cells report frequency, the percentage of regulatory pattern subgroup represented within the attachment category, and adjusted standardized residuals.

Contrary to hypotheses, the Fisher's exact test provided no evidence of an association between five-month regulatory patterns and organized attachment classification at seventeen months ($p = .76$). Similarly, Cohen's kappa did not indicate an association between regulatory patterns and organized attachment classification ($\kappa = .04$, $p = .66$). Finally, the Goodman and Kruskal tau coefficient indicated that regulatory patterns did not improve upon the marginal distribution of attachment classifications to reduce error in the prediction of seventeen-month attachment classification ($\tau = .005$, $p > .05$). In other words, prediction of seventeen-month attachment classification was no better with information about five-month regulatory patterns than it was without it.

*Does binary treatment of regulatory pattern and attachment status reveal association between social-positive responding in the SF and attachment security?*

In light of modest sample size and uneven distribution of observations in the cells of the three-by-three contingency table to evaluate association between five-month regulatory patterns and seventeen-month attachment classification, an exploratory two-by-two cross-tabulation was conducted. The three-group SF-based regulatory pattern variable was reduced to a binary variable by pooling the self-comfort-oriented category with the distressed-inconsolable regulatory pattern to form a single group of infants who did not receive a social-positive oriented

classification (Table 10). Similarly, infants who were classified as either insecure-avoidant or insecure-resistant in the Strange Situation were pooled into a single group of infants, each of whom received an organized-insecure attachment classification.[10]

**Table 10**

*Binary Treatment and Crosstabulation of Regulatory Patterns and Organized Attachment Classification*

| | | Attachment classification at 17 months | | |
|---|---|---|---|---|
| | | Organized-Secure | Organized-Insecure | Total |
| Regulatory pattern | Social-positive oriented | 39 (**84.8%)** 0.1 | 5 (15.2%) -0.1 | 46 |
| | Not social-positive oriented | 16 (84.2%) -0.1 | 3 (**15.8%**) 0.1 | 19 |
| Total | | 55 | 10 | 65 |

*Note*. With the exception of row and column totals, remaining cells report frequency, the percentage of regulatory pattern subgroup represented within the attachment category, and adjusted standardized residuals.

A chi-squared test for independence did not find evidence of association between two-level, five-month regulatory patterns (either social positive oriented or not) and binary (either organized-secure or organized-insecure) attachment classification in the Strange Situation one year later ($X^2(1,65) = 0.003$, $p = .95$). Similarly, the small-sample Fisher's exact test suggested that there was no association between regulatory patterns and attachment classification ($p = .61$). Cohen's kappa was used to index possible association between regulatory patterns and attachment classification, and this coefficient was statistically no different from zero ($\kappa = .007$, $p = .95$). Finally, a Goodman and Kruskal's tau coefficient further confirmed that classification of an infant as either social-positive oriented or not did not improve prediction of attachment security ($\tau = .005$, $p > .05$).

[10] Expected frequencies were greater than 5 in three out of the four cells of the contingency table, with one cell with an expected value of three. While expected frequencies in 75 percent of cells falls short of the 80 percent guideline, a chi-squared test of independence is more appropriate for this cross-tabulation table than in the three-by-three analysis above.

*Are infants' regulatory patterns in the SF associated with later interactive behavior ratings in the Strange Situation?*

It was hypothesized that infants' five-month regulatory patterns in the Still Face would be associated with infants' interactive behavior ratings assessed one year later in the SSP. To facilitate comparison to an existing study of similar design, interactive behavior ratings for each of the two reunion episodes of the Strange Situation were averaged across the two reunions, to generate a proximity-seeking score, contact maintenance score, resistance score, and avoidance score for each infant (Barbosa et al., 2021). A multivariate ANOVA indicated that interactive behavior ratings from the Strange Situation did not differ by Still-Face-based regulatory pattern (Wilks' $\Lambda = 0.939$, $F(8, 152 = 0.608$, $p = 0.77$, $\eta_p^2 = 0.031$).

*Are Still-Face-based reengagement codes associated with later interactive behavior ratings in the Strange Situation?*

Four separate multiple regression were planned in order to mirror the analytic approach in Kogan and Carter's (1996) assessment of their SF reunion reengagement codes and later interactive behavior ratings in the SSP. The first such multiple regression evaluated whether infant resistance scores and infant attention-to-mother in the Still-Face reunion at five months were predictive of infant avoidance ratings in the Strange Situation at seventeen months. The regression model indicated that the five-month reengagement scores were marginally predictive of avoidance ratings in the Strange Situation one year later ($F(2,77) = 3.11$, $p = 0.05$, $R^2 = 0.075$,). Within the model to predict avoidance ratings in the Strange Situation, infant resistance in the Still-Face episode at five months was negatively associated with avoidance in the Strange Situation one year later ($B = -0.603$, $t = -2.20$, $p = 0.03$). In other words, global ratings of the extent of infants' protest behaviors (including fussing, squirming, and back-arching) in the SF

reunion episode at five months of age was negatively associated with avoidance ratings in the SSP reunion one year later. Infants who protested more within the SF reunion episode at five months were less likely to receive avoidance ratings indicating that they ignored the mother upon her return from physical separation or otherwise actively avoided proximity to her. In contrast, attention towards the mother in the Still Face at five months was not predictive of avoidance ratings in the Strange Situation at seventeen months ($t$ = -0.343, $p$ = 0.73).

In keeping with Kogan and Carter's (1996) original analysis, a second multiple regression evaluated whether the five-month reengagement scores (specifically, resistance scores and attention-to-the-mother in the SF reunion) were predictive of resistance ratings in the Strange Situation. The model was not significant ($F$(2, 77) = 0.57, $p$ = 0.57).

