DIFFERENTIAL SUSCEPTIBILITY TO PARENTAL SENSITIVITY BASED ON EARLY-LIFE TEMPERAMENT IN THE PREDICTION OF ADOLESCENT AFFECTIVE PSYCHOPATHIC PERSONALITY TRAITS

KEVIN M. BEAVER
Florida State University
King Abdulaziz University
SARAH HARTMAN
JAY BELSKY
University of California at Davis

A body of research has examined the potential causes of psychopathy and psychopathic personality traits. What is surprisingly missing from these studies is an effort to estimate person–environment interactions that might explain variation in psychopathic personality traits. The current study addressed this lacuna, examining whether early-life temperament conditioned the effect of parental sensitivity on adolescent affective psychopathic personality traits. Drawing on data from the National Institute of Chlid Health and Human Development (NICHD) Study of Early Child Care and Youth Development, the results revealed some evidence of temperament–parenting interactions, which were more in line with a differential-susceptibility than a diathesis-stress model of environmental action. Findings indicated that male infants with an easy temperament were the most affected by maternal and paternal sensitivity when it came to predicting a measure of affective psychopathic traits and the subcomponent of callousness. In addition, early-life temperament also interacted with paternal sensitivity in a for-better-and-for-worse fashion for the subcomponent of unemotionality.

Keywords: diathesis stress; differential susceptibility; parenting; psychopathy; temperament

Psychopathy is a personality disorder characterized by an assortment of affective, behavioral, and interpersonal factors, though the focus of much research emphasizes traits related to the affective dimension (Hare, 1996, 2006). A great deal of effort has been devoted to studying psychopathy and psychopathic personality traits (Patrick, 2006), with much of this work focusing on its consequences (DeLisi, 2009; Hare, 1999). The results of this body of research, focused as it is on heterogeneous samples from around the world while assessing psychopathy in diverse ways, document a robust association between psychopathy and

AUTHORS' NOTE: *Correspondence concerning this article should be addressed to Kevin M. Beaver, College of Criminology and Criminal Justice, Florida State University, 145 Convocation Way, Tallahassee, FL 32306-1273; e-mail: kbeaver@fsu.edu.*

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a wide range of negative outcomes (DeLisi, 2009; Hare, 1996). The emergence of callous-unemotional traits in childhood, for instance, has been shown to predict serious antisocial behaviors and traits well into adulthood (Frick, Ray, Thornton, & Kahn, 2014). Additional outcomes that have been found to be associated with psychopathic personality traits include contact with the criminal justice system (DeLisi, 2009; DeLisi & Vaughn, 2008; Leistico, Salekin, DeCoster, & Rogers, 2008), problems forming and sustaining basic social relationships (Barry, Barry, Deming, & Lochman, 2008), and difficulty maintaining stable, lawful employment (Babiak & Hare, 2006). As such, psychopathy and psychopathic personality traits represent some of the most potent risk factors for a life marred by antisocial behavior and social dysfunction (Vaughn, Howard, & DeLisi, 2008; Walters, 2003a, 2003b).

Given the link between psychopathic personality traits and antisocial phenotypes, interest has arisen in unpacking the etiological and developmental origins of psychopathy and psychopathic personality traits (Beaver, Barnes, May, & Schwartz, 2011). Much of the relevant research has focused on how certain risk factors predict variation in callous-unemotional traits during childhood and adolescence and psychopathy later in life (Frick et al., 2014; Patrick, 2006). Despite this developmental focus, the degree to which various factors in infancy and early childhood might inform an etiologic understanding of later-life psychopathy remains an open-empirical issue (Farrington, 2005), as does the possibility that early-life temperamental factors and environmental conditions might work synergistically to foster the development of psychopathic personality traits. The goal of the current study, therefore, is to address this issue of person–environment interaction by evaluating whether temperament measured at 6 months of age might interact with parental sensitivity measured in infancy, childhood, and adolescence to predict affective psychopathic personality traits in adolescence. Given that we are focusing on adolescents and given that the sample is drawn from the community, affective psychopathic personality traits will be measured continuously as opposed to categorically.

THE DEVELOPMENT OF PSYCHOPATHY AND PSYCHOPATHIC PERSONALITY TRAITS

The precise factors that are responsible for producing variation in psychopathic personality traits has been at the center of a considerable amount of research (Farrington, 2005). Given that psychopathic personality traits begin to emerge early in life and remain relatively stable from adolescence through adulthood (Lynam, Caspi, Moffitt, Loeber, & Stouthamer-Loeber, 2007), these studies have tended to examine the developmental origins to psychopathy (Lynam & Gudonis, 2005). Much of this research has been behavioral-genetic in character, affording the decomposition of variance in measures of psychopathic personality traits into three components: a heritability component, a shared environmental component, and a non-shared environmental component. Although the estimates of each wax and wane across investigations, a meta-analysis revealed that callous-unemotional traits, psychopathy, and psychopathic personality traits are under substantial genetic influence, with approximately 40% to 70% of the variance explained by genetic influences (Frick et al., 2014). The remaining variance is accounted for by environmental factors, with most of that explained by non-shared influences (Waldman & Rhee, 2006).

Given the role that behavioral-genetic inquiry allocates to environmental influences, there has been a general interest in trying to uncover the specific environmental risk factors

for psychopathy (DeLisi, 2009). Findings from this line of research highlight significant associations between family- and parental-level variables and measures of psychopathic personality traits across different developmental time periods. To illustrate, a recent study conducted by Waller et al. (in press) examined the bidirectional relationship between parental warmth and callous-unemotional traits in a sample of 2- and 3-year-olds. The results of their cross-lagged models revealed that parental warmth predicted callous-unemotional traits in young children. Additional studies have linked different dimensions of parenting, such as harsh parenting, to callous-unemotional traits in adolescence as well (Barker, Oliver, Viding, Salekin, & Maughan, 2011).

The effects of parenting on psychopathic personality traits appear to extend beyond childhood and adolescence into adulthood. For instance, Farrington (2006) analyzed data from the Cambridge Study in Delinquent Development and detected significant associations between childhood and adolescent family factors (including harsh discipline, physical neglect, and poor supervision) and adulthood psychopathy. Other studies have chronicled similar links between negative parenting practices (including both maternal and paternal negativity) and various measures of psychopathic personality traits, even after controlling for genetic confounding (Beaver et al., 2011; Larsson, Viding, & Plomin, 2008; Viding, Fontaine, Oliver, & Plomin, 2009). Taken together, the available evidence thus suggests that parenting may play a role in the development of psychopathic personality traits and psychopathy (Frick et al., 2014).

