HHS Public Access
Author manuscript
Child Dev. Author manuscript; available in PMC 2019 September 01.

Published in final edited form as:
Child Dev. 2018 September ; 89(5): 1519–1534. doi:10.1111/cdev.12843.

Positive Affectivity and Fear Trajectories in Infancy: Contributions of Mother-child Interaction Factors

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Abstract

Fear and positive emotionality were considered in a growth-modeling context. Mothers, primarily Caucasian (91.9%) and of middle socio-economic status (SES), participated in play interactions with infants at 4 months ($N = 148$). Infant fear and positive affectivity were evaluated at 6, 8, 10, and 12 months-of-age. A linear trajectory was superior in explaining growth for parent-report and observation-based indicators of positive affectivity and parent-report of fearfulness; a piecewise model explained the non-linear growth of observation-based fear. Responsiveness in mother-infant interactions emerged as a significant predictor of the fear trajectory, with higher sensitivity predicting lower levels of observed fear. Reciprocity, tempo, emotional tone, and intensity of mother-infant interactions also made significant contributions to temperament development; however, analyses addressing these were exploratory.

Temperament is typically defined in terms of its enduring nature (e.g., Buss, 1989; Thomas, Chess, Birch, Hertzig, & Korn, 1963). Consistency across time has been reported as early as infancy (Bornstein et al., 2015), with stability of behavioral inhibition demonstrated for shorter (3–5 weeks) and longer-term (10 month) follow-up assessments (Garcia Coll, Kagan & Reznick, 1984). Seifer, Sameroff, Barrett, and Krafchuk, (1994) characterized these early individual differences as similar in stability to adult personality dimensions. At the same time, more recent theoretical formulations of temperament and empirical evidence point to important developmental shifts in affective expressions, especially fear and positive affectivity (Bridgett, Laake, Gartstein, & Dorn, 2013; Gartstein et al., 2010; Rothbart, 2011). Gartstein et al. (2010) reported increases in fear across infancy, with high initial fear and steeper increases predicting greater toddler anxiety. Braungart-Rieker, Hill-Soderlund, and Karrass (2010) also observed increases in fearfulness across infancy, reporting significant linear and quadratic effects. A linear trajectory was described as optimal for smiling and laughter, also noted to increase over the first year of life, with higher intercept and slope estimates predicting fewer negative parenting practices in the toddler period (Bridgett et al.,

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2013). Thus, results of growth-focused investigations indicate that changes in positive affectivity and fear across infancy form meaningful developmental patterns predictive of emerging symptoms of psychopathology and maladaptive parenting.

We examined positive affectivity and fearfulness in a growth-modeling context, as these individual differences represent affective components of approach and avoidance motivational-neurobehavioral systems (Diaz & Bell, 2012; Gray, 1987; Hane, Fox, Henderson, & Marshall, 2008), directing behavioral and emotional responses in tandem (Fox et al., 2001). Alongside stability, significant developmental shifts have been noted in approach-avoidance tendencies, including their neurophysiological correlates (Howarth, Fettig, Curby, & Bell, 2015). These transitions are consistent with the view of temperament as developing reactive and regulatory tendencies, with especially rapid changes in early childhood (Rothbart, 2011). Development has been described as a paradox, wherein stability is complemented by developmental shifts (e.g., Bornstein et al., 2015), yet the developmental shift component is relatively under-studied. Although several temperament growth-related investigations have been carried out, approach and avoidance related components have not been examined together via a parallel multi-method measurement scheme. Existing research suggests reliable and meaningful transitions across the first year of life, which require a more thorough study, as examining growth provides an opportunity to speak to developmental processes in a manner that single snapshot-in-time investigations, cross-sectional studies, or even other longitudinal designs do not permit (Little, 2013). The first year of life concludes with critical motor, cognitive, and social-emotional developmental milestones (Shonkoff & Phillips, 2000), and understanding transitions in temperament development in this context is of particular importance, as it does not occur in a vacuum, but is rather "channeled" as a function of the overall developmental progress.

Several maternal characteristics have been linked with growth trajectories of fear and positive affectivity in infancy, with higher severity of maternal depressive symptoms predicting steeper increases in fearful reactivity (Gartstein et al., 2010). Greater maternal effortful control and extraversion were associated with more initial infant smiling and laughter, whereas parenting stress predicted decreases in positive affectivity (Bridgett et al., 2013). Parent-child interactions represent critical contributors to the development of approach and avoidance, especially their affective components (Buss & Kiel, 2013; Fox et al., 2001); however, only responsiveness has been considered as a predictor of growth, as infants with more sensitive mothers showed slower fear increases between 4 and 16 months (Braungart-Rieker et al., 2010). Additional mother-infant interaction factors are likely important. Reciprocity, tempo, emotional tone, and intensity can also be expected to contribute to temperament growth based on their documented effects on early social-emotional and cognitive development (Ainsworth, Blehar, Waters, & Wall, 1978; Barnard, 1997; Belsky, Rovine, & Taylor, 1984; de Wolff & van IJzendoorn; Lindsey, Cremeens, Colwell, & Caldera, 2009).

There are remaining questions regarding the contribution of maternal sensitivity given evidence that it may be promoting fearful behavior, as infants showing behavioral inhibition were more likely to remain inhibited when mothers were consistently responsive to their distress (Arcus, 2001), interpreted as "coddling" preventing inhibited toddlers from developing more independent regulation skills. That is, highly sensitive responding to manifestations of fearful distress may be reinforcing of this behavioral pattern, with mothers also potentially serving as a distress cue (Park, Belsky, Putnam, & Crnic, 1997). In addition, mothers who are highly responsive to fearful displays, externally regulating infant distress, may be inadvertently decreasing opportunities for internal regulation, contributing to increased fearful reactivity. Buss and Kiel (2013) suggested that a positive direction of association between sensitive parenting, fear and inhibition, may be specific to children already displaying high levels of fearful reactivity. It is also possible that the association between responsiveness and child fear does not become positive until the toddler period, when parents have more opportunities to accommodate vs. encourage their children who encounter fear-eliciting objects and situations at greater frequency than infants. This study provides an opportunity to examine the role of sensitivity in shaping trajectories of approach and avoidance-related temperament attributes, assessed via a multi-method approach across the first year of life, independent of contributions made by additional potentially important mother-infant interaction dynamics (e.g., reciprocity), considered simultaneously in a latent growth modeling framework. As such, this investigation makes a contribution discerning differential predictive contributions of fine-grained parent-child interaction dimensions to the development of fear and positive affectivity in infancy.

