

What Is Temperament *Now*? Assessing Progress in Temperament Research on the Twenty-Fifth Anniversary of Goldsmith et al. (1987)

Rebecca L. Shiner,¹ Kristin A. Buss,² Sandee G. McClowry,³ Samuel P. Putnam,⁴
Kimberly J. Saudino,⁵ and Marcel Zentner⁶

¹Colgate University, ²Pennsylvania State University, ³New York University, ⁴Bowdoin College, ⁵Boston University, and ⁶University of York (UK)

ABSTRACT—*The now-classic article “What Is Temperament? Four Approaches” by H. H. Goldsmith et al. (1987) brought together originators of four prominent temperament theories—Rothbart, Thomas and Chess, Buss and Plomin, and Goldsmith—to address foundational questions about the nature of temperament. This article reviews what has been learned about the nature of temperament in the intervening 25 years. It begins with an updating of the 1987 consensus definition of temperament that integrates more complex current findings. Next, 4 “progeny” trained in the original temperament traditions assess contributions of their respective approaches. The article then poses essential questions for the next generation of research on the fundamentals of temperament, including its structure, links with personality traits, interaction with context, and change and continuity over time.*

KEYWORDS—childhood development; temperament change; personality traits; environmental effects; genes

At the 1985 meeting of the Society for Research in Child Development, H. Hill Goldsmith convened a roundtable conversation among leading temperament researchers to address foundational

questions about the nature of temperament. Following the roundtable, many of the panelists summarized the discussion in a now-classic 1987 article, “What Is Temperament? Four Approaches.” This seminal article highlighted four compelling temperament theories—those of Goldsmith, Mary Rothbart, Alexander Thomas and Stella Chess, and Arnold Buss and Robert Plomin—and articulated the key questions to be addressed by this burgeoning field: How should temperament be defined and distinguished from related individual differences? What are its key elements? How does it develop?

In this article, we reflect on what has been learned about the nature of child temperament in the 25 years since the publication of this important paper. We begin by updating the 1987 consensus definition of temperament in light of new research. Next, four “progeny” trained in each of the original temperament traditions assess progress in key aspects of their respective theories. Finally, we pose essential questions for the next generation of research on temperament.

NEW PERSPECTIVES ON THE DEFINITION OF TEMPERAMENT

The fundamental question addressed in Goldsmith et al. (1987) is stated in the title of the article: What is temperament? This question has been debated for centuries, and the scholars featured in the 1987 article continued the debate by offering different definitions. At the end of the 1987 article, the commentator Robert McCall shared a definition of temperament that attempted to integrate the four approaches:

Temperament consists of relatively consistent, basic dispositions inherent in the person that underlie and modulate the expression of activity, reactivity, emotionality, and sociability. Major elements of

This article was inspired by two panel discussions organized by Rebecca L. Shiner: Society for Research in Child Development 2009 biennial meeting, Denver, CO, and the 2010 Occasional Temperament Conference, Brunswick, ME.

Correspondence concerning this article should be addressed to Rebecca L. Shiner, Department of Psychology, Colgate University, 13 Oak Dr., Hamilton, NY 13346; e-mail: rshiner@colgate.edu.

© 2012 The Authors

Child Development Perspectives © 2012 The Society for Research in Child Development

DOI: 10.1111/j.1750-8606.2012.00254.x

temperament are present early in life, and those elements are likely to be strongly influenced by biological factors. As development proceeds, the expression of temperament increasingly becomes more influenced by experience and context. (p. 524)

This definition articulates many of the shared assumptions about temperament that have guided research over the past 25 years. However, new findings and approaches have offered new perspectives on many of these guiding assumptions. First, not all temperament traits are stable early in life, perhaps because new temperamental systems that control or inhibit the more reactive aspects of temperament emerge only later in infancy; as these control systems come on-line, they may change the expression and stability of the more reactive traits (Rothbart, 2011). Temperament traits become more consistent with age, showing substantial stability by at least the preschool years (Roberts & DelVecchio, 2000). Further, due to maturational processes occurring between infancy and later childhood, stability often may be heterotypic rather than homotypic. For example, visual exploratory behavior in infancy predicts novelty seeking in adolescence, possibly representing two developmentally specific expressions of a common process (Laucht, Becker, & Schmidt, 2006; see Schwartz et al., 2011, for a similar example involving behavioral inhibition).

Second, most temperament researchers would agree that the particular traits included in the definition do constitute individual differences in temperament (see, e.g., the definition offered by Zentner & Bates, 2008). However, the 1987 list leaves out dimensions of attention and self-regulation, which have turned out to be important individual differences that emerge in basic form in infancy, derive in part from developing biological systems, and modulate the development of more reactive emotional systems (Rothbart, 2011). In short, temperament researchers recognize now that affective and cognitive processing are highly integrated systems (Derryberry & Tucker, 2006; Forgas, 2008) and that, therefore, some aspects of temperament—such as attention and executive control—involve individual differences in domains traditionally considered more cognitive in nature.