Focusing only on environmental factors, such as parenting, without directly modeling person-level variables, likely produces misspecified models that may under-estimate environmental influences (Raine, 2002; Rowe, 1994). As is the case with virtually all phenotypes (Rutter, 2006), person–environment interactions likely play a role in generating variation in psychopathic personality traits. To date, though, not much psychopathy research has been devoted to uncovering which person-level variables might interact with which environmental variables (Lynam, Loeber, & Stouthamer-Loeber, 2008) and, as a result, virtually nothing is known about person–environment interactions as they relate to psychopathy and psychopathic personality traits. Even so, insights from the diathesis-stress model and the differential-susceptibility model provide a solid rationale for exploring person–environment interactions in relation to psychopathy, and they both offer some insight into the person-level variables and environmental factors that might be involved in these interactions.

MODELS OF PERSON–ENVIRONMENT INTERACTION

The diathesis-stress model has been the most widely used perspective to examine person–environment interactions in relation to human phenotypes. According to the logic of this model, the effects of negative environmental stimuli are not uniform across all people, but rather affect some individuals more than others, thereby making them "vulnerable" to adversity. Importantly, the diathesis-stress model does not acknowledge the possibility that some individuals may be differentially susceptible to supportive, enriched, or even just benign contextual conditions (Zuckerman, 1999). In other words, according to the prevailing diathesis-stress perspective on person–environment interaction, more and less vulnerable individuals differ markedly in their functioning under conditions of adversity, with the more vulnerable performing more poorly (e.g., manifesting more antisocial behavior), but not differing in their functioning under benign or supportive conditions.

The reason for such divergent responses to contextual adversity arise is presumed to be the result of person-level factors, such as genotype or temperament, which make some individuals more likely than others to be affected by contextual adversity. Central to diathesis-stress research is the disproportionate if not exclusive focus on negative contextual conditions (e.g., harsh parenting), negative person-level variables (e.g., negatively emotional temperament), and negative phenotypic outcomes (e.g., antisocial behavior). To illustrate, in a landmark study, Caspi et al. (2002) examined whether the effects of childhood maltreatment on antisocial phenotypes were moderated by the low-activity alleles of a polymorphism in the promoter region of the monoamine oxidase A (MAOA) gene regarded as a "risk" or "vulnerability" gene. Note that the contrasting contextual condition in this work, like in most person–environment interaction research informed by diathesis-stress thinking, was the absence of maltreatment, not the presence of particularly supportive or enriched care. Results revealed that it was among carriers of low-MAOA-activity alleles that exposure to maltreatment most strongly predicted antisocial phenotypes. Although other studies informed by the diathesis-stress model have examined other moderating influences (e.g., negative emotionality), other environmental factors (e.g., negative life events), and other phenotypes (e.g., depression), they all focus on the negative side to these variables.

An alternative model of person–environment interaction, based on an evolutionary analysis of developmental plasticity, is referred to as differential susceptibility (Belsky, 1997; Belsky & Pluess, 2009, 2013; Ellis, Boyce, Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2011). Rather than highlighting variation in responsiveness to contextual adversity, it highlights variation in responsiveness to both adverse and supportive contextual conditions. According to this model, those individuals who (according to diathesis-stress thinking) are especially vulnerable to adversity are simultaneously especially likely to reap the benefits of supportive environmental conditions. In other words, some individuals are more generally susceptible than others to environmental influences, for-better-*and*-for-worse (Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2007). But like the diathesis-stress model, the differential-susceptibility model identifies person-level factors as key priming agents, contending that individuals vary in their general developmental plasticity (i.e., susceptibility to environmental influences). Previous research, for instance, has shown that certain genetic polymorphisms, as well as early-life temperament, affect how susceptible an individual is to both positive and negative environmental influences (Bakermans-Kranenburg & van IJzendoorn, 2011; Belsky & Beaver, 2011; Belsky et al., 2009).

Consider in this regard a study conducted by Simons et al. (2011) which examined associations among social conditions, genotypes, and aggression. Results revealed that individuals possessing certain genetic variants routinely regarded as "risk alleles" in psychiatric research were the most susceptible to social conditions, both positive and negative, consistent with the notion that the genes in question might be better conceptualized as "plasticity genes" (Belsky et al., 2009). When exposed to the most negative environments, the individuals with these genetic variants displayed the most aggression, but when individuals with these same genetic factors were exposed to the most positive environments, they scored the lowest on aggression. Those not carrying these plasticity alleles were not affected at all. This type of for-better-and-for-worse interaction has been detected in other studies which collectively provide support for the differential-susceptibility model (for reviews, see Belsky & Pluess, 2009, 2013).

THE ROLE OF EARLY TEMPERAMENT

Although the diathesis-stress and differential-susceptibility models make distinct and different predictions, one of the common threads cutting across both of these conceptual frameworks is that early-life temperament appears to be an important moderating factor for how children and adolescents are affected by their developmental experiences and environmental exposures, including parenting (Belsky, 1997; Belsky & Pluess, 2009, 2013). This is particularly important when it comes to the development of psychopathic personality traits, because while parenting factors have been shown to predict variation in psychopathic personality traits, the effect sizes tend to be relatively small in magnitude (Beaver et al., 2011). These small effect sizes strongly suggest that there is heterogeneity in how children and adolescents respond to parenting and thus how parenting may ultimately shape the development of antisocial and psychopathic personality traits (Wright & Beaver, 2005). Some of this heterogeneity may be tied up in the moderating influences of certain individual-level factors, such as temperament (Belsky, 1997, 2005).

So although there is ample evidence to indicate that temperament might condition the effects of parenting, what is not clear-cut from the existing literature is whether an easy temperament or a difficult temperament should operate in a for-better-and-for-worse (as the differential-susceptibility model would predict) or in just a for-worse manner (as the diathesis-stress model would predict) when it comes to psychopathy and psychopathic personality traits. For the most part, the existing literature suggests that having a difficult temperament is associated with greater developmental plasticity (Belsky, 2005; Belsky & Pluess, 2009, 2013). For example, Pluess and Belsky (2009) reported that children with negative temperaments are more affected by the quality of their rearing experience when compared with children with positive temperaments.