A separate multiple regression model evaluated whether the SF-based reengagement codes at five months predicted proximity-seeking ratings at seventeen months, and this model was also not significant ($F$(2, 77) = 1.05, $p$ = 0.357), nor was the model to predict contact maintenance ratings in the Strange Situation at seventeen months from the SF-based reengagement codes at five months ($F$(2, 77) = 0.89, $p$ = 0.42).

## Discussion

The present study evaluated evidence for the hypothesis that infants' five-month regulatory patterns in the SF would be associated with later quality of attachment as assessed one year later in the SSP. The study's findings did not support this hypothesis, as regulatory patterns gleaned from the present sample's participation in the SF at five months were not associated with membership in the three organized attachment classifications at seventeen months.

A second and closely related hypothesis in the present study was that a majority of infants who exhibited the social-positive oriented pattern of responding to the caregiver (and their

temporary affective absence) in the SF would demonstrate attachment security toward this same caregiver one year later in the SSP. This hypothesis held, insofar as a majority—just shy of 85 percent of infants who exhibited the social positive oriented classification in the SF—indeed went on to be classified as organized-secure in the SSP; however, this observations risks misinterpretation, and must take into account the preponderance of securely attached infants in the sample as a whole. The predominance of securely attached infants here (in the subset of the sample who received an organized attachment classification rather than a designation of disorganized attachment in the SSP) is such that the percentage of social-positive infants who went on to be classified as securely attached would be (and is) expected in the absence of any association between the SF regulatory pattern and SSP-based attachment classification. A brief look at the breakdown between attachment-secure and attachment-insecure infants in the sample demonstrates this point. Of the 65 infants in the present sample who received an organized attachment classification, 55 of these infants—that is, 84.6% of infants with an organized classification to assess—were securely attached. The (essentially identical) 84.8% of infants within the social-positive oriented pattern who became securely attached is entirely consistent with the overall likelihood of attachment security in the sample as a whole, independent of regulatory pattern. This study also found no association between SF regulatory pattern at five months and later interactive behavior ratings that described dimension of infants' behaviors in the post-separation reunion episode of the SSP.

This study's findings contrast, first, with Barbosa and colleagues' (2021) report of moderate associations between infant regulatory patterns assessed at three and nine months and later quality of attachment assessed at one year of age. Barbosa and colleagues (2021) also found associations between the SF regulatory patterns and later ratings of interactive behavior in the

SSP that this study did not find. The longest interim between the SF and the SSP in the Barbosa et al. (2021) study was nine months, and the present study examined possible associations across a year-long span that also extended further into the infants' second year of life. The difference between the two studies in the length of time between the SF and the SSP may be one contributor to the absence, in this study, of the associations that Barbosa et al. (2021) identified between SF regulatory pattern and organized attachment classification in the SSP. However, other factors also warrant consideration.

One explanation for the absence of association between SF regulatory patterns and attachment classification in this study might draw on the fact that SF regulatory patterns in the present sample were not coded by the gold-standard developers of the regulatory pattern approach. Furthermore, the conditions under which the regulatory patterns were applied here (were comparable, but) did not precisely mirror the conditions under which the regulatory pattern approach was developed. It is possible that already-identified and/or unintended differences in this study's application of the regulatory pattern approach may account for discrepancies between this study's findings and those of Barbosa et al. (2021). For example, one identifiable difference between the application of the Coding System for Regulatory Patterns in the SF in the present study and its use by Barbosa et al. (2021) is the present study's reliance on a shorter (i.e., one-minute) reunion episode and (in select cases) consultation of a second reunion episode (following a second neutral-face episode) to discern whether infants' recovery from distress and return to positive and reciprocal interaction met the coding system's criteria for social-positive oriented responding. This is a departure from the conditions in which the coding system was originally developed and applied, and this study's provisional remedy for addressing the difference in reunion episode duration between this and Barbosa et al.'s (2021) study might mean

that some infants received assignment to a regulatory pattern that they would not otherwise receive. Unintended subjective differences in application of the coding approach are difficult to identify precisely because they are unintended, but a representative example is the possibility that coding teams may differ in their assessment of what constitutes a convincing return to positive and reciprocal interaction in the SF reunion episode. Consultation with the authors of the coding approach and review of the SF regulatory patterns in the present sample by gold-standard coders would be helpful to rule out or otherwise address this possibility.

While a methodological account of this study's non-replication of Barbosa et al.'s (2021) finding warrants the considerations elaborated above, this non-replication is particularly interesting given the ways that the regulatory patterns in the present study otherwise shared correlates similar to those reported in the existing line of work that makes use of the regulatory pattern (for example, associations between maternal sensitivity and independence from maternal report of temperament as discussed in Study 1, and differences in heart-rate responses that depended on regulatory pattern in Study 2 in ways that converged with several of Barbosa et al.'s (2018) findings). The replication of concurrent associations between the regulatory patterns and relevant correlates (in Studies 1 and 2) and the contrasting non-replication, in this sub-study, of any association between SF regulatory patterns and later attachment outcomes point to an intriguing possibility: It is possible that the absence of any association between regulatory patterns and later attachment classification in this sample reflects actual changes in infants' emerging internal working models over the course of the attachment-in-the-making phase, rather than shortcomings in discernment of the regulatory patterns in this sample. Indeed, Tronick et al. (1982; p. 89) suggested that continuity in infants' patterns of adaptation, when present, is "generated and maintained by the quality of the infant's interactions with its environment." In

other words, stability in environmental and caregiving contexts likely beget stability in infants' patterns of adaptation. The absence of any association between SF regulatory patterns and attachment classification in this sample may be a consequence of less continuity in environmental and caregiving contexts in the present higher-risk sample. In Barbosa et al.'s (2021) sample, which was characterized by lower socioeconomic and psychosocial risk, there may have been, by comparison, more continuity in the environmental conditions that arguably give way to iterations of infants' patterns of adaptation and transact with successive iterations that increasingly stabilize over time. This possibility could be evaluated empirically, and related proposals for future study are articulated in Chapter 6.

