



## Temperament Development, Theories of

Xiaoxue Fu and Koraly Pérez-Edgar, The Pennsylvania State University, University Park, PA, USA

© 2015 Elsevier Ltd. All rights reserved.

### Abstract

Temperament is defined as biologically rooted, early appearing dispositions that shape long-term patterns of socioemotional development. Much of the research has focused on broad dimensions of emotional reactivity, including positive and negative emotionality, and regulation, marked by effortful control. The article outlines five main research traditions that have approached temperament as both a continuous and a categorical construct. For each model, descriptions are provided for the dimensions/category proposed and their defining features, the underlying constitutional bases, and perspectives on temperamental continuity and discontinuity. Next, theoretical and measurement issues are discussed. Finally, we demonstrate how temperament may predict developmental psychopathology through temperament-by-temperament and temperament-by-environment moderations of early risk.

### Introduction

Temperaments reflect biologically based individual differences in how children interact with, and adapt to, their environments across development, leading to marked interpersonal variations in both normative behavior and psychopathological profiles. The landmark round table discussion on temperament at the 1985 meeting of the Society for Research in Child Development (Goldsmith et al., 1987) presented four core models of temperament. The models each focused on early emerging, constitutionally based, multidimensional constructs, emphasizing the stability of temperament as a motivator of behavior, while recognizing that the expression of temperament may change across time (Rothbart and Derryberry, 1981) and contexts (Goldsmith and Campos, 1982). No consensus was reached regarding the conceptual 'boundaries' of temperament. For example, Thomas and Chess (1977) confined temperament to observable behavioral styles. Goldsmith and Campos (1982) defined temperament during infancy as the presence of primary emotions. Finally, Rothbart and Derryberry (1981) included cognitive processes as core components of temperament.

Despite these discrepancies, each model pursues a dimensional approach to temperament, quantifying temperamental variations along a continuous spectrum. In contrast, Kagan (Kagan et al., 1984) takes a typological approach to temperament. He and colleagues identified a temperament category, behavioral inhibition (BI), characterized by hypervigilant and withdrawal behavior in response to unfamiliar people and situations in toddlerhood and childhood. Together, the five models have provided multidisciplinary (and complementary) assessment tools and theoretical frameworks for studying temperament and its development. These include parent- and self-report questionnaires, laboratory observations of behavior, psychophysiological measures, and behavioral genetic approaches.

Contemporary temperament research focuses on studying how intrinsic (neural and cognitive processes) and extrinsic (environmental) processes interact to moderate the continuity of temperament and influence the link between early temperament and subsequent socioemotional adjustment. This article will discuss (1) the five major approaches to temperament

(Table 1); (2) current theoretical and methodological issues in research on temperament development; and (3) the mechanisms by which documented relations between temperament traits and maladjustment are moderated by other temperament traits (temperament  $\times$  temperament moderation) and environmental factors (temperament  $\times$  environment moderation). We take the perspective that early temperament does not determine developmental outcomes. Rather, temperament traits interact with internal and external factors to influence individuals' risks and resilience to events and contexts that shape developmental trajectories.

### Theoretical Approaches to Temperament

#### The Thomas and Chess Approach

The New York Longitudinal Study stands as a landmark in temperament research. Thomas and Chess (1977) focused on behavioral styles characterized across nine dimensions: activity level, regularity, approach withdrawal, adaptability, threshold of responsiveness, intensity of reaction, quality of mood, attention span/persistence, and distractibility. Children are categorized into 'difficult,' 'easy,' and 'slow to warm' types based on their scores on each dimension. Moreover, Chess and Thomas introduced the concept of 'goodness of fit,' suggesting that optimal developmental outcomes are more likely to emerge when the child's temperament is closely matched to the demands, expectations, and opportunities of the environment (a good fit). Conversely, a mismatch between temperament and environmental characteristics is more likely to result in maladaptive outcomes (Thomas and Chess, 1977).

#### The Buss and Plomin Approach

Buss and Plomin (1975) proposed a behavior-genetics-oriented model, proposing that temperament traits have an early onset and are inherited, evolutionary adaptive, present in nonhuman animals, relatively stable during development and predictive of later behaviors. They identified three core dimensions: emotionality (E), activity (A), and sociability (S), each captured by the EAS Temperament Survey (Buss and Plomin, 1984). The approach utilized twin studies to

