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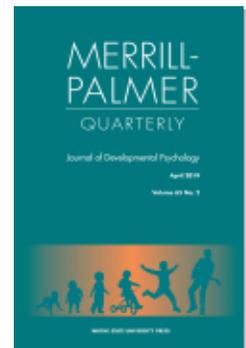
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## Temperamental Growth in Infancy: Demographic, Maternal Symptom, and Stress Contributions to Overarching and Fine-Grained Dimensions

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Temperament growth has been examined in infancy, but the spectrum of reactive and regulatory dimensions was not previously considered. We evaluated linear and nonlinear growth trajectories for overarching factors and fine-grained indicators of infant temperament obtained via parent report ( $N = 143$ ) at 4, 6, 8, 10, and 12 months of age. Contributions of infant sex, family socioeconomic status, maternal stress, depression, and anxiety to trajectory parameters were also considered. Results indicated nonlinear trajectories as best fitting for negative emotionality (quadratic model) and regulatory capacity/orienting (piecewise), with a linear model deemed most optimal for positive affectivity/surgency. However, models of best fit associated with the overarching temperament factors were not consistently representative of the underlying fine-grained dimensions. Results indicate primarily nonlinear growth of infant temperament across the first year of life and support the importance of fine-grained level analyses. Effects of infant sex, socioeconomic status, maternal stress, anxiety and depression symptoms were generally consistent with hypotheses.

Multiple temperament definitions have been proposed, with some work focusing on types, such as the classic categories including “difficult” temperament (Thomas & Chess, 1977) and behavioral inhibition (Kagan, 1998).

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More recently, 3–5 types (e.g., negative/reactive) have been identified as early as infancy (Beekman et al., 2015; Gartstein, Hancock, & Iverson, 2018). Although categorical approaches to temperament can be appealing, as these address the “What kind of child is this?” question, dimensional definitions have advantages of their own, especially in the longitudinal/developmental model context. Dimensional scores provide an opportunity to track individual trajectories over time, which is essential for research examining individual differences in temperament, thought to undergo significant developmental transitions in early childhood.

Rothbart’s psychobiological model of temperament (Rothbart & Derryberry, 1981), the primary theoretical foundation for the present investigation, has gained acceptance in part because it represents a systematic integration of existing temperament and personality theories, and other relevant areas of scientific inquiry, including neuroscience and comparative research. According to the psychobiological model, *temperament* represents constitutionally based individual differences in reactivity and regulation, influenced over time by heredity, maturation, and experience (Gartstein, Putnam, Aaron, & Rothbart, 2016; Rothbart & Derryberry, 1981). Rothbart’s temperament framework is notable in part because individual differences are conceptualized as developing as a function of maturation, contextual, and biological inputs. This developmental element of Rothbart’s model is consistent with the *differential emotions theory* (Abe, Beetham, & Izard, 2003; Izard, 1977), stressing that typical development of emotions involves more clearly defined patterns of facial expressions over time, thought to occur as a function of the neural system maturation and infant–other interactions. Despite notable differences, relevant definitions share common themes, outlining temperament as a set of early appearing and biologically influenced individual differences that form a core of emerging personality (Gartstein et al., 2016). Temperament is typically characterized as relatively stable, and, although these attributes appear to be enduring, manifestations of temperament change over time, with especially rapid development unfolding during infancy.

Structurally, the Rothbart model has framed temperament in terms of the overarching and fine-grained components. Although the overarching factors are largely conserved across childhood—negative emotionality, surgency/extraversion, and orienting/effortful control, with this three-factor structure reflecting infant, toddler, and child temperament—considerable variability exists at the fine-grained level. Negative emotionality, which parallels the adult personality trait of neuroticism, in infancy includes fine-grained components of fear, sadness, distress to limitations, and low falling reactivity (i.e., infants’ ability to lower their own distress/arousal;

Gartstein & Rothbart, 2003). Developmentally, negative emotionality attributes emerge at birth, initially appearing as undifferentiated distress and progressing to discernible manifestations of fear, anger, and sadness by the third month of life (Gartstein & Rothbart, 2003; Sroufe, 1996). Fear, as well as distress to limitations, generally increases over the second half of the first year of life (Carranza, Pérez-López, González Salinas, & Martínez-Fuentes, 2000; Rothbart, 1986, 1988), with the former related to the development of inhibition of approach toward novel and/or intense stimuli (Rothbart, 1988, 1994). Increases in distress to limitations shown to plateau by toddlerhood (e.g., Lemery, Goldsmith, Klinnert, & Mrazek, 1999), are thought to result in part from improved infant locomotor capabilities and an associated higher frequency of caregiver limit-setting (Gartstein & Rothbart, 2003).

Surgency in infancy is largely manifested through displaying pleasure (e.g., smiling and laughing) and approaching stimuli (Gartstein & Rothbart, 2003; Rothbart, 1989), incorporating characteristics of activity and enthusiasm (e.g., Rothbart & Ahadi, 1994). Individuals higher in positive affect have a tendency to be engaged, rather than disengaged, with their environment (Lonigan, Phillips, & Hooe, 2003), presumably because of enhanced approach tendencies that result from greater inputs of the *behavior activation system* (Gray, 1994; Rothbart, Ahadi, & Hershey, 1994). Positive emotionality (smiling, etc.) is rarely expressed during the newborn period, observed more reliably between 2 and 3 months of age (Rothbart, 1989). Positive emotionality continues to develop throughout the first year of life (Kochanska, Coy, Tjebkes, & Husarek, 1998; Rothbart, 1989), becoming increasingly stable thereafter (Lemery et al., 1999).

In infancy, the regulation-related factor is labeled *regulatory capacity/orienting* and includes duration of orienting, soothability, cuddliness/affiliation, and low-intensity pleasure, jointly predicting later-appearing effortful control, supported by executive functions that enable more effective behavioral/emotional control (Gartstein, Bridgett, Young, Panksepp, & Power, 2013; Posner, Rothbart, Sheese, & Voelker, 2012). Attention is closely linked with the emergence of self-regulation, and even very young infants rely on attentional strategies, such as self-stimulation and gaze aversion, to regulate the balance between needs of their internal systems (e.g., arousal) and external stimulation (Bornstein & Suess, 2000; Rothbart, Ziaie, & O'Boyle, 1992). Toward the end of the first year, advances in attentional skills associated with executive functions and the underlying maturation of the frontal brain regions contribute to increasing flexibility of orienting reactions and improved regulation (Bridgett, Burt, Edwards & Deater-Deckard, 2015; Posner et al., 2012).

An extensive literature has demonstrated relative consistency of temperament over time (e.g., Bornstein et al., 2015; Buss, 1989; Plomin, Loehlin, & DeFries, 1985; Rothbart, 1986). By comparison, developmental changes in temperament have received relatively little attention, yet can be expected because of rapid overall development occurring throughout infancy (Bornstein, Arterberry, & Lamb, 2014). Important questions regarding developmental transitions involve the nature of change or the shape of its trajectory over time. For example, anger reactions in infancy were described as developing in a U-shaped manner (Carranza et al., 2000), with a drop linked to greater flexibility in shifting eye gaze (Johnson, Posner, & Rothbart, 1991). Similarly, a quadratic slope was proposed for duration of orienting (Ruff & Rothbart, 1996), with decreases between 6 and 9 months, followed by a subsequent increase (Carranza et al., 2000).