This study's application of the Kogan and Carter (1996) approach to coding infant reengagement behaviors provided a useful reference point for interpreting the absence, in this sample, of association between infant regulatory patterns and later attachment outcomes. In a low-income sample that completed the SF and SSP eight months apart, Kogan and Carter found infants' SF reengagement behaviors to be only modestly predictive of later resistance and contact maintenance ratings in the SSP. The present study did not yield the same finding, and instead found that the extent of protest behaviors in the SF were modestly predictive of lower avoidance in the SSP reunions one year later. The absence of substantial association between SF behaviors and later attachment outcomes in this sample is not confined to the regulatory pattern approach, but rather extends to a reunion-focused measure of infant reengagement behaviors. This suggests that infant SF responses in this sample were generally not associated with attachment outcomes that were assessed one year later, even when infant SF responses were operationalized by other means. The absence of an association between attachment outcomes and either of the two approaches to describing infant SF response suggests that either (1) infant responses to the SF (or

the current study's ways of capturing them) do not index expectations of the caregiver in ways that undergird (or are otherwise important to) emerging attachment-related working models, or (2) infant responses to the SF indeed index expectations of the caregiver that inform attachment-related working models, and these emerging attachment-related working models shift and increasingly stabilize in response to continued experience over the postnatal year. The latter possibility is consistent with existing theory about the nature and timeline of the attachment-in-the-making phase (Bowlby, 1969).

A limitation of the present study is its focus on precursors to organized quality of attachment. Given possible links between attachment disorganization and later difficulties with dissociation, emotion dysregulation, and interpersonal functioning (e.g., Liotti, 2004; Khoury et al., 2019) early identification of risk for attachment disorganization may be of particular clinical importance and should be a focus of future study (for review, see van IJzendoorn et al., 1999, & Stovall-McClough & Dozier, 2016).

And yet, the present study's focus on organized patterns of regulatory behavior may be an important first step toward understanding whether infants' responses to the SF reflect implicit and embodied expectations of the caregiving relationship, and whether and under what conditions these expectations may persist, stabilize, and manifest as organization of attachment. This may lay a foundation for future study of precursors to attachment disorganization and their discernability in the SF paradigm.

The present study brought two existing approaches to bear to evaluate whether infants' responses to the SF were associated with later attachment outcomes. The absence of any such association in the present study is consistent with existing theory that infants' attachment-related expectations are in-the-making during the postnatal year, and that stability and change in these

early expectations is deeply intertwined with stability and change in the environment. This, too, is an area that is ripe for future study, and related recommendations are further discussed in this dissertation's final chapter.

# CHAPTER 6

# GENERAL DISCUSSION

Given the importance of attachment status as an "initiating condition" with long-term, transactional contributions to later biopsychosocial sources of risk and protection, the proposal that regulatory patterns in the SF might be a probe of attachment in the making is a possibility with implications for the assessment of dyadic adjustment in the first postnatal year and promotion of infant and long-term health (see Chapter 1; McIntosh et al., 2021). Importantly, an interest in attachment in the making within the first postnatal year does not assume that infants' quality of attachment is set down in this time, but only that precursors or emerging but unconsolidated patterns may coalesce and be at work in infants' responses to the removal of maternal responsiveness during the SF.

The latter distinction is an important one, especially given a growing appetite within subsections of intervention science to make use of infant response to the SF as an early assessment of dyadic adjustment. As one example, a recent study of a cognitive behavioral intervention for postpartum depression used features of infant response (and comparison to matched controls across three SF administration) as an outcome metric to evaluate the intervention (Ntow et al., 2021). A separate evaluation of an infant-carrying intervention (Williams & Turner, 2020) used an algorithmic approach to SF coding as an ostensible measure of attachment category and disorganization on the basis of a single unpublished dissertation (Abbott, 2016), and a 2022 preprint from researchers at the University of Edinburgh similarly touted this algorithmic application of SF coding as a measure of attachment category among nine-month-old infants with and without preterm birth (Jiménez-Sánchez et al., 2022). Enthusiasm for the possibility that precursors to attachment organization may be observable in

the SF should be (1) tempered by the still-modest and mixed evidence to this effect and (2) nuanced by an appreciation for attachment theory's tenets. A full account of attachment theory's underpinnings is beyond the scope of this chapter, but attachment theory takes into important account the emergence of locomotion in the latter half of infants' first year and the many implications of this developmental milestone for the infant's exploratory system and the survival-relevant function of proximity-seeking and return to a secure base. For this and other reasons, it would be a mistake to simply conflate SF-based regulatory patterns with SSP-based attachment classification or to regard the regulatory patterns or other features of infant response to the SF as a straightforward proxy for attachment classification. Indeed, authors of the regulatory pattern approach make no claim that the regulatory patterns are a proxy for later quality of attachment, and the organization of the regulatory patterns and the correlates of these patterns are informative in their own right. This dissertation regards patterns of regulatory behavior in the SF as a potential probe of attachment in the making, and not a proxy for later quality of attachment.

The findings from this dissertation's three sub-studies point to some strengths and suggest some points of departure for future research. Study 1 found that concurrent correlates to the regulatory patterns were not only consistent with existing study of the regulatory patterns, but also accorded with well-evidenced proposals about the origins of attachment security over the course of the attachment-in-the-making phase. Specifically, the regulatory patterns were associated with maternal sensitivity to distress and not accounted for by infants' trait-like propensity toward negative affect. Findings from this study uphold the possibility that regulatory patterns in the SF may be a meaningful probe of the attachment in the making.

