CHILD DEVELOPMENT

Child Development, November/December 2015, Volume 86, Number 6, Pages 1794–1811

The Development of Early Profiles of Temperament: Characterization, Continuity, and Etiology

Charles Beekman, Jenae M. Neiderhiser, Kristin A. Buss, Eric Loken, and Ginger A. Moore
The Pennsylvania State University

Leslie D. Leve
University of Oregon

Jody M. Ganiban
George Washington University

Daniel S. Shaw
University of Pittsburgh

David Reiss
Yale University

This study used a data-driven, person-centered approach to examine the characterization, continuity, and etiology of child temperament from infancy to toddlerhood. Data from 561 families who participated in an ongoing prospective adoption study, the Early Growth and Development Study, were used to estimate latent profiles of temperament at 9, 18, and 27 months. Results indicated that four profiles of temperament best fit the data at all three points of assessment. The characterization of profiles was stable over time, while membership in profiles changed across age. Facets of adoptive parent and birth mother personality were predictive of children's profile membership at each age, providing preliminary evidence for specific environmental and genetic influences on patterns of temperament development from infancy to toddlerhood.

Child temperament, defined as constitutionally based individual differences in reactivity and regulation that are present early in life and show evidence of both stability and change over time (Goldsmith et al., 1987; Rothbart & Derryberry, 1981), has proven to be a particularly robust predictor of outcomes in a number of domains of interest to psychologists. With evidence mounting that temperament may be an important mechanism in the development of adaptive and maladaptive functioning in domains like school adjustment (e.g., Blair, 2002) and psychopathology (e.g., Perez-Edgar & Fox, 2005), understanding the development of child temperament itself is of great importance. To this end, much of our current understanding of how temperament develops and what drives its development may be limited by a lack of focus on how facets of temperament co-occur within individuals and how that co-occurrence may change over time.

This article used latent profile analysis (LPA; Muthén & Muthén, 2000), a type of latent class analysis (LCA; Lazarsfeld & Henry, 1968), to address these limitations. Specifically, LPA can identify patterns in how continuous dimensions of temperament co-occur across individuals. Through the use of fit statistics, model selection can be more objective than approaches that are typically used to classify children into temperament types, such as using clinical cut scores, cluster analysis, configural frequency analysis, or mean/median splits. This study aimed to use LPA to address three major developmental issues in the temperament literature: (a) characterization of the temperament construct, (b) stability across time, and (c) the relative contribution of genetic influences from birth parents and environmental influences from adoptive parents (AP) on early child temperament.

This work was supported by Grant R305B090007 from the Institute of Education Sciences, R01 HD042608, NICHD, NIDA, and OBSSR, NIH, U.S. PHS (PI Years 1–5: David Reiss; PI Years 6–10: Leslie D. Leve), R01 DA020585 NIDA, NIMH, and OBSSR, NIH, U.S. PHS (PI: Jenae M. Neiderhiser). We thank the birth and adoptive parents who participated in this study and the adoption agencies that helped with the recruitment of study participants.

Correspondence concerning this article should be addressed to Charles Beekman, Department of Psychology, Arizona State University, Tempe AZ, 85281. Electronic mail may be sent to charles.beekman@asu.edu.

 0009-3920/2015/8606-0010
DOI: 10.1111/cdev.12417

Child Temperament From Infancy to Toddlerhood

Characterization

Research on child temperament is characterized by a variety of approaches to the operationalization of the temperament construct. Typological approaches are concerned with identifying meaningful groups, or types, of temperament. Two temperament types that have proven to be particularly robust in infancy are the behaviorally inhibited (BI; Kagan, Reznick, Clarke, Snidman, & Garcia-Coll, 1984) and the uninhibited/exuberant (Putnam & Stifter, 2005) child. BI children, who were initially selected based on their motor reactivity, are characterized by apprehension, crying, and clinging to a parent when faced with unfamiliar situations, whereas exuberant children are characterized by high levels of positive affect and social, fearless behavior. In contrast to typological approaches, a variable-centered approach operationalizes temperament as individual differences on a number of theorized temperament dimensions or traits. These temperament dimensions are usually derived from temperament theory and tested with factor analysis to establish valid and reliable constructs. Examples include, but are not limited to, measuring how toddlers differ in levels of fear, anger proneness, activity level, and pleasure (Goldsmith, 1996) or activity level, fear, distress to limitations, smiling and laughter, soothability, and duration of orienting (Rothbart, 1981). One limitation of research focused on temperament dimensions is that the dimensions are often examined individually to predict child outcomes. To some extent this has been useful, as each temperament dimension can provide unique and specific predictions; however, these dimensions are not conceptually orthogonal (Goldsmith et al., 1987). When the effects of temperament dimensions are assumed to operate independently of other dimensions of temperament, information inherent in relations *among* the dimensions may be lost (Rettew, Althoff, Dumenci, Ayer, & Hudziak, 2008).

There are many published examples of the importance of considering the full constellation of theorized temperament dimensions. Facets of negative affect and effortful control are consistently negatively associated, indicating that they may systematically co-occur in predictable patterns in children (Rothbart, Ahadi, Hershey, & Fisher, 2001). High activity level combined with low levels of fear in infant boys has been linked to an escalation in childhood externalizing behavior and depressive symptoms (Colder, Mott, & Berman, 2002). The co-occurrence of low levels of fear and high levels of approach has been suggested as an especially risky antecedent for the development of child conduct disorder (Nigg, 2006). There is also evidence for an association between the co-occurrence of low levels of approach/withdrawal and high levels of reactivity and anxiety in children (Merikangas, Swendsen, Preisig, & Chazan, 1998). Research focused on the development of patterns of co-occurrence of child temperament dimensions continues to be a vital, yet understudied area (Zentner & Bates, 2008).

One way to take advantage of the strengths, and simultaneously address some limitations of typological and dimensional approaches to studying temperament development is to use a complete set of dimensional indicators, meant to encompass temperament in its entirety, to form meaningful groups. For example, Carey and McDevitt (1978), building off of the theoretical work of Thomas and Chess (1977), developed a parent-report questionnaire that used cut points on ratings of nine temperament dimensions to identify *difficult*, *easy*, and *slow to warm up* temperament types (among others) in infants. Similarly, in older children, Aksan et al. (1999) used configural frequency analysis of multiple temperament dimensions and found two temperament types: noncontrolled expressive and controlled nonexpressive. Compared to this prior work, which used theoretical and ad hoc statistical approaches to create typologies, this article used LPA to create *data-driven* typologies of child temperament from psychometrically validated, continuous dimensions of temperament.

This method has been used to provide evidence for the validity of typologies already found in the literature (using LCA; Loken, 2004). Profiles of temperament can also help to identify patterns in how multiple facets of temperament (e.g., fear, anger, and positive affect) similarly co-occur across individuals, information that can be lost when averaging. For example, latent profiles of temperament estimated from maternal ratings of child sociability, activity level, and anger proneness have previously been studied in young children (van den Akker, Dekovic, Prinzie, & Asscher, 2010). Three temperament profiles, labeled *typical*, *expressive*, and *fearful*, were found when children were age 30 months and were found to be highly stable to when children were age 36 months. Three profiles of temperament were also indicated in a sample of adolescents that were consistent with those found in young children (Rettew et al., 2008). To date, we are not aware of any systematic study of the development of latent profiles of child temperament from infancy to toddlerhood. Given that the nature of the structure of

early temperament and its change over time remains a key question for the field (Shiner et al., 2012), we investigated temperament profiles across infancy in an effort to gain insight into the developmental patterning of co-occurring temperament dimensions early in life.

Continuity and Change in Early Child Temperament

Both the uninhibited and inhibited temperament types have been shown to be remarkably stable; three fourths of children retained their classification from toddlerhood to middle childhood (Kagan, 1994). Furthermore, extreme subgroups of children classified as BI or uninhibited, as opposed to those closer to the middle of the distribution of measured behaviors, were more likely to retain their classification from toddlerhood to middle childhood (Pfeifer, Goldsmith, Davidson, & Rickman, 2002). Results are more mixed in regard to the stability of specific temperament dimensions across infancy. Carranza, Perez-Lopez, Gonzalez, and Martinez-Fuentes (2000) found stability only for activity level and smiling and laughter (*r*s = .33–.63) across four measurements in infancy, from ages 3 to 12 months. This study replicated a prior study of temperament in 46 infants where, again, only levels of smiling and laughter and activity level were found to be stable from age 3 to 9 months (Rothbart, 1981). Stifter and Jain (1996) found moderate levels of stability in mother-rated temperament at ages 5, 10, and 18 months (*r* = .26–.53). Similarly, when mothers rated their infant's temperament once a week for 8 weeks, week to week stability was modest at best (*rs*= .14–.36; Seifer, Sameroff, Barrett, & Krafchuk, 1994). Stability was significantly less robust across informant and method when assessed earlier than age 2 (Rothbart, 1981; Seifer et al., 1994; Stifter & Jain, 1996). In addition, stability may depend on when in development temperament is measured, as there is evidence for lower levels of temperamental stability from the neonatal period to toddlerhood (Riese, 1987) and more substantial correlations (*r*s = .42–.77) from early to middle childhood (Rothbart, Derryberry, & Hershey, 2000). It is clear that investigating the mechanisms driving individual differences in child temperament across time is vital (McCall, 1986). To this end, this study focused on temperament in infancy and toddlerhood, where there is evidence for stability and change, by examining three possible mechanisms for individual differences in the development of early temperament: genetic influences, environmental influences, and the interaction between genetic and environmental (G × E) influences.

