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Sex differences in the relations between infant temperament and electrodermal responses in early childhood

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Abstract

The present study examines the relationship between sex, infant temperament, and childhood psychophysiological reactivity via electrodermal activity (EDA). Both temperament and EDA are known to be relatively stable traits across the lifespan reflecting individual reactivity and regulation linked to suboptimal behavioral development and risk for psychopathology. However, little is known about the role of sex in the relationship between temperament and EDA. As a part of a larger longitudinal study of behavioral development, 125 participants were followed from birth till 3 years-old to examine the relationship between temperament and psychophysiological reactivity in different gender groups. Measurements of temperament at 6 months-old, and EDA, via skin conductance response (SCR) rate to a series of six startling auditory stimuli at 3 years-old were collected. Median splits of SCR scores and three temperament dimensions (positive affect, negative affect, and regulation) were created to designate high/low groups. Results indicate sex moderated the relationships between temperament traits and SCR rates. Specifically, low positive affect was associated with an increased risk for high psychophysiological reactivity in boys (odds ratio = 3.8), whereas high regulation was associated with an increased risk for greater reactivity in girls (odds ratio = 4.2). While preliminary, these findings suggest the importance of sex in relation to psychophysiological and temperamental reactivity, risk factors for developmental psychopathology. As our participants age, follow-up research to investigate the stability of these associations will provide valuable insights for the potential of EDA as a psychophysiological marker for developmental psychopathology risk in young children.

Keywords

electrodermal activity; temperament; reactivity; sex differences

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Introduction

The early infant and childhood period is a time of rapid physical and psychological development that has often been found to cue future health and well-being. It is important to characterize this time period to understand how temperament, which is related to personality and risk for psychopathology, is related to underlying physiology. Moreover, it is important to understand how the nature of that relationship may depend on the child's sex. A large body of literature pointing to sex differences in early life behavior and the prevalence of externalizing/internalizing symptoms hint that trajectories of behavioral and biological regulation and reactivity may be intrinsically linked to sex. Here, we aim to investigate how sex may moderate the relationship between infant temperament and early childhood autonomic nervous system reactivity in an effort to better characterize this period of development and understand how early reactivity sets the stage for personality and symptomatology later in life.

Temperament

Temperament is a broad concept derived from an aggregate of many character traits relating to positive and negative emotions, arousability, and emotion regulation (Gartstein & Rothbart, 2003). It is widely assessed using The Infant Behavior Questionnaire (IBQ-R), a parent-report measure consisting of fourteen subscales: vocal reactivity, pleasure from low or high intensity stimuli, smiling and laughter, activity level, perceptual sensitivity, sadness, distress to limitation, fearfulness, falling reactivity, cuddliness, duration of orienting, soothability, and approach. These subscales are typically combined to form three higher order dimensions of positive affect/surgency, negative affect/withdrawal, and regulation/effortful control (Gartstein & Rothbart, 2003), each of which has been linked to activity in specific brain regions (Whittle, Allen, Lubman, & Yucel, 2006).

Many longitudinal studies have found that temperament is a moderately stable trait over time, with some changes influenced by genetic or environmental factors and events (Baker, Baibazarova, Ktistaki, Shelton, & Van Goozen, 2012; Carranza, Gonzalez-Salinas, Ato, 2013; Jarcho, Fox, Pine, Etkin, Leibenluft, Shechner, & Ernst, 2013; Kandler, Riemann, & Angleitner, 2013). Numerous studies point to the value of early measures of temperament to predict risk for future psychopathology, primarily through associations between temperament and externalizing/internalizing symptomatology. Evaluating the predictive value of temperament, Sayal, Heron, Maughan, Rowe, and Ramchani (2013) found that measures of emotional reactivity, adaptability, and activity level at 24 months predicted the presence of a psychiatric disorder at seven years of age. Furthermore, Glenn, Raine, Venables, and Mednick (2009) found that adults endorsing for more psychopathic traits were less fearful and inhibited at 3 years of age. Externalizing symptoms in 6–9-year-old children has also been associated with less regulation and higher impulsivity (Eisenberg et al., 2005). Gartstein, Putnam, and Rothbart (2012) found that negative affect in infancy predicted internalizing and externalizing symptoms at the preschool age. Positive affect has been associated with a host of outcomes, including better social and cognitive ability, lower internalizing symptoms, and both high and low externalizing symptoms (see Davis & Suveg, 2014 for a review). Valiente et al. (2003) found that regulation/effortful control was

negatively associated with externalizing symptoms in school age children, and that this relationship strengthened with time. Further, school age children with high internalizing symptoms were rated as being less impulsive and sadder than control and high externalizing children (Eisenberg et al., 2001). These findings suggest that assessing temperament at a young age can be a useful tool to gauge future risk for internalizing and externalizing symptoms, which are often related to psychopathology.