Study 2 identified associations between the regulatory patterns and sympathetic arousal that were in many ways consistent with the single published study that has reported on

physiological concomitants to the regulatory patterns (Barbosa et al., 2018). Study 2 extended existing work in this domain by examining whether the patterns of regulatory behavior were also associated with vagal reactivity and recovery in the SF. Heterogeneity of vagal response trajectories within the regulatory patterns introduces compelling questions about coupling of stress physiology and regulatory behavior. A compelling possibility is that closer examination of physiological response profiles might differentiate regulatory patterns beyond those identified here. For example, it is possible that infants who exhibit similar patterning of observable behavior in response to the SF but who differ in their trajectories of physiological responding to the SF may essentially be better described by two (or more) different regulatory patterns. A related possibility is that different combinations of regulatory behavior and physiology are a source of patterning, and some authors have argued persuasively that the predictive value of infant behavior during the SF has been limited or inconsistent in previous studies precisely because the physiological stress responses that accompany infant behaviors may condition the effects of behavior (Qu & Leerkes, 2018). In other words, it is possible that the co-occurrence or even coupling of infant behaviors with regulatory physiology during the SF might be more telling than behavior alone, and the extent to which infant SF behaviors are adaptive or prognostic of later attachment may depend on co-occurring mobilization and/or attenuation of physiological stress responses. Future study could evaluate this possibility.

Study 3 found no evidence of association between regulatory patterns in the SF and later organized quality of attachment, and this represents a departure from the single study that reported associations between the three-typology approach adopted here and later attachment-related outcomes (Barbosa et al., 2021). The absence of any such association in the present sample is particularly interesting given other ways in which the regulatory patterns performed as

expected in terms of concurrent correlates (in Study 1). This observation, together with the socioeconomic and psychosocial risk that characterized this sample, suggests that there may be lawful discontinuity in infants' emerging expectations of the attachment relationship. Patterns of adaptation and (relatedly) attachment-related internal working models are expected to persist over time when environmental conditions are relatively constant (Bowlby, 1969; Tronick et al., 1982; Sroufe, 2005). Insofar as regulatory patterns in the SF may index internal working models that, in stable conditions, become entrained and consolidated over time and take expression in the Strange Situation, future study should examine intervening factors that might account for association and non-association between regulatory profiles and attachment classification. Measures of maternal sensitivity at each timepoint would be a promising index of continuity in this feature of the caregiving environment, but other environmental-level factors (e.g., parenting stress, interparental conflict, changes in exposure to adversity, and even access to social support or clinical intervention) might condition continuity or (more conservatively, associations) between early regulatory patterns and later quality of attachment.

An additional approach to consider would be to examine whether continuity and discontinuity between SF-based regulatory patterns and SSP-based attachment classifications differentially predict socioemotional outcomes of interest. If continuity between the social-positive oriented pattern at five months and secure attachment in the SSP were differentially predictive of an outcome of interest (that is, relative to infants for whom there is arguable discontinuity in the form of a self-comfort-oriented or distressed-inconsolable pattern in the SF but later secure quality of attachment in the SSP), the predictive utility of association and non-association (or continuity and discontinuity) might suggest that the earlier, SF-related, regulatory pattern is not invalid or otherwise mistaken as an index of the infant's emerging expectations, but

is instead capturing a meaningful (albeit momentary) measure of attachment-related expectations that are indeed in the making.

## References


Abbott, K. (2016). *Attachment during the first year of life: Validity and longitudinal associations to 14 months, of attachment classification at 7 months.* [Doctoral dissertation, University of Liverpool]. https://livrepository.liverpool.ac.uk/3006895/

Adamson, L. B., & Frick, J. E. (2003). The Still Face: A history of a shared experimental paradigm. *Infancy, 4*(4), 451–473. https://doi.org/10.1207/S15327078IN0404_01

Agresti, A. (2019). *An Introduction to Categorical Data Analysis* (Third edition.). Wiley.

Ainsworth, M. D., Blehar, M. C., Waters, E., & Wall, S. (1978). *Patterns of attachment: A psychological study of the strange situation.* Lawrence Erlbaum.

Ainsworth, M. D., Blehar, M. C., Waters, E., & Wall, S. (2015). *Patterns of attachment: A psychological study of the strange situation.* Psychology Press. (Original work published 1978).

Avison, W. R., Turner, R. J., & Noh, S. (1986). Screening scale for problems in parenting. *Child Abuse and Neglect, 10*, 157-170.

Baker, L. A., Cesa, I. L., Gatz, M., & Mellins, C. (1992). Genetic and environmental influences on positive and negative affect: support for a two-factor theory. *Psychology and Aging*, *7*(1), 158.

Barbosa, M., Beeghly, M., Moreira, J., Tronick, E., & Fuertes, M. (2018). Robust stability and physiological correlates of infants' patterns of regulatory behavior in the Still-Face Paradigm at 3 and 9 months. *Developmental Psychology, 54*(11), 2032-2042. http://dx.doi.org/10.1037/dev0000616

Barbosa, M., Beeghly, M., Gonçalves, J. L., Moreira, J., Tronick, E., & Fuertes, M. (2019). Predicting patterns of regulatory behavior in the still-face paradigm at 3 months. *Infancy*,

*24*(4), 501-525.

Barbosa, M., Beeghly, M., Moreira, J., Tronick, E., and Fuertes, M. (2021). Emerging patterns of infant regulatory behavior in the Still-Face paradigm at 3 and 9 months predict mother-infant attachment at 12 months. *Attachment and Human Development*, *23*(6), 814-830.