Four studies were conducted to specifically examine temperament growth in samples of healthy/typically developing babies across the first year of life (Braungart-Rieker, Hill-Soderlund, & Karrass, 2010; Bridgett, Laake, Gartstein, & Dorn, 2013; Gartstein et al., 2010; Gartstein, Hancock, & Iverson, 2018). Gartstein et al. (2010) reported increases in fear across infancy, especially steep at the end of the first year of life. Parent-report and observation-based indicators were used, with parallel trajectories emerging across these approaches. Braungart-Rieker et al. (2010) also noted increases in fear, as well as anger across infancy, observing reactivity in response to structured laboratory episodes. Across infancy, fear showed significant increases captured by a linear slope, along with some deceleration, reflected in a quadratic effect. A linear trajectory was as optimal for smiling/laughter, assessed via parent report, also noted to increase over the first year of life (Bridgett et al., 2013). Using the same data set as the present study, Gartstein et al. (2018) found that a linear trajectory fit best for parent-reported smiling/laughter and fear, both increasing after 6 months of age.

Overall, results of these growth-focused investigations indicated considerable changes for several domains of temperament across the first year of life. Moreover, study results linking these patterns of changes with distal outcomes suggest the trajectories are meaningful insofar as their parameters were predictive of emerging symptoms and parenting in early childhood (Bridgett et al., 2013; Gartstein et al., 2010). Considering change or growth offers multiple advantages over other longitudinal analytic techniques, elucidating developmental processes rather than comparing static pictures of temperament at different times. Moreover, a growth oriented platform addresses longstanding questions regarding the nature of change across different domains of temperament, including the

overarching factors—negative emotionality, positive affectivity/surgency, and regulatory capacity/orienting—not orienting, not previously examined in this context.

We also considered effects of infant sex, family socioeconomic status (SES), and maternal characteristics (stress, depression, and anxiety) on developmental trajectories. Temperament differences between girls and boys tend to be less pronounced in infancy (Prior, Smart, Sanson, & Oberklaid, 1993), with some nonsignificant findings (e.g., Spinrad & Stifter, 2006), increasing with age. Sex differences in infant temperament have been largely limited to activity level, approach, and fear/behavioral inhibition. Whereas higher activity level and approach were reported for boys (Campbell & Eaton, 1999; Maziade, Boudreault, Thivierge, Capérea, & Côté, 1984), girls, relative to boys, were described as more hesitant to approach novel objects (Martin, Wisenbaker, Baker, & Huttunen, 1997; Rothbart, 1988). Campbell and Eaton (1999) summarized 46 studies addressing activity level in infancy in a meta-analysis, estimating the size of the sex difference at 0.2 standard deviations.

In a population-based study, lower SES was associated with a “difficult” temperament profile (Jansen et al., 2009). However, SES effects on the scores reflecting distress to limitations, falling reactivity, and duration of orienting were largely explained by maternal stress and psychological well-being. Maternal stress, anxiety, and depression frequently contribute to infant temperament. Maternal stress was linked with a variety of adverse child outcomes (e.g., lower social competence), along with “difficult” temperament (Guralnick, Neville, Connor, & Hammond, 2003; Mäntymaa, Puura, Luoma, Salmelin, & Tamminen, 2006). Mothers’ depressive symptoms similarly predicted child negative emotionality, such as increases in infant fearfulness (Gartstein et al., 2010). Pauli-Pott, Mertesacker, and Beckmann (2004) found that a combination of maternal depression and anxiety was associated with increases in infant fear. Caregiver anxiety symptoms were shown to have unique associations with infant temperament (Tees et al., 2010) and will also be considered in this study.

We investigated developmental trajectories of three infant temperament factors: negative emotionality, positive affectivity/surgency, and regulatory capacity/orienting, and their component scales. It was hypothesized that the functional form of component scale trajectories would be consistent with the shape determined most optimal for the overarching dimensions. A priori hypotheses concerning the functional shape for three fine-grained dimensions—fear, distress to limitations (or anger/frustration), and smiling/laughter—involved largely linear increases. At the same time, reported deviations from linearity for fearfulness and frustration (Braungart-Rieker

et al., 2010; Carranza et al., 2000), and the overall rapid growth in infancy (Bornstein et al., 2014), suggest the importance of nonlinear trajectories. Moreover, we considered effects of maternal characteristics, including perceived stress in the parental role and symptoms of anxiety and depression, as well as infant sex and family SES, on trajectories of the overarching and fine-grained temperament dimensions. We expected that lower SES, maternal symptoms, and stress would translate into higher initial values and steeper increases in negative emotionality, along with lower intercepts and decreases in positive affectivity/surgency and regulatory capacity/orienting, with parallel effects hypothesized for the underlying fine-grained dimensions. With respect to infant sex, boys were hypothesized to exhibit higher levels of surgency-related attributes (e.g., activity), along with greater gains across infancy, whereas girls were expected to show higher levels of fearfulness, increasing in fear faster compared to boys.

## Method

### *Participants*

A community sample of 148 English-speaking mothers with 4-month-old infants from adjacent communities in eastern Washington and northwestern Idaho was recruited through birth announcements released by hospitals and published in a local newspaper, as well as the primary prevention program First Steps. First Steps provided information about this research, along with developmental information aimed at preventing child maltreatment, to all parents of newborns in the local hospitals. Project staff telephoned potential participants identified through First Steps (i.e., those indicating an interest in this study). Only families with a healthy infant (i.e., without a history of prenatal/birth or developmental complications) were invited to take part, if the child met the age criterion. None of the potential participants recruited through the First Steps program declined participation, whereas seven families contacted based on the published birth announcements decided not to take part in this research (Table 1).

### *Measures*

*Demographics questionnaire.* Parents were asked questions regarding age, education, income, ethnicity, marital status, and occupation. Responses to the latter, indicating job titles and major responsibilities, provided the basis for assigning a Revised Duncan Sociometric Index (Stevens & Featherman, 1981), a widely used ranking of occupational prestige, or SES.

**Table 1.** Descriptive statistic: Primary caregiver and infant demographics, maternal stress, and symptoms

Variables	Mean	Range	Standard deviation	Percentage
Maternal age (years)	28.67	20–42	5.27	
Infant sex				
Boys				50.8
Girls				49.2
Ethnicity				
Caucasian				91.9
African American				3.7
Asian				2.9
Hispanic/Latino				1.5
Living arrangements				
Married				93.1
Divorced/ separated				1.6
Single				3.8
Remarried				1.5
Highest education attained	15.87 years	10–20 years	2.29 years	
Less than high school				2.8
High-school diploma				6.4
Some college				26.2
Bachelor's 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

*Continued*

**Table 1.** Descriptive statistic: Primary caregiver and infant demographics, maternal stress, and symptoms (*Continued*)

Variables	Mean	Range	Standard deviation	Percentage
\$50,001–\$75,000				17.2
Over \$75,000				15.7
Demographic/maternal predictors				
Socioeconomic status	37.61	15.00–90.33	26.98	
Total parenting stress <sup>a</sup>	18.69	10.80–33.00	3.49	
Beck Depression Inventory	8.18	00.00–35.00	6.67	
Beck Anxiety Inventory	5.67	00.00–25.00	0.15	

<sup>a</sup> Maternal parenting stress score represents an average of Parenting Stress Index maternal domain scores (competence, attachment to the child, role restriction, depression, and spouse/partner relationship).

*Maternal stress and symptoms.* The *parent domain* of the Parenting Stress Index (PSI; Abidin, 1995) consists of 54 items that are rated on a 5-point Likert scale (from 1 = *strongly agree* to 5 = *strongly disagree*), with higher scores indicative of greater stress. PSI parent domain subscales (competence, attachment to the child, role restriction, depression, and spouse/partner relationship) were averaged to compute a *total parenting stress* score, as previously described (Oddi, Murdock, Vadnais, Bridgett, & Gartstein, 2013). PSI is an established instrument with good psychometric properties (Abidin, 1995; Oddi et al., 2013). Total parenting stress scores were internally consistent ( $\alpha = .86$ ) in the present sample. The Beck Depression Inventory, second edition (BDI-II; Beck, Steer, & Brown, 1996) and the Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988) were used to assess the severity of depression and anxiety. The BDI-II and BAI each consists of 21 items that rely on a 4-point Likert scale (range 0–4). Reliability and validity have been consistently demonstrated for these self-report measures of current symptoms (e.g., Beck, Steer, Ball, & Ranieri, 1996). In this study,  $\alpha$  values for BDI-II and BAI were .89 and .80, respectively.