Genetic and Environmental Influences on Child Temperament

Twin studies have found significant and substantial genetic influences on child temperament throughout the toddler years. Genetic influences explained from 50% to 65% (across three assessments) of uninhibited temperament in infants from 14 to 24 months with near zero variance due to shared environment and the remaining variance due to nonshared environment (Robinson, Kagan, Reznick, & Corley, 1992). Goldsmith, Buss, and Lemery (1997) found moderate to substantial heritability for the temperament dimensions of activity level, pleasure, social fearfulness, anger proneness, and interest with low to moderate nonshared environmental influences (nongenetic influences that contribute to differences in family members) explaining the remaining variance. A review by Saudino (2005) that consolidated temperament findings across childhood from studies using a variety of methods reported that genetic influences accounted for 20%–60% of the variance in child temperament dimensions with the remaining variance typically due to nonshared environmental influences. Most of the findings regarding genetic and environmental influences on child temperament have come from twin studies, which are useful when the goal is to decompose genetic and environmental variance but are agnostic as to what a particular genetic or environmental influence on child temperament may actually be.

In this study, we focused on the personality of the child's biological parent and AP as a potential mechanism for both genetic and environmental influences on a child's temperament. Specifically, we focused on three personality factors from Cloninger's psychobiological model of personality: harm avoidance (caution, fearfulness), novelty seeking (impulsivity, excitability), and reward dependence (dedication, sociability; Cloninger, Svaric, & Przybeck, 1993). Variance in these personality factors has primarily been explained by genetic (38%–44%) and nonshared environmental influences (56%–62%; Heath, Cloninger, & Martin, 1994). In addition, children with more harm avoidant mothers and fathers tended to be more harm avoidant themselves and children with more reward dependent fathers tended to be more reward dependent as well (Rettew, Stanger, McKee, Doyle, & Hudziak, 2006). These studies converged in providing

evidence that suggests that harm avoidance, novelty seeking, and reward dependence may be linked through genetic and environmental pathways with child temperament development. However, one limitation of this work is that in typical studies of biological families it is impossible to determine whether any similarity arises from genetic transmission or influences from the rearing environment because parents provide both (Plomin & DeFries, 1983).

The Prospective Adoption Design

One way to disentangle genetic from environmental influences is to use an adoption design. Adoption is a natural experiment where children are reared by parents who are genetically unrelated to them (Haugaard & Hazan, 2003; Plomin, DeFries, Knopik, & Neiderhiser, 2013). This means that associations between AP and their adopted children cannot be due to shared genes. In the absence of selective placement and with negligible effects of the prenatal environment and adoptive/birth parent contact, the similarity between an adopted child's characteristics and their adoptive parents' characteristics is thought to result from environmental influences. Similarly, because birth parents are not rearing the adopted child, but do share genes with them, associations between adopted children's characteristics and their birth parents' characteristics reflect genetic influences (and in the case of the birth mother [BM], prenatal environmental influences; Leve et al., 2013; Plomin et al., 2013).

Evidence from adoption studies provides partial, albeit inconsistent support for the notion that parents' personality is associated with their children's temperament through both genetic and environmental pathways. Using parent–child comparisons, Scarr, Webber, Weinberg, and Wittig (1981) found not only evidence for genetic influences on personality but also significant correlations between AP and adopted child personalities, suggesting an environmental link, either through the rearing environment or an evocative process driven by the child. Evidence from temperament research using the sibling adoption design, comparing adopted and biological children raised in the same family, has been inconsistent. Some studies provide evidence that, in stark contrast with twin studies, suggests no genetic influences on child temperament (Plomin, Coon, Carey, DeFries, & Fulker, 1991; Schmitz, 1994). One adoption study has provided evidence for genetic and environmental influences on child temperament, through associations between BM personality and child temperament and adoptive mother personality and child temperament, respectively (Daniels, Plomin, & Greenhalgh, 1984). To the best of our knowledge, this study will be one of the first to examine how the personality dimensions of harm avoidance, novelty seeking, and reward dependence in BM (genetic influences) and AP (environmental influences) may be associated with profiles of temperament in infancy and toddlerhood. Recent research using only the first cohort of the Early Growth and Development Study (EGDS; Leve et al., 2013), a prospective adoption study that was also used for this investigation, has not found evidence for genetic main effects but has found evidence suggesting interactional genetic and environmental influences on child behavior (e.g., Brooker et al., 2011). Temperament theorists have suggested that evidence of genetic influences from adoption studies would be vital, in that they can support and extend evidence from twin designs by identifying *specific* environmental and genetic influences on child temperament development as opposed to estimating the amount of variance in child temperament explained by genes and environments on the whole (Goldsmith et al., 1987).

The Current Study

This study aimed to use a data-driven approach to address gaps in the literature by asking three questions regarding early child temperament development using an LPA framework and a genetically informative research design. First, what are the profiles of child temperament from infancy to early toddlerhood? Based on the extant literature (e.g., van den Akker et al., 2010) it is hypothesized that three profiles will emerge and that the characterization of two of these profiles will resemble the fearful or inhibited and the expressive or exuberant child with the third profile resembling a less extreme, more typical temperament type. Second, how does this profile structure change and to what extent do children transition between profiles over time? Based on literature reviewed above it is hypothesized that profile membership will be less stable in infancy and more stable in toddlerhood. Third, what is the role of parents' personality in influencing membership in child temperament profiles? Due to a lack of systematic associations in prior adoption studies and the exploratory nature of this study, we do not have any specific predictions about direction of effects or specific links

between adoptive or birth parent personality factors and child temperament profiles.

Method

Sample

Participants were drawn from two cohorts of the EGDS, a multisite longitudinal study of 561 linked families that includes adopted children (with birth dates ranging from January 2003 to May 2009), adoptive mothers (AM), adoptive fathers (AF), BM, and birth fathers. Participants were recruited from four sites across the United States: the mid-Atlantic, the West/Southwest, the Midwest, and the Pacific Northwest (Leve et al., 2013). Study participants were found to be representative of adoptive populations who completed adoption plans during the same time period (see Leve et al., 2013, for more detailed information on sample recruitment and description).

The mean age of adopted children at placement was 6 days (SD = 12 days), 57% of the children were male, and 55.6% were White (19.3% multiethnic, 13% African American, 10.9% Hispanic/Latino, 0.4% other). AP were older on average (M = 37.53, SD = 5.6) and primarily White (91%, 4.4% African American, 1.8% Hispanic/Latino, 1.0% multiethnic, 1.7% other) and college educated with middle-class yearly household incomes (Mdn = $100,000). Birth parents were on average, younger (M = 24.35, SD = 6.03), more racially and ethnically diverse (70% White, 12.4% African American, 7.9% Hispanic/Latino, 4.9% multiethnic, 4.9% other) than AP, had high school educations, and averaged less than $25,000 in household income. Attrition levels were modest (12%), considering the nature of the data (e.g., longitudinal and linked family study design) and families of children who attritted did not significantly differ from those who were retained in the primary study analysis with regard to demographic or temperament variables used in the study. Nineteen linked families had missing data on all study variables (but were still participating in the study) and were not included in subsequent analysis. These families showed no significant differences on key demographic variables (household income, education, and parent age).

Study Procedures

In-home assessments were administered by interviewers who completed at least 40 hr of training. All in-home assessments lasted 2–3 hr and questionnaires were completed via mail or the web in conjunction with the home visit. Interviews of the adoptive family were completed at ages 9, 18, and 27 months and interviews of birth parents were completed between 3 and 6 months postpartum and at 18 months postpartum.

Measures

Child Temperament

Both adoptive parents' reports of child temperament at age 9 months were assessed using the Infant Behavior Questionnaire (IBQ; Rothbart, 1981). Following standard scaling procedure, five scales of child temperament were computed from the IBQ items—activity level, distress to novelty, distress to limitations, duration of orienting, and smiling and laughing (αs = .71–.85). Adoptive parents' reports of child temperament at age 18 and 27 months were assessed using the Toddler Behavior Assessment Questionnaire (TBAQ; Goldsmith, 1996). Five scales of child temperament were computed from TBAQ items—activity level, fear, anger proneness, interest, and pleasure (αs = .75–.89). The TBAQ was developed to be a developmentally appropriate measure for toddlers with constructs that map directly onto constructs from the IBQ.