Factoring in sex may help make these associations more specific. Gartstein and Rothbart (2003) found that boys scored higher on activity level and lower on fearfulness when compared to girls, but noted that it is common for these differences to emerge only after infancy. Similarly, Maziade, Bernier, Boutin, and Thivierge (1989) found that although no sex differences in temperament were observed in infancy, of the infants classified as “difficult” (i.e., irritable, highly reactive), fewer girls than boys remained in that category at age 4. Karevold, Coplan, Stoolmiller, and Mathiesen (2011) also found sex effects, such that internalizing symptoms from early childhood to 8.5 years of age were predicted by shyness for both sexes, unless boys were also highly active. A meta-analysis of a broad age range (3 months to 13 years) found that girls score higher on measures of regulation and lower on measures of positive affect when compared to boys (Else-Quest, Hyde, Goldsmith, & Van Hulle, 2006). These findings may suggest that developmental trajectories of temperament and its correlates may in fact be intrinsically linked to a child’s sex. Better characterization of the biological processes driving temperament behaviors may help to inform the ways in which sex potentially drives temperament development. In the current study we look to autonomic nervous system functioning, which may subserve aspects of temperament and underlie atypical reactivity, to help clarify these associations at the biological level.

Physiology

Many researchers have studied the relationships between behavioral and biological reactivity. The latter is thought to be mediated by the autonomic nervous system (ANS), which functions to regulate internal mechanisms to maintain bodily homeostasis according to external conditions (Kandel, Schwartz, Jessell, Siegelbaum, & Hudspeth, 2014). The sympathetic (SNS) division of this system becomes active in the face of an environmental stressor to prepare and protect the body. One route through which the SNS acts is electrodermal activity (EDA), also called skin conductance, which directly measures eccrine sweat gland production levels (Kandel et al., 2014). Similar to temperament, EDA is also considered to be relatively stable over time with a moderate to large genetic influence (Tuvblad, Gao, Isen, Botwick, Raine, & Baker, 2012). Resting skin conductance levels (SCL) and event-related skin conductance responses (SCRs) can be quantified to represent autonomic arousal noninvasively (Braithwaite, Watson, Jones, & Rowe, 2013).

Studies have consistently related greater EDA with behaviorally inhibited temperaments characterized by high trait fearfulness and inhibitory control, suggesting a hyper-responsive sympathetic nervous system (Fowles, Kochanska, & Murray, 2000; Scarpa, Raine, Venables, & Mednick, 1997). Specifically, Fowles et al. (2000) found that fearfulness and effortful control were positively correlated with skin conductance level in 4 year olds, whereas Scarpa et al. (1997) found similar results in temperamentally inhibited 3 year olds. In a sample of

older children, Weems, Zakem, Costa, Cannon, and Watts (2005) found that skin conductance in 6–17-year-old children was positively associated with self-reported anxiety symptoms. Conversely, hypo-responsive EDA measures were found to be associated with features of psychopathy including proactive rather than reactive aggression (Gao, Tuvblad, Schell, Baker, & Raine, 2015; Isen, Raine, Baker, Dawson, Bezdijan, & Lozano, 2010). Further, 4–6-year-old children who were diagnosed with attention deficit hyperactivity disorder (ADHD) and oppositional defiant disorder (ODD) had fewer SCRs while playing a game for a reward (Crowell et al., 2006). In a longitudinal model, Baker, Shelton, Baibazarova, Hay, and Van Goozen (2013) demonstrated that skin conductance at 1 year of age predicted parent-reported aggression at 3 years of age.

Findings on sex differences in EDA remain inconclusive. Boucsein (1992) explained that varying results were due to the fact that men had greater resting skin conductance levels (SCL), whereas women had more exaggerated SCRs to stimuli and events. El-Sheikh, Keiley, and Hinnant (2011) found that boys exhibit higher resting SCL than girls at age 8, but not after, which supports other findings that observed increases in electrodermal reactivity after puberty in girls but not boys (Venables & Mitchell, 1996). In one study of 4-year-old children, fearfulness and skin conductance level were more strongly correlated in girls than boys (Fowles et al., 2000), whereas in another study of 3 year olds, no sex difference was found (Scarpa et al., 1997). Research on interactions between sex and stress hormones, and their impact on sympathetic nervous system and behavioral reactivity may elucidate these patterns.