*The Infant Behavior Questionnaire–Revised (IBQ-R; Gartstein & Rothbart, 2003).* This parent-report measure contains 191 items that rely on a 7-point Likert scale, asking the parent to report the frequency of

different child behaviors in the past 1–2 weeks (e.g., “How often during the last week did the baby smile or laugh when given a toy?”). This measure yields 14 scales shown to form three overarching factors: positive affectivity/surgency (activity level, smiling/laughter, approach, high-intensity pleasure, perceptual sensitivity, and vocal reactivity), negative emotionality (fear, distress to limitations, sadness, and negatively loading falling reactivity), and regulatory capacity/orienting (duration of orienting, soothability, cuddliness/affiliation, and low-intensity pleasure). The IBQ-R was shown as reliable for mothers and fathers, and samples from different cultures, with Cronbach’s  $\alpha$  values from .77 to .96 (Gartstein & Rothbart, 2003; Gartstein, Slobodskaya, & Kinsht, 2003; Parade & Leerkes, 2008). Predictive and construct validity were also supported (Gartstein & Bateman, 2008; Gartstein et al., 2010; Gartstein & Marmion, 2008). Internal consistency of the IBQ-R subscales in the present sample was generally good, with the Cronbach’s  $\alpha$  values ranging from .65 to .96 (mean  $\alpha = .82$ ).

### *Procedure*

Mothers reported concerning demographic factors, parenting stress, symptoms of depression, and anxiety when their infants were 4 months of age. Child temperament was evaluated in 2-month increments until the first birthday (i.e., at 4, 6, 8, 10, and 12 months of age). Mothers were asked to complete the IBQ-R within 2 weeks of their child turning each of the target ages, with reminder telephone calls conducted to ensure timely responses. The resulting age distribution was consistent with these instructions: 4 months ( $M = 16.12$ ,  $SD = 1.45$ ), 6 months ( $M = 24.31$ ,  $SD = 1.41$ ), 8 months ( $M = 31.87$ ,  $SD = 1.27$ ), 10 months ( $M = 40.12$ ,  $SD = 1.25$ ), and 12 months ( $M = 48.14$ ,  $SD = 1.28$ ). Questionnaires along with written informed consent materials were mailed to caregivers, and participants were reimbursed for each assessment (\$20). All procedures were approved by the institutional review board.

### *Analytic Strategy*

First, three basic models (linear, quadratic, and piecewise) were considered for each of the IBQ-R factors and their component fine-grained scales. Whereas linear and quadratic models were typically considered in prior research, piecewise representations have not been commonly used to study infant temperament. The piecewise functional shape provides an important nonlinear alternative, and an opportunity to model developmental shifts in

temperament across the first year of life, wherein growth differs at various time points (e.g., see Hancock, Haring, & Lawrence, 2013). These more abrupt transitions, inconsistent with linear or quadratic growth, are especially likely in infancy, given considerable developmental changes across the first year of life (Bornstein et al., 2014). In our piecewise models, every segment of data is treated separately (e.g., 4–6 months of age), with slope estimates computed for each (referred to as *trends*), and the intercept labeled as *level*. Second, infant sex and family SES were considered simultaneously to determine if either background variable explained trajectory parameters. Subsequently, maternal stress, anxiety, and depression symptoms were examined jointly to identify their unique contributions. The piecewise growth model is especially advantageous in this regard in its capacity for predictors to be differentially relevant across considered segments of time.

Indices used to assess growth models' data-model fit included an absolute fit index (standardized root mean square residual; SRMR), a parsimonious fit index (root mean square error of approximation; RMSEA), and an incremental fit index (comparative fit index; CFI), as well as the Akaike information criterion (AIC) and Bayesian information criterion (BIC). Robust/rescaling corrections for potential nonnormality were employed for fit indices derived from  $\chi^2$  statistics (i.e., all of the aforementioned except the SRMR; Mueller & Hancock, 2010) and standard error estimates for tests of model parameters (Satorra & Bentler, 1994). Robust/rescaled  $\chi^2$  difference tests (Satorra & Bentler, 1999) were consulted in comparing linear, quadratic, and piecewise models so as to determine the most appropriate form for the three overarching factors and their subscales. Some attrition occurred after the first two waves of data collection (Table 2). Responders and nonresponders at the subsequent waves (i.e., at 8, 10, and 12 months of age) were recently compared, showing minimal differences (Gartstein et al., 2018). Further, robust full information maximum likelihood estimation was used to accommodate missing data, which has the advantages of (a) being able to properly accommodate missingness when its mechanism is related to data from earlier time points and/or covariates in the model, and (b) facilitating corrections to parameter test statistics and fit indices for any impactful nonnormality in the data. Latent growth curve models were estimated by using *Mplus 7* (Muthén & Muthén, 2012).

## Results

Intraindividual change trajectories were estimated for negative emotionality, positive affectivity/surgency, and regulatory capacity/orienting overarching factors, as well as component fine-grained attributes, starting at 4 months

**Table 2.** Descriptive statistics: Infant Behavior Questionnaire–Revised (IBQ-R) factors and scales

Temperament variable	4 Months	6 Months	8 Months	10 Months	12 Months
<b>Negative emotionality</b>					
Mean ( <i>M</i> )	0.00 <sup>a</sup>	0.00	0.00	0.00	0.00
Standard deviation ( <i>SD</i> )	2.74	2.62	2.72	2.94	2.80
Skewness	0.09	-0.30	0.33	0.34	0.27
Kurtosis	-0.26	-0.10	0.53	0.53	0.59
Missing cases	1	1	34	46	47
Fear					
<i>M</i>	2.09	2.27	2.51	2.81	2.98
<i>SD</i>	0.80	0.77	0.91	0.85	0.93
Skewness	1.63	0.67	0.53	0.25	0.22
Kurtosis	3.19	-0.31	-0.27	0.18	-0.17
Missing cases	1	1	34	46	47
Distress to limitations					
<i>M</i>	3.41	3.54	3.87	4.21	4.28
<i>SD</i>	0.81	0.68	0.81	0.85	0.79
Skewness	-0.03	0.01	-0.10	0.14	0.22
Kurtosis	-0.73	0.68	0.05	-0.27	0.16
Missing cases	1	1	34	46	47
Sadness					
<i>M</i>	3.48	3.60	3.65	3.72	3.72
<i>SD</i>	0.88	0.87	0.92	0.86	0.86
Skewness	-0.12	0.03	0.23	-0.07	0.35
Kurtosis	-0.59	0.08	0.44	0.25	-0.09
Missing cases	1	1	34	46	47
Falling reactivity					
<i>M</i>	5.19	5.13	5.17	5.05	5.02
<i>SD</i>	0.84	0.74	0.78	0.83	0.67
Skewness	-0.64	-0.24	-0.54	-0.55	-0.21
Kurtosis	0.05	-0.40	0.29	-0.01	-0.50
Missing cases	1	1	34	46	47