Whether similar results would emerge when the focus is on psychopathic personality traits remains to be determined, and there is some evidence to suggest that the etiology of psychopathic personality traits may be quite different from the etiology of other types of antisocial phenotypes. In particular, psychopaths have been shown to be relatively fearless (J. Blair, Mitchell, & Blair, 2005); they fail to have the same physiological responses to emotionally charged images and situations as non-psychopaths (J. Blair et al., 2005; R. J. R. Blair, Jones, Clark, & Smith, 1997; Levenston, Patrick, Bradley, & Lang, 2000), and they have relatively low levels of anxiety (Frick, Lilienfeld, Ellis, Loney, & Silverthorn, 1999), thus proving quite difficult to condition (J. Blair et al., 2005; Flor, Birbaumer, Hermann, Ziegler, & Patrick, 2002). These unique aspects of psychopathy hint at the possibility that the development of psychopathic personality traits might be quite different from the development of other phenotypes, including other types of psychopathologies, at least insofar as the role of early temperament is concerned. Without any prior research on this issue, we remain agnostic as to whether children with an easy or a difficult temperament would prove more susceptible to the effects of parenting on the development of psychopathic personality traits. We also remain agnostic as to whether the diathesis-stress or differential-susceptibility models would best characterize the temperament–parenting interaction process that is the focus of the research reported herein.

THE CURRENT STUDY

In light of the issues raised, we examine temperament–parenting interactions in the prediction of adolescent affective psychopathic personality traits in this study for two key

reasons. First, previous developmental research testing the diathesis-stress and differential-susceptibility models has shown that early-life temperament is a significant moderator of environmental influences (Belsky, 1997, 2005; Belsky & Pluess, 2009). We use this previous work as a springboard to examine whether temperament moderates the effect of maternal and paternal behavior early in life on affective psychopathic personality traits in adolescence and whether it does so in a manner consistent with diathesis-stress or differential-susceptibility thinking. Second, we focus on parenting, specifically sensitive-responsive parenting, because existing research has shown that quality of parenting (a) predicts psychopathic personality traits (Farrington, 2006, Frick et al., 2014; Kochanska, 2002; Pardini & Loeber, 2008) and (b) interacts with early-life temperament in forecasting children's behavioral development (Pluess & Belsky, 2009).

Importantly, we adopt an exploratory approach to evaluate temperament–parenting interaction, not presuming that the data would reflect differential susceptibility, diathesis stress, or even some other recent models of person–environment interaction (e.g., vantage sensitivity; Pluess & Belsky, 2013). As a result, we purposefully eschewed one new analytic method for rigorous testing of differential susceptibility versus diathesis stress which involves the competitive evaluation of alternative theoretical models (Belsky et al., 2013; Widaman et al., 2012). However, we do implement criteria newly proposed by Roisman et al. (2012) for evaluating differential susceptibility, should evidence appear consistent with that theoretical framework.

Following Kochanska, Kim, Barry, and Philibert (2011), Roisman et al. (2012) proposed first that investigators conduct Regions of Significance (RoS) tests to determine the full range of values of the moderator for which the regression of the outcome on the predictor (*X*) is statistically significant. Moreover, they recommended that the difference between those scoring high versus low on the moderator (early temperament in the case of the present study) should be significant both on the low end of the predictor (i.e., insensitive parenting) and on the high end of the predictor (i.e., sensitive parenting) before concluding that results are consistent with differential-susceptibility predictions. Importantly, because the difference can be significant at values of a predictor that are not represented in the sample (e.g., at 14 *SD*s below the mean), Roisman et al. (2012) further recommended that investigators conduct RoS tests using common regions of interest (i.e., the range of the predictor for the RoS on *X* test should be bounded within 2 *SD*s from the mean).

Another important recommendation by Roisman et al. (2012) was to use new metrics specifically designed to index the disordinal-interaction effects central to differential-susceptibility. Thus, they proposed two closely related indices that take advantage of the fact that the crossover point of the interaction provides a natural way to conceptualize the point at which an effect of *Z* on *Y* can change from "for better" (i.e., benefiting from sensitive parenting) to "for worse" (i.e., being adversely affected by sensitive parenting). The first metric, labeled the *Proportion of Interaction* (PoI) index, represents the proportion of the total area between the lines of an interaction plot bounded within 2 *SD*s on the predictor that is above the crossover point. In a prototypical interaction plot for differential susceptibility, the lines will cross over near the mean of the predictor; as a result, 50% of the area bounded by the regression lines in such a plot would represent the "for better" region. In a prototypical case of diathesis stress (i.e., an ordinal interaction), the crossover point will be on the far right side of the plot, and 0% of the total area will represent the "for better" region. The second index, labeled the *Proportion Affected* or the *Percent Above* (PA) index, is similar to

the PoI, but is designed to quantify the proportion of all people in the sample who fall above the crossover point for the interaction. This value is an estimate of the number of people in the sample who are differentially affected "for the better." In a prototypical differential-susceptibility situation, 50% of people will be differentially affected for the better by *Z* (e.g., difficult temperament) as a function of *X* (e.g., parenting). In a prototypical diathesis-stress situation, 0% of people will be differentially affected for the better by *Z* as a function of *X*. When used in this manner, Roisman et al. (2012) recommend that differential susceptibility is highly consistent with PoI values between 40% and 60%, or PA values equal to or greater than 16%.

Roisman et al.'s (2012) third recommendation involved testing for non-linearity. Before investigators can conclude that the evidence supports differential-susceptibility, they first must demonstrate that non-linear effects are not statistically significant. If one or more of these terms is significant, then a researcher must demonstrate that the interaction between predictor and moderator holds when these non-linear terms are statistically controlled. Finally, Roisman et al. (2012) recommended that investigators attend to Type I error rates when examining multiple interactions in multi-wave data sets.

The last point to be made about the current inquiry is that we focus exclusively on males for two intertwined purposes. First, much of the research on psychopathy and psychopathic personality traits has centered on males. Second, and even more importantly, some of the available research indicates different etiology pathways to psychopathy for males and females, with some scholars even calling for unique theories tailored specifically to males and females (Verona & Vitale, 2006). Rather than try to develop unique statistical models for males and females, we focus on the research that can easily be applied to males. We do, however, make note of the results for females in respect to the temperament–parenting interactions for those who are interested in potential male–female differences.