Parent Personality

Birth mothers and AP reported on their personality using the Temperament and Character Inventory (Cloninger et al., 1993). Three scales were used: novelty seeking (higher scores indicate greater levels of impulsivity and excitability; αs = .72–.75), harm avoidance (higher scores indicate more caution, insecurity, fearfulness; αs = .63–.83), and reward dependence (higher scores indicate more dedication, tender-heartedness, warmth, and sociability; αs = .67–87; Cloninger et al., 1993).

Statistical Controls

Additional variables were added to control for possible confounds. Specifically, openness in adoption, child sex, AP age, and perinatal complications were included as statistical controls.

Adoption Openness

The level of openness in the adoption (contact between birth and adoptive families) may contaminate the quasi-experimental power of the adoption

design. Thus, we included perceived openness in the adoption constructed from BM and AP reports at 3–9 months (Ge et al., 2008).

Child Sex

Child sex was coded as 0 (female) or 1 (male).

Adoptive Parent Age

Adoptive mother and father ages were entered as control variables.

Prenatal Complications

This index summed items from a perinatal index, with scoring designed to parallel the McNeil–Sjostrom Scale for Obstetric Complications (Kotelchuck, 1994; McNeil, Cantor-Graae, & Sjostrom, 1994) that measures BM age, pregnancy difficulties (including premature birth), toxin exposure, drug and alcohol use, labor and delivery difficulties, and neonatal complications.

Data Analysis

Reports from both AP on child temperament were combined to obtain a more comprehensive and reliable measure of child temperament. Correlations between AP reports for the same temperament dimensions at the same times of assessment suggested composites could be generated (*r*s = .27–.62). These composites were formed in the following manner. The control variables described earlier (adoption openness, child sex, AP age, and obstetric complications) were first regressed out of AP-reported child temperament dimension variables. The unstandardized residuals from these regressions were saved and averaged to form a single temperament score for each measured dimension that reflected reports from both AP. These composited scores were then used as indicators for the subsequent LPA. Latent profiles of child temperament were estimated for each time of assessment using temperament dimensions (scaled in the standard manner for each measure) as indicators using the statistical package Mplus (Muthén & Muthén, 2000). The best fitting model was chosen using the Bayesian information criterion (BIC; Schwarz, 1978), where smaller values indicate a better relative fit, and model entropy. The BIC places a high value on parsimony and has been shown to accurately indicate the best fitting solution in simulation studies (Magidson & Vermunt, 2004). Model entropy values range from 0 to 1; values closer to 1 typically indicate greater confidence in appropriate classification (Celeux & Soromenho, 1996). The number of profiles was determined by fitting models with successively more profiles until the BIC reached a minimum (i.e., when an additional profile resulted in a higher estimated BIC). Membership in the profile with the highest posterior probability was then used as a dependent variable in separate multinomial logistic regressions with adoptive and birth parent personality characteristics, and their interactions, input as predictors.

Results

Temperament Development

Descriptive statistics for the temperament dimensions assessed at age 9, 18, and 27 months can be found in Table 1. Infant fear, anger, interest, and pleasure all showed mean-level increases (albeit minor) from 18 to 27 months and activity level showed a mean-level decrease. All measured dimensions of temperament approximated a normal distribution.

Bivariate Pearson correlations of temperament dimensions over time are reported in Table 2. All measured temperament dimensions showed modest to moderate cross-measure and cross-time stability

Table 1
Descriptive Statistics for Temperament Dimensions at Ages 9, 18, and 27 Months

	Min.	Max.	*M*	*SD*
Age 9 months				
Activity level	−2.17	2.82	0.00	0.84
Distress to limitations	−2.83	3.03	0.00	0.89
Distress to novelty	−2.44	2.89	−0.01	0.90
Duration of orienting	−2.34	2.80	−0.01	0.87
Smiling and laughter	−3.55	1.92	−0.01	0.88
Soothability	−3.92	2.42	−0.01	0.87
Age 18 months				
Activity level	−2.46	3.00	0.00	0.87
Anger	−2.38	2.99	0.00	0.88
Fear	−2.57	2.57	0.01	0.91
Interest	−2.34	2.79	0.00	0.85
Pleasure	−2.42	2.13	−0.01	0.84
Age 27 months				
Activity level	−2.86	3.02	0.00	0.88
Anger	−2.37	2.77	0.00	0.87
Fear	−2.53	2.97	0.00	0.91
Interest	−2.62	2.37	0.02	0.89
Pleasure	−3.13	2.52	0.02	0.86

Table 2
Bivariate Pearson Correlations Between Temperament Facets at Ages 9, 18, and 27 Months

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
9 months															
1. Activity level															
2. Distress to limitations	.36***														
3. Distress to novelty	.16***	.38***													
4. Duration of orienting	−.09*	−.26***	0												
5. Smiling/laughter	.02	−.20***	−.13***	.33***											
6. Soothability	.01	−.06	.03	.21***	.29***										
18 months															
7. Activity level	.40***	.35***	.19***	−.14***	.03	−.05									
8. Anger	.27***	.47***	.29***	−.11*	−.17***	−.13**	.46***								
9. Fear	.08	.19***	.41***	−.08	−.17***	−.04	.01	.27***							
10. Interest	−.11**	−.18***	−.10*	.42***	.25***	.12**	−.31***	−.17***	−.10*						
11. Pleasure	.02	−.11**	−.11**	.24***	.67***	.19***	.19***	−.10*	−.34***	.27***					
27 months															
12. Activity level	.38***	.32***	.13**	−.04	.07	.01	.68***	.38***	.01	−.20***	.18***				
13. Anger	.28***	.45***	.21***	−.11*	−.12**	−.04	.43***	.69***	.16***	−.19***	−.08	.46***			
14. Fear	.06	.14***	.33***	−.05	−.16***	0	0	.22***	.65***	−.11	−.27***	−.03	.20***		
15. Interest	−.10*	−.15***	−.03	.38***	.27***	.17***	−.24***	−.08	−.06	.69***	.27***	−.21***	−.20***	−.08	
16. Pleasure	.04	−.11**	−.09	.21***	.61***	.21***	.13***	−.11**	−.26***	.17***	.69***	.22***	−.06	−.42	.22

*$p < .05$. **$p < .01$. ***$p < .001$.

from ages 9 to 18 months (r = .40–.67) with the highest stability found between smiling and laughing at age 9 months and pleasure at age 18 months (r = .67). Stability correlations from ages 18 to 27 months were moderate to robust (rs = .65–.69). Correlations between facets of negative affect and positive affect were negative and significant at each assessment, usually between dimensions related to fear (or distress to novelty at 9 months) and pleasure (or smiling and laughter at 9 months). The direction and magnitude of these associations are consistent with those found in previous research utilizing these measures (Goldsmith, 1996; Rothbart, 1981). Latent profiles of child temperament were then estimated for each point of assessment. Fit statistics for this process, including BIC and entropy are reported in Table 3. At 9, 18, and 27 months, the BIC reached a minimum for the four profile solution. Raftery (1999) suggests that the differences in BIC between the four profile and three profile solutions (3.8–11.9) are meaningful and should be considered positive to very strong. The entropy values for our final profile solutions (.65–.74), although low, compare well to one of the few studies to report model entropy of latent profiles of temperament in older children (.71; van den Akker et al., 2010). Based on these criteria, four profile solutions were selected as the best fitting models at ages 9, 18, and 27 months.

Profiles of Child Temperament at Age 9 Months

The estimated characteristics for each temperament profile at age 9 months are reported in Figure 1. The temperament dimensions used as indicators can be found along the x-axis. Each line represents a temperament profile with the levels for each profile expressed as standard deviations from the sample mean for each respective dimensional indicator. The profile describing the most children (n = 226) was characterized by slightly below average values across all indicators of child temperament compared to other children (Typical, Low Expressive profile). The second most prevalent temperament profile (n = 147) was characterized by slightly above average values across all dimensions of child temperament compared to other children (Typical, Expressive profile). The next temperament profile (n = 90) was characterized by well above average activity level, distress to novelty, and distress to limitations along with below average levels of duration of orienting, smiling and laughter, and soothability (Negative Reactive profile). The final temperament profile (n = 67) was characterized by below average levels of activity level and distress to limitations as well as above average levels of duration of orienting, smiling and laughter, and soothability (Positive Reactive profile).

Profiles of Child Temperament at Age 18 and 27 Months

The estimated characteristics for each child temperament profile at ages 18 and 27 months can be found in Figures 2 and 3, respectively. The characterization of child temperament at these two points of assessment was remarkably consistent. The profile describing the most children at ages 18 and 27 months (ns = 206 and 236, respectively) was characterized by below average levels of activity level, fear, and anger as well as above average levels of pleasure and interest (Positive Reactive profile). The next profile (ns = 178 and 145) was characterized by above average levels of activity and anger, slightly above average fear, an average level of pleasure, and a slightly below average level of interest (Negative Reactive profile). The Active Reactive profile (n = 87 at both 18 and 27 months) was characterized by very high levels of activity level, and above average levels of both pleasure and anger compared to other children. The final temperament profile (ns = 42 and 64) was characterized by well below average values for activity level and pleasure, an above average level of fear and a below average level of interest (Fearful profile).