*Continued*

**Table 2.** Descriptive statistics: Infant Behavior Questionnaire–Revised (IBQ-R) factors and scales (*Continued*)

Temperament variable	4 Months	6 Months	8 Months	10 Months	12 Months
<b>Positive affectivity/surgency</b>					
M	-0.01	0.00	0.00	0.00	0.00
SD	4.20	4.28	4.08	3.95	3.96
Skewness	0.19	0.26	-0.11	0.06	0.04
Kurtosis	-0.29	-0.34	-0.30	0.12	-0.31
Missing cases	1	1	34	46	47
Activity level					
M	3.88	4.46	4.57	4.74	4.76
SD	0.83	0.73	0.80	0.75	0.76
Skewness	-0.04	0.01	-0.03	-0.10	-0.17
Kurtosis	-0.53	-0.56	-0.17	0.05	-0.23
Missing cases	1	1	34	46	47
Smiling/laughter					
M	4.49	4.50	4.49	4.48	4.56
SD	1.08	1.00	0.97	0.97	0.91
Temperament variable					
Skewness	0.00	-0.16	-0.47	0.18	-0.08
Kurtosis	-0.77	-0.17	-0.43	-0.66	-0.50
Missing cases	1	1	34	46	47
Approach					
M	4.06	4.87	5.27	5.46	5.60
SD	1.30	1.01	0.82	0.79	0.67
Skewness	0.01	-0.23	-0.34	-0.68	-0.66
Kurtosis	-0.48	-0.29	-0.54	1.29	.078
Missing cases	1	1	34	46	47
High-intensity pleasure					
M	5.13	5.62	5.86	5.82	5.94
SD	0.87	0.78	0.67	0.65	0.61

**Table 2.** Descriptive statistics: Infant Behavior Questionnaire–Revised (IBQ-R) factors and scales (*Continued*)

Temperament variable	4 Months	6 Months	8 Months	10 Months	12 Months
Skewness	−0.23	−0.41	−0.52	−0.68	−0.25
Kurtosis	−0.20	−0.21	−0.23	0.91	−0.14
Missing cases	1	1	34	46	47
<b>Perceptual sensitivity</b>					
M	3.26	3.76	3.85	3.98	4.07
SD	1.11	1.12	1.15	1.08	1.12
Skewness	0.31	0.54	−0.21	−0.21	−0.18
Kurtosis	−0.11	0.15	−0.67	−0.51	−0.35
Missing cases	1	1	34	46	47
<b>Vocal reactivity</b>					
M	4.19	4.42	4.69	4.93	5.06
SD	1.13	0.98	0.91	0.89	0.89
Skewness	0.01	−0.21	−0.50	−0.36	−0.27
Kurtosis	−0.37	0.16	−0.02	0.27	−0.45
Missing cases	1	1	34	46	47
<b>Regulatory capacity/ orienting</b>					
M	−0.01	0.03	0.00	0.00	0.00
SD	2.38	2.72	2.39	2.47	2.57
Skewness	0.05	0.13	0.05	0.54	−0.18
Kurtosis	−0.28	0.37	−0.26	1.24	−0.09
Missing cases	1	1	34	46	47
<b>Duration of orienting</b>					
M	3.99	3.83	3.71	3.50	3.78
SD	0.99	1.00	0.96	1.03	0.96
Skewness	0.14	0.29	0.15	0.31	0.05
Kurtosis	−0.38	0.07	−0.21	0.40	0.31
Missing cases	1	1	34	46	47

*Continued*

**Table 2.** Descriptive statistics: Infant Behavior Questionnaire–Revised (IBQ-R) factors and scales (*Continued*)

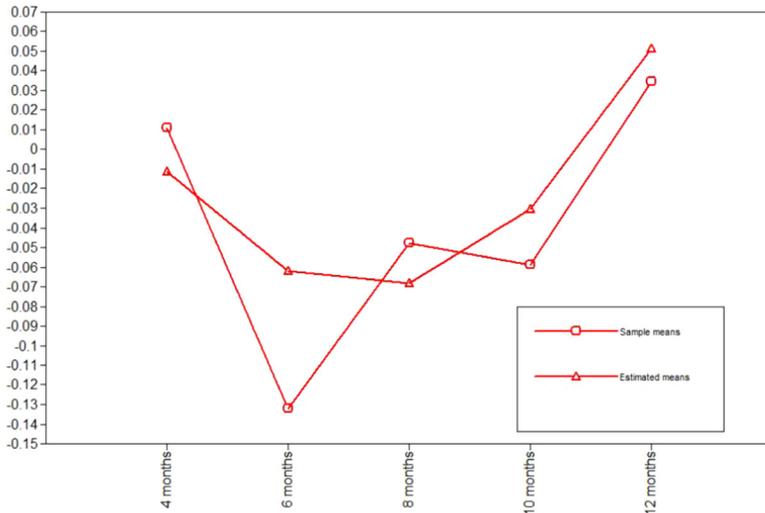
Temperament variable	4 Months	6 Months	8 Months	10 Months	12 Months
<b>Soothability</b>					
M	3.61	3.57	3.81	3.61	3.77
SD	0.66	0.71	0.71	0.69	0.66
Skewness	0.25	1.30	0.61	0.63	0.06
Kurtosis	0.38	4.32	0.69	0.75	-0.41
Missing cases	1	1	34	46	47
<b>Cuddliness</b>					
M	5.93	5.57	5.40	5.15	5.09
SD	0.65	0.74	0.76	0.83	0.88
Temperament variable	4 Months	6 Months	8 Months	10 Months	12 Months
Skewness	-1.70	-0.71	-0.82	-0.95	-0.56
Kurtosis	5.73	0.29	0.64	1.09	0.49
Missing cases	1	1	34	46	47
<b>Low-intensity pleasure</b>					
M	5.13	5.04	4.86	4.61	4.80
SD	0.80	0.76	0.74	0.85	0.76
Skewness	-0.13	0.04	0.43	-0.04	0.17
Kurtosis	0.08	-0.17	-0.18	0.68	-0.17
Missing cases	1	1	34	46	47

<sup>a</sup> IBQ-R overarching factor scores represent sums of relevant standardized scale scores, and scale scores are on a 7-point Likert scale.

of age and measured every 2 months over the first year of life (Table 2). The growth models were centered around the baseline infant temperament measurement point at 4 months of age.

### *Negative Emotionality*

Negative emotionality analyses indicated that a quadratic model (Figure 1) provided the most optimal fit, based on the considered fit indices, parameter estimates (Table 3), and (robust/rescaled)  $\chi^2$  difference tests. Specifically, a comparison between linear and quadratic models was statistically



**Figure 1.** Infant negative emotionality measured every 2 months, from 4 to 12 months of age.

significant ( $\chi^2$  diff = 9.80,  $p < .05$ ); however, linear and piecewise, as well as quadratic and piecewise, model comparisons did not result in statistically significant differences.

*Negative emotionality fine-grained components.* Fear  $\chi^2$  difference testing indicated that a linear model provided adequate fit, as comparisons with quadratic and piecewise models (as well as between quadratic and piecewise models) were nonsignificant. For distress to limitations, all  $\chi^2$  difference tests were statistically significant: linear vs. quadratic ( $\chi^2$  diff = 16.86,  $p < .01$ ), linear vs. piecewise ( $\chi^2$  diff = 34.56,  $p < .001$ ), and quadratic vs. piecewise ( $\chi^2$  diff = 17.70,  $p < .01$ ). A piecewise model provided superior fit based on data-model fit indices (Table 4), along with  $\chi^2$  difference testing. Model testing for sadness supported a linear model—none of the  $\chi^2$  difference tests produced statistically significant results. A comparison between linear and quadratic models for Falling Reactivity was statistically significant ( $\chi^2$  diff = 9.62,  $p < .05$ ), with remaining  $\chi^2$  difference tests failing to reach significance. Thus, a quadratic model was adopted as optimal, primarily reflecting a quadratic mean trend, given that the variance estimate for the quadratic component was not statistically significant. Thus, a linear model was demonstrated as superior for two negative emotionality fine-grained dimensions, with the piecewise representation providing