METHOD

PARTICIPANTS

Families were recruited for the NICHD Study of Early Child Care and Youth Development (SECCYD) in 1991 from hospitals located in or near Little Rock, AR; Orange County, CA; Lawrence, KS; Boston, MA; Pittsburgh, PA; Philadelphia, PA; Charlottesville, VA; Seattle, WA; Morganton, NC; and Madison, WI. During selected 24-hr sampling periods, 8,986 women who gave birth were screened, 5,416 of whom met the eligibility criteria for the study. Families were excluded if (a) the mother was younger than 18 years of age, (b) the family planned to move, (c) there was a multiple birth, (d) the infant had a known disability or remained in the hospital more than 7 days, (e) the mother acknowledged substance abuse, (f) the mother did not speak English, or (g) the mother lived more than an hour from the laboratory site or in an extremely unsafe neighborhood, as determined by local police. From that group, 1,364 families became study participants on completing an interview when their infants were 1 month old. Details about recruitment and selection procedures are available in prior publications from the study (see NICHD Early Child Care Research Network [ECCRN], 2005) and http://www.icpsr.umich.edu/icpsrweb/ICPSR/series/0023. Note that although large, demographically diverse, and methodologically rich, the SECCYD was not designed to be a nationally representative study. All data collections were approved by ethics' review boards at each of the participating universities.

Analysis Sample

Analyses for this report are based on an all-male subset of 705 children for whom data on observed parenting quality was available at 6-, 15-, 24-, 36-, and 54 months, and first and third grade. As for race/ethnicity, 81% of the children from the analysis sample were White/non-Hispanic. For all analyses, we used multiple imputation ($m = 5$) to account for missing values in the mother and father sensitivity variables. This was accomplished with raw case-level analytic data as input, in an effort to produce less-biased and more consistent parameter estimates than techniques such as pairwise or listwise deletion for longitudinal missing data (Newman, 2003; Schafer, 1997; Schafer & Graham, 2002); we purposefully chose not to impute the predicted outcome (affective psychopathic personality traits). This strategy resulted in an analysis sample of 478 of the original 705 boys, due to the fact that 227 boys were not included in the age 15 assessments, principally due to their own or their parent's refusal to participate. Also of note is that, for some analyses of particular psychopathic traits up to five boys could not be included because they did not complete the instrument measuring the traits.

The 227 cases not included differed from the 478 included cases on a number of demographic and psychosocial measures. At study enrollment, mothers of the excluded boys were significantly younger (27.2 vs. 28.3 years), less educated (13.7 vs. 14.4 years), and had a lower income-to-needs ratio (2.53 vs. 2.97) than mothers of those included in the analysis sample; but the groups did not significantly differ on race and ethnicity, marital status, or maternal depression.

MEASURES

Three sets of measures are described pertaining to parenting, temperament, and psychopathy.

Early Parental Sensitivity

Observed parenting measurements were obtained across multiple time points. Positive, non-intrusive, responsive, and supportive parenting was assessed by observing and videotaping for later scoring (a) mother–child semi-structured interaction with toys when the children were 6-, 15-, 24-, 36-, and 54 months old, and when they were in first and third grade, and (b) father–child semi-structured interactions with toys when the children were 6-, 36-, and/or 54 months old, and when they were in first and third grades. Detailed descriptions of the procedures and coding of the mother–child and father–child interactions are provided in publications of the NICHD ECCRN (1999, 2000, 2003, 2004).

Videotapes of the parent–child interaction sessions from the 10 data collection sites were scored by coders blind to family circumstances at a site not involved in data collection. Parent behavior was rated on a series of 4- or 7-point rating scales, which were composited a priori to produce a summary measure of sensitive parenting reflecting positive, non-intrusive, responsive, and supportive care. When the children were 6-, 15-, and 24 months of age, the composite measure was generated by the summation of scores on sensitivity to non-distress, intrusiveness (reverse scored), and positive regard. The sensitivity composites at 36 and 54 months and in first and third grade were created by summing scores for supportive presence, hostility (reverse scored), and respect for autonomy. Internal consistency (Cronbach's alphas) ranged from .70 to .84 for the maternal sensitivity composites and .71

to .79 for the paternal composites. For purpose of analysis, age-specific composites were standardized and averaged, thereby generating grand, multi-age composite measures of both observed mother and father sensitivity.

Early Temperament

At the 1- and 6-month visits, mothers completed the Carey and McDevitt's (1978) Infant Temperament Questionnaire, which contained 38 items rated on a 6-point scale. Items were designed to quantify behaviors of approach, activity, intensity, mood, and adaptability. From the standpoint of validity, Pluess and Belsky (2009) found that early temperament construct moderated effects of both parenting and child-care experience in a manner anticipated on a variety of middle-childhood outcomes. Following these investigators, a multi-age composite was created by averaging 1- and 6-month temperament data, with higher scores reflecting a more irritable and difficult infant. Reliability for 1- and 6-month data were $\alpha = .67$ and $\alpha = .81$, respectively.

Affective Psychopathic Personality Traits

Affective psychopathic personality traits were assessed when adolescents were 15 years of age using a 15-item subset of the Youth Psychopathic Traits Inventory (YPI; Andershed, Kerr, Stattin, & Levander, 2002). This self-report assesses the affective rather than behavioral aspects of psychopathy. Specifically, the total affect score is created by compositing three subscales, each comprised of five items: remorselessness (e.g., "To feel guilty and remorseful about things you have done to hurt other people is a sign of weakness"), unemotionality (e.g., I usually feel calm when other people are scared"), and callousness (e.g., "I think that crying is a sign of weakness, even if no one sees you"). Participants responded to each items using a 4-point Likert-type scale (1 = *does not apply at all*, 2 = *does not apply well*, 3 = *applies fairly well*, and 4 = *applies very well*). After reverse-scoring three items, composite scores were produced for each subscale by summing the item scores. The total affect score was computed by proportional weighting of each subscale score. For the total score and each subscale, higher scores reflect greater psychopathic tendencies. Cronbach's alphas ranged from .61 to .69 for the subscales, and equaled .82 for the total score. A previous study demonstrated convergent validity between the YPI and Psychopathy Checklist: Youth Version (PCL:YV) among a community sample with moderate correlations between the corresponding dimensions of the two instruments and supportive evidence of categorical convergent validity (Andershed, Hodgins, & Tengström, 2007). Within the NICHD data, the total affect score displayed convergent validity with other youth self-report measures obtained at age 15 including non-sexual risk taking ($r = .33$**), sexual risk taking ($r = .16$**), impulse control ($r = -.33$**). It also displayed convergent validity with various subscales of youth-self reported behavior problems (YSR; Achenbach & Rescorla, 2001): Externalizing ($r = .23$**), Delinquency ($r = .23$**), Social Problems ($r = .10$**), Aggression ($r = .19$**), and Thought Problems ($r = .13$**).