Third, the field's understanding of the joint workings of biological factors and experience in development has become more complex. The definition argues that temperamental differences are strongly influenced by biology at the start, but become more influenced by environmental experiences with time. This dichotomy between biological and environmental influences is not tenable. Before a child's birth, the intrauterine environment has already influenced the expression of each child's genetic material (Huizink, 2012), and experiences continue to shape gene expression after birth (Champagne & Mashoodh, 2009). Both genetic and environmental factors influence temperament from infancy onward, and new genetic influences on temperamental traits arise later in development (Saudino & Wang, 2012). Thus, temperament should no longer be viewed as biologically derived at birth and later shaped by experience; rather, it should be

viewed as the result of biological and environmental factors working together throughout development.

Taken together, the newest work on temperament suggests an alternative definition: Temperament traits are early emerging basic dispositions in the domains of activity, affectivity, attention, and self-regulation, and these dispositions are the product of complex interactions among genetic, biological, and environmental factors across time. As McCall noted in his commentary on the four temperament approaches, "Definitions are not valid or invalid, confirmable or refutable. Instead, they are more or less useful" (p. 524). It is important that the field not be dogmatic in adherence to a single definition of temperament. As new findings accumulate, additional basic dispositions may be identified, and an amended definition may prove to be more useful.

ASSESSING PROGRESS IN THE FOUR ORIGINAL TEMPERAMENT TRADITIONS

All four approaches articulated in the Goldsmith et al. (1987) article have yielded important insights over the past 25 years. Some tenets of the theories have received robust support, whereas other aspects have required modification. In the following section, "progeny" of the four temperament traditions offer their assessment of the specific contributions of each approach: the structure of temperament and importance of self-regulatory traits (Rothbart), goodness of fit and the application of temperament concepts (Chess and Thomas), the interplay of genetic and environmental factors in development (Buss and Plomin), and the significance of the emotional nature of temperament (Goldsmith).

Putnam: The Rothbart Approach

Of the perspectives presented in the 1987 article, Rothbart's was perhaps the most broad, emphasizing motor and emotional reactivity as well as attentional processes that serve to regulate initial reactive tendencies. This inclusive stance was manifest in the links made between temperament and biological reactivity and self-regulation from the start (Rothbart & Derryberry, 1981) and in the questionnaire, observation, and laboratory measures developed by Rothbart and colleagues over subsequent years (Goldsmith & Rothbart, 1991; Posner & Rothbart, 2007; Putnam, Ellis, & Rothbart, 2001). Rothbart (2011) has recently integrated biological and environmental influences on temperament with the development of conscience, personality, and psychopathology.

Rothbart and colleagues developed questionnaire measures with over 20 fine-grained facets of temperament indicated in earlier temperament measures and in the animal temperament, emotional development, and adult personality literatures. In addition to promoting more detailed measurement of temperament facets, these instruments have enabled examination of the

higher order factor structure of temperament. An important insight into temperament structure since the 1987 article is that temperament differences are organized hierarchically across the lifespan. Particular facets of temperament tend to covary, and the covariation among those traits is accounted for by higher order factors with greater breadth. Three higher order factors are consistently identified from questionnaires: Surgency (including activity level, sociability, and pleasure expressed in anticipation of reward or during high-intensity activities); Negative Affectivity (including anger, sadness, fear, physical discomfort, and recovery from distress); and a factor labeled Regulatory Capacity in infants and Effortful Control in older individuals (including the ability to focus attention, demonstrate satisfaction during low-intensity activities, and, in older children, to exercise inhibitory control). Across the lifespan, in multiple cultures, and through both self and other reports, the results of these factor analyses converge considerably. Furthermore, the structure obtained with Rothbart's measures bears similarities to those emerging from other temperament batteries (e.g., Halverson, Kohnstamm, & Martin, 1994) and personality inventories (e.g., Tellegen, 1985). By providing a common taxonomy of traits, derivation of these factors has enhanced communication among temperament researchers and provided conceptual building blocks for the study of personality, social development, and adjustment.

The intercorrelations among facet scales comprising the factors are strong but not large enough to indicate redundancy. These higher order factors appear to represent robust and elementary components of temperament, but each facet within a factor is expected to also link to unique underpinnings and outcomes. In addition, traits may contribute to the particular manifestations of other higher order traits or facets, so that an individual who is high in general negativity may react to loss with anger if high in Surgency, whereas a person who is similar in negativity, but low in Surgency might react with sadness in the same situation. The factors are not perfectly orthogonal, and some higher order traits appear to be influenced by common underlying facets. For instance, shyness loads heavily (in different directions) on Surgency and Negative Affectivity, suggesting that it is shaped by individual differences in opposing approach and inhibition processes.

Of the three broad dimensions, Effortful Control has received particularly intense attention over recent decades (Eisenberg, Smith, & Spinrad, 2011). Research on Effortful Control illustrates the increasingly interdisciplinary nature of temperament study, which, in this case, integrates perspectives from developmental cognitive neuroscience. Rothbart, in collaboration with Michael Posner, has identified neural networks of executive attention that appear to underlie individual differences in infant attention, connecting attentional control to emotional and behavioral regulation and setting the stage for the study of Gene \times Environment interaction (see Rueda, Posner, & Rothbart, 2011). Increased consideration of regulatory mechanisms

reflects an enhanced appreciation for the developmental nature of temperament. Whereas initial theory emphasized early appearing traits and stability from infant behavior onward, it is now clear that neural systems underlying attention continue to develop into adulthood. These changes can, in turn, contribute to resilience, modifying the trajectories of more reactive traits (Shiner & Masten, 2012). Because later emerging control of attention and behavior can also moderate connections between reactivity and adjustment outcomes, these dimensions of temperament represent important new directions for basic research and advances in intervention and treatment of psychopathology.