Transitions in Temperament Profile Membership Over Infancy

Transitions in child temperament profiles are described in Table 4, which contains cross-tabulations between profile memberships from ages 9 to 18 months, 9 to 27 months, and 18 to 27 months. Different subscripts across rows in Table 4 denote statistically significant differences using the chi-square statistic. For example, the first row in Table 4 shows how children in the Positive Reactive profile at 9 months were significantly more likely to be in the Positive Reactive profile at 18 months (i.e., Positive Reactive has a subscript that is different from the other three profiles at 18 months). The most salient pattern in the results for transitions in temperament profiles across infancy was the statistically significant stability in profile membership for children in either the Positive Reactive or the Negative Reactive profiles. Members of the Positive Reactive profile at age 9 months were significantly more likely to be in the Positive Reactive profile

Table 3
Summary of Fit Statistics for Latent Profile Analysis of Child Temperament

No. profiles	BIC	Entropy
9-month temperament		
One profile	4,154.7	N/A
Two profiles	4,093.5	0.72
Three profiles	4,076.8	0.68
Four profiles	4,070.2	0.74
Five profiles	4,081.9	0.69
18-month temperament		
One profile	3,204.5	N/A
Two profiles	3,150.2	0.54
Three profiles	3,114.3	0.64
Four profiles	3,102.4	0.65
Five profiles	3,129.9	0.64
27-month temperament		
One profile	2,916.6	N/A
Two profiles	2,872.2	0.59
Three profiles	2,833.2	0.67
Four profiles	2,829.4	0.73
Five profiles	2,846.8	0.66

Note. BIC = Bayesian information criterion.

(78%) than any other profile at age 27 months and children who were members of the Negative Reactive profile at age 9 months were significantly more likely to be members of the Negative Reactive profile (51%) at age 27 months. Also worth noting was how children who were members of the more expressive typical profile (Typical Expressive) at age 9 months were significantly more likely to transition to the Positive Reactive profile (51%) at age 18 months. This result can be compared to children in the Typical Low Expressive profile at age 9 months, who were equally likely to transition to either the Positive Reactive (37%) or the Negative Reactive (37%) profiles.

Children who were members of the emergent Fearful and Active Reactive profiles at age 18 months showed contrasting patterns of transition. Those in the Fearful profile were significantly more likely to remain members of the Fearful profile (55%) as opposed to transitioning to any other temperament profile at age 27 months, whereas children who were in the Active Reactive profile at age 18 months transitioned to the Positive Reactive (34%), Active Reactive (29%), and Negative Reactive (37%) profiles. Interestingly, not a single child who was classified as Active Reactive at age 18 months transitioned into the Fearful profile at age 27 months.

Parent Personality as a Predictor of Child Temperament Profile Membership

Environmental and relative genetic influences on child temperament profile membership were tested using multinomial logistic regression with profile membership as the dependent variable and AP (environmental) and BM (genetic) personality characteristics as predictor variables. AM, AF, and BM personality characteristics were centered at zero

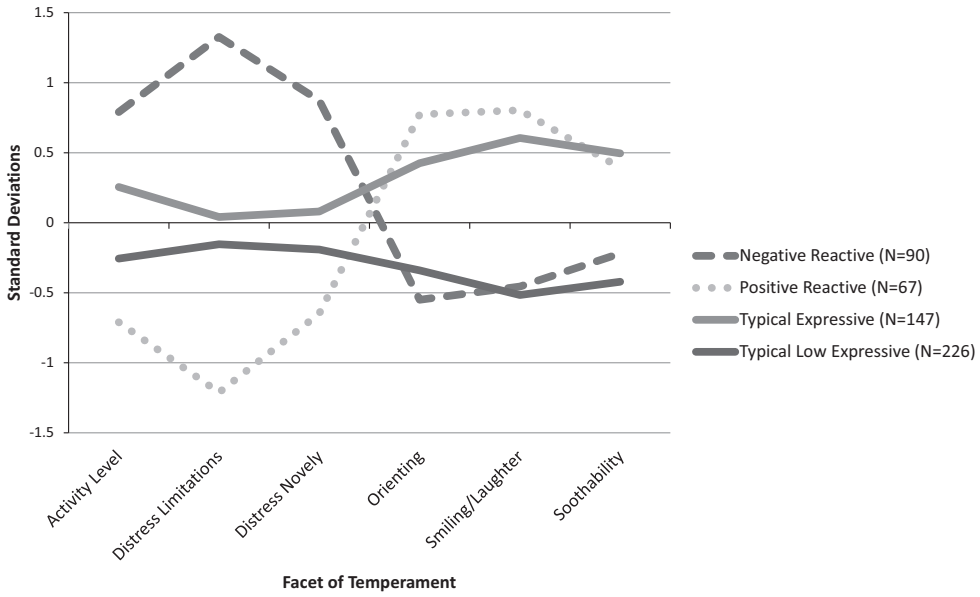

Figure 1. Temperament profiles at 9 months.

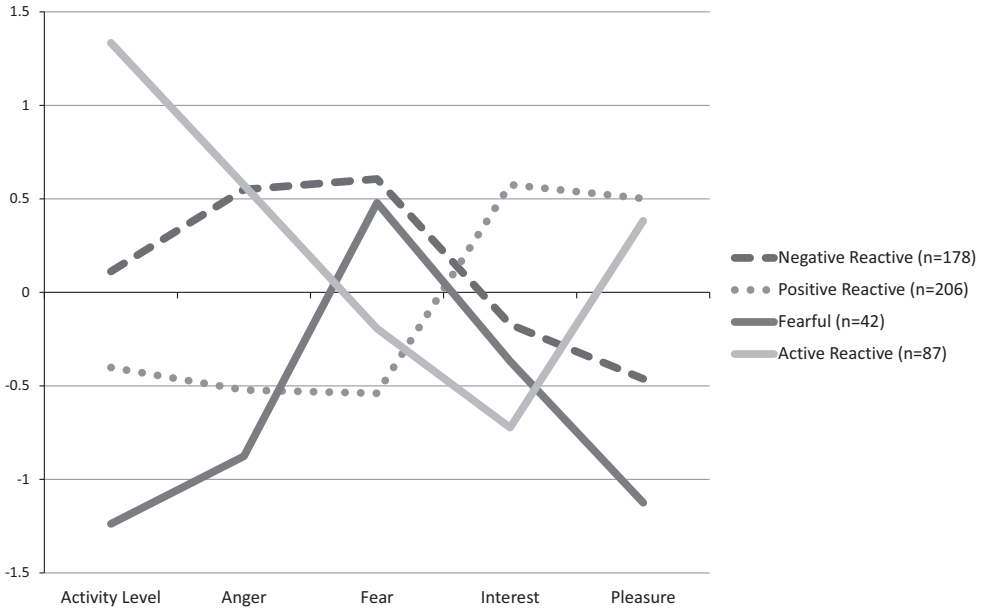

Figure 2. Temperament profiles at 18 months.

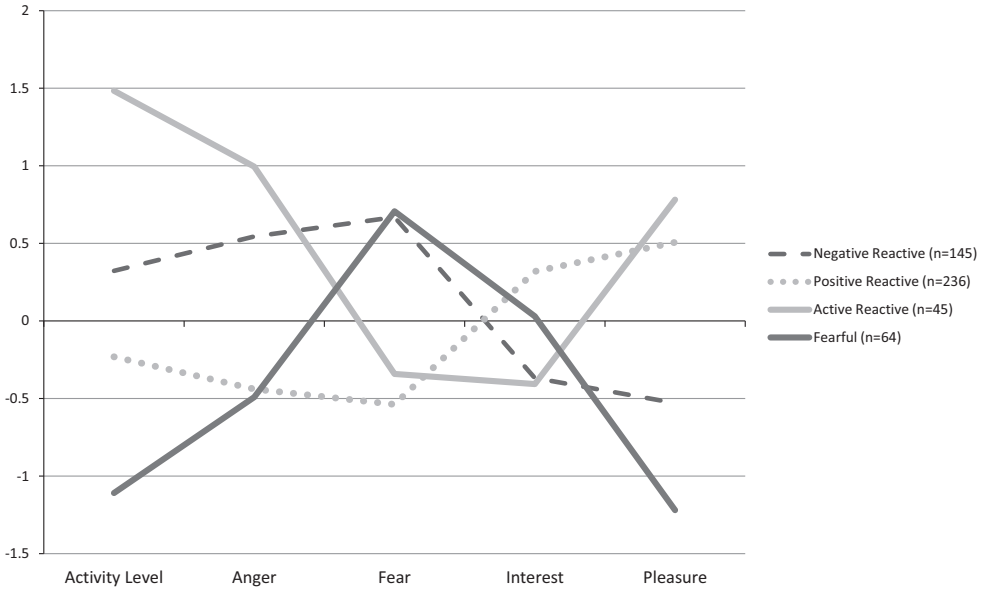

Figure 3. Temperament profiles at 27 months.

and entered into one multinomial logistic regression equation predicting child temperament profile membership at ages 9, 18, and 27 months for a total of *three separate models*. All possible three-way interactions between BM, AM, and AF personality characteristics were tested as predictors. None of these three-way interactions were statistically significant and were dropped from further analysis. Two-way interactions between BM and either AM or AF personality were also input as predictors so that each model had a total of 27 predictors (9 main effects, 9 two-way interactions between BM and AM, and 9 two-way interactions between BM and AF). Because this analysis was exploratory, full models were trimmed in a backward stepwise fashion until the most parsimonious model remained.