DATA ANALYSIS

Hierarchical linear regression was used to test whether temperament and parenting interacted to predict affective psychopathic traits, with main effects tested before interactions. Of special importance is that we used Roisman et al.'s (2012) framework for rigorously

evaluating differential susceptibility. Thus, we implemented RoS tests to determine the full range of values of the moderator (*Z*) for which the regression of the outcome (*Y*) on the predictor (*X*) is statistically significant, referred to as the test of RoS on *Z*. We also used RoS to determine in which parts of the parenting distribution the prediction of the outcomes varies as a function of early temperament, referred to as the test of RoS on *X*. Recall that the difference between individuals high or low on the moderator should be significant for both the low-end and high-end values of *X* before concluding that results support differential susceptibility. In doing so, common regions of interest should be used by bounding the range of *X* to ±2 *SD*s and also by attending to whether observed cases actually exist within the regions of the *X* distribution. Furthermore, to determine whether an interaction effect was disordinal, the PoI index was used which quantifies the "for better" region of an interaction plot by calculating the proportion above the crossover point based on the total area between the lines bounded by ±2 *SD*s on *X*. Recall that for an interaction plot to reflect differential-susceptibility, the crossover point should fall near the mean of *X* with the "for better" region representing about 50% of the area bounded by the regression lines. On the other hand, an interaction plot representing a diathesis-stress model should show a crossover point falling on the upper end of *X* with close to 0% of the total area representing the "for better" region. A fourth evaluative statistic proposed by Roisman et al. (2012) and used here, the PA index, evaluates the point at which an effect of *Z* on *Y* can change from "for better" to "for worse" by measuring the proportion of individuals in the total sample who fall above the crossover point for the interaction. This value approximates the number of people who are affected in a "for better" manner within a sample. In a differential-susceptibility model, about 50% of people will exhibit beneficial effects by *Z* (e.g., difficult temperament) as a function of *X* (e.g., parenting). However in a diathesis-stress model, 0% of people will exhibit the beneficial effects of *Z* as a function of *X*. Roisman et al. (2012) recommend that PoI values fall between 40% and 60%, with PA values equal to or greater than 16% to draw conclusions supporting differential susceptibility.

Also determined was whether there exist non-linear relationships between predictor and outcome. If so, then the original person–environment interaction was examined to determine whether it remains statistically significant after accounting for such non-linear effects. The final condition for testing differential susceptibility involves adjusting *p* values to take into account multiple testing and thereby controlling the Type I error rate. In sum, evidence of differential susceptibility would emerge if, following detection of an alpha-adjusted statistically significant person–environment interaction not due to non-linear effects (or remained with these controlled), these three conditions were obtained: (a) the RoS on *X* test proved significant for both sides of *X* within a range bounded by ±2 *SD*s on *X*; (b) the PoI index fell between 40% to 60%, and (c) the PA index was 16% or greater. For the analyses reported herein, we used a web-based program developed by Fraley (2012) to generate RoS on *Z*, RoS on *X*, PoI, the crossover point for the interaction, and the PA indices.

RESULTS

Using the Roisman et al. (2012) approach just reviewed, we evaluated whether the effect of maternal and, separately, paternal sensitivity on affective psychopathic traits was moderated by difficult temperament in infancy. Analysis focused initially on the total affective psychopathic personality traits score (i.e., Affect).

TABLE 1: Summary of Hierarchical Regression Analysis for Variables Predicting Psychopathic Traits[a]

		Affect Components		
Predictor Variable	Affect Total	Remorselessness	Unemotionality	Callousness
Maternal sensitivity				
Step 1				
Sensitivity				
B (SE)	−1.51 (.59)	−1.07 (.60)	−1.07 (.59)	−1.51 (.59)
β	−0.89*	−0.63†	−0.63†	−0.89*
t value	−2.58	−1.78	−1.81	−2.57
Temperament				
B (SE)	−0.15 (.11)	−0.18 (.12)	−0.08 (.11)	−0.12 (.11)
β	−0.07	−0.08	−0.04	−0.06
t value	−1.32	−1.52	−0.70	−1.10
Step 2				
Sensitivity × Temperament				
B (SE)	0.38 (.17)	0.26 (.18)	0.28 (.18)	0.37 (.17)
β	0.75*	0.52	0.55	0.74*
t value	2.17	1.46	1.57	2.15
Paternal sensitivity				
Step 1				
Sensitivity				
B (SE)	−1.80 (.63)	−1.15 (.65)	−1.94 (.63)	−1.39 (.65)
β	−1.04**	−0.66	−1.12**	−0.79*
t value	−2.86	−1.77†	−3.07	−2.16
Temperament				
B (SE)	−0.12 (.11)	−0.16 (.12)	−0.05 (.11)	−0.10 (.11)
β	−0.05	−0.07	−0.02	−0.05
t value	−1.07	−1.37	−0.46	−0.91
Step 2				
Sensitivity × Temperament				
B (SE)	0.50 (.19)	0.29 (.20)	0.57 (.19)	0.37 (.20)
β	0.93*	0.55	1.09**	0.68
t value	2.57	1.46	2.97	1.86†

[a]See Table 2 for R^2 change statistics.
†$p < .10$. *$p < .05$. **$p < .01$.

AFFECT TOTAL SCORE

Multiple regression analyses revealed that greater maternal sensitivity significantly predicted lower Affect scores. This main effect was moderated by a significant interaction between maternal sensitivity and temperament (see Table 1), but it did not survive adjustment for multiple testing. In the case of paternal sensitivity, the same results emerged, but the interaction remained significant even after adjusting for multiple testing. Infant temperament did not, by itself, predict Affect.

Given the significant interactions depicted in Figures 1-5, tests recommended by Roisman et al. (2012) were carried out. First, we estimated RoS tests (see Table 2). For maternal sensitivity, the association between Affect and temperament is statistically significant in the range above $X = .41$ (i.e., at high maternal sensitivity) and also below $X = -.19$ (i.e., at low maternal sensitivity). Moreover, the RoS on X test revealed that both the lower bound ($X = -.19$) and upper bound ($X = .41$) regions of significance on X fall within the recommended