McClowry: The Chess and Thomas Approach

In 1987, Stella Chess and Alexander Thomas were at the forefront of naturalistic studies of childhood temperament and the practical applications derived from them. They focused on variations in children's typical behavioral style that emerged early in infancy, and presumed that such differences have an endogenous biological basis (Thomas & Chess, 1977). In their well-known New York Longitudinal Study (NYLS), Chess and Thomas (1984) developed an influential list of nine temperament traits based on a content analysis of prior interviews with parents of infants. They asserted that many children fall into three types based on their combinations of traits: easy, difficult, and slow to warm. Chess and Thomas's work helped to convince researchers, practitioners, and parents that children vary biologically from one another from early in life and that these differences operate in transaction with the environment to influence social relationships and adjustment. Chess and Thomas's clinical wisdom continues to inspire practitioners and educators to develop, implement, and test the efficacy of temperament-based interventions.

Recent study has addressed Chess and Thomas's claims about both temperament traits and temperament types. Mounting evidence from a large number of psychometric studies indicates that, although Chess and Thomas's original nine dimensions highlight clinically important aspects of temperament (e.g., mood and activity), they are not empirically distinct (Pauw & Mervielde, 2010). In contrast, Chess and Thomas's typology (easy, difficult, and slow to warm) has received some empirical support through the application of more sophisticated statistical methodologies (e.g., person-centered analytic techniques; Lacourse et al., 2002). In this newer work, the types are labeled "resilient," "undercontrolled," and "overcontrolled" (Caspi & Shiner, 2006). Some researchers and practitioners have substituted other, more descriptive labels for the term "difficult child," such as "resistant to control" (Bates, Pettit, Dodge, & Ridge, 1998) or "high maintenance" (McClowry, 2002), recognizing that particular constellations of traits are not necessarily "difficult" for all parents (Paulussen-Hoogbeem, Stams, Hermanns, & Peetsma, 2007).

Theoretical advances in the field have expanded the concept of "goodness of fit," which is at the core of temperament-based intervention. Chess and Thomas (1984) defined goodness of fit as

the consonance between a child's temperament and the demands, expectations, and opportunities of the environment. The onus of intervention, as originally conceived by Chess and Thomas, was on advising parents and other caregivers to modify the environment to create a better fit with a child's particular temperament. From a pragmatic perspective, goodness of fit can be more complicated to enhance when children get older and engage in educational and community settings that lack flexibility to accommodate to temperament variations (McClowry, Rodriguez, & Koslowitz, 2008). Studies demonstrating that children's self-regulation is malleable (Kochanska & Aksan, 2006) offer alternative paths for providing goodness of fit. Rather than modifying the environment, an expanded goodness-of-fit approach applies temperament-based strategies to scaffold and stretch children's emotional, attentional, and behavioral repertoires. With practice, children and adults can implement such strategies when they experience temperamentally challenging situations.

Another advance since 1987 is the development of temperament-based interventions that have demonstrated efficacy in enhancing adaptation across the lifespan and in a variety of settings (McClowry et al., 2008). For example, after attending the Cool Little Kids Program, temperamentally inhibited preschool children who had a parent with an anxiety disorder showed a reduction in observed and parent-reported behavioral inhibition, relative to a comparable group of children placed on a wait list (Kennedy, Rapee, & Edwards, 2009). Another intervention, INSIGHTS into Children's Temperament, targeted urban primary-grade children and their parents and teachers. Compared to children in an attention control group, children in INSIGHTS showed a significant reduction in disruptive behaviors at home and at school (McClowry, Snow, Tamis-LeMonda, & Rodriguez, 2010). Temperament-based interventions continue to benefit from the Chess and Thomas approach. Current clinical applications also have benefited from interventions that, although not specifically labeled temperament based, have demonstrated that they enhance children's self-regulation (e.g., Duckworth & Allred, 2012).

Saudino: The Buss and Plomin Approach

Buss and Plomin's approach comprises three dimensions (emotionality, activity, and sociability) that are enduring across age and situation and, perhaps most important to their theory, are genetically influenced. A fourth dimension—impulsivity, referring to the low end of a trait comprising emotional and behavioral control, persistence, and planfulness—was dropped from their original theory because it did not appear to be genetically influenced. However, recent findings indicate that the components of impulsivity are heritable and thus meet Buss and Plomin's criteria for a temperament dimension (Buss, 1995; Gagne & Saudino, 2010).

Several important advancements stemming from behavioral genetics research have informed the study of temperament. In 1987, most behavioral genetics studies focused on simply

showing whether or not temperament dimensions were genetically influenced. This research was important because it addressed the issue of temperament's constitutional foundation, but it was theoretically limited. Recent methodological advancements have allowed the field to go beyond heritability estimates to address more interesting questions. For example, longitudinal quantitative genetic analyses explore genetic and environmental contributions to phenotypic continuity and change across age. These methods inform about developmental processes by assessing the extent to which genetic and environmental effects on a trait persist across age and whether new genetic and environmental influences emerge across time. Studies of early temperament typically find that stability is due to genetic factors and change is largely environmental; however, for some dimensions there is also evidence of genetic contributions to developmental change (Saudino & Wang, 2012).