Measurement of temperament in infancy has been the subject of considerable debate, as there is no “gold standard,” with distinct advantages and disadvantages of each approach. Although trained observer ratings are thought to control for biases expected in parental perceptions (Seifer et al., 2004), drawbacks of this approach have also been noted, including a limited number of behavioral observations (Stifter et al., 2008), impact of experimenter’s presence (Majdandžić & van den Boom, 2007), and concerns about ecological validity (Rothbart & Goldsmith, 1985). Moderate agreement between parent-report and laboratory observations of temperament has been noted (Garcia Coll et al., 1984), yet largely non-overlapping scores based on parental and independent observer ratings were also reported (Seifer et al., 1994). The present study is responsive to recommendations for a multi-method measurement strategy, leveraging strengths of each approach (Kagan, Snidman, McManis, Woodward, & Hardway, 2002; Stifter et al., 2008).

We examined growth trajectories of smiling and positive affect, as well as fearfulness in infancy, expecting observation-based and mother-reported indices to form coherent multi-method constructs. It was hypothesized that a linear trajectory would fit positive affect indicators. As fear development was shown to deviate from linearity (Braungart-Rieker et al., 2010), our analytic strategy included quadratic and piecewise models, expected to prove superior to a linear trajectory in explaining changes in fearfulness, with the piecewise technique considering each phase of development individually (i.e., 6 to 8, 8 to 10, and 10 to 12 months; Hancock, Harring, & Lawrence, 2013). We identified mother-infant interaction dynamics influencing these trajectories, with responsiveness expected to dampen fear growth, in accord with prior research. Analyses of other mother-infant interaction factors should be considered exploratory.

Method

Participants

A community sample of 148 English-speaking mothers with healthy full-term infants was recruited through birth announcements and a universal prevention program (First Steps), completing longitudinal evaluations (2004–2007). Mothers resided in two adjoining mid-size towns in the Pacific Northwest, were primarily Caucasian (91.9%), and of middle socio-economic status (SES). Caregivers provided demographic information (Table 1) and participated in mother-infant interaction laboratory observations at 4 months-of-age. Mothers responded to the Infant Behavior Questionnaire Revised (Gartstein & Rothbart, 2003) at 6, 8, 10, and 12 months of age, and returned to the laboratory with their infants, who participated in the Laboratory Temperament Assessment Battery (Goldsmith & Rothbart, 1996) Masks and Peek-a-boo episodes.

A few participants did not complete all 6-month measures (see Table 1), with additional attrition in subsequent evaluations. Thus, responders and non-responders at subsequent waves (8, 10, and 12 months of age) were compared via independent-group *t*-tests on the results of preceding assessments, and χ^2 tests for categorical demographic variables. In total, 84 comparisons were conducted to address temperament and parent-child interaction variables, covariates, and demographics reported to describe the sample, with two *t*-tests producing statistically significant results. Comparison of parent-report responders and non-responders at 12 months of age resulted in a significant difference ($t = -2.25$; $p<.05$), with infants of non-responders demonstrating more fearfulness (mean = 0.43; SD = 1.03) in the 10-month laboratory assessment, compared to those whose mothers answered IBQ-R questions (mean = −0.07; SD = 0.70). A significant difference was noted in the comparison of maternal age, which varied for responders and non-responders for 12-month parent report ($t = 2.05$; $p<.05$). Mothers of non-responders were significantly younger (mean = 27; SD = 4.73), compared to responders (mean = 29.24; SD = 5.38). Thus, minimal differenced were observed for responders and non-responders overall.

Caregivers were compensated $20 for each evaluation. Observations of parent-child interactions were timed prior to temperament evaluations, subsequently conducted every two months because of rapid development during this period (Carranza, Pérez-López, Salinas, & Martínez-Fuentes, 2000; Gartstein & Rothbart, 2003).

Measures

The Infant Behavior Questionnaire-Revised (IBQ-R; Gartstein & Rothbart, 2003), a parent-report instrument with good psychometric properties (Gartstein & Rothbart, 2003; Parade & Lerkes, 2008), was utilized to measure fear, and smiling and laughter. The Fear scale measures distress in different naturally-occurring fear-eliciting situations: startle to new stimuli (e.g., “How often during the last week did the baby startle to a sudden or loud noise?”); distress to novel stimuli (e.g., “When visiting a new place, how often did the baby show distress for the first few minutes?”), and sudden changes to the environment (e.g., “How often during the last week did the baby startle at a sudden change in body position [e.g., suddenly being moved]?”), and has demonstrated good psychometric properties (for ages 3 to 6 months, α = .90; for ages 6 to 9 months, α = .89; and for ages 9 to 12 months, α = .87). The Smile and Laughter scale addresses manifestations of positive emotionality during general care-taking and play, with items such as: "How often during the last week did the baby smile or laugh when given a toy?"; "When face was washed, how often did the baby smile or laugh?"; also shown as reliable across the first year of life (for ages 3 to 6 months, α = .85; for ages 6 to 9 months, α = .72; and for ages 9 to 12 months, α = .82; Gartstein & Rothbart, 2003). In the present sample, Fear Cronbach's α values across four time points (i.e., at 6, 8, 10, and 12 months of age) ranged from .79 to .86 (mean α = .82), and for Smiling and Laughter the range was from .76 to .83 (mean α = .79).

The Laboratory Temperament Assessment Battery (Lab-TAB; Goldsmith & Rothbart, 1996), a reliable and valid observation protocol (Diaz & Bell, 2012; Gagne, Van Hulle, Aksan, Essex, & Goldsmith, 2011) was administered, with Masks and Peek-a-boo providing indicators of fear and positive affectivity. These episodes were selected because the scope of the protocol (which included tasks not relevant to the present investigation) precluded multiple episodes targeting the same temperament domain, and pilot testing demonstrated Masks and Peek-a-boo as most reliable in eliciting a range of emotional expressions from infants of different ages evaluated in this study. In Masks, four masks are presented to the infant sitting in a high chair in front of an enclosure with a curtain, lifted to reveal each mask for 10 seconds. Mothers were instructed not to comment or react to the masks, or to their infants' responses, and that they could stop the administration at any time. Trained research assistants coded intensity of facial fear, distress vocalizations, bodily fear, and escape behaviors according to specific criteria (e.g., intensity of body fear: 0 = no sign of body fear; 1 = decreased activity: an apparent or sudden decrease in the activity; sense of body apprehension and ambiguous body fear; 2 = tensing: visible tensing of the muscles, associated with decreased activity; 3 = freezing or trembling: tensing of the entire body with no motion, or trembling due to extreme muscular tension), with ratings assigned every 5 seconds and averaged over the 5-second epochs. Interrater reliability was evidenced by intraclass correlation coefficients (*ICC*s .60–.98; mean *ICC* = .76) computed with scores averaged over epochs, and reported across assessments. There was a tendency for bodily fear and escape behavior codes to be associated with somewhat lower agreement, yet all estimates were at .60 or higher (consistent with our a-priori criteria), and the latter codes contributed to a reliable construct. Across assessments, intensity of fear facial expression, distress vocalization, bodily fear, and escape ratings formed a cohesive scale (Cronbach's α .69–.78; mean α = .74), and were thus standardized and summed forming a fear and avoidance composite, as previously described (e.g., Gartstein & Marmion, 2008; Gartstein et al., 2010).