**Table 3.** Infant Behavior Questionnaire-Revised (IBQ-R) factors: basic growth model fit statistics and estimated intercepts and slopes

Model	Negative emotionality			Positive affectivity/surgency			Regulatory capacity/orienting		
	N = 143			N = 143			N = 143		
	Linear (df = 10)	Quadratic (df = 6)	Piecewise (df = 0)	Linear (df = 10)	Quadratic (df = 6)	Piecewise (df = 0)	Linear (df = 10)	Quadratic (df = 6)	Piecewise (df = 0)
$\chi^2$	13.31 (p = .21)	3.30 (p = .77)	0.00 (p = 1.00)	16.78 (p = .08)	5.76 (p = .45)	0.00 (p = 1.00)	21.84 (p = .02)	18.07 (p = .01)	0.00 (p = 1.00)
CFI	0.99	1	1	0.98	1	1	0.96	0.96	1
RMSEA	0.05	0	0	0.07	0	0	0.09	0.12	0
SRMR	0.06	0.03	0	0.05	0.02	0	0.07	0.07	0
AIC	2,415.94	2,414.16	2,423.04	2,660.02	2,657.62	2,663.78	2,254.58	2,260.04	2,254.49
BIC	2,445.57	2,455.65	2,482.30	2,689.65	2,699.11	2,723.04	2,284.20	2,301.52	2,313.75
Intercept/level mean <sup>a</sup>	-0.08	-0.01	0.01	0.03	0.02	0.02	0.05	0.06	0.07
Intercept/level variance	4.23**	4.57**	7.44**	12.95**	13.40**	17.18**	3.91**	3.08**	5.72**
Linear slope mean	0.03	-0.07	-	0.10	0.11	-	0.07	0.05	-
Linear slope variance	0.31**	2.16*	-	0.27*	3.70*	-	0.14**	-0.30	-
Quadratic mean	-	0.02	-	-	0.00	-	-	0.01	-

Quadratic variance	—	0.11*	—	—	0.14 <sup>#</sup>	—	—	-0.02	—
Trend 1 slope mean	—	—	-0.14	—	—	0.15	—	—	0.08
Trend 2 slope mean	—	—	0.09	—	—	-0.08	—	—	-0.08
Trend 3 slope mean	—	—	-0.01	—	—	0.37	—	—	0.24
Trend 4 slope mean	—	—	0.09	—	—	-0.09	—	—	0.03
Trend 1 variance	—	—	7.44**	—	—	10.71**	—	—	4.86**
Trend 2 variance	—	—	5.31**	—	—	6.89**	—	—	3.71**
Trend 3 variance	—	—	3.98**	—	—	4.64**	—	—	3.77**
Trend 4 variance	—	—	4.48**	—	—	5.34**	—	—	3.11**

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

<sup>a</sup> Level corresponds to intercept in the piecewise model.

\*  $p < .05$ . \*\*  $p < .01$ . <sup>#</sup>  $p < .10$ .

**Table 4.** Infant Behavior Questionnaire-Revised (IBQR) factors: negative emotionality component scale basic model fit statistics and estimated intercepts and slopes

Model	Fear N = 143			Distress to limitations N = 143			Sadness N = 143			Falling reactivity N = 143		
	Linear	Quadratic	Piecewise	Linear	Quadratic	Piecewise	Linear	Quadratic	Piecewise	Linear	Quadratic	Piecewise
	(df = 10)	(df = 6)	(df = 0)	(df = 10)	(df = 6)	(df = 0)	(df = 10)	(df = 6)	(df = 0)	(df = 10)	(df = 6)	(df = 0)
$\chi^2$	6.51 (p = .77)	3.91 (p = .68)	0.00 (p = 1.00)	34.56 (p = .00)	17.69 (p = .01)	0.00 (p = 1.00)	3.77 (p = .96)	2.85 (p = .83)	0.00 (p = .00)	12.84 (p = .23)	2.61 (p = .86)	0.00 (p = .00)
CFI	1.00	1.00	1.00	0.89	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
RMSEA	0.00	0.00	0.00	0.13	0.12	0.00	0.00	0.00	0.00	0.05	0.00	0.00
SRMR	0.07	0.05	0.00	0.15	0.11	0.00	0.06	0.05	0.00	0.14	0.05	0.00
AIC	1,175.73	1,180.28	1,187.84	1,087.12	1,078.14	1,072.51	1,223.44	1,230.29	1,238.64	1,156.57	1,154.87	1,164.20
BIC	1,205.36	1,221.76	1,247.10	1,116.74	1,119.62	1,131.77	1,253.07	1,271.77	1,297.90	1,186.20	1,196.35	1,223.46
Intercept/ level mean <sup>a</sup>	2.06**	2.07**	2.08**	3.36**	3.36**	3.42**	3.46**	3.47**	3.49**	5.21**	5.17**	5.18**
Intercept/ level variance	0.30**	0.20	0.64**	0.35**	0.38**	0.66**	0.44**	0.43**	0.76**	0.39**	0.38*	0.71**
Linear slope mean	0.23**	0.21**	—	0.24**	0.26**	—	0.06**	0.05	—	-0.05*	0.03	—
Linear slope variance	0.02**	-0.06	—	0.03**	0.28**	—	0.02*	0.07	—	0.03**	0.17#	—



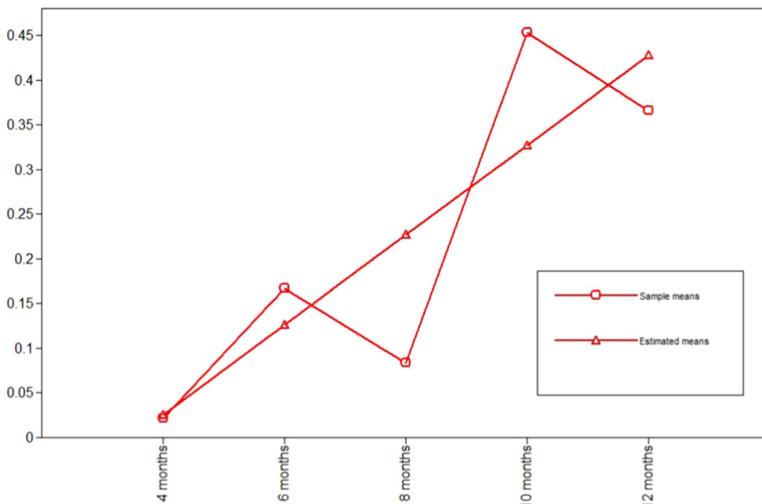
optimal fit for distress to limitations, and a best-fitting quadratic model for falling reactivity, consistent with the overarching factor in terms of the functional shape.

*Negative emotionality demographic/maternal predictors.* Infant sex and family SES did not account for significant variance in overall negative emotionality; however, maternal stress emerged as a significant predictor of the intercept ( $\beta = .26; p < .05$ ), resulting in higher initial values. Among the fine-grained scales, infant sex made a significant contribution to infant Fear, specifically the intercept ( $\beta = .29; p < .05$ ), with girls demonstrating higher levels at 4 months of age. Maternal stress predicted intercepts for falling reactivity ( $\beta = -.32; p < .05$ ) and sadness ( $\beta = .30; p < .05$ ), contributing to lower and higher values, respectively.

### *Positive Affectivity/Surgency*

Positive affectivity/surgency analyses indicated the best fit for a linear model (Figure 2) in explaining the trajectory of growth (Table 3). Tests conducted comparing linear, quadratic, and piecewise models indicated a lack of statistically significant differences ( $p > .05$ ).