Multivariate analyses exploring genetic and environmental sources of *covariance* between variables provide novel information about cross-situational and contextual effects, method effects, and links between temperament and developmental outcomes. Studies of the *same* temperament dimension assessed across *different* situations (e.g., shyness in the laboratory and in the home) find that genetic factors explain cross-situational consistency, but behavioral differences across situations are due to both genetic and environmental effects (Cherny et al., 2001). Similarly, temperament assessed via *different* methods within the *same* situation shows measure-specific genetic effects, signifying that different measures engage different temperamental processes (Saudino, 2009). Multivariate analyses can also address mechanisms linking temperament and developmental outcomes by assessing the extent to which associations between the two domains are due to common genetic and/or environmental factors. Although there are some exceptions, links between temperament and behavior problems are primarily a result of common genetic influences (Lemery-Chalfant, Doelger, & Goldsmith, 2008), suggesting that temperament may convey a genetic risk for maladaptive outcomes. Analyses of temperament dimensions as possible endophenotypes for clinical disorders may, therefore, be fruitful.

Inclusion of measured environments in behavioral genetics research makes it possible to elucidate environmental mechanisms relevant to temperament. For example, to some extent, the environments that children experience (e.g., parenting) reflect their genetically influenced temperaments, indicating genotype–environment correlations (Boivin et al., 2005). Exploration of genotype–environment interactions finds that parenting behaviors can moderate the heritability of temperament and, although shared or family-wide environmental influences on temperament are typically modest, they may have significant effects when the child experiences poor parenting (Krueger, South, Johnson, & Iacono, 2008).

Finally, advances in molecular genetic techniques make it possible to identify specific genes associated with temperament

and provide a first step in understanding *how* genes influence temperament. In recent years, there has been a flurry of molecular genetic studies of temperament-related behaviors (see Saudino & Wang, 2012). The results are mixed, with many failures to replicate, but genes linked to dopaminergic and serotonergic functions have been associated with temperament. Studies of genotype–environment interactions have identified specific genes that moderate environmental influences on temperament (e.g., Ivorra et al., 2010), indicating that the impact of specific environments on temperament can differ across genotypes.

Clearly, much has changed in the field’s understanding of the genetic and environmental influences on temperament since 1987, but the Buss and Plomin approach helped point researchers to this important aspect of temperament development.

Buss: The Goldsmith Approach

Deeply rooted in the functionalist perspective on emotion, Goldsmith’s approach, developed in collaboration with Joseph Campos, considers individual differences in propensities to experience and express emotional behavior to be a defining feature of temperament (Goldsmith et al., 1987; Goldsmith & Campos, 1982). Goldsmith focuses on temperament dimensions that correspond to discrete emotions (e.g., anger vs. fear) in contrast to those approaches that only consider emotionality as a single dimension; this approach has generated some important findings.

Goldsmith’s perspective has shaped the way individual differences in emotional behavior are conceptualized. The expression and regulation of the *primary* emotions have been robust predictors of a variety of socioemotional, clinical, and adjustment outcomes (Goldsmith, Lemery, & Essex, 2004). For example, extreme fearfulness has received a great deal of study as a risk factor for social anxiety (Buss, 2011). Goldsmith’s approach, as well as the affective dimensions of Rothbart’s model, falls within a larger body of research on affective style, a broader construct used to define any trait-level individual differences in affective phenomena (e.g., trait differences in EEG asymmetry; Davidson, 2000) and personality theories focused on emotions (e.g., positive and negative emotionality; Tellegen, 1985). Thus, it can be argued that, as Goldsmith points out in the 1987 article, the study of individual differences in emotions would exist “without the construct of temperament” (p. 516). However, emotion-based temperament perspectives differ in their focus on early appearance, biological mechanisms, and developmental processes accounting for stability and change in trajectories of these traits. In addition, it is common for emotion researchers to characterize these differences using several parameters (e.g., rise time, peak intensity, duration; Davidson, 2000; Rothbart & Derryberry, 1981). Thus, from this perspective, it is not temperament as broadly conceptualized (e.g., emotionality) that relates to outcomes (e.g., anxiety disorders); rather, specific facets of emotions (e.g., fear reactivity) account for these temperament–outcome relations.

One example of the contribution arising from the focus on emotion components of temperament is the surge in research examining links between individual differences in affective behavior and psychobiological reactivity. Study in this area has examined peripheral physiology, such as cardiac reactivity (Buss, Davidson, Kalin, & Goldsmith, 2004) and neuroendocrine measures, such as cortisol (Fortunato, Dribin, Granger, & Buss, 2008) and neural processes (Davidson & Rickman, 1999). The importance of this topic is highlighted in an SRCD monograph (Dennis et al., 2012) reviewing cutting-edge study on emotion and physiology.

KEY REMAINING QUESTIONS ON THE NATURE OF TEMPERAMENT

Although temperament researchers have made considerable progress since the publication of Goldsmith et al. (1987), some fundamental questions remain only partially answered. In the following section, we pose five questions on the nature of temperament for the next generation of temperament researchers.

How Is Temperament Structured?