Bazhenova, O. V., Plonskaia, O., & Porges, S. W. (2001). Vagal reactivity and affective adjustment in infants during interaction challenges. *Child Development*, *72*(5), 1314-1326.

Beebe, B., Cohen, P., & Lachmann, F. (2016). The Mother-Infant Interaction Picture Book: Origins of Attachment. New York, NY: Norton.

Beeghly, M., Fuertes, M., Liu, C., & Delonis, M. S. (2010). Maternal sensitivity in dyadic context: Mutual regulation, meaning-making, and reparation. In D. W. Davis & M. C. Logsdon (Eds.), *Maternal sensitivity: A scientific foundation for practice* (pp. 59–83). Hauppauge, NY: Nova Science Publishers.

Belsky, J., & Fearon, R. M. P. (2002). Early attachment security, subsequent maternal sensitivity, and later child development: Does continuity in development depend upon continuity of caregiving? *Attachment & Human Development, 4*(3), 361-387.

Bishop, Y. M., Fienberg, S. E., & Holland, P. W. (2007). *Discrete multivariate analysis: Theory and practice*. Springer.

Bornstein, M. H. (2013). Mother-infant attunement: A multilevel approach via body, brain, and behavior. In M. Legerstee, D. W. Haley, & M. H. Bornstein (Eds.), *The infant mind: Origins of the social brain* (pp. 266-298). New York, NY: Guilford.

Bowler, G. M. (2020). *Lawful patterns of attachment disorganization are related to externalizing*

*behaviors across childhood* (Publication No. 27834396) [Doctoral dissertation, Temple University]. ProQuest Dissertations Publishing.

Braungart-Rieker, J., Garwood, M. M., Powers, B. P., & Notaro, P. C. (1998). Infant affect and affect regulation during the still-face paradigm with mothers and fathers: The role of infant characteristics and parental sensitivity. *Developmental Psychology*, *34*, 1428–1437.

Braungart-Rieker, J. M., Garwood, M. M., Powers, B. P., & Wang, X. (2001). Parental sensitivity, infant affect, and affect regulation: Predictors of later attachment. *Child Development*, *72*(1), 252-270.

Braungart-Rieker, J. M., Zentall, S., Lickenbrock, D. M., Ekas, N. V., Oshio, T., & Planalp, E. (2014). Attachment in the making: Mother and father sensitivity and infants' responses during the Still-Face Paradigm. *Journal of Experimental Child Psychology*, *125*, 63-84. http://dx.doi.org/10.1016/j.jecp.2014.02.007

Brazelton, T. B., Koslowski, B., & Main, M. (1974). The origins of reciprocity: The early mother-infant interaction. In M. Lewis & A. Rosenblum (Eds.), *The effect of the infant on its caregiver* (pp. 49-76). New York: Wiley.

Cassidy, J. (1994). Emotion regulation: Influences of attachment relationships. *Monographs of the Society for Research in Child Development, 59*(2-3), 228-249.

Cassidy, J., Jones, J. D., & Shaver, P. R. (2013). Contributions of attachment theory and research: A framework for future research, translation, and policy. *Development and Psychopathology*, *25*(4), 1415-1434.

Cassidy, J., Ehrlich, K. B., & Sherman, L. J. (2013). Child-parent attachment and response to threat: A move from the level of representation. In M. Mikulincer & P. R Shaver (Eds.),

*Nature and Development of Social Connections: From Brain to Group* (pp. 125-144). Washington, DC: American Psychological Association.

Chorney, J. M., McMurtry, C. M., Chambers, C. T., and Bakeman, R. (2015) Developing and modifying behavioral coding schemes in pediatric psychology: A practical guide. *Journal of Pediatric Psychology*, *40*(1), pp. 154-164.

Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement*, *20*(1), 37-46.

Cohn, J. F., Campbell, S. B., and Ross, S. (1991). Infant response in the still-face paradigm at 6 months predicts avoidance and secure attachment at 12 months. *Development and Psychopathology*, *3*(4), 367-376.

Cohn, J. F. (2003). Additional components of the still-face effect: Commentary on Adamson and Frick. *Infancy*, *4*, 493–497.

Conradt, E., & Ablow, J. (2010). Infant physiological response to the still-face paradigm: Contributions of maternal sensitivity and infants' early regulatory behavior. *Infant Behavior and Development*, *33*(3), 251-265.

Conradt, E., Measelle, J., & Ablow, J. C. (2013). Poverty, problem behavior, and promise: Differential susceptibility among infants reared in poverty. *Psychological Science*, *24*(3), 235-242.

Coppola, G., Aureli, T., Grazia, A., & Ponzetti, S. (2016). Reunion patterns in the Still-Face Paradigm as predicted by maternal sensitivity and dyadic coordination. *Infancy*, *21*(4), 453-477.

Cox, M. J., Mills-Koonce, R., Propper, C., & Gariépy, J. L. (2010). Systems theory and cascades in developmental psychopathology. *Development and Psychopathology*, *22*(3), 497-506.

Dagan, O., & Sagi-Schwartz, A. (2020). Infant attachment (to mother and father) and its place in human development: Five decades of promising research (and an unsettled issue). In J. J. Lockman & C. S. Tamis-LeMonda (Eds.), *The Cambridge Handbook of Infant Development: Brain, Behavior, and Cultural Context* (pp. 687–714). Cambridge University Press. https://doi.org/10.1017/9781108351959.025

De Wolff, M. S., & Van Ijzendoorn, M. H. (1997). Sensitivity and attachment: A meta-analysis on parental antecedents of infant attachment. *Child Development*, *68*(4), 571-59.

DiCorcia, J. A., & Tronick, E. D. (2011). Quotidian resilience: Exploring mechanisms that drive resilience from a perspective of everyday stress and coping. *Neuroscience & Biobehavioral Reviews*, *35*(7), 1593-1602.