At age 9 months, the final model was significant, $\chi^2(9,\ N = 501) = 53.1,\ p < .001$. Omnibus, statistically significant predictors of 9-month profile membership were AM harm avoidance and reward

Table 4
Cross-Tabulations of Temperament Profile Transitions

	18-month profiles			
	Fearful	Positive Reactive	Negative Reactive	Active Reactive
9-month profiles				
Positive Reactive	8_a	42_b	7_a	4_a
Negative Reactive	2_a	5_a	53_b	25_b
Typical Expressive	2_a	68_c	36_b	$26_{b,c}$
Typical-Low Expressive	29_a	79_b	80_b	27_b

	27-month profiles			
	Fearful	Positive Reactive	Negative Reactive	Active Reactive
9-month profiles				
Positive Reactive	5_a	44_b	5_a	2_a
Negative Reactive	8_a	17_a	39_b	14_b
Typical Expressive	5_a	75_b	28_c	18_b
Typical-Low Expressive	44_a	90_b	68_b	8_c
18-month profiles				
Fearful	22_a	13_b	4_b	0_b
Positive Reactive	16_a	140_b	23_a	6_a
Negative Reactive	25_a	46_b	88_c	$11_{a,b}$
Active Reactive	0_a	26_b	27_d	23_c

Note. Differing subscripts across rows denote chi-square differences at $p < .05$.

Table 5
Summary of Parent Personality Predicting 9-Month Child Temperament Profile

Parent personality	Membership differences at 9 months	Odds ratios	*p*
AM harm avoidance	**Negative Reactive** versus Positive Reactive	2.53	< .001
	Negative Reactive versus Typical Expressive	1.64	.001
	Typical Expressive versus Positive Reactive	1.54	.012
	Typical Low Expressive versus Positive Reactive	2.02	< .001
	Typical Low Expressive versus Typical Expressive	1.31	.019
AF harm avoidance	**Negative Reactive** versus Positive Reactive	1.60	.017
	Typical Expressive versus Positive Reactive	1.61	.008
	Typical Low Expressive versus Positive Reactive	1.55	.011
AM reward dependence	**Positive Reactive** versus Negative Reactive	1.52	.018
	Typical Expressive versus Negative Reactive	1.68	< .001
	Typical Expressive versus Typical Low Expressive	1.33	.019

Note. The bolded profile is more likely given higher levels of the parent personality predictor. AM = adoptive mothers.

dependence and AF harm avoidance. At age 18 months, the final model was once again statistically significant, $\chi^2(33, N = 484) = 81.2$, $p < .001$. In this model, again both AM and AF harm avoidance were significant omnibus predictors, along with BM harm avoidance and interactions between BM reward dependence and AF novelty seeking and BM novelty seeking and AM harm avoidance. At age 27 months, the final model was statistically significant, $\chi^2(30, N = 464) = 55.4$, $p = 003$. Significant omnibus predictors included AM reward dependence, AF harm avoidance, and an interaction between BM harm avoidance and AF harm avoidance. A summary of results from the regression model for age 9 months can be found in Table 5, and for 18 and 27 months in Table 6.

We report a summary of the results in Tables 5 and 6 because in multinomial logistic regression, the dependent variable is categorical. In this study, the independent variables (parent personality traits) are associated with either an increase or a decrease in the odds of a child being in one temperament profile compared to a referent temperament profile. As can be seen in Tables 5 and 6, changing the referent profile allows for different levels of the dependent variable to be tested within the same age-specific model. To ease interpretation, we have bolded the profile that is *more likely* given an *increase* in the corresponding predictor.

For example, from Table 6, a 1 *SD* increase in the level of BM harm avoidance corresponded to an odds ratio of 1.49, or a 49% increase in the odds of a child being a member of the Fearful profile relative to the Negative Reactive profile at 18 months. Similarly, a 1 *SD* increase in the level of AM reward dependence corresponded to a 44% increase in the odds of a child being a member of the Positive Reactive profile relative to the Negative Reactive profile at 27 months. Taken together, these patterns suggested that higher levels of harm avoidance in parents were associated with their children having higher odds of membership in the Fearful or the Negative Reactive profiles whereas higher levels of parental reward dependence corresponded with increased odds for the Active Reactive and/or the Positive Reactive profile.

Table 6
Summary of Parent Personality Predicting 18- and 27-Month Child Temperament Profiles

Parent personality	Membership differences at 18 months	Odds ratios	*p*	Membership differences at 27 months	Odds ratios	*p*
AM harm avoidance	**Negative Reactive** versus Positive Reactive	1.56	< .001	**Negative Reactive** versus Positive Reactive	1.36	.011
	Active Reactive versus Positive Reactive	1.44	.018			
AF harm avoidance	**Negative Reactive** versus Positive Reactive	1.49	.001	**Negative Reactive** versus Positive Reactive	1.55	< .001
AM reward dependence	**Active Reactive** versus Fearful	1.76	.006	**Active Reactive** versus Fearful	1.92	.016
	Active Reactive versus Positive Expressive	1.41	.034	**Positive Reactive** versus Negative Reactive	1.44	.003
				Active Reactive versus Negative Reactive	2.33	< .001
				Active Reactive versus Positive Reactive	1.62	.041
AF reward dependence	**Active Reactive** versus Fearful	1.76	.006			
BM harm avoidance	**Fearful** versus Negative Reactive	1.49	.036			
BM Novelty Seeking × AM Harm Avoidance	Active Reactive versus **Negative Reactive**	.67	.011			
BM Reward Dependence × AF Novelty Seeking	Fearful versus **Negative Reactive**	.51	< .001			
BM Harm Avoidance × AF Harm Avoidance				Active Reactive versus **Negative Reactive**	.62	.028

Note. The bolded profile is more likely given higher levels of the parent personality predictor. AM = adoptive mothers; BM = birth mothers.

There was also evidence for specific Gene × Environment interactions that predicted child temperament profile membership. An illustration of how the interaction between BM harm avoidance and AF harm avoidance predicts the probability of child temperament profile membership at 27 months can be found in Figure 4. When levels of BM and AF harm avoidance are high, children have an extremely high probability of being members of the Negative Reactive profile as opposed to any other estimated profile. When BM harm avoidance is average or low, the probability of the child being a member of the Negative Reactive profile is lower but increases as the level of AF harm avoidance increases.

Discussion

The focus of this study was to provide a data-driven description of child temperament development in infancy and toddlerhood that addressed gaps in the current temperament literature. We examined several issues regarding the development of temperament: The stability of *patterns of associations* among dimensions that comprise profiles of temperament, stability in the characterization of profiles, and continuity and change in transitions in child membership from infancy to toddlerhood. This conceptualization of temperament, along with a genetically informative adoption design, also allowed for a novel investigation of possible environmental and genetic correlates of membership in child temperament profiles from infancy to toddlerhood.