A clear and firm understanding of the relationship between temperament and sympathetic nervous system functioning in early life, and how the nature of that relationship may depend on biological sex has remained elusive. This may be in part due to the rapid growth and change that characterize this period. Studying these relationships as dynamic trajectories that form the foundation for the child's personality and behavior beginning in infancy may be essential to uncovering critical patterns with the potential to predict future mental health and well-being.

The Current Study

Utilizing a startle probe paradigm to measure electrodermal activity (EDA) in young children, the current study examines how infant temperament predicts early childhood electrodermal reactivity, and whether child sex moderates that relationship. It was hypothesized that temperament characteristics related to inhibition and internalizing, namely high negative affect, low positive affect, and high regulation scores in infancy would predict greater skin conductance response rate to startling auditory stimuli in early childhood. Temperament characteristics related to extraversion and externalizing, namely low negative affect, high positive affect, and low regulation, were hypothesized to predict lower skin conductance response rate. With regard to sex, we hypothesized that girls would be more electrodermally reactive than boys, regardless of temperament. Lastly, we hypothesized that sex would moderate the relationship between temperament and EDA, such that girls with high negative affect, low positive affect, and high regulation scores would have higher rates of skin conductance responses than their male counterparts.

Methods

Participants

A total of 150 participating in the study were recruited from the prenatal obstetrics and gynecological clinics (OB/GYN) in metropolitan New York during their 2nd trimester (baseline), and followed throughout their pregnancy, and subsequently completed a follow-up assessment with their children (ranging from 18–60 months in age, $M = 35.1$, $SD = 13.6$). Demographic information including mother's race, education, age, were collected through a battery of self-report questionnaires at baseline trimester. Child's infant temperament was collected via mother-report ($M = 7.6$ months of age, $SD = 3.6$) using the Infant Behavior Questionnaire (IBQ-R). When a child reached 18 months of age (ranging from 18 to 60 months, $M = 35.14$, $SD = 13.6$), the family was invited to the assessment center for a follow-up assessment of several neurodevelopmental indices. At this time, each child completed a psychophysiological assessment of startle response. Informed consent was obtained from the mothers of the children prior to participation and all study procedures were approved by the institutional review board at the assessment center in accordance with the standards set forth by the 1964 Declaration of Helsinki.

Of this 150, 15 mothers were excluded for lack of completed temperament questionnaires. An additional 10 were excluded due to child movement artifact resulting in distorted signal during at least half of the psychophysiological recording period, leaving 125 participants for this current study. Approximately 32.8% of mothers are white Hispanic, 20.8% black, 17.6% mixed-Hispanic, 11.2% Caucasian, 9.6% Asian, 6.4% black-Hispanic, 1.6% identified as "other." 51% of children were female. Independent samples t-test indicated that children missing data did not significantly differ from children with complete data in terms of sex, age, behavioral startle response, skin conductance response rate, or the temperament dimensions of negative affect, positive affect/surgency, or regulation.

All participants were consented according to protocol approved by the Institutional Review Boards at the City University of New York, New York Presbyterian-Queens, and Icahn School of Medicine at Mount Sinai. A full description of the parent study can be found elsewhere (Finik & Nomura, 2017).

Materials

Temperament—Mothers completed the Infant Behavior Questionnaire-Revised (IBQ-R, Gartstein & Rothbart, 2003) at around 6 months postpartum ($M = 7.6$ months of age, $SD = 3.6$). This 91-item parent report measure assesses the frequency of occurrence of a wide array of behaviors ranging from 1 (never) to 7 (always). These items form 14 subscales that are further combined into three higher order dimensions of temperament (Gartstein & Rothbart, 2003; Putnam, Helbig, Gartstein, Rothbart, & Leerkes, 2014): positive affect/approach (approach, vocal reactivity, high intensity stimuli pleasure, smiling and laughter, activity level, and perceptual sensitivity; Cronbach's $\alpha = .75$), negative affect/withdrawal (sadness, distress, fearfulness, fall reactivity; Cronbach's $\alpha = .56$), and regulation/surgency (low intensity stimulus pleasure, cuddliness, duration of orienting, soothability; Cronbach's $\alpha = .45$) according to the algorithm provided in the instrument.