Although temperament research has clarified the broad outlines of childhood traits, this study has been hampered by the use of competing models. Pauw, Mervielde, and Leeuwen (2009) examined the joint structure of preschoolers’ temperament traits across questionnaires from the Rothbart, Buss and Plomin, and Chess and Thomas models and found that, although the questionnaires converged on a general set of traits, each model added valuable, nonoverlapping information. Future measures could assess temperament traits more thoroughly by incorporating constructs from different models. Insights into temperament structure can also come from observational systems (Buckley, Klein, Durbin, Hayden, & Moerk, 2002) and laboratory tasks (Buss & Goldsmith, 2000), as well as person-centered analyses that complement variable-oriented techniques. In addition, future research should investigate whether traits become reorganized in different periods of life. Changes in the structure of traits may reflect changes in the underlying mechanisms and therefore may provide clues about biological and psychological processes underlying the traits.

What Is the Relation Between Temperament and Personality Traits?

In the 1987 article, almost all the theorists used existing knowledge about adult personality traits to guide their thinking about possible temperament traits. Yet, there remains confusion about how temperament and personality traits, such as the Big Five, are related. A common metaphor for thinking about personality development has been that young children display genetically influenced temperament traits and that life experiences “layer” personality traits onto the early biological temperament (a view akin to the definition of temperament offered by McCall). An

alternative possibility is that temperament traits in childhood and the Big Five traits in adulthood may be manifestations of the same basic dimensions (Clark & Watson, 2008; McCrae et al., 2000; Rothbart, 2011; Shiner & De Young, in press). From this point of view, personality traits are broader in content because biological maturation and expanding experiences permit the expression of new facets of the underlying traits. If this second possibility is correct, temperament research could be enhanced by measuring traits more broadly as children get older (Shiner & Caspi, 2012). For example, Effortful Control could expand to include tendencies toward orderliness, dependability, and achievement motivation. Other traits identified in personality trait research may be considered as possible temperament traits. Individual differences in children's empathy and kindness may reflect early temperament differences in the Big Five trait of Agreeableness (Knafo & Israel, 2012; Shiner & De Young, in press) or a similar trait labeled Affiliativeness by Rothbart (2011). Likewise, differences in children's curiosity, imagination, and sensory sensitivity—aspects of Openness to Experience—may reflect temperamental differences in a biological system promoting active exploration of the environment (Shiner & De Young, in press).

How Do Temperament Traits and Context Interact to Predict Behavior in Specific Situations?

Although temperament has been assumed to show consistency across situations, sometimes behaviors considered to reflect an underlying trait show limited cross-situational consistency (Buss, 2011). The classic approach to handling this problem is to average behavior across situations, but this solution could obscure meaningful differences if behavior across situations derives from different underlying traits. An alternative is to take the eliciting context into consideration. For example, by capitalizing on this approach, a pattern of observed fear across six episodes characterized by high fear in low-threat situations but typical fear levels in high-threat episodes (i.e., dysregulated fear), was shown to be a stronger predictor of anxiety than was behavioral inhibition averaged across varied situations (Buss, 2011). Thus, contextual information should help reveal elements or basic processes that may be considered in temperament domains we have yet to discover.

How Do Temperament and the Environment Interact to Shape Developmental Outcomes Over Time?

As noted, Chess and Thomas put forth the idea of “goodness of fit,” suggesting that the environment moderates the outcomes of children's early individual differences. Several replicable patterns of interactions between temperament and contextual factors have been identified as influencing whether temperament will remain stable or change and whether other adjustment outcomes will be negative or positive (Bates, Schermerhorn, & Petersen, 2012; Lengua & Wachs, 2012; Rothbart & Bates, 2006). For example, a toddler's level of fearfulness becomes either a regulatory advantage or disadvantage, depending on the context.

Fearful children develop internalized self-controls best with mothers who use gentle child disciplinary strategies, whereas fearless children develop best with mothers who are warm and responsive yet firmer (Kochanska & Aksan, 2006). A new line of study documents a different type of interaction—*differential susceptibility*—in which a trait, such as infant irritability, confers especially positive development in response to good environments and negative development in bad environments (Belsky & Pluess, 2009; van IJzendoorn & Bakermans-Kranenburg, 2012). Studies that examine specific genetic and environmental mechanisms of risk and resiliency will be useful in addressing questions about differential susceptibility and questions about temperament–environment interactions more generally. Future study will benefit from exploring the transactions between children and their contexts, explicating not only the ways that children are influenced by their contexts but also the ways that children shape their contexts (Bates et al., 2012; Lengua & Wachs, 2012). The role of culture in temperament development is another important topic for further investigation (Chen, Yang, & Fu, 2012).

How Are Changes in Temperament Related to Biological and Psychological Processes?

In the 1987 article, the theorists were particularly interested in the question of whether temperament shows continuity over time. We know now that at the behavioral level, children and adults do show rank-order continuity over time, but significant change occurs as well (Roberts & DelVecchio, 2000). Although researchers remain interested in temperamental continuity, they are now eager to understand the specific biological and psychological processes underlying temperamental discontinuity. Intervention programs have been designed to modify children's typical patterns of behavior, including their self-regulation abilities, emotional competence, and coping skills (Blair & Diamond, 2008; Duckworth & Allred, 2012; McClowry & Collins, 2012). If more basic research can identify the processes underlying temperament discontinuity, these processes can be harnessed to support the development of resilient outcomes for children at risk by virtue of their temperaments or their environments. Temperament instruments could potentially be used as screening tools to identify children at risk for negative outcomes and as follow-up measures to assess progress. Parents, teachers, clinicians, and policy makers have much to gain by understanding the processes leading to temperament change.