DiCorcia, J.A., Snidman, N., Sravish, A.V., & Tronick, E. (2016). Evaluating the nature of the still-face effect in the double face-to-face still-face paradigm using different comparison groups. *Infancy, 21*(3), 332–352. https://doi.org/10.1111/infa.12123

Ehrlich, K. B., Miller, G. E., Jones, J. D., & Cassidy, J. (2016). Attachment and psychoneuroimmunology. In J. Cassidy & P. R. Shaver (Eds.), *Handbook of Attachment: Theory, Research, and Clinical Applications* (3rd ed., pp. 180–201). New York, NY: Guilford.

Ekas, N. V., Haltigan, J. D., & Messinger, D. S. (2013). The dynamic still-face effect: Do infants decrease bidding over time when parents are not responsive?. *Developmental Psychology*, *49*(6), 1027.

Field, T. (1981). Infant arousal, attention, and affect during early interactions. *Advances in Infancy Research*, *1*, 57-100.

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.

Fraley, R. C., & Brumbaugh, C. C. (2004). A dynamical systems approach to conceptualizing and studying stability and change in attachment security. In W. S. Rholes & J. A. Simpson (Eds.), *Adult attachment: Theory, research, and clinical implications* (pp. 86–132). Guilford Publications.

Fuertes, M. (2005). *Rotas da Vinculacao.* [Doctoral dissertation, Porto University]. https://repositorio-aberto.up.pt/handle/10216/53629

Fuertes, M., Santos, P. L. D., Beeghly, M., & Tronick, E. (2006). More than maternal sensitivity shapes attachment: Infant coping and temperament. *Annals of the New York Academy of Sciences*, *1094*(1), 292-296.

Fuertes M., & Lopes-dos-Santos, P. (2009). *Coding System for Regulatory Patterns in the FFSF*. Unpublished manuscript. Centro de Psicologia da Universidade do Porto: Faculdade de Psicologia e Ciências da Educacão.

Fuertes, M., Lopes-dos-Santos, P., Beeghly, M., & Tronick, E. (2009). Infant coping and maternal interactive behavior predict attachment in a Portuguese sample of healthy preterm infants. *European Psychologist*, *14*(4), 320-331.

Fuertes, M., Beeghly, M., dos Santos, P. L., & Tronick, E. (2011). Predictors of infant positive, negative and self-direct coping during face to face still-face in a Portuguese preterm sample. *Análise Psicológica*, *29*(4), 553-565.

Gartstein, M. K., & Rothbart, M. K. (2003). Studying infant temperament via the revised Infant Behavior Questionnaire. *Infant Behavior and Development, 26,* 64-86.

Gavalgno, L. G. G., De Grandis, M. C., Elgier, A. M., & Mustaca. A. E. (2021). *Factores*

*moduladores de las respuestas de los infantes al Paradigma Still-Face: Una revisión sistemática.* [Modulating factors of infants' responses to the Still-Face Paradigm: A systematic review]. *Psykhe*, *30*(2), 1-15.

Gianino, A., & Tronick, E. Z. (1988). The mutual regulation model: The infant's self and interactive regulation and coping and defensive capacities. In T. Field., P. McCabe, & N. Schneiderman (Eds.)., *Stress and Coping Across Development* (pp. 47-68). Erlbaum.

Goodman, L. A., & Kruskal, W. H. (1954). Measures of association for cross classifications. *Journal of the American Statistical Association, 49,* 732–769. https://doi.org/10.2307/2281536

Graham, A. M., Ablow, J. C., & Measelle, J. R. (2010). Interparental relationship dynamics and cardiac vagal functioning in infancy. *Infant Behavior and Development*, *33*(4), 530-544.

Grossmann, K. E., & Grossmann, K. (2006). Attachment quality as an organizer of emotional and behavioral responses in a longitudinal perspective. In *Attachment Across the Life Cycle* (pp. 101-122). Routledge.

Haley, D. W., & Stansbury, K. (2003). Infant stress and parent responsiveness: Regulation of physiology and behavior during still-face and reunion. *Child Development*, *74*, 1534-1546.

Hampel, F. R., Ronchetti, E. M., Rousseeuw, P. J., & Stahel, W. A. (1986). *Robust statistics: The approach based on influence functions*. New York: Wiley.

Ham, J., & Tronick, E. (2006). Infant resilience to the stress of the still-face. *Annals of the New York Academy of Sciences*, *1094*, 297–302. https://doi.org/10.1196/annals.1376.038

Hill, A. L., & Braungart-Rieker, J. M. (2002). Four-month attentional regulation and its prediction of three-year compliance. *Infancy, 3*(2), 261–273.

https://doi.org/10.1207/S15327078IN0302_9

Hunnius, S. (2007). The early development of visual attention and its implications for social and cognitive development. *Progress in Brain Research*, *164*, 187-209.

Jamieson, S. (2004). *Identifying precursors of attachment in the still -face paradigm* (Publication No. 305088763) [Doctoral dissertation, Queens University]. ProQuest Dissertations & Theses Global.