**Table 1** Summaries of the five theoretical approaches to temperament

	<i>Defining features</i>	<i>Dimension(s)/Type(s)</i>	<i>Underlying biological mechanisms</i>	<i>Major instrument(s)</i>	<i>Key reading(s)</i>
Thomas and Chess	<ul style="list-style-type: none"> <li>● Represent stylistic components of behavior</li> </ul>	Dimensions: <ul style="list-style-type: none"> <li>● Activity level</li> <li>● Regularity</li> <li>● Approach withdrawal</li> <li>● Adaptability</li> <li>● Threshold of responsiveness</li> <li>● Intensity of reaction</li> <li>● Quality of mood</li> <li>● Attention span/persistence</li> <li>● Distractibility</li> </ul> Types: <ul style="list-style-type: none"> <li>● Difficult</li> <li>● Easy</li> <li>● Slow to warm up</li> </ul>	Not discussed	1–3 years old: The Toddler Temperament Scale (TTS; Fullard et al., 1984); 3–7 years old: The Behavioral Style Questionnaire (BSQ, McDevitt and Carey, 1978); 8–12 years old: The Middle Childhood Temperament Questionnaire (MCTQ, Hegvik et al., 1982).	Thomas and Chess (1977)
Buss and Plomin	<ul style="list-style-type: none"> <li>● Inherited traits</li> <li>● Evolutionary adaptive</li> <li>● Present in our phylogenetically related species</li> <li>● Early emerging and relatively stable in childhood</li> <li>● Preserved in adulthood</li> </ul>	Dimensions: <ul style="list-style-type: none"> <li>● Emotionality</li> <li>● Activity</li> <li>● Sociability</li> <li>● Impulsivity (dropped)</li> </ul>	Temperament dimensions have genetic bases.	EAS Temperament Survey (EAS, Buss and Plomin, 1984)	Buss and Plomin (1975) Buss and Plomin, (1984)
Goldsmith	<ul style="list-style-type: none"> <li>● An emotional phenomenon;</li> <li>● Related to individual differences;</li> <li>● Behavioral tendencies rather than actual observable emotional behavior;</li> <li>● Does not contain cognitive and perceptual components;</li> <li>● Has cross-situational generality and short-term stability rather than being transitory.</li> </ul>	Assessed in Lab-TAB: <ul style="list-style-type: none"> <li>● Activity level</li> <li>● Positive affect</li> <li>● Fear</li> <li>● Anger</li> <li>● Sadness</li> <li>● Shyness</li> <li>● Approach</li> <li>● Persistence</li> <li>● Inhibitory control</li> </ul>	Temperament dimensions are genetically influenced	Toddler Behavior Assessment Questionnaire (TBAQ, Goldsmith, 1996); Laboratory Temperament Assessment Battery (Lab-TAB, Goldsmith and Rothbart, 1993)	Goldsmith and Campos (1982, 1986);
Rothbart	<ul style="list-style-type: none"> <li>● Biologically based</li> <li>● Contains reactive and regulatory aspects</li> </ul>	Dimensions: <ul style="list-style-type: none"> <li>● Negative affect</li> <li>● Surgency</li> <li>● Effortful control</li> </ul>	The attention network: Encompasses the anterior cingulate cortex and the lateral prefrontal regions	3–12 months: The Infant Behavior Questionnaire (IBQ, Rothbart, 1981); 18–36 months: The Early Childhood Behavior Questionnaire (ECBQ, Putnam et al., 2006); 3–7 years: The Children's Behavior Questionnaire (CBQ, Rothbart et al., 2001); 7–10 years: The Temperament in Middle Children Questionnaire (TMCQ, Simonds and Rothbart, 2004); 9–15 years: The Early Adolescent Temperament Questionnaire (EATQ, Capaldi and Rothbart, 1992)	Rothbart and Derryberry (1981) Rothbart and Bates (2007)
Kagan	<ul style="list-style-type: none"> <li>● Biologically based and early emerging</li> <li>● Defined a specific temperament category characterizes children who show elevated physiological reactivity, hypervigilance and withdrawal upon encountering novel stimuli (behavioral inhibition)</li> </ul>	Type: Behavioral inhibition	Hyperresponsive amygdala	Not developed	Kagan (1994); Kagan and Fox (2007)

quantify genetic contributions to individual variance in temperament traits (Buss and Plomin, 1984). Monozygotic (MZ) twin pairs showed significantly larger correlations in all three EAS traits versus dizygotic (DZ) twins. Given that MZ twins have twofold more genetic similarity than DZ twins, the greater phenotypic similarity in MZ twins indicates genetic influences on trait variance (Saudino, 2009).

### The Goldsmith Approach

Goldsmith and Campos (1982) defined temperament as individual differences in the propensity to express and experience primary emotions (e.g., joy, anger, and fear). Individual differences in temperament are reflected in variations in intensive and temporal parameters of behavior, including facial expressions, gestures, vocal and motor behaviors. The definition is restricted to infant temperament, in order to obtain a relatively 'pure' conceptualization of temperament expressions unmediated by socialization influences and cognitive processes. However, recent variants of the model include emotion regulation as a defining feature, as emotion expression and regulation might not be separable, even in infancy (Campos et al., 2004).

Goldsmith and colleagues developed the Toddler Behavior Assessment Questionnaire (Goldsmith, 1996), and the age-adapted Laboratory Temperament Assessment Battery (Lab-TAB; Goldsmith and Rothbart, 1993; Table 1). The Lab-TAB provides a series of standardized behavioral tasks and coding schemes that assess temperament dimensions in emotion-eliciting episodes in the laboratory or at home. It stresses that the context of behavior needs to be considered in measuring temperament, since the eliciting situations affect the expression of temperament dimensions (Goldsmith and Gagne, 2012).

Building on their initial conceptualization, Goldsmith and colleagues focused on the psychobiological processes underlying emotion reactivity and regulation. For example, Buss et al. (2004) combined both Lab-TAB and physiological measurements and found that heightened fearfulness in a mildly threatening situation was associated with heightened baseline sympathetic reactivity a week later. This implies a possible association between fearful temperament and reduced physiological regulation.

### The Rothbart Approach

The Rothbart model (Rothbart and Derryberry, 1981) provides a more inclusive conceptualization, defining temperament as biologically rooted individual differences in reactivity and self-regulation in emotional, activation, and attentional processes. Reactivity refers to levels of biological arousal triggered by changes in internal and external stimulations, captured as dimensions of negative affect and surgency. Self-regulation refers to the processes that modulate reactivity (Rothbart and Derryberry, 1981) and is reflected in the temperament dimension, effortful control (EC). Taking a dimensional approach, each of the three higher-order dimensions is comprised of lower-order temperament traits (Rothbart and Bates, 2007).

Questionnaires from this approach assume heterotypic continuity in temperament development (Caspi, 1998). That

is, age-appropriate questions or eliciting tasks take different forms of expression but are thought to evoke the same underlying bases throughout development (Fox and Henderson, 1999). As presented in Rothbart and colleagues' age-specific questionnaires, the broad dimensions remain stable, but the specific traits indexing each dimension changes across age groups. For example, EC during early infancy is measured as a form of involuntary attention orienting. As external controls become internalized, indices of EC come to also encompass attention shifting and focusing (Rueda, 2012).

The Rothbart model is unique in prominently placing self-regulation as a core component of temperament. EC has been studied with multiple-levels of analyses, including the aforementioned parent- and self-report questionnaires, as well as computerized cognitive tasks and laboratory observation tasks. Findings from computerized tasks demonstrate that EC capacities, including error detection and conflict resolution, first emerge at the end of first year of life and continue to improve during late childhood and into adolescence (Rothbart et al., 2007; Rueda, 2012). Neuroimaging research adopting these marker tasks suggests that the development of EC is subserved by the executive attention network, a neural system centered on the prefrontal cortex (Posner et al., 2014).