CONCLUSION

The 1987 article by Goldsmith et al. helped galvanize the field of temperament and established key questions for this area of research. Looking back on this article, its prescience in outlining the issues that would be central to the field of temperament for the next 25 years is remarkable. Although little was known then about the long-term outcomes of temperament traits, there

are now well-documented connections between temperament and a wide variety of critical life outcomes—relationships, academic achievement, health, and psychopathology (Zentner & Shiner, 2012). Temperament clearly has an impact on the course of individuals' lives. The next 25 years of temperament research undoubtedly will continue to pursue sophisticated answers to questions about the nature of temperament; we hope that this basic research increasingly will be applied to improve the quality of children's lives.

REFERENCES

- Bates, J. E., Pettit, G. S., Dodge, K. A., & Ridge, B. (1998). The interaction of temperamental resistance to control and parental discipline in the prediction of children's externalizing problems. *Developmental Psychology, 34*, 982–995.
- Bates, J. E., Schermerhorn, A. C., & Petersen, I. T. (2012). Temperament and parenting in developmental perspective. In M. Zentner & R. L. Shiner (Eds.), *Handbook of temperament* (pp. 425–441). New York: Guilford.
- Belsky, J., & Pluess, M. (2009). The nature (and nurture?) of plasticity in early human development. *Perspectives in Psychological Science, 4*, 345–351.
- Blair, C., & Diamond, A. (2008). Biological processes in prevention and intervention: The promotion of self-regulation as a means of preventing school failure. *Development and Psychopathology, 20*, 899–911.
- Boivin, M., Pélusé, D., Dionne, G., Sayssset, V., Zoccolillo, M., Tarabulsky, G. M., et al. (2005). The genetic–environmental etiology of parents' perceptions and self-assessed behaviors toward their 5-month-old infants in a large twin and singleton sample. *Journal of Child Psychology and Psychiatry, 46*, 612–630.
- Buckley, M. E., Klein, D. N., Durbin, E., Hayden, E. P., & Moerk, K. C. (2002). Development and validation of a Q-sort procedure to assess temperament and behavior in preschool-age children. *Journal of Clinical Child and Adolescent Psychology, 31*, 525–539.
- Buss, A. H. (1995). *Personality: Temperament, social behavior, and the self*. Boston: Allyn & Bacon.
- Buss, K. A. (2011). Which fearful toddlers should we worry about? Context, fear regulation and anxiety risk. *Developmental Psychology, 47*, 804–819. doi:10.1037/a0023227
- Buss, K. A., Davidson, R. J., Kalin, N. H., & Goldsmith, H. H. (2004). Context specific freezing and associated physiological reactivity as a dysregulated fear response. *Developmental Psychology, 40*, 583–594.
- Buss, K. A., & Goldsmith, H. H. (2000). *Manual and normative data for the Laboratory Temperament Assessment Battery–Toddler Version*. (Technical report). University of Wisconsin-Madison.
- Caspi, A., & Shiner, R. L. (2006). Personality development. In W. Damon & R. Lerner (Series Eds.), & N. Eisenberg (Vol. Ed.), *Handbook of child psychology: Vol. 3. Social, emotional, and personality development* (6th ed., pp. 300–365). New York: Wiley.
- Champagne, F. A., & Mashoodh, R. (2009). Genes in context. *Current Directions in Psychological Science, 18*(3), 127–131.
- Chen, X., Yang, F., & Fu, R. (2012). Culture and temperament. In M. Zentner & R. L. Shiner (Eds.), *Handbook of temperament* (pp. 462–478). New York: Guilford.
- Cherny, S. S., Saudino, K. J., Fulker, D. W., Plomin, R., Corley, R. P., & DeFries, J. C. (2001). The development of observed shyness from 14 to 20 months: Shyness in context. In R. N. Emde & J. K. Hewitt (Eds.), *Infancy to early childhood: Genetic and environmental influences on developmental change* (pp. 269–282). New York: Oxford University Press.
- Chess, S., & Thomas, A. (1984). *Origins and evolution of behavior disorders*. New York: Bruner/Mazel.
- Clark, L. A., & Watson, D. (2008). Temperament: An organizing paradigm for trait psychology. In O. P. John, R. W. Robins, & L. A. Pervin (Eds.), *Handbook of personality: Theory and research* (pp. 265–286). New York: Guilford.
- Davidson, R. J. (2000). Affective style, psychopathology, and resilience: Brain mechanisms and plasticity. *American Psychologist, 55*, 1196–1214.
- Davidson, R. J., & Rickman, M. (1999). Behavioral inhibition and the emotional circuitry of the brain: Stability and plasticity during the early childhood years. In L. A. Schmidt & J. Schulkin (Eds.), *Extreme fear, shyness, and social phobia: Origins, biological mechanisms, and clinical outcomes* (pp. 67–87). New York: Oxford University Press.
- Dennis, T. A., Buss, K. A., & Hastings, P. D. (Eds.). (2012). Physiological measures of emotion from a developmental perspective: State of the science. *Monographs of the Society for Research in Child Development, 77*(2).
- Derryberry, D., & Tucker, D. E. (2006). Motivation, self-regulation, and self-organization. In D. Cicchetti & D. J. Cohen (Eds.), *Developmental psychopathology: Vol. 2. Developmental neuroscience* (2nd ed., pp. 502–532). New York: Wiley.
- Duckworth, A., & Allred, K. A. (2012). Temperament in the classroom. In M. Zentner & R. L. Shiner (Eds.), *Handbook of temperament* (pp. 627–644). New York: Guilford.
- Eisenberg, N., Smith, C. L., & Spinrad, T. L. (2011). Effortful control: Relations with emotion regulation, adjustment, and socialization in childhood. In K. D. Vohs & R. F. Baumeister (Eds.), *Handbook of self-regulation: Research, theory, and applications* (2nd ed., pp. 263–283). New York: Guilford.
- Forgas, J. P. (2008). Affect and cognition. *Perspectives on Psychological Science, 3*(2), 94–101.
- Fortunato, C. K., Dribin, A. E., Granger, D. A., & Buss, K. A. (2008). Salivary alpha-amylase and cortisol in toddlers: Differential relations to affective behaviors. *Developmental Psychobiology, 50*, 807–818.
- Gagne, J. R., & Saudino, K. J. (2010). Wait for it! A twin study of inhibitory control in early childhood. *Behavior Genetics, 40*, 327–337.
- Goldsmith, H. H., Buss, A. H., Plomin, R., Rothbart, M. K., Thomas, A., Chess, S., et al. (1987). Roundtable: What is temperament? Four approaches. *Child Development, 58*, 505–529.
- Goldsmith, H. H., & Campos, J. J. (1982). Toward a theory of infant temperament. In R. N. Emde & R. J. Harmon (Eds.), *The development of attachment and affiliative systems* (pp. 161–193). New York: Plenum.
- Goldsmith, H. H., Lemery, K. S., & Essex, M. J. (2004). Temperament as a liability factor for childhood behavioral disorders: The concept of liability. In L. F. DiLalla (Ed.), *Behavior genetics principles: Perspectives in development, personality, and psychopathology* (pp. 19–39). Washington, DC: American Psychological Association.
- Goldsmith, H. H., & Rothbart, M. K. (1991). Contemporary instruments for assessing early temperament by questionnaire and in the laboratory. In A. Angleitner & J. Strelau (Eds.), *Explorations in*