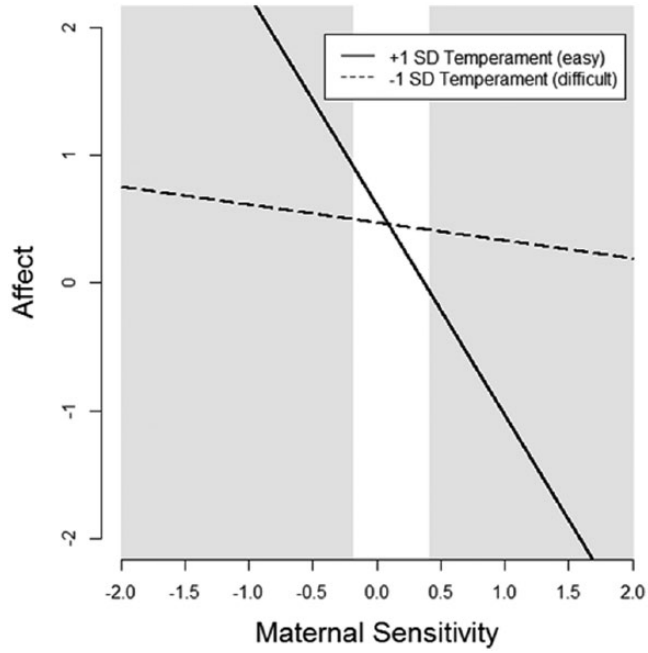

Figure 1: Maternal Sensitivity–Temperament Interaction Predicting Affect

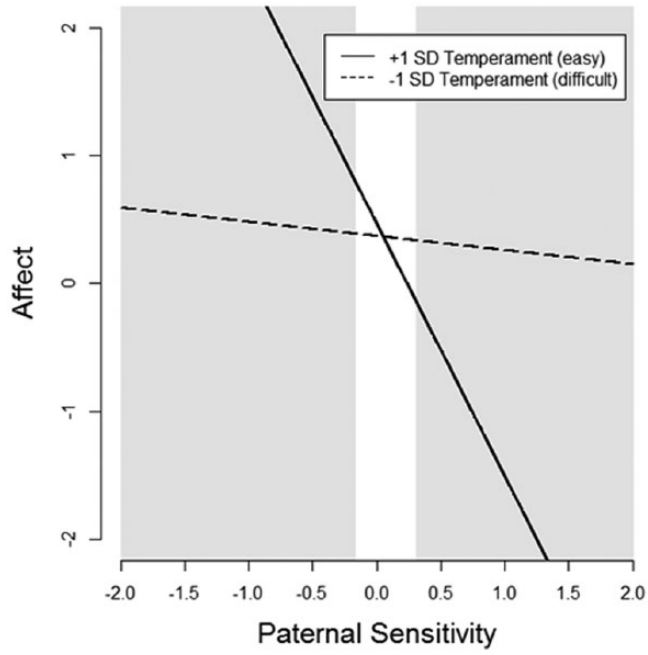

Figure 2: Paternal Sensitivity–Temperament Interaction Predicting Affect

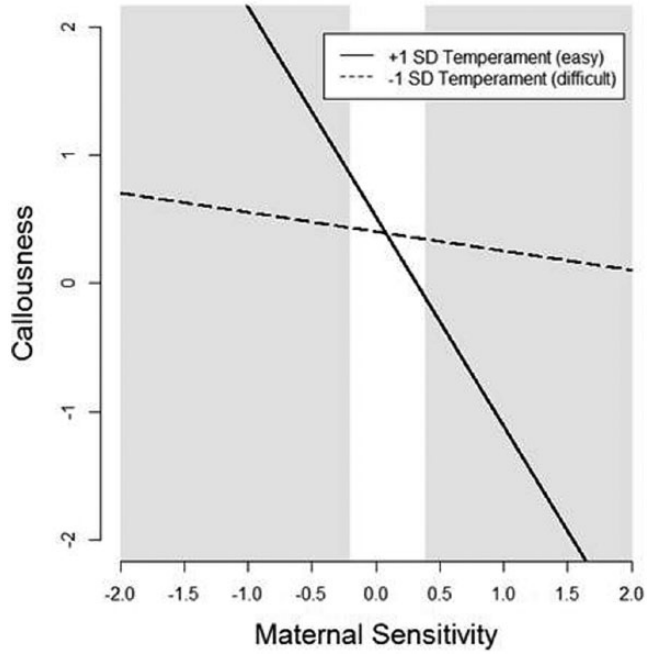

Figure 3: Maternal Sensitivity–Temperament Interaction Predicting Callousness

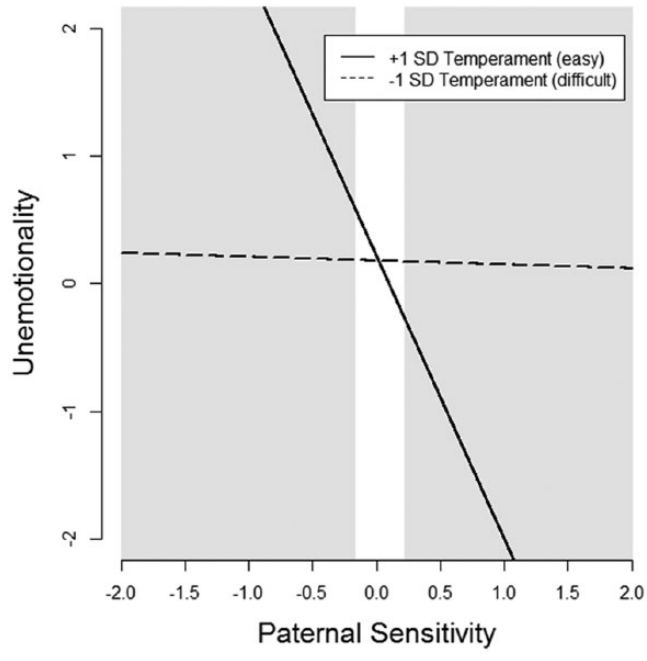

Figure 4: Paternal Sensitivity–Temperament Interaction Predicting Unemotionality

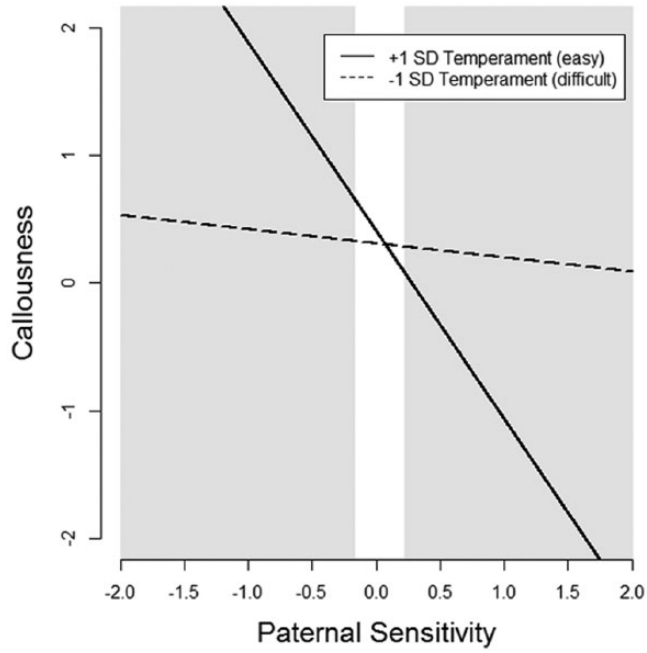

Figure 5: Paternal Sensitivity–Temperament Interaction Predicting Callousness

TABLE 2: Regression Estimates and Differential Susceptibility/Diathesis-Stress Diagnostic Indices