As EC develops during toddlerhood, it exerts 'brakes' on unregulated negative emotionality and motor activities (Rothbart and Derryberry, 2002), and enhances children's abilities to adapt to environmental demands. Longitudinal data indicate that higher EC predicts less negative emotional arousal. Conversely, elevated negative emotionality predicts lower EC efficiency (Eisenberg et al., 2010). At the neural level, efficiency in regulating reactivity is subserved by the coupling between regions associated with regulation (e.g., the prefrontal regions) and reactivity (e.g., the amygdala and the striatum; Dennis, 2010). The continued dynamic and reciprocal interactions between temperamental reactivity and regulation contribute to the observed instability of temperament expression over time (Rothbart and Bates, 2007).

### The Kagan Approach

Distinct from dimensional approaches to temperament, Kagan and colleagues defined BI as a temperamental *category* characterized by discrete biological dispositions: high psychophysiological reactivity coupled with hypervigilance and behavioral withdrawal upon encountering novel people, objects, and events (Kagan et al., 1984). Kagan's approach emphasizes the use of behavioral observations and biological measures instead of parent-report questionnaires (Kagan, 2003). Based on laboratory observations, 4-month-old infants who displayed elevated motor reactivity and distress toward novel visual and auditory stimuli were categorized as 'high reactive' (Kagan and Snidman, 1991) or 'high negative' (Fox et al., 2001). BI in young children (14–48 months) is examined by coding their behavior toward unfamiliar people and objects. Assessment in older children (4 years to school age) focuses on their interactions with unfamiliar peers. Hence, Kagan's approach also focuses on heterotypic continuity of temperament development over time (Fox et al., 2001). Kagan and colleagues found that although not all high-reactive infants become behaviorally inhibited in childhood, the percentage of high-reactive infants

who are later categorized with BI was greater than those who were identified as uninhibited (Kagan, 2003). Fox et al. (2001) showed that at 14 months, infants who were classified as 'high negative' displayed higher levels of BI than those who were identified as 'low reactive' or 'high positive.'

Kagan proposed that the neurobiological foundation of BI is rooted in a highly excitable amygdala, which predisposes children to become hypervigilant toward unfamiliar stimuli (Kagan, 2012), and contributes to the moderate stability of BI (Fox et al., 2005). Adults who were identified as 'high reactive' at 4 months showed greater amygdala responses when presented with neutral unfamiliar faces compared to those who had been 'low reactive' (Schwartz et al., 2003, 2011). Moreover, Pérez-Edgar et al. (2007) found that, compared to non-inhibited adolescents, adolescents with sustained BI in childhood showed elevated amygdala response while rating how afraid they were of emotional and neutral faces. The amygdala has extensive connections to cortical areas that contribute to behavioral avoidance and deficient safety learning observed in behaviorally inhibited individuals (Schwartz et al., 2011).

Stable BI across childhood is a risk factor for anxiety disorders, especially social anxiety disorder (SAD, Pérez-Edgar and Fox, 2005a). BI and anxiety disorders have a range of overlapping behavioral, cognitive, and neurological features. Retrospective evidence suggests that adolescents and adults with anxiety symptoms also reported higher levels of social withdrawal in childhood (Degnan et al., 2010). Additionally, Clauss and Blackford's (2012) meta-analysis showed that the risk for SAD increases sevenfold for behaviorally inhibited children. However, only 43% of behaviorally inhibited children developed SAD. The central tenet of the Kagan's approach argues that early BI does not necessarily predict stability of temperament and later anxiety disorders. Rather, it constrains possible socioemotional development outcomes (Kagan and Fox, 2007).

### Current Methodologies and Issues in Temperament Research

Contemporary temperament research has shifted its focus from debating the defining features and structure of temperament (Goldsmith et al., 1987) to studying developmental trajectories from early temperament to subsequent socioemotional adjustment outcomes. Summarizing the shared viewpoints and new perspectives on temperament since the round table discussion, Shiner et al. (2012) define temperament as early appearing traits in the domains of motor activity, emotion, attention, and self-regulation. They stress that temperament is the product of the continuous influences of genetic, biological, and environmental processes throughout development.

First, traits may have different developmental courses, and those that come online later during infancy and childhood (e.g., regulatory traits) may affect the expression of existing traits' (e.g., temperamental reactivity; Rothbart and Derryberry, 1981). Second, assessments of temperament, including the questionnaires developed under the Rothbart approach (Rueda, 2012) and laboratory observation tasks (Lab-TAB, Goldsmith and Rothbart, 1993; BI tasks, Fox et al., 2001),

reflect a priori conceptualization of heterotypic continuity in temperament development (Caspi, 1998). Third, although temperament traits are biologically based, behavioral genetic research has found only moderate genetic influences. Rather, both genetic and environmental factors, especially nonshared environmental influences, contribute to the stability and change of temperament over time (Saudino and Wang, 2012).

There is an on-going debate regarding whether specific temperament traits are best captured as variations along a continuum or qualitative differences across distinct categories. Support for the typological approach has come from sophisticated modeling analyses (Loken, 2004), which replicated Kagan and Snidman (1991)'s categorization of high-reactive infants. Moreover, BI profile is associated with distinct profiles of neural reactivity evident in limbic (Pérez-Edgar et al., 2007; Schwartz et al., 2003, 2011) and striatal (Helfinstein et al., 2012) responses to salient stimuli. However, this association was not found when BI was treated as a continuous variable (Pérez-Edgar et al., 2013). Yet, longitudinal studies using discrete BI profiles (e.g., Chronis-Tuscano et al., 2009) and those adopting continuous measures of BI (e.g., Muris et al., 2001) have provided converging results, both suggesting that BI predicts greater risks for SADs. Hence, both categorical and dimensional conceptualizations could potentially provide useful frameworks to study the link between early temperament and later psychopathology (Clauss and Blackford, 2012).