- temperament: *International perspectives on theory and measurement* (pp. 249–272). New York: Plenum.
- Halverson, C. F., Kohnstamm, G. A., & Martin, R. P. (1994). *The developing structure of temperament and personality from infancy to adulthood*. Hillsdale, NJ: Erlbaum.
- Huizink, A. (2012). Prenatal influences on temperament. In M. Zentner & R. L. Shiner (Eds.), *Handbook of temperament* (pp. 297–314). New York: Guilford.
- Ivorra, J. L., Sanjuan, J., Jover, M., Carot, J. M., Frutos, R., & Molto, M. D. (2010). Gene–environment interaction of child temperament. *Journal of Developmental and Behavioral Pediatrics*, 31, 545–554.
- Kennedy, S., Rapee, R., & Edwards, S. (2009). A selective intervention program for inhibited preschool-aged children of parents with an anxiety disorder: Effects on current anxiety disorders and temperament. *Journal of the American Academy of Child and Adolescent Psychiatry*, 48, 602–609.
- Knafo, A., & Israel, S. (2012). Kindness: A neglected temperamental dimension of empathy and prosociality. In M. Zentner & R. L. Shiner (Eds.), *Handbook of temperament* (pp. 168–179). New York: Guilford.
- Kochanska, G., & Aksan, N. (2006). Children's conscience and self-regulation. *Journal of Personality*, 74, 1587–1617.
- Krueger, R. F., South, S., Johnson, W., & Iacono, W. (2008). The heritability of personality is not always 50%: Gene–environment interactions and correlations between personality and parenting. *Journal of Personality*, 76, 1485–1522.
- Lacourse, E., Cote, S., Nagin, D. S., Vitaro, F., Brendgen, M., & Tremblay, R. E. (2002). A longitudinal-experimental approach to testing theories of antisocial behavior development. *Development and Psychopathology*, 14, 909–924.
- Laucht, M., Becker, K., & Schmidt, M. H. (2006). Visual exploratory behavior in infancy and novelty seeking in adolescence: Two developmentally specific phenotypes of DRD4? *Journal of Child Psychology and Psychiatry*, 47, 1143–1151.
- Lemery-Chalfant, K., Doelger, L., & Goldsmith, H. H. (2008). Genetic relations between effortful and attentional control and symptoms of psychopathology in middle childhood. *Infant and Child Development*, 17, 365–385.
- Lengua, L. J., & Wachs, T. D. (2012). Temperament and risk: Resilient and vulnerable responses to adversity. In M. Zentner & R. L. Shiner (Eds.), *Handbook of temperament* (pp. 519–540). New York: Guilford.
- McClowry, S. G. (2002). The temperament profiles of school-age children. *Journal of Pediatric Nursing*, 17, 3–10.
- McClowry, S., & Collins, A. (2012). Temperament-based intervention: Reconceptualized from a response to intervention framework. In M. Zentner & R. L. Shiner (Eds.), *Handbook of temperament* (pp. 607–626). New York: Guilford.
- McClowry, S. G., Rodriguez, E. T., & Koslowitz, R. (2008). Temperament-based intervention: Re-examining goodness of fit. *European Journal of Developmental Science*, 2, 120–135.
- McClowry, S. G., Snow, D. L., Tamis-LeMonda, C. S., & Rodriguez, E. T. (2010). Testing the efficacy of *INSIGHTS* on student disruptive behavior, classroom management, and student competence in inner city primary grades. *School Mental Health*, 2, 23–35.
- McCrae, R. R., Costa, P. T., Jr., Ostendorf, F., Angleitner, A., Hrebickova, M., Avia, M. D., et al. (2000). Nature over nurture: Temperament, personality, and life span development. *Journal of Personality and Social Psychology*, 78, 173–186.
- Paulussen-Hoogbeem, M. C., Stams, G. J. J. M., Hermanns, J. M. A., & Peetsma, T. T. D. (2007). Child negative emotionality and parenting from infancy to preschool: A meta-analytic review. *Developmental Psychology*, 43, 438–453.