The Peek-a-boo episode was used to elicit smiling, laughter, and other manifestations of joy and positive affectivity. With infants in a high chair, mothers were asked to disappear behind a screen and re-appear through a series of windows while simultaneously saying "peek-a-boo" and smiling. For the first three trials each mother appears when directed, with two subsequent unsuccessful attempts to "find" the mother, who re-appears on the sixth trial. Coders demonstrating agreement (*ICC*s .80–.92; mean *ICC* = .87) provided ratings for: (1) intensity of smiling; (2) laughter; (3) positive vocalization (e.g., squealing, babbling); and

(4) positive motor activity (e.g., clapping, waving hands), using scales such as intensity of smiling (0 = no smiling; 1 = small smile, with lips only slightly upturned, little or no involvement of cheeks, and no crinkling about eyes; 2 = medium smile, with lips visibly upturned, mouth perhaps open, some bulging of the cheeks, and possible light crinkling about eyes; and 3 = large smile, with lips stretched and quite upturned or perhaps mouth open, cheeks bulging, and definite crinkling around the eyes). The observation-based positive affectivity indicators were standardized and summed to form a composite, based on adequate internal consistency across assessments (Cronbach's α .62–.68; mean α = .64).

Parent-child interaction observations were conducted and recorded in the laboratory at 4 months of age. Ratings for responsiveness, reciprocity, tempo, intensity, and emotional tone (Table 2), designed to serve as markers of dyadic processes that involve coordinated actions of caregivers and infants, were subsequently assigned, as described by Gartstein, Crawford, and Robertson (2008), by coders demonstrating inter-rater reliability (*ICC*s .62–.98; mean *ICC* = .83). There were relatively more instances of lower agreement for emotional tone, likely because of the normative nature of our sample, with little evidence of negative emotional tone in the interactional context. Interactions tasks involved free play, with mothers engaging infants in typical interactions for two minutes, and a teaching task, wherein mothers were asked to teach their baby to do something they were not yet able to accomplish. Caregivers were further instructed that they were responsible for terminating the teaching task, which lasted two minutes on average. Codes assigned across these two tasks produced significantly correlated indicators (*r*s .51–.75; mean *r* = .64) supporting data reduction, and creations of composite scores (sums).

Demographic information included occupational status, utilized to compute the Revised Duncan Sociometric Index (TSEI2; Stevens & Featherman, 1981), an indicator of occupational prestige. The average ranking (mean = 37.62; SD = 26.98) was consistent with sales, administrative support staff, and service occupations.

Analytic Strategy

Our analytic strategy began with multi-method construct development, followed by latent growth curve model (linear, quadratic, and piecewise) testing. Infant sex and SES were then jointly considered as covariates, because of their links with temperament development (e.g., Bornstein et al., 2015; Gartstein & Rothbart, 2003), and retained in subsequent models if they contributed to individual differences in intercept or slope estimates and resulted in acceptable model fit. Mother-infant interaction predictors were considered simultaneously, and retained under the same criteria, with conditional growth curve models based on basic and covariate model testing.

Results

Descriptive statistics were computed first (Table 1). Simple correlations among parent-report and Lab-TAB fear and positive affectivity indicators were computed to determine if multi-method constructs were justified and, contrary to our expectations, two sources of information were largely independent across infancy (Positive Affectivity *r*s .07–.14, mean *r* = .08; Fear *r*s .03–.21, mean *r* = .13), with only 8-month fear correlation coefficient approaching significance (p = .051; Table 3). Latent growth curve models were thus estimated separately for laboratory-based and parent-report indicators (across 6, 8, 10, and 12 months of age) using Mplus 7 (Muthén & Muthén, 2012), with robust full information maximum likelihood estimation to accommodate missing data (e.g., Enders, 2013).

Basic Models: Linear vs. Non-linear Growth

Fear—For laboratory-based observations, a linear model provided least optimal fit, significantly worse than quadratic (χ^2 diff = 22.51, $p < .001$) and piecewise (χ^2 diff = 25.09, $p < .001$) alternatives. Comparison of the latter failed to produce a statistically significant result ($p > .05$). Although BIC and AIC indices (Table 4) were minimized under the quadratic model, parameter estimates for the quadratic trend were not statistically significant. This pattern of results suggests a piecewise representation as most optimal (Figure 1), which was thus considered in subsequent analyses. As none of the χ^2 difference tests were significant for IBQ-R Fear, non-linear trajectory options did not yield improved model fit relative to the linear model (Figure 2); linear model fit was deemed adequate on the basis of fit indices (e.g., minimized AIC and BIC) as well as parameter estimates (i.e., significant mean and slope variance estimates, indicative of a nonzero trajectory with inter-individual differences).

Positive Affectivity—No significant differences among the three basic models for observation-based or parent-report indicators were noted, indicating that the linear functional shape was adequate in describing positive emotionality trajectories. Model fit indices (Table 4), specifically minimized AIC and BIC, along with parameter estimates (significant mean and slope variance), further supported a linear model, regardless of the source of information (Figures 3 and 4).

Time-Invariant Covariate Models: Infant Sex and Family SES

Fear—A significant negative association ($p < .001$) was observed between SES and the 8–10 month trend in a piecewise model – higher SES linked with decreases in observed fearfulness. For parent-report, infant sex was significantly associated with the intercept ($p < .01$; see Table 5), indicating that girls demonstrated higher initial levels of fear.

Positive Affectivity—Covariate models provided support for the contribution of infant sex, which differed for laboratory observations and parent-report. Infant sex significantly predicted the slope of observed positive emotionality ($p < .05$; Table 5), with boys' trajectories steeper over the first year of life. For maternal ratings of smiling and laughter, analyses indicated that infant sex was associated with intercept ($p < .01$) and slope (p < . 05) values, wherein girls started out lower than boys but demonstrated greater gains over the first year of life (Table 5).

Conditional Growth Models: Mother-infant Interaction Dynamics as Predictors

Fear—Responsiveness was significantly associated with initial observed fear and avoidance (Level in a piecewise model; Table 5), as more responsive exchanges contributed to lower fearfulness. Association between tempo and slope of the third trend in a piecewise model was significant - faster-paced play linked with decreases in fear. Intensity was also predictive of the 10–12 month trend, but more intense interactions were associated with increases in fearfulness. Reciprocity was a significant contributor to the linear slope of mother-reported fear, as higher levels of synchrony were linked with increases (Table 5).

Positive Affectivity—No significant observed positive affectivity effects were identified; however, sensitivity, tone, and tempo made significant contributions to trajectories of mother-reported smiling and laughter (Table 5). Higher maternal responsiveness was linked with lower initial levels of positive emotionality, and an increase over the first year of life. Greater reciprocity and a more positive emotional tone were associated with higher initial levels, whereas tempo contributed to the slope of smiling and laughter, with faster-paced interactions resulting in increases.