Electrodermal activity—A BioNomadix Wireless EDA transmitter connected to two pre-gelled disposable Ag/AgCl electrodes via snap connection transmitted electrodermal activity data at 2000 Hz to the BioPac MP150 acquisition system and a computer running Acqknowledge software. Electrodes were placed on the left side of the left foot of the children, with .05 molar NaCl electrode gel added to better conduct the signal between skin and electrode. Mothers were present in the room with the child during recording to mitigate any distress unrelated to stimulus presentation. 60 Hz and 1 Hz noise were filtered from the signal. A skin conductance response (SCR) specific to a startle stimulus was defined as an increase in sweat production of at least 0.02 μ S occurring 1–7 seconds after the auditory stimulus.

Procedure

Children were seated next to their mothers for the duration of the experiment in a room kept at 71.6–75.2 °F, as per Braithwaite et al. (2013). In order to keep background sound to a minimum, the door to the experiment room was kept shut throughout, with another empty room and shut door between the experiment room and a communal hallway. Participants were asked to remain still and passively watch the computer monitor in front of them. The startling stimuli were presented on a computer running E-Prime 2.0 while psychophysiological signals were recorded. A period of approximately one minute of a series of six 90 dB auditory stimuli 1 second in duration with varying inter-stimulus intervals of 6–12 seconds was preceded and followed by 3-minute baseline period videos with no startling stimuli depicting nature scenes.

Analysis

SCR analysis—The percentage of startle probes that successfully elicited a skin conductance response (SCR), is referred to as “frequency,” and each of the three temperament dimensions from the IBQ (positive affect, negative affect, regulation) were dichotomized using median splits to determine high and low scores within the current sample. Nonspecific skin conductance responses occurring during the baseline period were also quantified as a continuous variable. Two trained research assistants visually inspected the raw signal for each subject and reached a consensus about whether or not the file should be excluded due to artifact ($n = 15$). Independent samples t-tests indicated that there were no differences between data with artifact and data without artifact with respect to child gender, age, behavioral startle response, or the three temperament dimensions (all $p > .17$).

Behavioral data—A trained research assistant reviewed video recorded of the experiment to code for overall behavioral response to the startling stimuli. Behavior was coded on a scale from 0–3. A score of 0 represented a total lack of behavioral startle response, whereas a score of 3 represented an extreme startle response characterized by movement, facial expression, or vocalization indicating intense surprise.

Statistical analysis—Analysis of descriptive statistics and Pearson correlation analysis was conducted for the whole sample and for each sex to observe associations between child sex, age, behavioral startle response, baseline nonspecific skin conductance occurrence, number of skin conductance responses specific to the startling stimuli, and the three

temperament dimensions of interest (see Table 1). Pearson chi square analysis was used to examine the association between SCR (low vs high) and three temperament dimensions (low vs. high). Odds ratios (OR) were calculated. This was followed by the same chi square analysis with additional Breslow Day procedure. This procedure tests the differential magnitude of association between the two factors, i.e., temperament and EDA, by the third factor, i.e., sex, serving as a formal test of interaction. Odds ratios for each stratum (boys and girls) were separately calculated. In order to adjust for potential confounders, binomial logistic regressions were performed, predicting a binary measure of SCR frequency. Age, race of the child, number of nonspecific skin conductance responses occurring during the baseline period, and behavioral startle response were *a priori* determined as confounders sex. To correct for multiple testing, the Benjamini-Hochberg procedure was followed with a 15% false discovery rate (Benjamini & Hochberg, 1995).

Results

Pearson correlations

As seen in Table 1, behavioral startle was positively correlated with negative affect. The rate of skin conductance responses to the startling stimuli was positively correlated with the number of nonspecific skin conductance responses that occurred during the baseline period. Lastly, regulation/surgency was positively correlated with child age and positive affect, and negatively correlated with negative affect.

Main effects predicting SCR frequency

Temperament—There was no sex difference in positive affect ($X^2[1] = 1.4$, $p = .23$, OR = 0.6), negative affect ($X^2[1] = 1.2$, $p = .28$, OR = 1.5), or regulation ($X^2[1] = 1.8$, $p = .84$, OR = 1.7).

Sex—Pearson Chi-square between sex and frequency of skin conductance responses was not significant $X^2(1) = 0.1$, $p = .75$, OR = 0.9, suggesting there are no notable sex differences in SCR frequency rate.