- De Pauw, S. S. W., & Mervielde, I. (2010). Temperament, personality and developmental psychopathology: A review based on the conceptual dimensions underlying childhood traits. *Child Psychiatry and Human Development*, 41, 313–329.
- De Pauw, S. S. W., Mervielde, I., & Van Leeuwen, K. G. (2009). How are traits related to problem behavior in preschool children? Similarities and contrasts between temperament and personality. *Journal of Abnormal Child Psychology*, 37, 309–325.
- Posner, M. I., & Rothbart, M. K. (2007). *Educating the human brain*. Washington, DC: American Psychological Association.
- Putnam, S. P., Ellis, L. K., & Rothbart, M. K. (2001). The structure of temperament from infancy through adolescence. In A. Elias & A. Angleitner (Eds.), *Advances/proceedings in research on temperament* (pp. 165–182). Germany: Pabst Scientist Publisher.
- Roberts, B. W., & DelVecchio, W. F. (2000). The rank-order consistency of personality traits from childhood to old age: A quantitative review of longitudinal studies. *Psychological Bulletin*, 126, 25–30.
- Rothbart, M. K. (2011). *Becoming who we are: Temperament and personality in development*. New York: Guilford.
- Rothbart, M. K., & Bates, J. E. (2006). Temperament. In W. Damon & R. Lerner (Series Eds.) & N. Eisenberg (Vol. Ed.), *Handbook of child psychology, Vol. 3. Social, emotional, and personality development* (6th ed., pp. 99–166). New York: Wiley.
- 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.
- Rueda, M. R., Posner, M. I., & Rothbart, M. K. (2011). Attentional control and self-regulation. In K. D. Vohs & R. R. Baumeister (Eds.), *Handbook of self-regulation: Research, theory and applications* (2nd ed., pp. 284–299). New York: Guilford.
- Saudino, K. J. (2009). Do different measures tap the same genetic influences? A multi-method study of activity level in young twins. *Developmental Science*, 12, 626–633.
- Saudino, K. J., & Wang, M. (2012). Quantitative and molecular genetic studies of temperament. In M. Zentner & R. L. Shiner (Eds.), *Handbook of temperament* (pp. 315–346). New York: Guilford.
- Schwartz, C., Kunwar, P. S., Greve, D. N., Kahan, J., Snidman, N. C., & Bloch, R. B. (2011). A phenotype of early infancy predicts reactivity of the amygdala in male adults. *Molecular Psychiatry*. Advance online publication doi:10.1038/mp.2011.96
- Shiner, R. L., & Caspi, A. (2012). Temperament and the development of personality traits, adaptations, and narratives. In M. Zentner & R. L. Shiner (Eds.), *Handbook of temperament* (pp. 497–516). New York: Guilford.
- Shiner, R. L., & Masten, A. S. (2012). Childhood personality as a harbinger of competence and resilience in adulthood. *Development and Psychopathology*, 24, 507–528.
- Shiner, R. L., & De Young, C. G. (in press). The structure of temperament and personality traits: A developmental perspective. In P. Zelazo (Ed.), *Oxford handbook of developmental psychology*. New York: Oxford University Press.
- Tellegen, A. (1985). Structures of mood and personality and their relevance to assessing anxiety, with an emphasis on self-report. In A. H. Tuma & J. D. Maser (Eds.), *Anxiety and the anxiety disorders* (pp. 681–706). Hillsdale, NJ: Erlbaum.

- Thomas, A., & Chess, S. (1977). *Temperament and development*. New York: New York University Press.
- van IJzendoorn, M. H., & Bakermans-Kranenburg, M. J. (2012). Integrating temperament and attachment: The differential susceptibility paradigm. In M. Zentner & R. L. Shiner (Eds.), *Handbook of temperament* (pp. 403–424). New York: Guilford.
- Zentner, M., & Bates, J. E. (2008). Child temperament: An integrative review of concepts, research programs, and measures. *European Journal of Developmental Science*, 2, 7–37.
- Zentner, M., & Shiner, R. L. (Eds.). (2012). *Handbook of temperament*. New York: Guilford.