Discussion

As laboratory observation and parent-report indicators of fear and positive affectivity were not significantly correlated, support for multi-method scores was not obtained, and model testing was conducted separately for these sources of information. Basic models were established, selecting among linear and non-linear (quadratic vs. piecewise) options. Our hypotheses concerning growth trajectories were partly confirmed, with a linear model superior in characterizing positive affectivity trajectories, and a deviation from linearity (best captured by the piece-wise model) noted for laboratory-based fear. We hypothesized greater responsiveness would predict lower fearfulness, which was demonstrated for laboratory-based scores in the predicted direction, but for the intercept, rather than slope estimates, as anticipated. Overall, differential predictive relations with fear and positive affectivity growth parameters were observed for the fine-grained dimensions of parent-child interactional dynamics examined in this study, despite significant intercorrelations among these domains (Table 6).

Results suggest meaningful developmental shifts in affective components of approach and avoidance, and although this developmental progression was largely linear in nature, we found anticipated evidence of deviation from linearity for laboratory-based fearfulness. These results indicate that alongside relative stability - in this study longitudinal correlations were all statistically significant (rs .44–.62; mean $r = .52$; Table 7) - systematic changes in infant temperament can also be reliably identified. Consistency in the rank order of individuals has been emphasized in longitudinal research, yet a considerable amount of variance is typically unaccounted for, as “71%–80% of the variance in temperament at a later time point was not explained by temperament at an earlier time point” (Bornstein et al. 2015; p. 856). Individual differences in growth trajectories are thus important to consider along with stability, as affective components of approach and avoidance change over time, in part due to maturation, but also experience, with parent-child interactions as a critical context.

In practical terms, results of this study indicate that infants can be expected to increase their expressions of emotionality associated with approach and avoidance tendencies, displaying greater fearful reactivity and positive emotionality across the first year of life. Thus, caregivers should not be alarmed if they note such shifts over time, observing more frequent or intense emotional reactions later in infancy. Laboratory observations of fearful reactivity, best explained by a piecewise model, suggest a particularly significant shift at the end of the first year of life – between 10 and 12 months of age. Although additional research is required to definitively interpret this trend, which did not emerge based on parent-report, it may be indicative of a marked developmental transition in infants' responses to novel stimuli in unfamiliar settings, relative to those encountered in the course of daily routine.

Sensitivity of mother-infant interactions translated into dampening fearful reactivity, with infants of more sensitive mothers demonstrating lower initial levels of fear. That is, play interactions marked by greater sensitivity and responsiveness translated into lower levels of infant fearful distress at 6 months of age. However, Braungart-Rieker et al. (2010) reported that higher sensitivity resulted in slower development of fearfulness, and our results are not entirely consistent, likely as a function of differences in the timing of evaluations and assessment strategies. Nonetheless, responsiveness played a protective role with respect to fear development in both studies. Glöggler and Pauli-Pott (2008) found that children of more sensitive mothers engaged in greater active regulation in a fear-eliciting situation, which could explain this protective effect. This interpretation is consistent with maternal sensitivity described as the mechanism protecting behaviorally inhibited children from developing increased anxiety by promoting effective emotion-regulation strategies (Buss & Kiel, 2013). Results of the present study suggest this promotion of regulation could play a protective function as early as the first year of life. It should be noted, however, that our assessment of sensitivity was conducted in the context of a play interaction, rather than a distress-eliciting situation. The latter would provide an opportunity to address mechanisms related to promotion of regulation more directly, as such efforts would be required of the infant.

Analyses addressing contributions of sensitivity to positive affectivity, and other mother-infant interaction dynamics expected to influence approach and avoidance-related growth, should be considered exploratory, and require replication in future research. Associations between tempo and intensity of interactions, and slope of the third trend (10 to 12 months of age) in a piecewise model for observed fearfulness were significant, but differed in direction. That is, faster-paced play was linked with decreases in fear, whereas more intense interactions were associated with increases in fearfulness. Reciprocity predicted greater increases in mother-reported fear, similar to the effect noted for intensity of exchanges in the observed fearfulness piecewise model. It may be that more reciprocal exchanges are also challenging to the infant, similar to the highly intense interactions, contributing to increases in fear, albeit from mothers' perspective only. On the other hand, greater reciprocity and a more positive emotional tone were associated with higher initial levels of mother-reported smiling and laughter, and tempo contributed to the slope, with faster-paced interactions resulting in greater smiling and laughter increases. Thus, tempo was in a sense protective with respect to fearfulness and positive affectivity, contributing to decreases in fear reactivity and increases in smiling and laughter, whereas the effects associated with reciprocity were mixed for the two temperament domains. It should be noted, however, this protection could be tempered, as extremely low levels of fearfulness coupled with high surgency and positive affectivity have been linked with a greater risk for externalizing type problems (Berdan, Keane, & Calkins, 2008; Frick & Morris, 2004).

It is not surprising that more emotionally positive play exchanges translated into higher baseline infant smiling and laughter, or that more responsive play led to an increase in positive emotionality over the first year of life. However, an association between higher sensitivity and lower initial levels of smiling and laughter was not anticipated, and may be best interpreted as consistent with “child effects”, although parent-child interactional dynamics were conceptualized as etiological factors with respect to infant fear and positive emotionality in this study. Nonetheless, it may be that mothers who perceive their infants as displaying fewer positive emotions increase responsiveness in play as a result, over time contributing to a steeper growth of smiling and laughter. This possibility cannot be adequately addressed in the present study, as maternal responsiveness was measured 2 months prior to the evaluation of infant temperament, and should be examined in the future. Possible “child effects” related to trajectories of fear and other aspects of mother-infant interactions should also be considered. Overall, these preliminary findings indicate that mother-infant interactions influence temperament development in infancy, and factors other than responsiveness should be investigated in this context. These results await replication, and could be informative to parents, providing guidance regarding interactional strategies and their links with temperament development.

Our results contribute to the discussion concerning agreement between laboratory-observation and parent-report indicators of temperament, and their respective strengths and weaknesses. The low non-significant correlations between parent-report and observation-based scores in this study were more consistent with the Seifer et al. (1994) than Garcia Coll et al. (1984) findings. These sources of information agreed only with respect to a linear functional shape being optimal for the positive affectivity trajectory, with considerable differences in covariate and conditional models based on parent-report and laboratory observations. Discordant models for fearfulness could be indicative of differences in the ability of the two methodologies to detect developmental shifts in this domain of temperament. It has been suggested that laboratory-based measures offer an advantage in terms of sensitivity to developmental changes, as parents tend to be stable in their expectations, not shifting perceptions of child attributes effectively in response to developmental transitions (Gagne et al., 2011; Saudino, 2003), and our results support this perspective. This additional sensitivity may be especially critical in measuring temperament during periods of rapid transitions, such as early developmental shifts in fear and avoidance examined in this study. More generally, observation-based techniques may be preferred to parent-report in the context of research questions concerned with change at times of rapid development.