Jiménez-Sánchez, L., Ginnell, L., O'Carroll, S., Ledsham, V., Corrigan, A., Stoye, D. Q., Sullivan, G., Hall, J., Clemens, A. M., Boardman, J. P., & Fletcher-Watson, S. (2022). *Early life attachment in term and preterm infants.* medRxiv. https://doi.org/10.1101/2022.04.29.22274482

Kearney, M. W. (2017). Cramér's V. In M. R. Allen (Ed.), *The SAGE Encyclopedia of Communication Research Methods*. https://doi.org/10.4135/9781483381411

Khoury, J. E., Zona, K., Bertha, E., Choi-Kain, L., Hennighausen, K., & Lyons-Ruth, K. (2019). Disorganized attachment interactions among young adults with borderline personality disorder, other diagnoses, and no diagnosis. *Journal of Personality Disorders*, 1–21. doi: 10.1521/pedi_2019_33_408

Kiser, L. J., Bates, J. E., Maslin, C. A., & Bayles, K. (1986). Mother-infant play at six months as a predictor of attachment security at thirteen months. *Journal of the American Academy of Child Psychiatry*, *25*(1), 68-75.

Kobak, R. R., Cole, H. E., Ferenz-Gillies, R., Fleming, W. S., & Gamble, W. (1993). Attachment and emotion regulation during mother-teen problem solving: A control theory analysis. *Child Development*, *64*(1), 231-245.

Kogan, N., & Carter, A. S. (1996). Mother-infant reengagement following the still-face: The role

of maternal emotional availability an infant affect regulation. *Infant Behavior and Development*, *19*(3), 359-370.

Larntz, K. (1978). Small-sample comparisons of exact levels for chi-squared goodness-of-fit statistics. *Journal of the American Statistical Association*, *73*(362), 253–263. https://doi.org/10.2307/2286650

Leerkes, E. M. (2011). Maternal sensitivity during distressing tasks: A unique predictor of attachment security. *Infant Behavior and Development*, *34*(3), 443-446.

Lewinsohn, P. M. (1996). Oregon Research Institute infant development study wave 1—wave 4 assessment protocol and documentation. Unpublished manual.

Liotti, G. (2004). Trauma, dissociation, and disorganized attachment: Three strands of a single braid. *Psychotherapy: Theory, Research Practice, Training, 41,* 472-486. doi: 10.1037/0033-3204.41.4.472

Lowe, J. R., MacLean, P. C., Duncan, A. F., Aragón, C., Schrader, R. M., Caprihan, A., & Phillips, J. P. (2012). Association of maternal interaction with emotional regulation in 4- and 9-month infants during the Still Face Paradigm. *Infant Behavior and Development*, *35*(2), 295-302.

Madigan, S., Deneault, A.-A., Duschinsky, R., Bakermans-Kranenburg, M. J., Schuengel, C., van IJzendoorn, M. H., Ly, A., Fearon, R. M. P., Eirich, R., & Verhage, M. L. (2024). Maternal and paternal sensitivity: Key determinants of child attachment security examined through meta-analysis. *Psychological Bulletin.* Advance online publication. https://doi.org/10.1037/bul0000433

Main, M. (1990). Cross-cultural studies of attachment organization: Recent studies, changing

methodologies, and the concept of conditional strategies. *Human Development*, *33*(1), 48-61.

Main, M., & Solomon, J. (1990). Procedure for identifying infants as disorganized/disoriented during the Ainsworth Strange Situation. In M. Greenberg, D. Cichetti, & E. M. Cummings (Eds.), *Attachment during the preschool years: Theory, research and intervention*. Chicago: University of Chicago Press.

McHugh M. L. (2012). Interrater reliability: The kappa statistic. *Biochemia Medica*, *22*(3), 276–282.

McHugh, M. L. (2013). The chi-square test of independence. *Biochemia Medica*, *23*(2), 143-149.

McIntosh, J. E., Olsson, C. A., Schuijers, M., Tan, E. S., Painter, F., Schnabel, A., LeBas, G., Higgs-Howarth, S., Benstead, M., Booth, A. T., & Hutchinson, D. (2021). Exploring perinatal indicators of infant social-emotional development: a review of the replicated evidence. *Clinical Child and Family Psychology Review*, *24*(3), 450-483.

McQuaid, N. E., Bibok, M. B., & Carpendale, J. I. (2009). Relation between maternal contingent responsiveness and infant social expectations. *Infancy*, *14*(3), 390-401.

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*(2), 120-162.

Mesman, J., Linting, M., Joosen, K. J., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2013). Robust patterns and individual variations: Stability and predictors of infant behavior in the still-face paradigm. *Infant Behavior and Development*, *36*(4), 587–598. https://doi.org/10.1016/j.infbeh.2013.06.004

Mills-Koonce, W. R., Propper, C. B., & Barnett, M. (2012). Poor infant soothability and later

insecure-ambivalent attachment: Developmental change in phenotypic markers of risk or two measures of the same construct?. *Infant Behavior and Development*, *35*(2), 215-225.

Montirosso, R., Casini, E., Provenzi, L., Putnam, S. P., Morandi, F., Fedeli, C., & Borgatti, R. (2015). A categorical approach to infants' individual differences during the Still-Face paradigm. *Infant Behavior and Development*, *38*, 67-76.

Moore, G. A. (2010). Parent conflict predicts infants' vagal regulation in social interaction. *Development and Psychopathology*, *22*(1), 23-33.

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*(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*(5), 706–714. https://doi-org/10.1037/0012-1649.37.5.706

Murray, L., Fiori-Cowley, A., Hooper, R., & Cooper, P. (1996). The impact of postnatal depression and associated adversity on early mother-infant interactions and later infant outcomes. *Child Development, 67*(5), 2512-2526.

Northrup, J. B., Ridley, J., Foley, K., Moses-Kolko, E. L., Keenan, K., & Hipwell, A. E. (2019). A transactional model of infant still-face response and maternal behavior during the first year. *Infancy*, *24*(5), 787-806.

Ntow, K. O., Krzeczkowski, J. E., Amani, B., Savoy, C. D., Schmidt, L. A., & Van Lieshout, R. J. (2021). Maternal and infant performance on the face-to-face still-face task following

maternal cognitive behavioral therapy for postpartum depression. *Journal of Affective Disorders*, *278*, 583-591.