Interactions between temperament and sex on SCR frequency

Chi-square and odds ratio between each of the three temperament dimensions computed from the IBQ and the SCR frequency were stratified by sex with a formal test of interaction using Breslow-Day tests to determine whether the odds ratios for SCR frequency by temperament was homogeneous for each sex, or strata. These tests revealed that child temperament was differentially associated with SCR frequency according to sex for positive affect and regulation. See Table 2 for full results.

Positive affect—There was a significant association between positive affect and SCR frequency among boys [$X^2(1, n = 62) = 6.5$, $p = .01$, OR = 4.2] but not among girls [$X^2(1, n = 63) = .7$, $p = .40$, OR = 1.6] (see Fig. 1). The mean positive affect score for boys with low SCR frequency ($M = 5.5$, $SE = .21$) was greater than boys with higher frequency skin conductance responses ($M = 5.2$, $SE = .14$). Boys with lower positive affect scores had greater SCR frequencies ($M = 37.0\%$, $SE = 5.2$) than boys with higher positive affect scores

($M = 28.2\%$, $SE = 6.7$). Overall, low positive affect temperament scores were associated with an over 4-fold greater rate of SCR frequency for boys. No notable association between SCR frequency and positive affect was found among girls. Breslow-Day tests indicated that the magnitude of risk for low frequency response posed by positive affect significantly differed by sex $X^2(1) = 5.8$, $p = .016$. This suggests the strata were heterogeneous, providing evidence for interaction, with low positive affect boys at greater odds for high SCR frequency, and girls' odds for SCR frequency unaffected by positive affect.

Negative affect—Pearson Chi-square between temperament dimension of negative affect and SCR frequency by sex was not significant for boys [$X^2(1, n = 62) = 2.2$, $p = .14$, $OR = 2.3$] or girls [$X^2(1, n = 63) = .01$, $p = .91$, $OR = 1.1$] (see Fig. 2). Further, Breslow-Day tests indicated that the difference in risk for high or low frequency response posed by negative affect did not significantly differ by sex $X^2(1) = 1.0$, $p = .32$.

Regulation—Pearson Chi-square between temperament dimension of regulation and SCR frequency by sex was significant among girls [$X^2(1, n = 63) = 5.7$, $p = .017$, $OR = 3.7$] but not among boys [$X^2(1, n = 62) = .3$, $p = .59$, $OR = 0.7$] (see Fig. 3). The mean regulation score for girls with low SCR frequency was lower ($M = 5.2$, $SE = .1$) than that of girls with higher frequency responses ($M = 5.6$, $SE = .1$). Girls with lower regulation scores had lower response frequencies ($M = 22.2\%$, $SE = 5.4$) than girls with higher regulation scores ($M = 34.4\%$, $SE = 5.2$). Overall, higher regulation scores were associated with a nearly 4-fold greater rate of SCR frequency for girls. No observable differences were found for boys. Breslow-Day tests indicated that the magnitude of risk for low frequency response posed by regulation significantly different by sex $X^2(1) = 4.3$, $p = .04$. This suggests the strata were heterogeneous, with an interaction indicating that low regulation increased odds of low SCR frequency in girls. The odds for boys were unaffected by regulation.

Logistic regression—Logistic regression analysis after controlling for age, race of the child, behavioral startle response, and number of baseline nonspecific skin conductance responses revealed that the observed associations between SCR frequency and temperament were almost identical. Specifically, high positive affect predicted greater SCR frequency in boys ($OR = 3.8$, $p = .04$), but not girls. There were no significant results related to negative affect in boys or girls. High regulation predicted lower SCR frequency in girls ($OR = 4.2$, $p = .03$), but not boys. These results remained significant following the Benjamini-Hochberg procedure for multiple testing with a false discovery rate of 15%. See Table 3 for full results.

Discussion

This preliminary study found a significant sex by temperament interaction, but no main effect of either, on skin conductance response (SCR) frequency. Neither infant temperament nor sex alone predicted SCR frequency in early childhood. Our findings suggest that the association between SCR frequency and temperament traits may be moderated by sex. While preliminary, this is the first study that documented an interaction between sex and temperament dimensions on a measure of sympathetic nervous system reactivity such as SCR. More specifically, among boys, those with low positive affect scores had greater SCR

frequencies than those with high positive affect. Among girls, those with high regulation scores had greater SCR frequencies than those with lower regulation scores.