Periods of rapid transition also appear optimal for utilizing non-linear growth alternatives, piecewise models in particular. In this study, a piecewise trajectory deemed optimal for observed fear enabled us to examine contributions of parent-child interaction factors specific to the notable change occurring between 10 to 12 months of age (Figure 1). Of interest, results indicated associations between earlier tempo and intensity of parent-child play and this shift in observed fear, so that more intense, overall stimulating interactions were predictive of increases in fearfulness, with faster-paced play having an opposite effect, dampening expressions of fearful distress. Although these results require replication and extension, developmental shifts observed in fear (and the associated parent-child interaction dynamics) may be important to a variety of outcomes, and future research should link these to symptoms of developmental psychopathology. Despite low and non-significant correlations between observation-based and parent-report indicators of positive affectivity (Table 3), these sources of information provided convergent information regarding growth in the first year of life, as the linear model was deemed optimal for both. This convergence stands in opposition to the results obtained for fearful reactivity, wherein a discrepancy may have been induced by a particularly rapid developmental transition at the end of the first year of life.

A few shortcomings deserve mentioning, as the present sample is limited with respect to ethnic and economic diversity, largely as a function of demographics in our catchment area. As the assessment scheme was limited to observation-based and parent-report indicators, future research should consider cortisol reactivity or EEG asymmetry indicators of fear and avoidance, as well as positive affectivity and approach. While generally satisfactory, reliability of Lab-TAB and parent-child interaction observation-based indictors could have attenuated relations examined in this study, resulting in fewer significant effects. In addition, although care was taken to ensure coder consistency, greater changes in observation-based indictors could reflect the fact that caregiver perceptions are provided by a single individual. Finally, single episodes were utilized to address fear and positive affectivity, respectively, limiting the scope of observational measures included in this study. Future research should include additional fear and positive emotion-eliciting tasks in an effort to develop more robust observation-based indicators, which could lead to stronger associations with parent-report scores.

Results suggest important developmental shifts in fear and positive affectivity over the first year of life, in part a function of mother-infant interaction dynamics. Although parent-report and laboratory-based scores were not significantly correlated, and overall did not provide a uniform picture in terms of the observed results, both methodologies appear to capture important developmental transitions in emotional functioning in the first year of life.

Acknowledgments

Research described in this manuscript was made possible by a Small Research Grant (R03 MH0670) from the National Institute of Mental Health (NIMH) to the first author.

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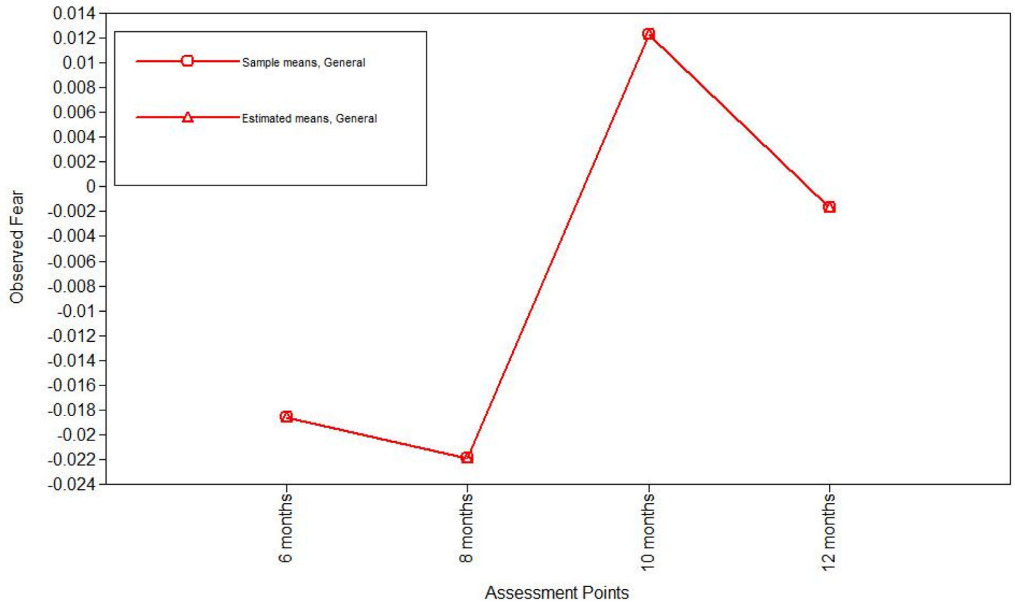

Figure 1.

Observed fear reactivity from 6 to 12 months of age.

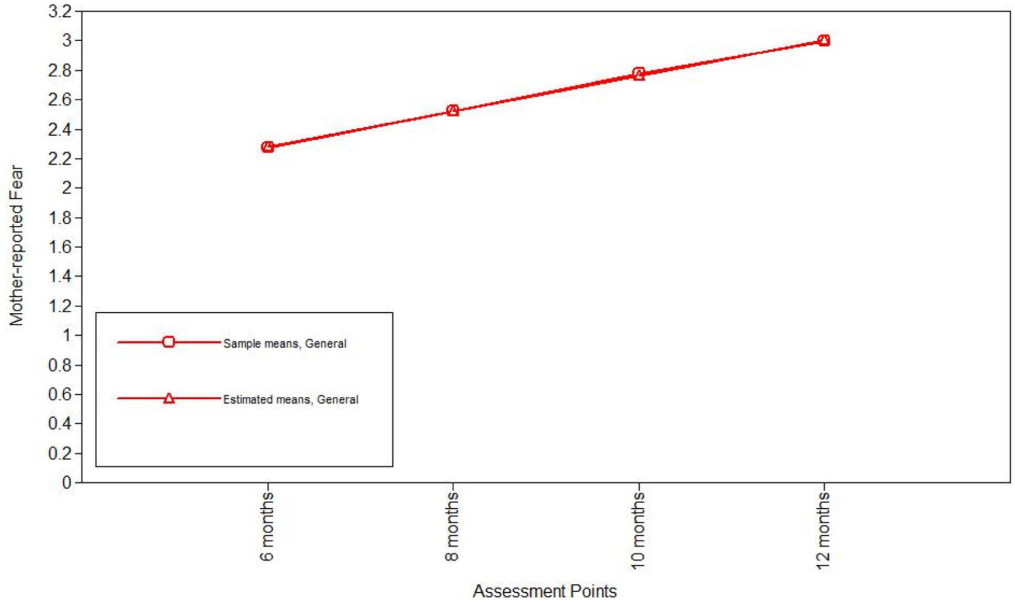

Figure 2.
Mother-reported fear reactivity from 6 to 12 months of age.