*Positive affectivity/surgency fine-grained components.* Activity-level  $\chi^2$  difference testing produced two statistically significant results: linear vs. quadratic ( $\chi^2$  diff = 33.84,  $p < .001$ ) and linear vs. piecewise ( $\chi^2$  diff =



**Figure 2.** Infant positive affectivity/surgency measured every 2 months, from 4 to 12 months of age.

43.28,  $p < .001$ ). An examination of fit indices and parameter estimates (Table 5) suggested that a piecewise model was more optimal, primarily reflecting the piecewise nonlinear trend of means. All  $\chi^2$  difference comparisons conducted for smiling/laughter produced nonsignificant results, indicating that a linear model provided the best fit, consistent with multiple fit indices and parameter estimates. For the approach scale, linear vs. quadratic ( $\chi^2$  diff = 41.67,  $p < .001$ ), as well as linear vs. piecewise ( $\chi^2$  diff = 49.96,  $p < .001$ )  $\chi^2$  difference tests yielded statistically significant results, whereas the quadratic vs. piecewise comparison did not. Fit indices and parameter estimates provided evidence in support of a piecewise model being superior overall, again reflecting the piecewise trend of means. All of the  $\chi^2$  difference tests for high-intensity pleasure were statistically significant: linear vs. quadratic ( $\chi^2$  diff = 30.01,  $p < .001$ ), linear vs. piecewise ( $\chi^2$  diff = 47.65,  $p < .001$ ), and quadratic vs. piecewise ( $\chi^2$  diff = 16.48,  $p < .05$ ). Thus, a piecewise model was deemed optimal for this aspect of positive affectivity. Perceptual sensitivity  $\chi^2$  difference comparisons between linear and quadratic models ( $\chi^2$  diff = 15.51,  $p < .01$ ), as well as linear and piecewise ( $\chi^2$  diff = 20.44,  $p < .05$ ) models, were statistically significant, whereas the quadratic vs. piecewise model comparison was not. The linear model was thus rejected, with the piecewise trajectory deemed superior based on fit indices and parameter estimates (e.g., significant  $\chi^2$  in the quadratic model case; Table 5). None of the  $\chi^2$  difference tests for vocal reactivity reached statistical significance, providing support for a linear model, along with fit indices and parameter estimates. In summary, a linear trajectory identified as optimal for the positive affectivity/surgency factor adequately captured two of its fine-grained dimensions—smiling/laughter and vocal reactivity, with the piecewise model shown as optimal for activity level, approach, high-intensity pleasure, and perceptual sensitivity.

*Positive affectivity/surgency demographic/maternal predictors.* Infant sex made a significant contribution to explaining positive/affectivity surgency intercept ( $\beta = -.24$ ,  $p < .05$ ), with girls demonstrating lower levels at baseline. Infant sex was also predictive of intercept estimates for activity level ( $\beta = -.17$ ,  $p < .05$ ), approach ( $\beta = -.21$ ,  $p < .05$ ), and high-intensity pleasure ( $\beta = -.18$ ,  $p < .05$ ), with girls starting out at lower values. There were two significant slope effects for activity level, wherein SES was associated with Trend 3 ( $\beta = .32$ ,  $p < .01$ ) and Trend 4 ( $\beta = -.27$ ,  $p < .05$ ), serving to increase activity from 8 to 10 months, but decreasing it from 10 to 12 months. Infant sex was predictive of Perceptual Sensitivity Trend 4 ( $\beta = -.25$ ,  $p < .05$ ), as girls showed a decline in this attribute from 10 to 12 months of age. Maternal anxiety was associated with the slope for Activity Level Trend 2 and a decrease from 6 to 8 months ( $\beta = -.26$ ,

**Table 5.** Infant Behavior Questionnaire-Revised (IBQ-R) factors: positive affectivity/surgency component scale basic model fit statistics and estimated intercepts and slopes

	Activity level		Smiling and laughter				Approach		
	N = 143		N = 143				N = 143		
$\chi^2$	43.28	10.57	0	4.45	1.33	0	49.96	7.21	0
	(p = .00)	(p = .10)	(p = 1.00)	(p = .92)	(p = .97)	(p = 1.00)	(p = .00)	(p = .30)	(p = .00)
CFI	0.82	0.98	1	1	1.00	1	0.66	0.99	1
RMSEA	0.15	0.07	0	0	0.00	0	0.17	0.04	0
SRMR	0.19	0.11	0	0.03	0.02	0	0.18	0.08	0
AIC	1,111.86	1,084.89	1,085.06	1,162.76	1,167.50	1,178.04	1,346.62	1,310.89	1,315.67
BIC	1,141.49	1,126.37	1,144.32	1,192.38	1,208.98	1,237.30	1,376.25	1,352.37	1,374.93
Intercept/ level mean <sup>a</sup>	4.13**	3.95**	3.89**	4.50**	4.51**	4.50**	4.56**	4.15**	4.06**
Intercept/ level variance	0.34**	0.24*	0.69**	0.84**	0.85**	1.15**	0.58**	0.51#	1.69**
Linear slope mean	0.19**	0.47**	—	0.04#	0.01	—	0.28**	0.77**	—
Linear slope variance	0.02*	0.11	—	0.03**	0.08	—	0.02	0.24	—
Quadratic mean	—	-0.06**	—	—	0.01	—	—	-0.10	—
Quadratic variance	—	0.01	—	—	0.01	—	—	0.01	—

Trend 1 slope	—	—	0.55**	—	—	0.07	—	—	0.84**
mean	—	—	0.14*	—	—	-0.03	—	—	0.38**
Trend 2 slope	—	—	0.19**	—	—	0.06	—	—	0.20**
mean	—	—	0.03	—	—	0.06	—	—	0.12#
Trend 3 slope	—	—	0.71**	—	—	0.58**	—	—	1.84**
mean	—	—	0.35**	—	—	0.46**	—	—	0.71**
Trend 4 slope	—	—	0.33**	—	—	0.51**	—	—	0.41**
mean	—	—	0.38**	—	—	0.28**	—	—	0.44**
Trend 1	—	—	—	—	—	—	—	—	—
variance	—	—	—	—	—	—	—	—	—
Trend 2	—	—	—	—	—	—	—	—	—
variance	—	—	—	—	—	—	—	—	—
Trend 3	—	—	—	—	—	—	—	—	—
variance	—	—	—	—	—	—	—	—	—
Trend 4	—	—	—	—	—	—	—	—	—
variance	—	—	—	—	—	—	—	—	—

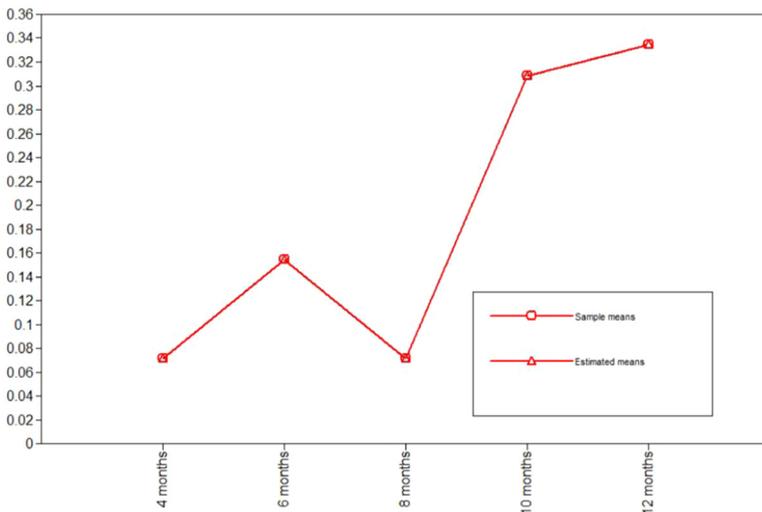
Note. CFI = comparative fit index; RMSEA = root-mean-square error of approximation; SRMR = standardized root-mean-square residual; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion.  
a Level corresponds to intercept in the piecewise model.