Opie, J. E., McIntosh, J. E., Esler, T. B., Duschinsky, R., George, C., Schore, A., ... & Olsson, C. A. (2021). Early childhood attachment stability and change: A meta-analysis. *Attachment & Human Development*, *23*(6), 897-930.

Oppenheimer, J. E., Measelle, J. R., Laurent, H. K., & Ablow, J. C. (2013). Mothers' vagal regulation during the Still-Face Paradigm: Normative reactivity and impact of depression symptoms. *Infant Behavior and Development*, *36*(2), 255-267.

Ostlund, B. D., Measelle, J. R., Laurent, H. K., Conradt, E., & Ablow, J. C. (2017). Shaping emotion regulation: Attunement, symptomatology, and stress recovery within mother–infant dyads. *Developmental Psychobiology*, *59*(1), 15-25.

Papoušek, M. (2007). Communication in early infancy: An arena of intersubjective learning. *Infant Behavior and Development*, *30*(2), 258-266.

Planalp, E. M., & Braungart-Rieker, J. M. (2015). Trajectories of regulatory behaviors in early infancy: Determinants of infant self-distraction and self-comforting. *Infancy*, *20*(2), 129-159.

Qu, J., & Leerkes, E. M. (2018). Patterns of RSA and observed distress during the still-face paradigm predict later attachment, compliance and behavior problems: A person-centered approach. *Developmental Psychobiology*, *60*(6), 707-721.

Radloff, L. S. (1977). The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement, 1,* 385-401.

Sacrey, L. A. R., Raza, S., Armstrong, V., Brian, J. A., Kushki, A., Smith, I. M., & Zwaigenbaum, L. (2021). Physiological measurement of emotion from infancy to

preschool: A systematic review and meta-analysis. *Brain and Behavior*, *11*(2), e01989.

Safyer, P. (2019). *M(other) nurture: Exploring the influence of maternal care on the development of infant emotion processing, regulation, and the emotional brain.* [Doctoral dissertation, University of Michigan]. Deep Blue Documents. https://deepblue.lib.umich.edu/handle/2027.42/151486

Speck, B., Isenhour, J., Gao, M. M., Conradt, E., Crowell, S. E., & Raby, K. L. (2023). Pregnant women's autonomic responses to an infant cry predict young infants' behavioral avoidance during the still-face paradigm. *Developmental Psychology*, *59*(12), 2237-2247.

Sroufe, L. A. (2005). Attachment and development: A prospective, longitudinal study from birth to adulthood. *Attachment & Human Development*, *7*(4), 349-367.

Sroufe, L. A., & Waters, E. (1977). Attachment as an Organizational Construct. *Child Development*, *48*, 1184-1199.

Stovall-McClough, K. C., & Dozier, M. (2016). Attachment states of mind and psychopathology in adulthood. In J. Cassidy & P. R. Shaver (Eds.), *Handbook of Attachment: Theory, Research, and Clinical Applications* (3rd ed., pp. 715–738). Guilford.

Tronick, E.Z. (2007). Neurobehavioral and Social Emotional Development of the Infants and Children. New York, NY: Norton Press.

Tronick, E. (2017). The caregiver–infant dyad as a buffer or transducer of resource enhancing or depleting factors that shape psychobiological development. *Australian and New Zealand Journal of Family Therapy*, *38*, 561–572. doi: 10.1002/anzf.1274

Tronick, E., Als, H., Adamson, L., Wise, S., & Brazelton, B. (1978). The infants' response to entrapment between contradictory messages in face-to-face interaction. *American Academy of Child Psychiatry, 1*, 1 – 13.

Tronick, E. Z., & Beeghly, M. (2011). Infants' meaning-making and the development of mental health problems. *The American Psychologist*, *66*(2), 107–119. https://doi.org/10.1037/a0021631

Tronick, E. Z., & Gianino, A. (1986). Interactive mismatch and repair: Challenges to the coping infant. *Zero to Three*, *6*(3), 1–6.

Tronick, E., Ricks, M., & Cohn, J. F. (1982). Maternal and infant affective exchange: Patterns of adaptation. In T. Field & A. Fogel (Eds.), *Emotion and early interaction* (pp. 83–100). Hillsdale, NJ: Lawrence Erlbaum.

Tronick, E. Z. & Weinberg, K. (1990). The Infnat Regulatory Scoring System (IRSS). Unpublished Manuscript. Children's Hospital and Harvard Medical School, Boston.

Wagner, N. J., Mills-Koonce, W., Propper, C. B., Willoughby, M. T., Rehder, P. D., Moore, G. A., & Cox, M. J. (2016). Associations between infant behaviors during the face-to-face still-face paradigm and oppositional defiant and callous-unemotional behaviors in early childhood. *Journal of Abnormal Child Psychology*, *44*, 1439–1453. https://doi.org/10.1007/s10802-016- 0141-0

Weinberg, M. K., & Tronick, E. Z. (1994). Beyond the face: An empirical study of infant affective configurations of facial, vocal, gestural, and regulatory behaviors. *Child Development*, *65*, 1503-1515.

Weinberg, M. K., & Tronick, E. Z. (1996). Infant affective reactions to the resumption of maternal interaction after the still-face. *Child Development*, *67*(3), 905-914.

Williams, L. R., & Turner, P. R. (2020). Infant carrying as a tool to promote secure attachments in young mothers: Comparing intervention and control infants during the still-face paradigm. *Infant Behavior and Development*, *58*, 101413.

Yoo, K., & Reeb-Sutherland, B. C. (2013). Effects of negative temperament on 5-month-old infants' behavior during the still-face paradigm. *Infant Behavior and Development*, *36*(3), 344-348.