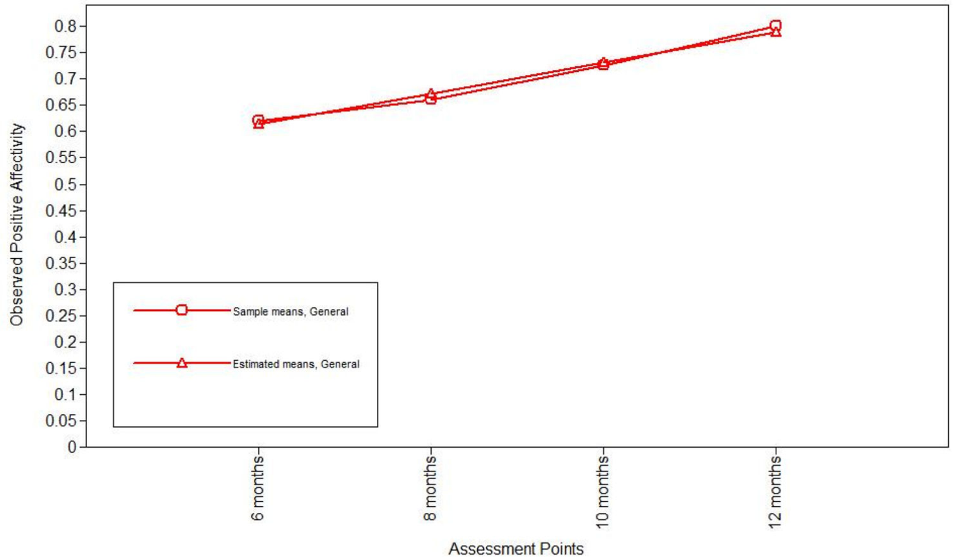

Figure 3.
Observed positive affectivity from 6 to 12 months of age.

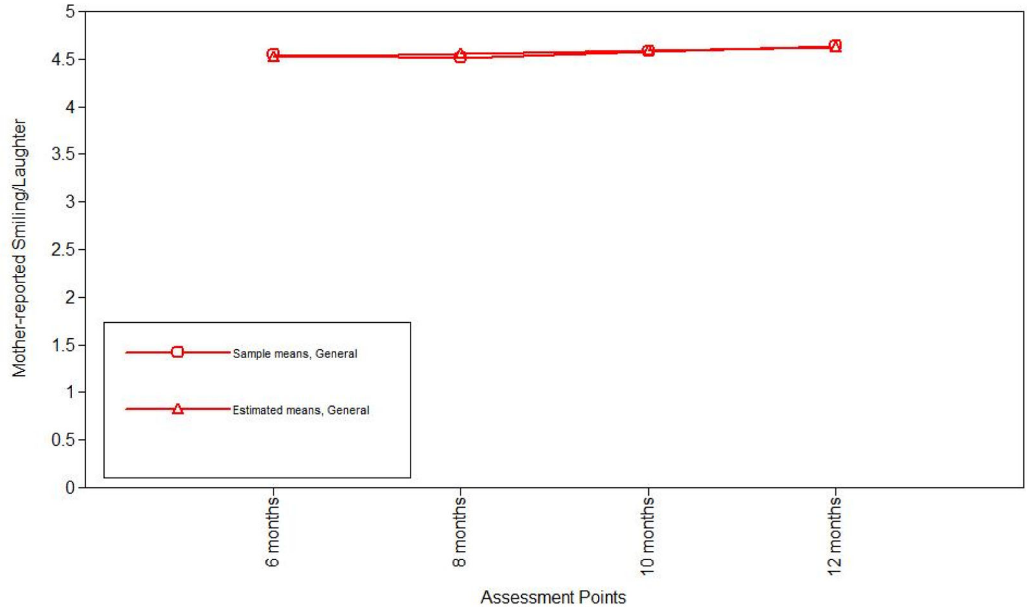

Figure 4.
Mother-reported smiling and laughter from 6 to 12 months of age.

Table 1

Descriptive Statistics: Primary Caregiver and Infant Demographics, Study Variables

Variable	Mean	Range	Standard Deviation	Percentage
Maternal Age (Years)	28.67	20 – 42	5.27	
Infant Sex				
Males				50.8%
Females				49.2%
Ethnicity				
Caucasian				91.9%
African American				3.7%
Asian				2.9%
Hispanic/Latino				1.5%
Living Arrangement				
Married				93.1%
Divorced/Separated				1.6%
Single				3.8%
Remarried				1.5%
Highest Education Attainment	15.87 Years	10 – 20 Years	2.29 Years	
Less Than High School				2.8%
High School Diploma				6.4%
Some College				26.2%
Bachelors Degree				39.7%
Graduate Degree				24.8%
Family Income				
$0 – $7,000				5.2%
$7,001 – $10,000				
3.0%				
$10,001 – $13,000				5.2%
$13,001 – $16,000				4.5%
$16,001 – $20,000				9.0%
$20,001 – $30,000				10.4%
$30,001 – $50,000				29.9%
$50,001 – $75,000				17.2%
Over – $75,000				15.7%
Mother-infant Interaction Factors (*N* = 148)				
Sensitivity/Responsiveness	10.58	4.00 – 14.00	2.25	
Reciprocity/Synchrony	7.46	2.00 – 14.00	2.57	
Tempo	7.12	2.00 – 12.00	2.54	
Emotional Tone	9.60	5.00 – 14.00	1.97	
Intensity	7.74	2.00 – 13.00	2.61	
Approach/Avoidance Indicators				
Parent-report of Fear				

Variable	**Mean**	**Range**	**Standard Deviation**	**Percentage**
6-Month IBQ-R (*N* = 147)[1]	2.27	1.00 – 4.31	0.77	
8-Month IBQ-R (*N* = 114)	2.51	1.06 – 5.25	0.91	
10-Month IBQ-R (*N* = 102)	2.81	1.00 – 5.13	0.85	
12-Month IBQ-R (*N* = 101)	2.98	1.00 – 5.56	0.93	
Laboratory Observations of Fear				
6-Month Lab-TAB (*N* = 137)[2]	0.00	−1.74 – 3.13	1.00	
8-Month Lab-TAB (*N* = 108)	0.00	−0.95 – 2.85	1.00	
10-Month Lab-TAB (*N* = 101)	0.00	−0.90 – 2.45	1.00	
12-Month Lab-TAB (*N* = 97)	0.00	−1.19 – 2.02	1.00	
Parent-report of Smiling/Laughter				
6-Month IBQ-R (*N* = 147)	4.50	1.70 – 6.80	1.00	
8-Month IBQ-R (*N* = 114)	4.49	2.00 – 6.20	0.97	
10-Month IBQ-R (*N* = 102)	4.48	2.30 – 6.70	0.97	
12-Month IBQ-R (*N* = 101)	4.56	2.10 – 6.60	0.91	
Laboratory Observations of Positive Affectivity				
6-Month Lab-TAB (*N* = 137)	0.00	−1.61 – 2.14	1.00	
8-Month Lab-TAB (*N* = 108)	0.00	−1.75 – 2.17	1.00	
10-Month Lab-TAB (*N* = 101)	0.00	−2.05 – 2.13	1.00	
12-Month Lab-TAB (*N* = 97)	0.00	−1.97 – 1.67	1.00	

Note. Mother infant interaction factors represent composite scores (sums); IBQ-R scores rep-resent 1–7 Likert scales; Lab-TAB composites are standardized sums.