	Regression Estimates						Roisman et al. Diagnostics					
							RoS *X*					
Outcome	b0	b1	b2	b3	*XZ* ΔR^2	*p* value	Lower	Upper	PoI	PA	Crossover	X^2 or ZX^2
Affect												
Maternal sensitivity	.54	−0.89*	−.07	.75*	.01	.03*	−.19	.41	.45	.46	.09	no
Paternal sensitivity	.42	−1.04**	−.05	.93*	.02	.01*	−.17	.31	.47	.49	.05	no
Affect components												
Remorselessness (M)	.61	−0.63†	−.08	.52	.006	.15	—	—	—	—	—	—
Unemotionality (M)	.30	−0.63†	−.08	.55	.006	.12	—	—	—	—	—	—
Callousness (M)	.46	−0.89*	−.06	.74	.012	.03*	−.21	.39	.46	.47	.08	no
Remorselessness (P)	.53	−0.66†	−.07	.55	.006	.15	—	—	—	—	—	—
Unemotionality (P)	.20	−1.12**	−.02	1.09*	.02	.003**	−.17	.22	.49	.49	.02	no
Callousness (P)	.36	−0.79*	−.05	.68†	.009	.06†	−.25	.47	.46	.47	.07	no

Note. M = maternal; P = paternal.
†$p < .10$. *$p < .05$. **$p < .01$.

range of ±2 *SD*s from the mean of *X*. These results are consistent with differential susceptibility rather than diathesis stress. As for the PoI and the PA tests, the PA is greater than the suggested 16% (PA = .46) and the PoI (.45) falls within the recommended range of 40% to 60% suggested for differential susceptibility and again is consistent with a differential-susceptibility model (i.e., both positive and negative effects).

Results were similar in the case of paternal sensitivity. RoS tests revealed that the relationship between Affect and temperament was significant for the range above *X* (.31) and below *X* (−.17). Because both the upper and lower bounds for regions of significance on *X* fall within Roisman et al.'s (2012) recommended range of ±2 *SD*s from the mean of *X*, the RoS on *X* test provides support for differential susceptibility. Furthermore, the PoI value of .47 falls within recommended range of 40% to 60%, and the related index of PA proved greater than the recommended 16% (PA = .49), thus making it consistent with differential susceptibility.

AFFECT COMPONENT SUBSCORES

In an effort to illuminate whether one or another component of the total Affect score accounted for the findings just reported, we performed regressions for each psychopathy subscale separately. For maternal sensitivity, no significant main effects or interactions emerged when predicting remorselessness or unemotionality. In the case of callousness, however, a significant main effect of maternal sensitivity ($p = .01$) as well as a significant interaction ($p = .03$) emerged (see Table 1), though the latter did not survive adjustment for multiple testing (i.e., .05/3). Nevertheless, further examination of the interaction using RoS tests revealed that the association between callousness and temperament was significant for both the lower bound region of *X* (−.21) and upper bound region of *X* (.39) when bounded by ±2 *SD*s. The PA (PA = .47) was greater than 16% and the PoI (PoI = .46) was within the recommended range, supporting a differential-susceptibility model.

Turning to paternal sensitivity, no significant findings emerged in the case of remorselessness. There was a marginally significant interaction ($p = .06$) between paternal sensitivity and temperament, but this significant effect did survive adjustment for multiple testing. Nevertheless, for the interaction in question, RoS tests revealed the range above $X = .47$ and below $X = -.25$ was significant with both the lower and upper bound regions being within ±2 *SD*s from the mean of *X*. Further evidence for differential susceptibility emerged when examining PoI and PA indices, with the PoI nearing .50 (PoI = .46) and the PA being greater than 16% (PA = .47).

Finally, a significant interaction emerged between sensitivity and temperament in predicting unemotionality ($p = .003$; see Table 1) which survived multiple testing. When subjected to a RoS *X* test, the range above $X = .22$ and below $X = -.17$ was statistically significant for temperament and unemotionality. Indeed, differential susceptibility was supported because the Roisman et al. (2012) recommended diagnostics were satisfied: The lower bound region of significance on *X* ($X = -.17$) was within the range of ±2 *SD*s of the mean of *X*, PA (PA = .49) was greater than 16%, and PoI (PoI = .49) was within the range of 40% to 60%.[1]

SIMPLE SLOPES

For each of the five previously mentioned interactions, simple slopes analyses (i.e., RoS on *Z* tests) were conducted. These results revealed that the association between maternal and paternal sensitivity and the dependent construct was negative and statistically significant for infants with easier temperaments (−1 *SD* below the mean, $n = 104$) compared with those with more difficult temperaments (+1 *SD* above the mean, $n = 110$). Specifically, the association between maternal sensitivity and Affect was statistically significant in the easy temperament group ($b = -1.64$, $p = .03$), but not in the difficult temperament group

($b = -.14$, $p = .73$). Similarly, the association between paternal sensitivity and Affect was statistically significant for those with easy temperament ($b = -1.97$, $p = .02$), but not difficult temperament ($b = -0.11$, $p = .81$). The association between maternal sensitivity and callousness was statistically significant among those in the easy temperament group ($b = -1.63$, $p = .03$), but not among those in the difficult temperament group ($b = -.15$, $p = .72$). The association between paternal sensitivity and unemotionality was statistically significant in those with easy temperaments ($b = 2.68$, $p = .008$), but not among those with difficult temperaments ($b = -.03$, $p = .95$). Finally, the association between paternal sensitivity and callousness was statistically significant in those with easy temperaments ($b = 2.68$, $p = .008$), but not among those with difficult temperaments ($b = .07$, $p = .94$).

DISCUSSION

Identifying the developmental origins of psychopathy and psychopathic personality traits has become an area of intense research interest. To date, however, there has been little empirical work examining person–environment interactions as they relate to the development of psychopathic personality traits. This is particularly surprising given the wealth of evidence that most human phenotypes are the result of a complex web of individual-level factors and environmental influences, working both independently and interactively (Raine, 2002; Rutter, 2006). The goal of the current study was to explore potential interactions between early-life temperament and parental sensitivity in the prediction of affective psychopathic personality traits in adolescence. More specifically, if such interactions emerged, we sought to determine whether they proved more consistent with the diathesis-stress or differential-susceptibility model of environmental action, and whether it was children with easy or difficult temperaments who proved most susceptible to parenting effects.