\*  $p < .05$ ; \*\* $p < .01$ ; # $p < .10$

$p < .05$ ). Parenting stress predicted lower initial values of approach ( $\beta = -.27$ ;  $p < .05$ ), whereas BDI-II and BAI scores had opposite effects on the Trend 2 slope, with depression contributing to increases ( $\beta = .34$ ,  $p < .05$ ) and anxiety to decreases ( $\beta = -.43$ ,  $p < .01$ ) in approach. Stress was also linked with lower initial values of smiling and laughter ( $\beta = -.22$ ,  $p < .05$ ) and high-intensity pleasure ( $\beta = -.22$ ,  $p < .05$ ). Anxiety symptoms were associated with Trend 2 slope—decreases in perceptual sensitivity from 6 to 8 months ( $\beta = -.27$ ,  $p < .05$ ). Maternal stress predicted intercept ( $\beta = -.27$ ,  $p < .05$ ) and slope ( $\beta = .39$ ,  $p < .05$ ) parameters for vocal reactivity, albeit in opposite directions.

### Regulatory Capacity/Orienting

A piecewise model was deemed superior for regulatory capacity/orienting (Figure 3), relative to linear and quadratic options (Table 2). Although the  $\chi^2$  difference test comparing linear and quadratic models did not produce statistically significant results, comparisons of linear and piecewise models ( $\chi^2$  diff = 21.84,  $p < .001$ ), as well as quadratic and piecewise models ( $\chi^2$  diff = 18.07,  $p < .001$ ), resulted in significant differences. Fit indices (Table 3) further supported the interpretation of a piecewise model as most optimal for regulatory capacity/orienting.



**Figure 3.** Infant regulatory capacity/orienting measured every 2 months, from 4 to 12 months of age.

*Regulatory capacity/orienting fine-grained components.* Model  $\chi^2$  difference comparisons conducted for duration of orienting indicated that a piecewise model provided the best fit, as all three  $\chi^2$  difference tests resulted in statistically significant differences: linear vs. quadratic ( $\chi^2$  diff = 19.61,  $p < .001$ ), linear vs. piecewise ( $\chi^2$  diff = 36.49,  $p < .001$ ), and quadratic vs. piecewise ( $\chi^2$  diff = 13.24,  $p < .05$ ). The fit indices were also consistent with this interpretation (Table 6). For soothability, the initial comparison of linear and quadratic models did not result in a statistically significant difference; however, linear vs. piecewise ( $\chi^2$  diff = 18.89,  $p < .05$ ) and quadratic vs. piecewise ( $\chi^2$  diff = 17.87,  $p < .05$ ) tests were statistically significant. A piecewise model again emerged as most optimal, in light of these comparisons, fit indices, and parameter estimates. Cuddliness/affiliation  $\chi^2$  difference tests were statistically significant for linear vs. quadratic ( $\chi^2$  diff = 13.66,  $p < .01$ ) and linear vs. piecewise models ( $\chi^2$  diff = 23.76,  $p < .01$ ), with a piecewise model providing a superior fit based on fit indices and parameter estimates (Table 6). All three low-intensity pleasure  $\chi^2$  difference tests were statistically significant—linear vs. quadratic ( $\chi^2$  diff = 17.43,  $p < .001$ ), linear vs. piecewise ( $\chi^2$  diff = 48.91,  $p < .001$ ), and quadratic vs. piecewise ( $\chi^2$  diff = 31.45,  $p < .05$ )—indicating superiority of a piecewise model. Thus, growth trajectories of all regulatory capacity/orienting fine-grained components were consistent with the functional shape of this overarching factor, described best by a piecewise representation.

*Regulatory capacity/orienting demographic/maternal predictors.* Infant sex was associated with Trend 1 ( $\beta = -.25$ ,  $p < .01$ ) slope, as girls decreased in overall regulation between 4 and 6 months. A similar effect was observed for infant sex and duration of orienting ( $\beta = -.26$ ,  $p < .01$ ), with girls decreasing in persistence of attention in the same time frame. Higher SES was linked with Trend 3 ( $\beta = -.29$ ,  $p < .05$ ), and a decrease in orienting between 8 and 10 months. Infant sex was predictive of the low-intensity pleasure intercept ( $\beta = .23$ ,  $p < .01$ ) and Trend 1 ( $\beta = -.22$ ,  $p < .01$ ), again declining for girls between 4 and 6 months of age, after starting out with higher values. Higher SES was predictive of greater low-intensity pleasure ( $\beta = .29$ ,  $p < .01$ ) at 4 months. Maternal depression was associated with Regulatory Capacity/Orienting Trend 3 ( $\beta = -.33$ ,  $p < .01$ ) and a decrease from 8 to 10 months of age, with a parallel effect observed for duration of orienting ( $\beta = -.38$ ,  $p < .01$ ). Stress predicted Trend 2 and a decrease in cuddliness/affiliativeness ( $\beta = -.22$ ,  $p < .01$ ) from 6 to 8 months, whereas anxiety symptoms were associated with Trend 3 ( $\beta = .28$ ,  $p < .01$ ) and an increase between 8 and 10 months of age.

**Table 6.** Infant Behavior Questionnaire-Revised (IBQ-R) factors: regulatory capacity/orienting component scale basic model fit statistics and estimated intercepts and slopes

	Duration of orienting		Soothability		Cuddliness/affiliation		Low-intensity pleasure					
	N = 143	N = 143	N = 143	N = 143	N = 143	N = 143	N = 143	N = 143				
$\chi^2$	34.75	13.26	0.00	18.94	17.87	0.00	23.76	8.41	0.00	48.91	31.45	0.00
	(p = .00)	(p = .04)	(p = 1.00)	(p = .04)	(p = .01)	(p = 1.00)	(p = .01)	(p = .21)	(p = .00)	(p = .00)	(p = .00)	(p = .00)
CFI	.90	.97	1.00	.90	.87	1.00	.92	.99	1.00	.75	.84	1.00
RMSEA	.13	.09	0.00	.08	.12	0.00	.10	.05	0.00	.17	.17	0.00
SRMR	.15	.11	0.00	.13	.16	0.00	.13	.10	0.00	.26	.15	0.00
AIC	1,294.01	1,280.05	1,279.29	1,025.49	1,031.20	1,023.14	1,012.77	1,006.05	1,009.82	1,130.19	1,121.38	1,102.68
BIC	1,323.64	1,321.53	1,338.55	1,055.12	1,072.68	1,082.40	1,042.40	1,047.53	1,069.08	1,159.82	1,162.86	1,161.94
Intercept/level												
mean <sup>a</sup>	3.93**	4.05**	4.02**	3.59**	3.60**	3.61**	5.89**	5.94**	5.95**	5.13**	5.21**	5.15**
Intercept/level												
variance	0.64**	0.53**	0.98**	0.24**	0.16 <sup>#</sup>	0.44**	0.28**	0.30**	0.41**	0.36**	0.20 <sup>#</sup>	0.64**
Linear slope												
mean	-0.06 <sup>#</sup>	-0.32**	-	0.05**	.03	-	-0.21**	-0.36**	-	-0.10**	-0.22**	-
Linear slope												
variance	0.03**	-0.02	-	.01	-0.03	-	0.02**	0.08	-	0.02 <sup>#</sup>	0.04	-
Quadratic												
mean	-	0.07**	-	-	.01	-	-	0.04**	-	-	0.03 <sup>#</sup>	-
Quadratic												
variance	-	0.00	-	-	0.00	-	-	0.01 <sup>#</sup>	-	-	0.00	-



## Discussion

Results of this study were in part consistent with our hypotheses, as a number of the fine-grained attributes retained the optimal functional shape associated with the relevant overarching factor, and others paralleled previously reported trajectories. The former was true for the four scales of the regulatory capacity/orienting factor, all of which manifested the most optimal piecewise trajectory, same as the overarching factor. Two of the positive affectivity/surgency scales (smiling/laughter and vocal reactivity) were best represented by the linear slope, as was the factor itself. Notably, only one negative emotionality component, falling reactivity, was consistent with this factor in terms of the best-fitting quadratic trajectory. A linear slope previously described as defining the smiling/laughter trajectory (Bridgett et al., 2013) was replicated in this study, and results also provided evidence of increases in fearfulness and anger/frustration during infancy, consistent with prior research (Braungart-Rieker et al., 2010).