### Cultural Influences on Temperament

The influences of cultural values on temperament development are nonnegligible. Culture creates a bioecological environment (Bronfenbrenner and Morris, 2006) that encompasses children's physical and social environment. Parents' cultural belief system influences how they perceive, evaluate, and respond to their children's temperament, which, in turn, shape children's temperament development and adjustment (Super and Harkness, 2002). In studying the impacts of immigration and involvement in the host culture (i.e., acculturation) on parental perception of infant temperament, Gartstein et al. (2009) found that among Russian families who immigrated to the United States, greater adherence to Russian culture was correlated with higher ratings of child positive emotionality. In contrast, for immigrants to Israel, greater parental involvement in Russian culture was linked to lower child positive emotionality. Moreover, Russian parents with greater acculturation to Israeli society rated their children higher on orienting and focusing of attention.

Cultural norms may shift parental perception of what traits are adaptive, which, in turn, affect parental practice, how the child's temperament is manifested, and the parent's perception of their child's temperament (Gartstein et al., 2009). For example, BI is associated with greater maternal warmth and acceptance in Chinese children, whereas Canadian children with BI experience more maternal rejection (Chen et al., 1998). Furthermore, early BI predicted subsequent social and academic competence among Chinese children (Chen et al., 1999, 2009a). Greater social acceptance of BI in China, in contrast to findings from the West, may facilitate adaptive socioemotional development. However, Chen et al. (2009b)



also found increased maladjustment in inhibited Chinese children from urban areas, likely due to rapid Westernization. Taken together, the cross-cultural studies support the presence of cultural difference in temperamental reactivity and regulation and associated developmental outcomes.

### Issues Relating to Measurement Approaches

Temperament assessments target naturally occurring behaviors reported by caregivers, behaviors elicited by laboratory controlled tasks, and neurophysiological correlates of these behaviors (Goldsmith and Gagne, 2012; Rothbart and Bates, 2007). Across approaches, temperament research stresses the adoption of a multimethod perspective (Kagan and Fox, 2007). Multiple measurement approaches complement each other to overcome limitations of a specific method, and together they provide insights into unique aspects of temperament. Caregiver reports have been criticized for being biased, unreliable, invalid, and limited in revealing the underlying mechanisms of overt traits (Kagan and Fox, 2007). However, Rothbart and Bates (2007) argue that parent reports provide unique information on children's general behavioral tendencies across different situations.

Laboratory observations allow for relatively objective assessments of microlevel information on latency, duration, and frequency of facial, vocal, and gestural responses to specific elicitors that are inaccessible to verbal reports and neurological measures. However, behavioral coding may be subject to experimenters' biases, observations may lack ecological validity, and laboratory triggers may elicit emotional states rather than measuring temperament traits (Goldsmith and Gagne, 2012). Despite these limitations, laboratory observations, particularly the Lab-TAB battery (Goldsmith and Rothbart, 1993), allow for flexibility in behavioral coding and data reduction compared to questionnaire assessments (Goldsmith and Gagne, 2012). This advantage is reflected in research on dysregulated fear (DF). Buss (2011) adopted a multilevel modeling approach to capture changes in fear behaviors across episodes low, moderate, and high in contextual threat. The analyses identified a DF profile in two-year-olds, characterized by high levels of fear in low threat and benign contexts (e.g., playing with puppets and a clown). This is different from the analytic method used to identify BI, where behavioral parameters are aggregated across episodes containing different levels of threat. Buss et al. (2013) found that children characterized with DF were four times more likely to show social anxiety symptoms at the transition to kindergarten than other fearful children. Children characterized with DF might be a more homogeneous group within BI that is associated with a developmental trajectory to social anxiety.

Behavioral genetics, as a theoretical and empirical approach, has made prominent contributions to evaluating the relative contributions of genetic, shared, and nonshared environmental effects on the continuity and instability of temperament (Saudino, 2009). It also provides a tool to examine the cross-method and cross-situation validity of temperament measures. For example, Saudino and Zapfe (2008) found different genetic influences for activity levels assessed at home versus the laboratory. These findings suggest that

different instruments and measurement contexts may tap into distinct etiology of observed behaviors. Therefore, caution must be taken when making generalizations across data gathered from different measurement tools under different contexts.

### Temperament and Developmental Psychopathology

A temperament trait may act as a risk or resilience factor that predisposes individuals to psychopathology or protects them from disorders, in part by influencing the child's experiences with the external environment and their exposure to additional risk or protective factors (Lengua and Wachs, 2012). The developmental psychopathology perspective stresses that temperament is an etiological factor that should be studied in interactive systems, in order to reflect the complex, transactional nature of developmental processes, in which adjustment outcomes are the result of successive adaptations that build upon one another (Sroufe, 2009). This includes both temperament-by-temperament interactions and temperament-by-environment interactions in predicting outcome (Zentner and Bates, 2008).

### Temperament × Temperament Moderation

The framework of temperament-by-temperament moderation is rooted in the Rothbart approach, which highlights the interplay between reactive and self-regulatory components of temperament in shaping developmental trajectories. For example, components of EC moderate the link between BI (as negative reactivity) and anxiety. BI is associated with increased attention toward potentially threatening stimuli (Pérez-Edgar and Fox, 2005b), which is likely to elicit a cascade effect on subsequent information processing, leading individuals to encode and interpret relatively neutral social information as threatening, which in turn produces maladaptive behaviors such as social withdrawal. These processes influence each other through a feedback loop, contributing to the formation of a response repertoire that perpetuates and strengthens anxious behaviors over time. Indeed, longitudinal studies indicate that childhood BI strongly predicts subsequent social withdrawal only in adolescents and children displaying attention biases to threat (Pérez-Edgar et al., 2010a,b, 2011), suggesting that attention bias acts as a 'tether' to predispose children with BI to a developmental trajectory marked by elevated anxiety symptoms (Pérez-Edgar et al., 2014). In contrast, executive attention control, as an EC function, facilitates voluntary attention shifts from threat and a subsequent focus on more positive cues, which may, in turn, allow for better self-regulation of emotion and behavior (Lonigan and Vasey, 2009), decreasing the risk for anxiety in high-BI children (White et al., 2011).