Temperament Development: Structure and Characterization

Temperament at Age 9 Months

The structure and characterization of the temperament profiles estimated at age 9 months partially supported study hypotheses. The number of profiles estimated was somewhat surprising based on previous literature that had found evidence for three profiles of temperament at age 30 months (van den Akker et al., 2010) and in early adolescence (Rettew et al., 2008). The presence and structure of the Typical-Low Expressive and Typical-Expressive profiles, characterized by a lack of differentiation across indicators and high

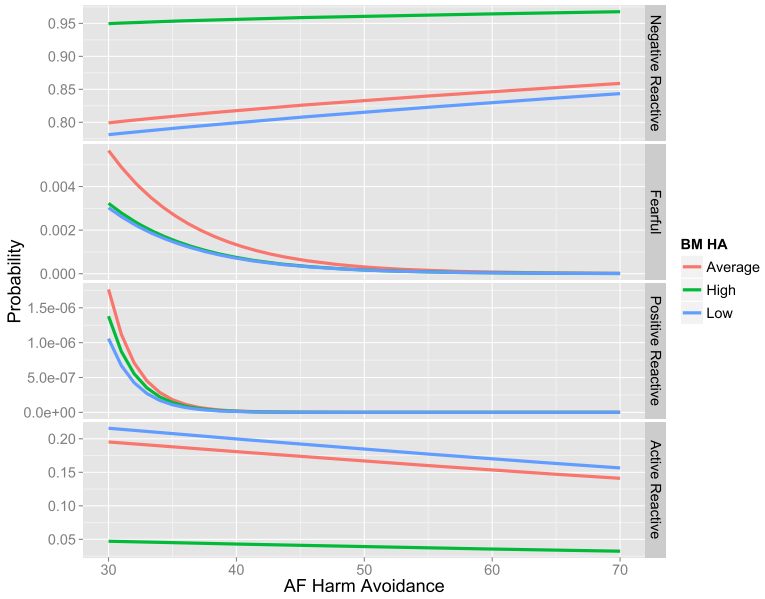

Figure 4. Interaction between birth mother's and adoptive father's harm avoidance predicting probabilities of profile membership at 27 months. AF = adoptive father; BM = birth mother; HA = harm avoidance.

prevalence of membership, are consistent with the lack of differentiation in the biological systems thought to underlie dimensions of temperament assessed in early infancy. For example, infant attentional systems are thought to be developing for most infants during this time period (Posner & Rothbart, 1998). The Typical-Expressive and Typical-Low Expressive profiles might be capturing infants who are following more typical developmental patterns at age 9 months, whereas the remaining two profiles characterize infants who share similar patterns of individual differences in dimensions of infant temperament that are developing differently.

Infants who were more active, more distressed, less prone to positive affect, and had lower levels of orienting (thought of as an early measure of attention) than the rest of the sample were likely members of the Negative Reactive profile. This profile may be more comparable to the high reactive profile found in previous work. For example, Kagan and Snidman (1991) classified infants into high- and low-reactive groups at 4 months and another study of the same infants found evidence for a latent high reactivity profile that contained about 10% of the sample (Woodward, Lenzenweger, & Kagan, 2000). However, these classifications were based primarily on observations of motor activity and distress to novelty (Kagan & Snidman, 1991; Woodward et al., 2000), while the profiles estimated in this study are from questionnaires and contain additional information concerning positive affect, orienting, and soothability, making direct comparisons difficult. Infants in the Positive Reactive profile were less active and exhibited lower levels of negative reactivity and had higher levels of orienting and smiling and laughter compared to the rest of the sample. Although speculative, one possible developmental explanation for the presence of the Positive Reactive profile is that these infants may be developing an early regulatory system. The attention system is thought to develop early in life primarily to regulate distress (Posner & Rothbart, 1998). The high levels of duration of orienting (thought to capture attentional control) and low levels of distress that characterize the Positive Reactive profile might reflect a group of infants who have developed an early capacity to regulate emotional reactivity through attention (Bell, 2012).

Temperament at Age 18 and 27 Months

The structure and characterization of temperament profiles at age 18 and 27 months also partially supported study hypotheses. Four profiles best fit the data and the deviations from the sample mean for indicators within profiles were consistent at both times of assessment. The consistency in the characterization of the Positive Reactive and Negative Reactive profiles across time provides some evidence for the developmental salience of these temperament profiles. The characterization of the Active Reactive profile was

consistent with an uninhibited, or exuberant profile (Fox, Henderson, Marshall, Nichols, & Ghera, 2005; Stifter, Putnam, & Jahromi, 2008). The characterization and the prevalence of the Fearful profile are consistent with a BI temperament type (Kagan et al., 1984).

The structure and characterization of all four temperament profiles, Positive Reactive, Negative Reactive, Fearful, and Active Reactive, may reflect individual differences in how children transition from more biologically based, reactivity profiles at age 9 months to behavioral tendencies related to the development of the behavioral approach systems (BAS) and behavioral inhibition systems (Gray, 1994) that are evident at ages 18 and 27 months. The high levels of activity and anger found in the Negative Reactive profile may be indicative of children who are more actively seeking out goals and who respond with anger when those goals are thwarted. Approach and anger are often associated in temperament research (Deater-Deckard et al., 2010) and are components of a more dominant BAS (Gray, 1994). The Positive Reactive profile's combination of high positive affect, engagement/approach, and lower levels of fear parallel the exuberant or uninhibited temperament type, while the low levels of activity level and anger do not (Stifter et al., 2008). Contrasting the Active Reactive and Positive Reactive profiles provides an example for the importance of considering the full constellation of temperament dimensions, as both profiles are characterized by low levels of fear and high levels of pleasure while the combination of differences in activity level, anger, and engagement/approach between the two profiles suggests they are distinct.

Transitions in Child Membership

Results concerning the stability of child membership in profiles of temperament across infancy were consistent with prior literature in that they were mixed. Members of the Positive Reactive or Negative Reactive profiles consistently showed the highest levels of stability from ages 9 to 18, 18 to 27, and even 9 to 27 months. Children who were members of the Typical-Low Expressive profile at age 9 months (which had the largest membership) were equally likely to transition to the Fearful, Negative Reactive, or Positive Reactive profiles at age 18 months. These results are consistent with the large body of temperament literature that has shown greater stability for children in extreme temperament groups (Pfeifer et al., 2002). Profile membership at age 18 months was, in most cases, predictive of profile membership at age 27 months; children were significantly more likely to remain members of their respective profiles as opposed to transitioning to a different temperament profile. By age 18 months, most children in this study settled into a temperament profile that was indicative of where they would be 9 months later.

Genetic and Environmental Influences on Profile Membership

This study provided evidence for specific genetic, environmental, and Gene × Environment influences on child temperament profile membership. While there has been a plethora of evidence for genetic influences on child temperament development from twin studies, sparse evidence from adoption studies and concerns about possible contrast effects in twin designs, especially for parent reports of child temperament, highlight the need for more research utilizing adoption designs (Goldsmith et al., 1987). Utilizing a data-driven, person-centered framework, this study found direct evidence for genetic influences on child temperament profile membership.

With regard to specific, relative genetic influences on child temperament, children with BM who had higher levels of harm avoidance were more likely to be members of the Fearful temperament profile as opposed to the Negative Reactive profile at age 18 months. This result fits into a large body of literature that suggests that fearful, harm-avoidant, or anxious behavior is heritable (Cloninger, 1985) and provides some of the first evidence for specific genetic influences on child temperament profiles from an adoption study but are in stark contrast to a lack of genetic findings from prior adoption studies measuring child temperament (e.g., Plomin et al., 1991). Some possible reasons for these differences are measurement (i.e., different measures being used), the age of the children under consideration, and analytic strategy (i.e., dimensional correlations compared to multinomial logistic regression and LPA). These results can, and should, be compared to those from a larger body of evidence from twin research focused on the mechanisms influencing the development of early child behavior. For example, there is evidence from twin research that both shared environmental and genetic influences play a role in the development of symptoms of anxiety (Thapar & McGuffin, 1995).

The most robust environmental predictor of temperament profile membership in this study proved to be the level of adoptive parents' harm avoidance. For example, for every 1 *SD* increase in harm avoidance of AP, children were about 30% less likely to be members of the Positive Reactive profile at age 18 months. This high level of harm avoidance in parents may be indicative of an overprotective, intrusive, or restrictive parenting style, which has been linked to the development of internalizing problems (Bayer, Sanson, & Hemphill, 2006; Rubin, Burgess, & Hastings, 2002). Interestingly, there is not a consensus in the literature regarding the direction of this effect; it is equally possible that temperamental characteristics of the child may actually drive parenting behavior (Kennedy, Rubin, Hastings, & Maisel, 2004). We plan to address this issue of evocative Gene × Environment correlation in future studies.

In addition, children of AP who were higher in reward dependence were more likely to be members of the Positive Reactive or Active Reactive temperament profiles as opposed to the Negative Reactive or Fearful temperament profiles. In other words, children of more sociable and dedicated AP were more likely to be members of temperament profiles characterized by higher levels of pleasure and activity level. This finding was consistent across multiple child ages and both adoptive mother and adoptive father reports of their personality. This set of findings, coupled with a lack of prediction from birth mother's reward dependence, could suggest that the rearing environment is especially important for the development of positivity as opposed to negativity in young children. Confidence in this interpretation is strengthened by the positive associations that have been found between parent and child reward dependence in biological families (Rettew et al., 2006) and by evidence from genetically informative research suggesting that environmental influences may be more important for positive as opposed to negative facets of temperament in young children (Goldsmith et al., 1997).