[1]One family did not complete 6-month IBQ-R.

[2]Ten infants did not participate in 6-month laboratory observations.

Table 2

Parent-Infant Interaction Coding Scheme

Scales	Codes/Descriptions 1	4	7
Responsiveness/sensitivity	Extremely non-responsive/sensitive: lacks genuine empathy and interest in infant. Parent does not a) initiate play; b) reinforce infant activities; c) draw infant into joint activity; d) give encouragement; e) allow infant independent activity; f) effectively extends infant activity	Moderately responsive/sensitive: moderate empathy and interest in infant. Parent periodically a) initiates play b) reinforces infant activities; c) draws infant into joint activity; d) gives encouragement; e) allows infant independent activity; f) effectively extends infant activity	Extremely responsive/sensitive: prompt, regular, genuine empathy and interest in infant. Parent consistently a) initiates play; b) reinforces infant activities; c) draws infant into joint activity; d) gives encouragement; e) allows infant independent activity; f) effectively extends infant activity
Reciprocity/synchrony	Extremely asynchronous/non-reciprocal: a) low frequency of simultaneous movement; b) low tempo similarity; c) low coordination/smoothness	Moderately synchronous/reciprocal: a) moderate frequency of simultaneous movement; b) moderate tempo similarity; c) moderate coordination/smoothness	Extremely synchronous/reciprocal: a) high frequency of simultaneous movement; b) high tempo similarity; c) high coordination/smoothness
Tempo	Extremely slow paced: a) low frequency of changing objects/activity; b) low levels of physical activation; c) low levels of verbal/vocal expression	Moderately paced: a) moderate frequency of changing objects/activity; b) moderate levels of physical activation; c) moderate levels of verbal expression	Extremely fast paced: a) high frequency of changing objects/activity; b) high levels of physical activation; c) high levels of verbal/vocal expression
Intensity	Extremely low intensity: a) very quiet verbal/vocal exchange; b) low levels of complexity; c) low parental exuberance	Moderate intensity: a) moderately audible verbal/vocal exchange; b) moderate complexity; c) moderate parental exuberance	Extremely high intensity: a) very loud verbal/vocal exchange; b) high levels of complexity; c) high parental exuberance
Emotional tone	Extremely negative emotional tone: a) frequent critical/negative comments; b) frequent expressions of distress; c) frequent negative physical displays	Neutral emotional tone: a) mostly neutral verbal exchanges; b) few, if any, expressions of affect; c) few, if any, physical displays of affect	Extremely positive emotional tone: a) frequent enthusiastic/positive comments; b) frequent expressions of positive emotion/joy/pleasure; c) frequent positive physical displays

Note. All coding scales based on 7-point Likert Scales (1–7).

Table 3

Correlations Between Parent-Report and Observation-Based Indicators of Fear and Positive Affectivity.

Fearfulness	**Reported fear 6M**	**Reported fear 8M**	**Reported fear 10M**	**Reported fear 12M**
Observed fear 6M	0.15			
Observed fear 8M		0.21[#]		
Observed fear 10M			0.03	
Observed fear 12M				0.14
PA	Reported PA 6M	Reported PA 8M	Reported PA 10M	Reported PA 12M
Observed PA 6M	−0.08			
Observed PA 8M		0.03		
Observed PA 10M			0.14	
Observed PA 12M				0.08

[#] $p < .10$

Note. M = months; PA = positive affectivity

Table 4

Model Fit Statistics, Estimated Intercepts, and Slopes

Fearfulness	**Observed Fear: Lab-TAB Masks** ***N* = 137**			**Mother-Reported Fear IBQ-R** ***N* = 147**		
Model	Linear (df = 5)	Quadratic (df = 1)	Piecewise (df = 0)	Linear (df = 5)	Quadratic (df = 1)	Piecewise (df = 0)
χ^2	23.09 (*p* = *.00*)	0.11 (*p* = *.74*)	0.00 (*p* = *1.00*)	2.79 (*p* = *.73*)	0.21 (*p* = *.88*)	0.00 (*p* = *1.00*)
RMSEA	0.17	0.00	0.00	0.00	0.00	0.00
SRMR	0.14	0.01	0.00	0.04	0.00	0.00
AIC	960.48	945.01	946.91	892.49	897.52	899.50
BIC	986.22	982.18	986.94	917.94	934.29	939.09
Inter-cept/Level[1]	−0.02	−0.03	−0.02	2.28**	2.01**	2.27**
Intercept/Level Variance	0.29**	−0.05	0.64**	0.36**	1.06	0.56**
Estimated Slope	0.01	0.01	------	0.24**	0.28**	------
Slope Variance	0.01	0.12	------	0.05*	0.71	------
Quadratic Slope	-----	0.00	------	------	-0.01	------
Quadratic Slope Variance	-----	0.06	-----	-----	0.03	------
Trend 1 Slope	------	------	0.00	------	------	0.25**
Trend 2 Slope	------	------	0.03	------	------	0.25**
Trend 3 Slope	------	------	0.12	------	------	0.22**
Trend 1 Variance	------	------	0.55**	------	------	0.67**
Trend 2 Variance	------	------	1.42**	------	------	0.55**
Trend 3 Variance	------	------	0.85**	------	------	0.43**

Positive Affectivity	**Observed Positive Affectivity: Lab-TAB Peek-a-boo** ***N* = 147**			**Mother-Reported Smiling/Laughter IBQ-R** ***N* = 148**		
Model	**Linear (df = 5)**	**Quadratic (df = 1)**	**Piecewise (df = 0)**	**Linear (df = 5)**	**Quadratic (df = 1)**	**Piecewise (df = 0)**
χ^2	4.29 (*p* = *.51*)	0.03 (*p* = *.87*)	0.00 (*p* = *.00*)	4.45 (*p* = *.92*)	1.33 (*p* = *.97*)	0.00 (*p* = *.00*)
RMSEA	0.00	0.00	0.00	0.00	0.00	0.00
SRMR	0.06	0.00	0.00	0.03	0.02	0.00
AIC	350.82	355.99	355.96	1162.76	1167.50	1178.04

Positive Affectivity	Observed Positive Affectivity: Lab-TAB Peek-a-boo *N* = 147			Mother-Reported Smiling/Laughter IBQ-R *N* = 148		
Model	**Linear (df = 5)**	**Quadratic (df = 1)**	**Piecewise (df = 0)**	**Linear (df = 5)**	**Quadratic (df = 1)**	**Piecewise (df = 0)**
BIC	376.49	391.07	395.89	1192.38	1208.98	1237.30
Inter-cept/Level[1]	0.61**	0.62**	0.62**	4.50**	4.51**	4.50**
Intercept/Level Variance	0.09**	0.14**	0.15**	0.84**	0.85**	1.15**
Estimated Slope	0.06**	0.03	------	0.04#	0.01	------
Slope Variance	0.01*	0.11	------	0.03**	0.08	------
Quadratic Slope	------	0.01	------	------	0.01	------
Quadratic Slope Variance	------	0.01	------	------	0.01	------
Trend 1 Slope	------	------	0.04	------	------	0.07
Trend 2 Slope	------	------	0.07	------	------	-0.03
Trend 3 Slope	------	------	0.07	------	------	0.06
Trend 1 Variance	------	------	0.15**	------	------	0.58**
Trend 2 Variance	------	------	0.15**	------	------	0.46**
Trend 3 Variance	------	------	0.19**	------	------	0.51**

* $p < .05$;

** $p < .01$;

\# $p < .10$.