Inhibitory control and response monitoring are two additional EC components that may impact the expression of temperamental reactivity. While better inhibitory control and response monitoring is associated with reduced externalizing and internalizing symptoms for most children (Eisenberg et al., 2010), high levels of these EC abilities in behaviorally

inhibited children increase their risks for the developing anxiety problems (Degnan and Fox, 2007; Lahat et al., 2014; McDermott et al., 2009; White et al., 2011). Presumably, when involuntary control functions, such as heightened reactivity, are combined with high voluntary control systems (i.e., EC functions), they may increase behavioral rigidity and inability to adjust to environmental demands (Derryberry and Rothbart, 1997).

### Temperament × Environment Moderation

The conceptualization of temperament–environment interactions are in line with the mechanisms associated with gene-by-environment interplay. First, temperament traits influence how children perceive and react to positive and negative reinforcements from the environment (Shiner and Caspi, 2012). For example, threat-related attention biases may predispose behaviorally inhibited children to perceive negative aspects of the environment as more salient (Pérez-Edgar et al., 2014; Todd et al., 2012). This facilitates the learning of negative associations linked to their behavior (Shiner and Caspi, 2012), which may, in turn, lead to the emergence and maintenance of anxiety (Pérez-Edgar et al., 2014).

The second mechanism is environmental elicitation, suggesting that individual differences in children's temperament elicit different parenting behaviors. Social withdrawal in behaviorally inhibited children may evoke parental overcontrol (Rubin et al., 2009), which may limit children's opportunities to attain social competency. Indeed, parental overcontrol moderates the link between early BI and subsequent anxiety symptoms (Lewis-Morrarty et al., 2012).

In environmental selection, children actively select specific niches in their environments that are compatible with their temperament, which may, in turn, influence their exposure to risks (Shiner and Caspi, 2012). Rubin et al. (2006) found that behaviorally inhibited children are more likely to have best friends who are also more socially withdrawn and victimized compared to the best friends of noninhibited children. Such dyads may perpetuate social withdrawal, leading to continued rejection from larger peer groups and vice versa (Degnan et al., 2010).

Finally, environmental construal refers to the processes by which temperament shapes individuals' environmental exposure through influencing social cognition (Shiner and Caspi, 2012). From repeated experience of social rejections, children may develop an attributional schema characterized by self-blame for negative experiences (Rubin et al., 2008), as well as avoidant coping strategies (Wichmann et al., 2004). These attributional and coping styles may form a self-reinforcing cycle that leads to continued withdrawal and internalizing symptoms (Rubin et al., 2009).

A number of theoretical models have been proposed to explain how certain temperament traits make individuals more susceptible to aversive or supportive social environments (Lengua and Wachs, 2012; Reiss et al., 2013). The goodness-of-fit model originating from Thomas and Chess' (1977) approach emphasizes that children whose temperament matches the characteristics of their environment will have better adjustment outcomes than

those who have a poorer fit. The traditional diathesis–stress model suggests that given the same amount of environmental adversity, temperamentally at-risk children will develop more adjustment problems compared to children without these risks. Negative emotionality, including anger/frustration and fearful temperament, is considered to be a direct risk factor for both externalizing and internalizing symptoms (Lengua, 2002) and may be shaped by parenting. For example, permissive parenting styles predict more internalizing symptoms in behaviorally inhibited children versus uninhibited children (Williams et al., 2009), while a rejecting parenting style is linked to increased externalizing symptoms in high-frustration but not low-frustration children (Lengua, 2008).

Extending from the diathesis–stress model, the differential susceptibility model (Belsky and Pluess, 2009) argues that temperamentally at-risk individuals may not only be more affected by negative experiences, but could also benefit the most from supportive environments, relatively to children with less temperamentally based sensitivity to the environment. Negative emotionality is likely to be a susceptibility marker (Belsky and Pluess, 2009). Compared to children with an 'easy' temperament, children with high negative emotionality display more behavioral problems during the transition to schools if they experienced low-quality day care, but they show fewer problems if they received high-quality day care (Pluess and Belsky, 2009). Moreover, temperamental irritability is associated with lower attachment security. At the same time, the beneficial effects of an intervention on attachment are significantly greater for highly irritable versus moderately irritable infants (Cassidy et al., 2011). The model underscores the importance of studying phenotypic and genetic markers of sensitivity to environmental influences, as well as both risk and resilient contextual factors for socioemotional development.

### General Conclusions

Theoretical approaches to temperament have not reached a full consensus regarding the inclusive criteria and structure of temperament. Working definitions of temperament incorporate the domains of affectivity, self-regulatory processes, and motor activity in their conceptualization of the construct (Shiner et al., 2012). There is solid agreement that temperament is a multilevel construct, which is observable via behavioral and neurobiological measurements, and is continually influenced by genetic, biological, cognitive, and environmental factors. Developmental psychopathology and behavioral genetic perspectives provide theoretical and methodological frameworks to study temperament as a biologically based risk or resilience factor that influences individuals' trajectory to certain socioemotional adjustment outcomes through complex interactive processes involving individuals' own cognition, affect, and their external developmental contexts. Different temperament traits impose inherent vulnerability (e.g., high negative emotionality) or resilience (high EC) mechanisms that influence outcomes by moderating individuals' exposure to negative or enriching environments, constraining what environmental

characteristics are beneficial or harmful to specific temperament traits. Temperament traits also affect individuals' level of susceptibility to both aversive and favorable environmental influences. These dynamic interactive processes support the fundamental notion that temperament does not determine developmental outcomes. Rather, it sets the complex foundation on which multiple actors come together to shape developmental outcomes (Kagan, 2003).

### Acknowledgment

Support for manuscript preparation was provided by grants from the National Institutes of Health (MH# 094633) and The Pennsylvania State University Social Science Research Institute (Level II Grant) to Koralý Pérez-Edgar.

**See also:** Neonatal Temperament: From Phenomenology to Mechanism; Temperament and Human Development; Temperament and Motivation; Temperament.