Heterogeneity of form was thus most pronounced in the domain of negative emotionality, wherein a quadratic model emerged as superior for the overarching factor and one component subscale: falling reactivity. A piecewise model was deemed optimal for distress to limitations, with a linear trajectory for sadness and fear. This pattern of results can be thought of as consistent with the literature indicating that fine-grained dimensions of negative emotionality vary in terms of their predictive relationships despite forming a coherent overarching factor (Lengua, 2006; Ruschena, Prior, Sanson, & Smart, 2005). Importantly, results of this study indicate that these attributes also differ with respect to their developmental trajectories in infancy. A quadratic functional shape was not supported for distress to limitations, demonstrating increases from 4 to 12 months instead, and this discrepancy could be a function of assessment timing, with the described U-shaped effect likely taking place earlier in infancy (Johnson et al., 1991).

The quadratic trajectory identified as superior for the overall negative emotionality resembled the nonlinear functional shape discerned as optimal for the “difficult temperament” constellation including rhythmicity, adaptability, withdrawal responses, negative mood, and intensity of reactions (Partridge & Lerner, 2007), reflecting a broader construct that incorporates distress along with components of regulation (Rothbart & Bates, 2006). The only significant covariate effect observed for a negative emotionality dimension was consistent with the literature indicting higher levels of fear/behavioral inhibition for girls (Else-Quest, Hyde, Goldsmith, & Van Hulle, 2006; Gartstein & Rothbart, 2003). As hypothesized, mother’s parenting

stress predicted higher initial negative emotionality, along with sadness, and lower falling reactivity. Maternal symptoms were not associated with any of the negative emotionality growth parameters, which may result from the nature of our sample, with infants exhibiting relatively lower levels of negative emotionality.

Results obtained in the positive affectivity/surgency domain also indicated considerable differences between factor and scale-level growth trajectories, as the linear functional shape was optimal for only two of the subscales. Smiling/laughter and vocal reactivity progressed linearly, similar to the overarching factor, whereas activity level, approach, high-intensity pleasure and perceptual sensitivity were associated with more complex growth patterns in the first year of life, best represented by a piecewise trajectory. It should also be noted that there were more significant demographic effects for positive affectivity/surgency dimensions, compared to negative emotionality. Perhaps most importantly, girls demonstrated lower levels of overall positive affectivity/surgency, as well as activity level, approach, and high-intensity pleasure, at baseline. These results indicate that infant sex represents an important covariate in the temperament context. Moreover, infant sex contributed to the development of both approach and avoidance trajectories: Whereas girls started out higher on fear, according to their primary caregivers, boys demonstrated higher baseline levels of approach/positive affectivity. These early sex differences in emotionality may be precursors of the widely observed variability in developmental psychopathology, wherein boys are at greater risk for externalizing problems, and girls are more likely to suffer from internalizing-type difficulties (Baillargeon, Keenan, & Cao, 2012; Zahn-Waxler, Klimes-Dougan, & Slattery, 2000) and should be examined further.

Maternal stress, depression, and anxiety effects were not consistently associated with the dampening of surgency-related attributes. Stress in the parental role was associated with lower initial values of smiling and laughter, approach, high-intensity pleasure, and vocal reactivity, and a decrease in activity level, as expected; however, it also contributed to increasing vocal reactivity. Anxiety symptoms were associated with decreases in approach and perceptual sensitivity scores, as hypothesized, between 6 and 8 months of age, whereas maternal depression predicted increased approach tendencies during the same mid-infancy period. Although these findings require replication, maternal symptoms of anxiety and depression appear to play different roles with respect to development of surgent tendencies. Infants of mothers reporting higher levels of depression may engage in more approach behaviors in an attempt to compensate for mothers' withdrawal (Field, 1998; Pelaez, Field, Pickens, & Hart, 2008). On the other hand, approach

may decrease as a consequence of intrusive behaviors, likely exhibited by more anxious mothers (Elwood, Williams, Olatunji, & Lohr, 2007; Lex, 1999). Thus, maternal symptoms of anxiety and depression likely operate differently in the context of typical temperament development.

Regulation-related components were consistent with the overarching temperament factor with respect to the optimal functional shape, with all four component dimensions demonstrating piecewise trajectories as best-fitting across infancy. Demographic effects were also noted, as higher SES was associated with higher initial low-intensity pleasure as hypothesized, but unexpectedly predicted declines in duration of orienting between 8 and 10 months. The present study does not allow a conclusive interpretation of the latter, yet is consistent with results indicating that protection of higher socioeconomic standing is not ubiquitous (Jansen et al., 2009).

Effects of maternal depression were in the predicted direction, with links to declines in regulatory capacity/orienting, as well as duration of orienting, between 8 and 10 months of age. Parenting stress predicted a decrease in cuddliness/affiliativeness from 6 to 8 months, whereas anxiety symptoms were associated with an increase between 8 and 10 months of age. The latter effect was not anticipated; however, it may be that more anxious mothers are particularly interested in maintaining proximity with the infant, holding and encouraging cuddling to a greater extent. On the other hand, infants of more anxious mothers may be seeking out these opportunities to a greater extent. Regardless of the predominant direction of influence, the growing cuddliness trend between 8 and 10 months of age may not be adaptive, as the overall sample is showing a decline during this developmental period, and the increase demonstrated by infants of more anxious mothers might reflect clinginess rather than effective regulation strategies.

A number of limitations of the present study should be noted, including a somewhat small sample size, potentially restricting power and generalizability. Future research should include larger samples, as well as observational and/or psychophysiological measures, along with parent report. Effects on infant temperament associated with maternal characteristics may be in part a function of mothers providing report for both sets of indicators, although our longitudinal design mitigates these concerns to some extent. As maternal characteristics may change across time, future studies should consider their trajectories, as well. Importantly, future research should examine the consequences of developmental trajectories identified in this study, linking these with emerging behavior problems/symptoms, key aspects of parenting/parent-child interactions, and/or school readiness. Other potential contributors to temperament trajectories should

also be considered—for example, attachment security (Näslund, Persson-Blennow, McNeil, Kaij, & Malmquist-Larsson, 1984).

In conclusion, our findings indicate largely nonlinear developmental trajectories for both overarching and fine-grained temperament attributes in infancy. This dynamic nature of temperament development in infancy has a number of implications, for example, for caregivers, who need to adapt in creating/maintaining the *goodness of fit* (Thomas & Chess, 1977), defined as the degree of match between the child's characteristics and the parent's demands or expectations, in the face of rapid transitions. Importantly, results of this study have methodological implications and support the use of fine-grained temperament components, associated with growth patterns that often differed from those observed for the overarching factors. That is, differences in the functional form deemed preferred for overarching vs. subscale scores suggest fine-grained indicators may be better suited for developmental/longitudinal investigations, as the temperament factor trajectories often obscured divergent patterns that emerged for the narrowly defined domains of individual differences. Moreover, results of this study provide evidence for infant sex and family SES as critical covariates, and maternal stress/symptoms as predictors, of infant temperament, albeit not always in a consistent direction. Nonetheless, the latter findings provide evidence that variability in postpartum stress and symptoms predicts developmental trajectories of individual differences in reactivity and regulation, even in nonclinical samples.

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