There was also evidence for specific Gene × Environment interactions that predicted child temperament profile membership. One example is illustrated in Figure 4. Children of BM with high levels of harm avoidance (a genetic influence) had an extremely high probability of being members of the Negative Reactive profile. When BM harm avoidance was average or low, the probability of the child being a member of the Negative Reactive profile was lower but increased as the level of adoptive father's harm avoidance (an environmental influence) increased. In addition, another interaction result suggested that children were more likely to be members of the Negative Reactive as opposed to the Fearful temperament profile only when levels of both BM reward dependence (a genetic influence) and AF novelty seeking (an environmental influence) were high. Taken together, these interactions suggest that the magnitude of influence from AP personality on certain types of child temperament may, in some cases, be dependent on the genetic influences transmitted from the personality of the child's BM. These findings are some of the first results to illustrate a *specific* interaction between genetic (BM personality) and environmental (AP personality) factors in predicting profiles of temperament in young children and could be a first step in identifying specific parent personality interactions that may be more important for influencing the development of specific configurations of child temperament.

Limitations and Future Directions

Although the prospective adoption design provides more specific information about environmental, and to some extent, genetic influences (while controlling for passive Gene × Environment correlation) compared to the more general decomposition of variance found in twin studies, there are other methodologies that are more specific in regard to genes. For example, molecular genetic studies have identified links between specific genes, brain function, and personality (e.g., Pezawas et al., 2005). Future studies could use the above techniques along with a data-driven operationalization of child temperament to increase confidence in the findings presented in this report.

There are also limitations specific to this study. First, because AP reported on their child's temperament and their own temperament, rater effects may inflate the associations between AP personality and child temperament profiles. This was partially addressed by compositing adoptive mother and adoptive father reports of child temperament. Second, because the IBQ was used to measure child temperament at 9 months and the TBAQ was used at both 18 and 27 months, it is possible that similarities in profile characterization at 18 and 27 months are due in part to measurement effects. However, the TBAQ was chosen because it was specifically designed to be a developmentally appropriate measure of child temperament for toddlers that mapped directly onto the constructs in the IBQ (Goldsmith,

1996). The EGDS does include observational data indexing child temperament, for example, an arm restraint task, but use of these data was not possible in this study as coding is not complete for all assessments or cohorts. Future studies could use these observational data in conjunction with questionnaire data to test measurement effects. Third, although this study suggests there are direct effects of AP temperament on child temperament profile membership, it is unclear how this influence occurs, while one likely mechanism is social learning or modeling. This question was beyond the scope of this study, but the EGDS includes a wide range of measures on parenting and home environment that can be utilized in subsequent studies. As the EGDS is an ongoing study, currently funded to follow the sample through middle childhood, future studies can extend the work begun in this report by examining temperament profile structure and membership continuity from 9 months to 7 years. Extending this research into middle childhood will allow for linking temperament profiles to child behavioral outcomes and can also facilitate our ability to link genetic and environmental influences to individual differences in patterns of stability in profile membership over time. In sum, we hope that the future directions of this work can help to clarify how temperament develops from infancy to middle childhood, investigate whether some children show more transitions in profile membership and whether those transitions are particularly problematic, and finally, continue to specify mechanisms by considering genetic (birth parent) and environmental (AP) influences on these profiles over time.

References

Aksan, N., Goldsmith, H. H., Smider, N. A., Essex, M. J., Clark, R., Hyde, J. S., . . . Vandell, D. L. (1999). Derivation and prediction of temperamental types among preschoolers. *Developmental Psychology*, *35*, 958–971. doi: 10/1037/0012-1649.35.4.958

Bayer, J. K., Sanson, A. V., & Hemphill, S. A. (2006). Parent influences on early childhood internalizing difficulties. *Journal of Applied Developmental Psychology*, *27*, 542–559. doi:10.1016/j.appdev.2006.08.002

Bell, M. A. (2012). A psychobiological perspective on working memory performance at 8 months of age. *Child Development*, *83*, 251–265. doi:10.1111/j.1467-8624.2011.01684.x

Blair, C. (2002). School readiness: Integrating cognition and emotion in a neurobiological conceptualization of children's functioning at school entry. *American Psychologist*, *57*, 111–127. doi:10.1037//0003-066X.57.2.111

Brooker, R. J., Neiderhiser, J. M., Kiel, E. J., Leve, L. D., Shaw, D. S., & Reiss, D. (2011). The association between infants' attention control and social inhibition is moderated by genetic and environmental risk for anxiety. *Infancy*, *16*, 490–507. doi:10.1111/j.1532-7078.2011.00068.x

Carey, W. B., & McDevitt, S. C. (1978). Revision of the Infant Temperament Questionnaire. *Pediatrics*, *61*, 735–740.

Carranza, J. A., Perez-Lopez, J., Gonzalez, C., & Martinez-Fuentes, M. T. (2000). A longitudinal study of temperament in infancy: Stability and convergence of measures. *European Journal of Personality*, *14*, 21–37. doi:10.1002/(SICI)1099-0984(200001/02)14:1<21::AID-PER367>3.0.CO;2-A

Celeux, G., & Soromenho, G. (1996). An entropy criterion for assessing the number of clusters in a mixture model. *Journal of Classification*, *13*, 195–212.

Cloninger, C. R. (1985). A unified biosocial theory of personality and its role in the development of anxiety states. *Psychiatric Developments*, *4*, 167–226.

Cloninger, C. R., Svaric, D. M., & Przybeck, T. R. (1993). A psychobiological model of temperament and character. *Archives of General Psychiatry*, *44*, 573–588.

Colder, C. R., Mott, J. A., & Berman, A. S. (2002). The interactive effects of infant activity level and fear on growth trajectories of early childhood behavior problems. *Development and Psychopathology*, *14*, 1–23. doi:10.1017/S0954579402001013

Daniels, D., Plomin, R., & Greenhalgh, J. (1984). Correlates of difficult temperament in infancy. *Child Development*, *55*, 1184–1194.

Deater-Deckard, K., Beekman, C., Wang, Z., Kim, J., Petrill, S., Thompson, L., & DeThorne, L. (2010). Approach/positive anticipation, frustration/anger, and overt aggression in childhood. *Journal of Personality*, *78*, 991–1010. doi:10.1111/j.1467-6494.2010.00640.x

Fox, N. A., Henderson, H. A., Marshall, P. J., Nichols, K. E., & Ghera, M. M. (2005). Behavioral inhibition: Linking biology and behavior within a developmental framework. *Annual Review of Psychology*, *56*, 235–262. doi:10.1146/annurev.psyc.55.090902.14.1532

Ge, X., Natsuaki, M. N., Martin, D. M., Leve, L. D., Neiderhiser, J. M., Shaw, D. S., . . . Reiss, D. (2008). Bridging the divide: Openness in adoption and postadoption psychosocial adjustment among birth and adoptive parents. *Journal of Family Psychology*, *22*, 529–540. doi: 10.1037/a0012817

Goldsmith, H. H. (1996). Studying temperament via construction of the Toddler Behavior Assessment Questionnaire. *Child Development*, *67*, 218–235. doi:10.2307/1131697

Goldsmith, H. H., Buss, K. A., & Lemery, K. S. (1997). Toddler and childhood temperament: Expanded content, stronger genetic evidence, new evidence for the importance of environment. *Developmental Psychology*, *33*, 891–905. doi:10.1037//0012-1649.33.6.891

Goldsmith, H. H., Buss, A. H., Plomin, R., Rothbart, M. K., Thomas, A., & Chess, S. (1987). What is tempera-

ment? Four approaches. *Child Development*, *58*, 505–529. doi:10.2307/1130527

Gray, J. A. (1994). Three fundamental emotion systems. In P. Ekman & R. J. Davidson (Eds.), *The nature of emotion: Fundamental questions* (pp. 243–247). New York, NY: Oxford University Press.

Heath, A. C., Cloninger, C. R., & Martin, N. G. (1994). Testing a model for the genetic structure of personality: A comparison of the personality systems of Cloninger and Eysenck. *Journal of Personality and Social Psychology*, *66*, 762–775. doi:10.1037//0022-3514.66.4.762

Haugaard, J. J., & Hazan, C. (2003). Adoption as a natural experiment. *Development and Psychopathology*, *15*, 909–926. doi:http://dx.doi.org/10.1017/S0954579403000427

Kagan, J. (1994). *Galen's prophecy*. New York, NY: Basic Books.

Kagan, J., Reznick, J. S., Clarke, C., Snidman, N., & Garcia-Coll, C. (1984). Behavioral inhibition to the unfamiliar. *Child Development*, *55*, 2212–2225. doi:10.2307/1129793

Kagan, J., & Snidman, N. (1991). Temperament factors in human development. *American Psychologist*, *46*, 856–862.

Kennedy, A. E., Rubin, K. H., Hastings, P. D., & Maisel, B. (2004). Longitudinal relations between child vagal tone and parenting behavior: 2 to 4 years. *Developmental Psychobiology*, *45*, 10–21. doi:10.1002/dev.20013

Kotelchuck, M. (1994). An evaluation of the Kessner Adequacy of Prenatal Care Index and a proposed Adequacy of Prenatal Care Utilization Index. *American Journal of Public Health*, *84*, 1414–1420. doi:10.2105/AJPH.84.9.1414

Lazarsfeld, P. F., & Henry, N. W. (1968). *Latent structure analysis*. New York, NY: Houghton Mifflin.