### Bibliography

- Belsky, J., Pluess, M., 2009. Beyond diathesis stress: differential susceptibility to environmental influences. *Psychological Bulletin* 135 (6), 885–908.
- Bronfenbrenner, U., Morris, P.A., 2006. The bioecological model of human development. In: Lerner, R.M. (Ed.), *Handbook of Child Development: Vol. 1. Theoretical Models of Human Development*, sixth ed. Wiley, Hoboken, NJ, pp. 793–828.
- Buss, K.A., 2011. Which fearful toddlers should we worry about? Context, fear regulation, and anxiety risk. *Developmental Psychology* 47 (3), 804–819.
- 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 (4), 583–594.
- Buss, K.A., Davis, E.L., Kiel, E.J., Brooker, R.J., Beekman, C., Early, M.C., 2013. Dysregulated fear predicts social wariness and social anxiety symptoms during kindergarten. *Journal of Clinical Child & Adolescent Psychology*, 603–616.
- Buss, A.H., Plomin, R., 1975. *A Temperament Theory of Personality Development*. Wiley, New York.
- Buss, A.H., Plomin, R., 1984. *Temperament: Early Developing Personality Traits*. Erlbaum, Hillsdale, NJ.
- Campos, J.J., Frankel, C.B., Camras, L., 2004. On the nature of emotion regulation. *Child Development* 75 (2), 377–394.
- Caspi, A., 1998. Personality development across the life course. In: Damon, W., Eisenberg, N. (Eds.), *Handbook of Child Psychology: Vol. 3. Social, Emotional, and Personality Development*. Wiley, New York, pp. 311–388.
- Cassidy, J., Woodhouse, S.S., Sherman, L.J., Stupica, B., Lejuez, C.W., 2011. Enhancing infant attachment security: an examination of treatment efficacy and differential susceptibility. *Development and Psychopathology* 23 (1), 131–148.
- Chen, X., Chen, H., Li, D., Wang, L., 2009a. Early childhood behavioral inhibition and social and school adjustment in Chinese children: a 5-year longitudinal study. *Child Development* 80 (6), 1692–1704.
- Chen, X., Hastings, P.D., Rubin, K.H., Chen, H., Cen, G., Stewart, S.L., 1998. Child-rearing attitudes and behavioral inhibition in Chinese and Canadian toddlers: a cross-cultural study. *Developmental Psychology* 34 (4), 677–686.
- Chen, X., Rubin, K.H., Li, B.S., Li, D., 1999. Adolescent outcomes of social functioning in Chinese children. *International Journal of Behavioral Development* 23 (1), 199–223.
- Chen, X., Wang, L., Wang, Z., 2009b. Shyness-sensitivity and social, school, and psychological adjustment in rural migrant and urban children in China. *Development* 80 (5), 1499–1513.
- Chronis-Tuscano, A., Degnan, K.A., Pine, D.S., Perez-Edgar, K., Henderson, H.A., Diaz, Y., Raggi, V.L., Fox, N.A., 2009. Stable early maternal report of behavioral inhibition predicts lifetime social anxiety disorder in adolescence. *Journal of the American Academy of Child & Adolescent Psychiatry* 48 (9), 928–935.
- Clauss, J.A., Blackford, J.U., 2012. Behavioral inhibition and risk for developing social anxiety disorder: a meta-analytic study. *Journal of the American Academy of Child & Adolescent Psychiatry* 51 (10), 1066–1075.
- Capaldi, D.M., Rothbart, M.K., 1992. Development and validation of an early adolescent temperament measure. *The Journal of Early Adolescence* 12 (2), 153–173.
- Degnan, K.A., Fox, N.A., 2007. Behavioral inhibition and anxiety disorders: multiple levels of a resilience process. *Development and Psychopathology* 19 (3), 729–746.
- Degnan, K.A., Almas, A.N., Fox, N.A., 2010. Temperament and the environment in the etiology of childhood anxiety. *Journal of Child Psychology and Psychiatry* 51 (4), 497–517.
- Dennis, T.A., 2010. Neurophysiological markers for emotion regulation from the perspective of emotion-cognition integration: current directions and future challenges. *Developmental Neuropsychology* 35, 212–230.
- Derryberry, D., Rothbart, M.K., 1997. Reactive and effortful processes in the organization of temperament. *Developmental Psychopathology* 9 (4), 633–652.
- Eisenberg, N., Spinrad, T.L., Eggum, N.D., 2010. Emotion-related self-regulation and its relation to children's maladjustment. *Annual Review of Clinical Psychology* 6, 495–525.
- Fox, N.A., Henderson, H.A., 1999. Does infancy matter? Predicting social behavior from infant temperament. *Infant Behavior and Development* 22 (4), 445–455.
- 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.
- Fox, N.A., Henderson, H.A., Rubin, K.H., Calkins, S.D., Schmidt, L.A., 2001. Continuity and discontinuity of behavioral inhibition and exuberance: psychophysiological and behavioral influences across the first four years of life. *Child Development* 72 (1), 1–21.
- Fullard, W., McDevitt, S.C., Carey, W.B., 1984. Assessing temperament in one-to-three-year-old children. *Journal of Pediatric Psychology* 9 (2), 205–217.
- Gartstein, M.A., Peleg, Y., Young, B.N., Slobodskaya, H.R., 2009. Infant temperament in Russia, United States of America, and Israel: differences and similarities between Russian-speaking families. *Child Psychiatry and Human Development* 40 (2), 241–256.
- Goldsmith, H.H., 1996. Studying temperament via construction of the Toddler Behavior Assessment Questionnaire. *Child Development* 67 (1), 218–235.
- Goldsmith, H.H., Buss, A.H., Plomin, R., Rothbart, M.K., Thomas, A., Chess, S., Hinde, R.A., McCall, R.B., 1987. Roundtable: what is temperament? Four approaches. *Child Development*, 505–529.
- Goldsmith, H.H., Campos, J.J., 1982. Toward a theory of infant temperament. In: Emde, A.N., Harmon, R.J. (Eds.), *The Development of Attachment and Affiliative Systems*. Plenum, New York, pp. 161–193.
- Goldsmith, H.H., Gagne, J.R., 2012. Behavioral assessment of temperament. In: Zentner, M., Shiner, R. (Eds.), *The Handbook of Temperament*. Guilford Press, New York, pp. 209–228.
- Goldsmith, H.H., Rothbart, M.K., 1993. *The Laboratory Temperament Assessment Battery (LAB-TAB)*. University of Wisconsin Press, Madison.
- Goldsmith, H.H., Campos, J.J., 1986. Fundamental issues in the study of early temperament: the Denver Twin Temperament Study. In: Lamb, M.E., Brown, A. (Eds.), *Advances in Developmental Psychology*. Erlbaum, Hillsdale, NJ, pp. 231–283.
- Halfonstein, S.M., Fox, N.A., Pine, D.S., 2012. Approach-withdrawal and the role of the striatum in the temperament of behavioral inhibition. *Developmental Psychology* 48 (3), 815–826.
- Hegvik, R.L., McDevitt, S.C., Carey, W.B., 1982. The middle childhood temperament questionnaire. *Journal of Developmental & Behavioral Pediatrics* 3 (4), 197–200.
- Kagan, J., 2003. Behavioral inhibition as a temperamental category. In: Davidson, R.J., Scherer, K.R., Goldsmith, H.H. (Eds.), *Handbook of Affective Sciences*. Oxford University Press, New York, pp. 320–331.
- Kagan, J., 2012. The biography of behavioral inhibition. In: Zentner, M., Shiner, R. (Eds.), *The Handbook of Temperament*. Guilford Press, New York, pp. 69–82.
- Kagan, J., Fox, N.A., 2007. Biology, culture, and temperamental issues. In: Damon, W., Lerner, R., Eisenberg, N. (Eds.), *Handbook of Child Psychology: Vol. 3. Social, Emotional, and Personality Development*, sixth ed. Wiley, New York.
- Kagan, J., Reznick, J.S., Clarke, C., Snidman, N., Garcia-Coll, C., 1984. Behavioral inhibition to the unfamiliar. *Child Development* 55 (6), 2212–2225.
- Kagan, J., Snidman, N., 1991. Temperamental factors in human development. *American Psychologist* 46 (8), 856–862.
- Kagan, J., 1994. *Galen's Prophecy*. Basic Books, New York.
- Lahat, A., Lamm, C., Chronis-Tuscano, A., Pine, D.S., Henderson, H.A., Fox, N.A., 2014. Early behavioral inhibition and increased error monitoring predict later social phobia symptoms in childhood. *Journal of the American Academy of Child & Adolescent Psychiatry* 53 (4), 447–455.