This may suggest that low positive affect boys were more autonomically reactive to the startling stimuli than their high positive affect counterparts, whereas positive affect had no notable impact on reactivity in girls. Positive affect has a negative relationship with internalizing symptoms (see Davis & Suveg, 2014 for a review), and internalizing symptoms have been correlated with higher EDA measures (Weems et al., 2005). It is possible that boys with low positive affect and high sympathetic nervous system reactivity are at risk for internalizing symptoms. Contrary to prior research (Gartstein & Rothbart, 2003), we did not find that boys had higher positive affect scores than girls. It may be that this sex difference in temperament emerges later in development.

Among girls, we found that those with high emotion regulation scores had higher SCR frequencies than those with low emotion regulation. It is notable that the difference in temperament scores increased their likelihood of having reactive SCRs as compared to boys. This finding may indicate that high emotion regulation girls were more autonomically reactive to the stimuli than those with low emotion regulation. The higher SCR frequency in girls with higher regulation scores may indicate that girls are well equipped in regulating their emotions in the face of experienced autonomic arousal.

Given that women disproportionately develop internalizing disorders such as depressive and anxiety disorders and men disproportionately develop neurodevelopmental disorders (Rutter, Caspi, & Moffitt, 2003), sex differences in temperament and their potential developmental trajectories by examining their psychophysiological reactivity may serve to help explain this phenomenon. For example, a female tendency to over-regulate emotions may predispose women toward behavioral inhibition and, in some cases, develop depression or anxiety. Indeed, researchers have associated traits related to regulation such as behavioral inhibition and low impulsivity with internalizing (Eisenberg et al., 2001). Similarly, low male regulation reported in the literature may predispose men to develop disorders such as attention deficit hyperactivity disorder. Measures of autonomic reactivity such as EDA may help to identify common underlying mechanisms linking temperament and psychopathological risk. The earlier in development these investigations occur, the more likely it is that researchers will be able to distinguish between biological and environmental influences on psychopathological risk.

Consideration of the limitations of this study are important for the interpretation of its findings. As the present study is preliminary in nature, the sample is small and the age range is large, although adjustments for age of the child in logistic regression did not alter results. Further, although race was not a significant predictor in our regressions, there are known race effects on EDA in the literature, and a more nuanced analysis of race within our diverse sample may reveal some differences (El-Sheikh et al., 2010). Moreover, we broadly dichotomized the temperament domains and electrodermal reactivity as “high” and “low” using median splits. This dichotomy does not necessarily represent pathological levels of each measure. The use of median splits allowed for an examination of general tendencies

toward each, and was considered to be the best option given the sample size and lack of normal distribution in the SCR frequency data.

Despite those limitations, the current study demonstrated evidence for interactions between sex and temperament on EDA in young children. The Centers for Disease Control and Prevention report that the prevalence of psychopathology in children in the United States is on the rise, with 13–20% meeting diagnostic criteria per year (CDC, 2013). Identifying precursors for psychopathology in early childhood, such as atypical behavioral and biological reactivity, provides mental health practitioners the opportunity for early intervention and lends insight into the pathways through which psychopathology develops. Consensus surrounding an objective risk factor that exhibits both reliability and predictive validity for this purpose is lacking within the literature, and advocated for by the National Institute of Mental Health's Research Domain Criteria (RDoC) initiative, which emphasizes the need to integrate pathophysiological considerations in our understanding of mental illnesses (Insel, et al., 2010). As discussed above, atypical electrodermal patterns have been associated with a variety of psychopathologies, and may prove to be a useful addition to the RDoC mission. In sum, our preliminary findings suggest that autonomic arousal may underlie, and perhaps precede the emergence of the behavioral temperament characteristics often reported in prior research. Further, biological sex may moderate these relationships through sex hormone levels, social-environment influence, or a combination of the two. The literature also indicates that sex differences in EDA and temperament may fluctuate with age. As this cohort develops, we will be able to evaluate sex-specific trajectories of reactivity. Future research is necessary to determine whether autonomic nervous system functioning precedes behavioral reactivity, and how this may impact future psychopathological symptomatology. If so, we may be able to identify children at risk for mental illness and institute sex-specific interventions geared toward young children to promote mental health.