Leve, L. D., Neiderhiser, J. M., Shaw, D. S., Ganiban, J., Natsuaki, M. N., & Reiss, D. (2013). The Early Growth and Development Study: A prospective adoption study from birth through middle childhood. *Twin Research and Human Genetics*, *16*, 412–423. doi:10.1017/thg.2012.126

Loken, E. (2004). Using latent class analysis to model temperament types. *Multivariate Behavioral Research*, *39*, 625–652. doi:10.1207/s15327906mbr3904_3

Magidson, J., & Vermunt, J. K. (2004). Latent class models. In D. Kaplan (Ed.), *The Sage handbook of quantitative methodology for the social sciences* (pp. 175–198). Thousand Oaks, CA: Sage.

McCall, R. B. (1986). Issues of stability and continuity in temperament research. In R. Plomin & J. Dunn (Eds.), *The study of temperament: Changes, continuities, and challenges* (pp. 13–25). Hillsdale, NJ: Erlbaum.

McNeil, T. F., Cantor-Graae, E., & Sjostrom, K. (1994). Obstetric complications as antecedents of schizophrenia: Empirical effects of using different obstetric complication scales. *Journal of Psychiatric Research*, *28*, 519–530. doi:10.1016/0022-3956(94)90042-6

Merikangas, K. R., Swendsen, J. D., Preisig, M. A., & Chazan, R. Z. (1998). Psychopathology and temperament in parents and offspring: Results of a family study. *Journal of Affective Disorders*, *51*, 63–74. doi:10.1016/S0165-0327(98)00157-8

Muthén, B. O., & Muthén, L. K. (2000). *Mplus: The comprehensive modeling program to applied researchers*. Los Angeles, CA: Author.

Nigg, J. T. (2006). Temperament and developmental psychopathology. *Journal of Child Psychology and Psychiatry*, *47*, 395–422.

Perez-Edgar, K., & Fox, N. A. (2005). Temperament and anxiety disorders. *Child and Adolescent Psychiatric Clinics of North America*, *14*, 681–706. doi:10.1016/j.chc.2005.05.008

Pezawas, L., Meyer-Lindenberg, A., Drabant, E. M., Verchinski, B. A., Munoz, K. E., Kolachana, B. S., . . . Weinberger, D. R. (2005). 5-HTTLPR polymorphism impacts human cingulate-amygdala interactions: A genetic susceptibility mechanism for depression. *Nature Neuroscience*, *8*, 828–834. doi:10.1038/nn1463

Pfeifer, M., Goldsmith, H. H., Davidson, R. J., & Rickman, M. (2002). Continuity and change in inhibited and uninhibited children. *Child Development*, *73*, 1474–1485. doi:10.1111/1467-8624.00484

Plomin, R., Coon, H., Carey, G., DeFries, J. C., & Fulker, D. (1991). Parent-offspring and sibling adoption analyses of parental ratings of temperament in infancy and childhood. *Journal of Personality*, *59*, 705–732. doi:10.1111/j.1467-6494.1991.tb00928.x

Plomin, R., & DeFries, J. C. (1983). The Colorado Adoption Project. *Child Development*, *54*, 276–289.

Plomin, R., DeFries, J. C., Knopik, V. S., & Neiderhiser, J. M.. (2013) *Behavioral genetics* (6th ed.). New York, NY: Worth.

Posner, M. I., & Rothbart, M. K. (1998). Attention, self-regulation and consciousness. *Philosophical Transactions of the Royal Society of London, B*, *353*, 1915–1927.

Putnam, S. P., & Stifter, C. A. (2005). Behavioral approach-inhibition in toddlers: Prediction from infancy, positive and negative affective components, and relations with behavior problems. *Child Development*, *76*, 212–226. doi:10.1111/j.1467-8624.2005.00840.x

Raftery, A. E. (1999). Bayes factors and BIC. *Sociological Methods & Research*, *27*, 411–417.

Rettew, D. C., Althoff, R. R., Dumenci, L., Ayer, L., & Hudziak, J. J. (2008). Latent profiles of temperament and their relations to psychopathology and wellness. *Journal of the American Academy of Child and Adolescent Psychiatry*, *47*, 273–281. doi:10.1097/CHI.0b013e318160b403

Rettew, D. C., Stanger, C., McKee, L., Doyle, A., & Hudziak, J. J. (2006). Interactions between child and parent temperament and child behavior problems. *Comprehensive Psychiatry*, *47*, 412–420.

Riese, M. L. (1987). Longitudinal assessment of temperament from birth to 2 years: A comparison of full-term

infants. *Infant Behavior and Development*, *10*, 347–363. doi:10.1016/0163-6383(87)90022-1

Robinson, J. L., Kagan, J., Reznick, J. S., & Corley, R. (1992). The heritability of inhibited and uninhibited behavior: A twin study. *Developmental Psychology*, *28*, 1030–1037.

Rothbart, M. K. (1981). Measurement of temperament in infancy. *Child Development*, *52*, 569–578. doi:10.2307/1129176

Rothbart, M. K., Ahadi, S. A., Hershey, K. L., & Fisher, P. (2001). Investigations of temperament at three to seven years: The children's behavior questionnaire. *Child Development*, *72*, 1394–1408. doi:10.1111/1467-8624.00355

Rothbart, M. K., & Derryberry, D. (1981). Development of individual differences in temperament. In M. E. Lamb & A. L. Brown (Eds.), *Advances in developmental psychology* (Vol. 1, pp. 37–86). Hillsdale, NJ: Erlbaum.

Rothbart, M. K., Derryberry, D., & Hershey, K. (2000). Stability of temperament in childhood: Laboratory infant assessment to parent report at seven years. In V. J. Molfese & D. L. Molfese (Eds.), *Temperament and personality development across the life span* (pp. 85–119). Hillsdale, NJ: Erlbaum.

Rubin, K. H., Burgess, K. B., & Hastings, P. D. (2002). Stability and social-behavioral consequences of toddlers' inhibited temperament and parenting behaviors. *Child Development*, *73*, 483–495. doi:10.1111/1467-8624.00419

Saudino, K. J. (2005). Behavioral genetics and child temperament. *Journal of Developmental and Behavioral Pediatrics*, *26*, 214–223. doi:10.1097/00004703-200506000-00010

Scarr, S., Webber, P. L., Weinberg, R. A., & Wittig, M. A. (1981). Personality resemblance among adolescents and their parents in biologically related and adoptive families. *Journal of Personality and Social Psychology*, *40*, 885–898.

Schmitz, S. (1994). Personality and temperament. In J. C. DeFries, R. Plomin, & D. W. Fulker (Eds.), *Nature and nurture during middle childhood* (pp. 120–140). Cambridge, UK: Blackwell.

Schwarz, G. (1978). Estimating the dimension of a model. *Annals of Statistics*, 6461–6464.

Seifer, R., Sameroff, A. J., Barrett, L. C., & Krafchuk, E. (1994). Infant temperament measured by multiple observations and mother report. *Child Development*, *65*, 1478–1490.

Shiner, R. L., Buss, K. A., McClowry, S. G., Putnam, S. P., Saudino, K. J., & Zentner, M. (2012). What is temperament now? Assessing progress in research on the twenty-fifth anniversary of Goldsmith et al. *Child Development Perspectives*, *6*, 436–444. doi:10.1111/j.1750-8606.2012.00254.x

Stifter, C. A., & Jain, A. (1996). Psychophysiological correlates of infant temperament: Stability of behavior and autonomic patterning from 5 to 18 months. *Developmental Psychobiology*, *29*, 379–391.

Stifter, C. A., Putnam, S., & Jahromi, L. (2008). Exuberant and inhibited toddlers: Stability of temperament and risk for problem behavior. *Development and Psychopathology*, *20*, 401–421. doi:10.1017/S0954579408000199

Thapar, A., & McGuffin, P. (1995). Are anxiety symptoms in childhood heritable? *Journal of Child Psychology and Psychiatry*, *36*, 439–447.

Thomas, A., & Chess, S. (1977). *Temperament and development*. New York, NY: Brunner/Mazel.

van den Akker, A. L., Dekovic, M., Prinzie, P., & Asscher, J. J. (2010). Toddlers' temperament profiles: Stability and relations to negative and positive parenting. *Journal of Abnormal Child Psychology*, *38*, 485–495. doi:10.1007/s10802-009-9379-0

Woodward, S. A., Lenzenweger, M. F., & Kagan, J. (2000). Taxonic structure of infant reactivity: Evidence from a taxometric perspective. *Psychological Science*, *11*, 296–301. doi:10.1111/1467-9280.00259

Zentner, M., & Bates, J. E. (2008). Child temperament: An integrative review of concepts, research programs, and measures. *International Journal of Development of Science*, *2*, 7–37.