- Lengua, L.J., 2002. The contribution of emotionality and self-regulation to the understanding of children's response to multiple risk. *Child Development* 73 (1), 144–161.
- Lengua, L.J., 2008. Anxiousness, frustration, and effortful control as moderators of the relation between parenting and adjustment in middle-childhood. *Social Development* 17 (3), 554–577.
- Lengua, L.J., Wachs, T.D., 2012. Temperament and risk: resilient and vulnerable responses to adversity. In: Zentner, M., Shiner, R. (Eds.), *The Handbook of Temperament*. Guilford Press, New York, pp. 519–540.
- Lewis-Morrarty, E., Degnan, K.A., Chronis-Tuscano, A., Rubin, K.H., Cheah, C.S., Pine, D.S., Heather, A.H., Fox, N.A., 2012. Maternal over-control moderates the association between early childhood behavioral inhibition and adolescent social anxiety symptoms. *Journal of Abnormal Child Psychology* 40 (8), 1363–1373.
- Loken, E., 2004. Using latent class analysis to model temperament types. *Multivariate Behavioral Research* 39 (4), 625–652.
- Lonigan, C.J., Vasey, M.W., 2009. Negative affectivity, effortful control, and attention to threat-relevant stimuli. *Journal of Abnormal Child Psychology* 37 (3), 387–399.
- McDermott, J.M., Pérez-Edgar, K., Henderson, H.A., Chronis-Tuscano, A., Pine, D.S., Fox, N.A., 2009. A history of childhood behavioral inhibition and enhanced response monitoring in adolescence are linked to clinical anxiety. *Biological Psychiatry* 65 (5), 445–448.
- Muris, P., Merckelbach, H., Schmidt, H., Gadet, B., Bogie, N., 2001. Anxiety and depression as correlates of self-reported behavioral inhibition in normal adolescents. *Behavior Research and Therapy* 39 (9), 1051–1061.
- McDevitt, S.C., Carey, W.B., 1978. The measurement of temperament in 3–7 year old children. *Journal of Child Psychology and Psychiatry* 19 (3), 245–253.
- Pérez-Edgar, K., Bar-Haim, Y., McDermott, J.N.M., Chronis-Tuscano, A., Pine, D.S., Fox, N.A., 2010a. Attention biases to threat and behavioral inhibition in early childhood shape adolescent social withdrawal. *Emotion* 10 (3), 349–357.
- Pérez-Edgar, K., McDermott, J.N.M., Korelitz, K., Degnan, K.A., Curby, T.W., Pine, D.S., Fox, N.A., 2010b. Patterns of sustained attention in infancy shape the developmental trajectory of social behavior from toddlerhood through adolescence. *Developmental Psychology* 46, 1723–1730.
- Pérez-Edgar, K., Fox, N.A., 2005a. Temperament and anxiety disorders. *Child and adolescent psychiatric Clinics of North America* 14 (4), 681–706.
- Pérez-Edgar, K., Fox, N.A., 2005b. A behavioral and electrophysiological study of children's selective attention under neutral and affective conditions. *Journal of Cognition and Development* 6 (1), 89–118.
- Pérez-Edgar, K., Hardee, J., Guyer, A.E., Benson, B., Nelson, E., Gorodetsky, E., Goldman, D., Fox, N.A., Pine, D.S., Ernst, M., 2013. DRD4 and striatal modulation of the link between childhood behavioral inhibition and adolescent anxiety. *Social Cognitive and Affective Neuroscience* 9 (4), 445–453.
- Pérez-Edgar, K., Reeb-Sutherland, B.C., McDermott, J.M., White, L.K., Henderson, H.A., Degnan, K.A., Hane, A.A., Pine, D.S., Fox, N.A., 2011. Attention biases to threat link behavioral inhibition to social withdrawal over time in very young children. *Journal of Abnormal Child Psychology* 39, 885–895.
- Pérez-Edgar, K., Roberson-Nay, R., Hardin, M.G., Poeth, K., Guyer, A.E., Nelson, E.E., McClure, E.B., Henderson, H.A., Fox, N.A., Pine, D.S., Ernst, M., 2007. Attention alters neural responses to evocative faces in behaviorally inhibited adolescents. *Neuroimage* 35 (4), 1538–1546.
- Pérez-Edgar, K., Taber-Thomas, B., Auday, E., Morales, S., 2014. Temperament and attention as core mechanisms in the early emergence of anxiety. In: Lagattuta, K. (Ed.), *Children and Emotion: New Insights into Developmental Affective Science*, vol. 26. Karger Publishing, pp. 42–56.
- Pluess, M., Belsky, J., 2009. Differential susceptibility to rearing experience: the case of childcare. *Journal of Child Psychology and Psychiatry* 50 (4), 396–404.
- Posner, M.I., Rothbart, M.K., Sheese, B.E., Voelker, P., 2014. Developing attention: behavioral and brain mechanisms. *Advances in Neuroscience Article ID 405094*, 9. Hindawi Publishing Corporation.