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Figure 1.
Positive Affect x Gender Predicting Skin Conductance Response Rate
Note: Boys $n = 55$, Girls $n = 53$

Figure 2.
Negative Affect and Gender Predicting Skin Conductance Response Rate
Note: Boys $n = 55$, Girls $n = 53$

Figure 3.
Regulation and Gender Predicting Skin Conductance Response Rate
Note: Boys $n = 55$, Girls $n = 53$

Table 1

Pearson's Correlations Among Variables of Interest

	1	2	3	4	5	6	7	8	Mean	SD	Range
1. Gender	--	-.12	.14	-.12	-.08	.18*	.20*	.08			
2. Child Age		--	.12	-.04	.12	-.07	-.15	.23**	34.56	13.40	48.26
3. Behavioral Startle			--	-.04	-.06	.05	.20*	-.02	0.72	0.98	3.00
4. Baseline Nonspecific Skin Conductance Responses				--	.37**	.13	.07	.09	2.70	4.03	19.00
5. Skin Conductance Response Rate					--	.02	.03	.08	30.93%	31.23	100%
6. Positive Affect						--	.09	.37**	5.42	0.83	4.77
7. Negative Affect							--	-.32**	3.69	0.84	4.77
8. Regulation								--	5.38	0.68	3.64
Boys											
1. Child Age	--	-.09	-.01	.22	-.08	-.17	.23		36.19	13.71	45.21
2. Behavioral Startle		--	-.03	-.04	-.03	.20	-.26*		0.58	4.46	3.00
3. Baseline Nonspecific Skin Conductance Responses			--	.27*	.19	.25	.06		3.19	4.46	19.00
4. Skin Conductance Response Rate				--	.01	.11	-.002		33.33%	32.36	100%
5. Positive Affect					--	-.02	.46**		5.27	0.92	4.77
6. Negative Affect						--	-.38**		3.52	0.80	3.85
7. Regulation							--		5.32	0.75	3.64
Girls											
1. Child Age	--	.32*	-.12	.00	-.02	-.08	.26*		33.01	13.00	44.91
2. Behavioral Startle		--	-.00	-.05	.06	.16	.15		0.86	1.06	3.00
3. Baseline Nonspecific Skin Conductance Responses			--	.49**	.11	-.09	.16		2.22	3.53	19.00
4. Skin Conductance Response Rate				--	.07	-.02	.20		28.57%	30.15	83.33%
5. Positive Affect					--	.14	.22		5.56	0.71	2.95
6. Negative Affect						--	-.30*		3.85	0.85	4.17
7. Regulation							--		5.44	0.61	2.94

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Note: Boys *n* = 62, Girls *n* = 63. Item anchors: behavioral startle (0 = *no visible startle*, 3 = *extreme startle response*), positive affect, negative affect, and regulation (1 = *behavior never occurs*, 7 = *behavior always occurs*).

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

Table 2

Chi Square Test of Association between Temperament and Skin Conductance Response Rate by Gender

Scale	Skin Conductance Response Rate				X ² (1) <i>p</i> -value OR		Homogeneity Test of OR
			Low (n)	High (n)			
Positive Affect	Boys	low	7	26	5.38	0.002	0.27
		high	13	13			
	Girls	low	11	14	1.16	0.28	1.79
		high	11	25			
<i>p</i> = .016							
Negative Affect	Boys	low	13	20	1.30	0.26	1.95
		high	6	18			
	Girls	low	10	15	0.14	0.71	1.22
		high	12	22			
<i>p</i> = 0.56							
Regulation	Boys	low	9	19	0.07	0.79	0.89
		high	11	20			
	Girls	low	15	14	5.88	0.02	3.82
		high	7	25			
<i>p</i> = 0.057							

Note OR = odds ratio; Boys *n* = 55, Girls *n* = 53.

Table 3

Age and Race Adjusted Binomial Logistic Regression Predicting Skin Conductance Response Rate by Gender

	B [95% CI]	df	OR	p
Positive Affect				
Boys	1.3 [1.04, 14.03]	1	3.8	.04*
Girls	-.36 [0.20, 2.44]	1	0.7	.57
Negative Affect				
Boys	-.73 [0.12, 1.98]	1	0.5	.31
Girls	.18 [0.33, 4.33]	1	1.2	.78
Regulation				
Boys	0.1 [0.27, 4.83]	1	1.1	.86
Girls	-1.4 [0.07, 0.86]	1	4.2	.03*

Note: OR = Odds Ratio; Boys $n = 55$, Girls $n = 53$.

* $p < .05$