SUMMARY OF THE FINDINGS

Analysis of data drawn from the NICHD Study and collected originally for purposes different than those pursued here revealed some evidence of significant temperament–parental sensitivity interactions. Of particular importance were the findings with respect to the total psychopathy score (i.e., Affect), wherein the results revealed that the effects of maternal sensitivity and paternal sensitivity were moderated by infant temperament. Additional analyses revealed that the interactions were in line with predictions derived from a differential-susceptibility perspective, not a diathesis-stress one. Specifically, those children characterized as having an easy temperament scored the highest on the psychopathy measure in the presence of low parental sensitivity, but the lowest on the measure of psychopathy in the presence of high parental sensitivity. Similar results emerged when examining the subcomponents of callousness for both maternal and paternal sensitivity, as well as unemotionality in the case of paternal sensitivity.

In some respects, the findings indicating that it was infants with easy temperaments who were most affected by parental sensitivity in a for-better-and-for-worse fashion were somewhat surprising. And this is because much previous research has documented just the opposite, though none of this research focused on psychopathy or psychopathic personality traits (Belsky, 1997, 2005; Belsky & Pluess, 2009, in press). As such, results reported herein begin to suggest that both an easy and a difficult temperament can operate as plasticity traits *depending on the phenotype being investigated*. To the extent that a difficult temperament

reflects, at least in part, a tendency toward fearfulness and anxiety, the current findings accord reasonably well with research showing that psychopathy is related to fearlessness. Future research would do well to move beyond global measures of easy versus difficult temperament and examine particular temperamental features such as fearlessness when trying to understand the early-life roots of psychopathy and psychopathic personality traits.

Precisely why no person–environment interactions were detected for some of the subcomponents to psychopathy, particularly remorselessness, is not immediately obvious. Given that this is the first study to examine person–environment interactions in respect to remorselessness necessarily suggests that there could be something unique to this study that masks significant interactions. More likely, however, is that remorselessness is the result of other etiological factors that were not examined in this study. Genetic influences, for instance, might account for most of the variation in remorselessness. In addition, environments not directly examined in the current study or other person–environment interactions that were not explored in this study may also be involved. Moving forward, research would benefit greatly by examining a broader range of factors that might contribute to the development in remorselessness and other components to psychopathic personality traits.

FUTURE DIRECTIONS

Future research should explore other person-level variables in addition to temperament that might condition the influence of environments on psychopathy and psychopathic personality traits. Much of differential-susceptibility- and diathesis-stress-related research focuses on specific genetic polymorphisms that might act as plasticity markers for environmental influence (e.g., Belsky & Beaver, 2011; Simons et al., 2011). Some of these polymorphisms, particularly those related to the dopaminergic system, have also been shown to predict variation in measures of psychopathic personality traits (Wu & Barnes, 2013). To date, no research has examined whether these polymorphisms condition the effects of specific environmental influences, such as family and parenting factors, in the prediction of psychopathy. This type of research could go a long way toward identifying more of the developmental origins to psychopathy and, depending on the results, might also provide some guidance as to the most effective treatment options for psychopathic individuals. Knowing, for example, which psychopaths are the most susceptible to environmental influences may also reveal which psychopaths are the most susceptible to treatment. As it stands now, most rehabilitation programs are not very effective for offenders (Lab & Whitehead, 1990), and they tend to be even less effective for chronic offenders, with some experts arguing that rehabilitation programs are completely ineffective for psychopaths (Hare, 1996). But it may be the case that due to lack of appreciation for person–environment interactions, such conclusions are too sweeping and that the more susceptible individuals may benefit from treatment.

As with all studies, there are a number of limitations that should be addressed by future research seeking to replicate and extend the current inquiry. First, the NICHD Study sample was not nationally representative, so whether the findings can be broadly generalized remains to be determined. Second, the measure of affective psychopathic personality traits was not based on a clinical diagnosis and it did not include the full spectrum of traits related to psychopathy. As a result, future research should attempt to replicate the findings reported here with other measures of psychopathy and psychopathic personality traits. Third, we focused only on parental sensitivity as the environmental influence. Certainly, there are

other such factors to consider, some of which are also are features of families (e.g., discipline practices), but some of which are extrafamilial (e.g., neighborhood deprivation). Last, our analysis was centered on early-life temperament as it had previously been shown to condition the effects of environmental influences. Future research would benefit by exploring a wider range of person-level variables.

CONCLUSION

Although the findings reported herein comport with the differential-susceptibility model more than with the diathesis-stress model, this should not be taken to mean that the diathesis-stress model has no application to psychopathy or that the differential-susceptibility model is the only key to understanding psychopathy. It is quite possible that both of these models provide some insight into the development of psychopathic personality traits, depending on the environmental and person-level factors examined, but future research is needed to more fully understand the various factors, particularly the various person–environment interactions, that may be responsible for creating variation in psychopathic personality traits.

NOTE

1. Analyses were also calculated to examine whether sex was a moderator of the significant temperament–parenting interactions. The results of these three-way interactions revealed only two significant effects of the eight that were estimated. Additional analyses that grouped together males and females revealed that some of the previous significant temperament–parenting interactions were no longer statistically significant and that no new interactions emerged.

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Kevin M. Beaver is a professor in the College of Criminology and Criminal Justice at Florida State University and a visiting distinguished professor in the Center for Social Humanities Research at King Abdulaziz University. His research focuses on the biosocial foundations to antisocial behaviors.

Sarah Hartman received her BS degree in psychology with an emphasis in biology from University of California, Davis, in 2009. During 2012, she obtained her MA degree in psychology with distinction from CSU Stanislaus. She is currently a PhD student at University of California, Davis, working under the supervision of Professor Jay Belsky.

Jay Belsky, who obtained his PhD in 1978 in human development and family studies from Cornell University, is the Robert M. and Natalie Reid Dorn Professor of Human Development at the University of California, Davis. His areas of special expertise include the effects of day care, parent–child relations during the infancy and early childhood years, the transition to parenthood, the etiology of child maltreatment, and the evolutionary basis of parent and child functioning. In 2007, he was awarded the American Psychological Association Urie Bronfenbrenner Award for Lifetime Contribution to Developmental Psychology in the Service of Science and Society.