[1] Level corresponds to intercept in the piecewise model.

Notes. Best model fit: fear = piecewise; positive affectivity = linear; Trend 1= 6–8 months; Trend 2 = 8–10 months; Trend 3 = 10–12 months.

RMSEA = root-mean-square error of approximation; SRMR = standardized root-mean-square residual; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion.

Table 5

Predicting Fear and Positive Affectivity: Covariates, Mother-infant Interaction Factors

Model	Path Coefficients (Standardized)
Fearfulness	
Observed Fear: Lab-Tab Masks	
Covariates (Sex, SES) Model Fit: χ^2 (0, N = 137) = 0.00, p = 1.00; RMSEA = 0.00; SRMR = 0.00; AIC = 2,252.25; BIC = 2,332.99	
SES Level and Trend Estimates[1]	
Observed Fear Level/SES	0.19#
Observed Fear Trend1/SES	0.09
Observed Fear Trend2/SES	−0.37**
Observed Fear Trend3/SES	0.11
Mother-Infant Interaction Model Fit: χ^2 (0, N = 137) = 0.00, p = .00; RMSEA = 0.00; SRMR = 0.00; AIC = 4477.94; BIC = 4672.31	
Sensitivity Level and Trend Estimates	
Observed Fear Level	−0.21*
Observed Fear Trend1	−0.01
Observed Fear Trend2	0.16
Observed Fear Trend3	0.00
Tempo Level and Trend Estimates	
Observed Fear Level	0.27#
Observed Fear Trend1	0.09
Observed Fear Trend2	−0.08
Observed Fear Trend3	−0.31*
Intensity Level and Trend Estimates	
Observed Fear Level	−0.12
Observed Fear Trend1	0.07
Observed Fear Trend2	−0.20
Observed Fear Trend3	0.41*
Mother-Reported Fear IBQ-R	
Covariates (Sex, SES) Model Fit: χ^2 (9, N = 147) = 19.80, p = .02; RMSEA = 0.04; SRMR = 0.03; AIC = 2193.65; BIC = 2247.48	
Sex Intercept and Slope Estimates	
Mother-reported Fear Intercept/Infant Sex	0.30**
Mother-reported Fear Slope/Infant Sex	−0.15
Mother-Infant Interaction Model Fit: χ^2 (17, N = 147) = 20.59, p = .25; RMSEA = 0.00; SRMR = 0.05; AIC = 4002.96; BIC = 4146.82	
Reciprocity Intercept and Slope Estimates	
Mother-reported Fear Intercept	−0.24#
Mother-reported Fear Slope	0.30*
Positive Affectivity	
Observed Positive Affect: Lab-Tab Peek-a-boo	
Covariates (Sex, SES) Model Fit: χ^2 (9, N = 147) = 11.72, p = .23; RMSEA = 0.05; SRMR = 0.06; AIC = 1652.05; BIC = 1705.88	
Sex Intercept and Slope Estimates	
Observed Positive Affect Intercept/Infant Sex	0.00

Model	Path Coefficients (Standardized)
Observed Positive Affect Slope/Infant Sex	−0.32 *
Mother-Infant Interaction Model Fit: χ^2 (18, *N* = 147) = 26.32, *p* = .07; RMSEA = 0.05; SRMR = 0.04; AIC = 3501.21; BIC = 3645.0	
Sensitivity Intercept and Slope Estimates	
Observed Positive Affect Intercept	0.27#
Observed Positive Affect Slope	−0.16
Mother-Reported Smiling/Laughing IBQ-R	
Mother-Infant Interaction Model Fit: χ^2 (9, *N* = 148) = 12.26, *p* = .20; RMSEA = 0.05; SRMR = 0.04; AIC =2153.79; BIC= 2207.62	
Sex Intercept and Slope Estimates	−0.28 **
Mother-reported Positive Affect Intercept/Infant Sex	
Mother-reported Positive Affect Slope/Infant Sex	0.27 *
Mother-Infant Interaction Model Fit: χ^2 (17, *N* = 148) = 12.20, *p* = .78; RMSEA = 0.00; SRMR = 0.03; AIC = 3950.55; BIC = 3950.55	
Sensitivity Intercept and Slope Estimates	
Mother-reported Positive Affect Intercept	−0.27 **
Mother-reported Positive Affect Slope	0.32 *
Reciprocity Intercept and Slope Estimates	
Mother-reported Positive Affect Intercept	0.29 **
Mother-reported Positive Affect Slope	−0.27#
Tone Intercept and Slope Estimates	
Mother-reported Positive Affect Intercept	0.35 **
Mother-reported Positive Affect Slope	0.03
Tempo Intercept and Slope Estimates	
Mother-reported Positive Affect Intercept	−0.07
Mother-reported Positive Affect Slope	0.41 *

[*] $p < .05$;

[**] $p < .01$;

[#] $p < .10$.

[1] Level corresponds to intercept in the piecewise model.

Notes. Best model fit: fear = piecewise; positive affectivity = linear; Trend 2 = 8–10 months; Trend 3 = 10–12 months.

RMSEA = root-mean-square error of approximation; SRMR = standardized root-mean-square residual; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; Trend 1 = 6–8 months.

[1] Only covariates associated with significant paths to intercept/level or slope/trend estimates were presented in the table.

Table 6

Intercorrelations Between Parent-Child Interaction Variables at 4 Months

	1	2	3	4	5
1.Responsiveness					
2. Reciprocity	0.45**				
3. Tempo	0.35**	0.73**			
4. Intensity	0.39**	0.62**	0.79**		
5. Emotional Tone	0.56**	0.29**	0.29**	0.20**	

** $p < .01$

Table 7

Stability of Fear and Positive Affectivity Indicators Across Time

	6–8 months	8–10 months	10–12 month	6–10 month	6–12 month	8–12 month
Observed Fear	0.55**	0.56**	0.62**	0.52**	0.51**	0.59**
Reported Fear	0.53**	0.48**	0.61**	0.44**	0.52**	0.53**
Observed PA	0.46**	0.47**	0.49**	0.53**	0.49**	0.51**
Reported PA	0.53**	0.48**	0.61**	0.44**	0.52**	0.53**

** $p < .01$

Note. PA = positive affectivity