- Putnam, S.P., Gartstein, M.A., Rothbart, M.K., 2006. Measurement of fine-grained aspects of toddler temperament: the Early Childhood Behavior Questionnaire. *Infant Behavior and Development* 29 (3), 386–401.
- Reiss, D., Leve, L.D., Neiderhiser, J.M., 2013. How genes and the social environment moderate each other. *American Journal of Public Health* 103 (Suppl. 1), S111–S121.
- Rothbart, M.K. Temperament Questionnaires, 2006. <http://www.bowdoin.edu/~sputnam/rothbart-temperament-questionnaires/instrument-descriptions/>.
- Rothbart, M.K., Bates, J.E., 2007. Temperament. In: Damon, W., Lerner, R., Eisenberg, N. (Eds.), *Handbook of Child Psychology: Vol. 3. Social, Emotional, and Personality Development*, sixth ed. Wiley, New York.
- Rothbart, M.K., Derryberry, D., 1981. Development of individual differences in temperament. In: Lamb, M.E., Brown, A.L. (Eds.), *Advances in Developmental Psychology*, vol. 1. Erlbaum, Hillsdale, NJ, pp. 37–86.
- Rothbart, M.K., Derryberry, D., 2002. Temperament in children. *Psychology at the Turn of the Millennium* 2, 17–35.
- Rothbart, M.K., Sheese, B.E., Posner, M.I., 2007. Executive attention and effortful control: linking temperament, brain networks, and genes. *Child Development Perspectives* 1 (1), 2–7.
- Rubin, K.H., Bowker, J., Kennedy, A., 2008. Avoiding and withdrawing from the peer group in middle childhood and early adolescence. In: Rubin, K.H., Bukowski, W., Laursen, B. (Eds.), *Handbook of Peer Interactions, Relationships, and Groups*. Guilford, New York.
- Rubin, K.H., Coplan, R.J., Bowker, J.C., 2009. Social withdrawal in childhood. *Annual Review of Psychology* 60, 141–171.
- Rubin, K.H., Wojslawowicz, J.C., Rose-Krasnor, L., Booth-LaForce, C., Burgess, K.B., 2006. The best friendships of shy/withdrawn children: prevalence, stability, and relationship quality. *Journal of Abnormal Child Psychology* 34 (2), 139–153.
- Rueda, M.R., 2012. Effortful control. In: Zentner, M., Shiner, R. (Eds.), *The Handbook of Temperament*. Guilford Press, New York, pp. 145–167.
- Rothbart, M.K., 1981. Measurement of temperament in infancy. *Child Development* 52, 569–578.
- Rothbart, M.K., Ahadi, S.A., Hershey, K.L., Fisher, P., 2001. Investigations of temperament at 3–7 years: the Children's Behavior Questionnaire. *Child Development* 72, 1394–1408.
- Saudino, K.J., 2009. The development of temperament from a behavioral genetics perspective. *Advances in Child Development and Behavior* 37, 201–231.
- Saudino, K.J., Wang, M., 2012. Quantitative and molecular genetic studies of temperament. In: Zentner, M., Shiner, R. (Eds.), *The Handbook of Temperament*. Guilford Press, New York, pp. 315–346.
- Saudino, K.J., Zapfe, J.A., 2008. Genetic influences on activity level in early childhood: do situations matter? *Child Development* 79 (4), 930–943.
- Schwartz, C.E., Kunwar, P.S., Greve, D.N., Kagan, J., Snidman, N.C., Bloch, R.B., 2011. A phenotype of early infancy predicts reactivity of the amygdala in male adults. *Molecular Psychiatry* 17 (10), 1042–1050.
- Schwartz, C.E., Wright, C.I., Shin, L.M., Kagan, J., Rauch, S.L., 2003. Inhibited and uninhibited infants "grown up": adult amygdala response to novelty. *Science* 300 (5627), 1952–1953.
- 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 temperament research on the twenty-fifth anniversary of Goldsmith et al. (1987). *Child Development Perspectives* 6 (4), 436–444.
- Shiner, R.L., Caspi, A., 2012. Temperament and the development of personality traits, adaptations, and narratives. In: Zentner, M., Shiner, R. (Eds.), *The Handbook of Temperament*. Guilford Press, New York, pp. 497–518.
- Sroufe, L.A., 2009. The concept of development in developmental psychopathology. *Child Development Perspectives* 3 (3), 178–183.
- Super, C.M., Harkness, S., 2002. Culture structures the environment for development. *Human Development* 45, 270–274.
- Simonds, J., Rothbart, M.K., October 2004. The Temperament in Middle Childhood Questionnaire (TMCQ): a computerized self-report measure of temperament for ages 7–10. In: Poster Session Presented at the Occasional Temperament Conference. Athens, GA.
- Thomas, A., Chess, S., 1977. *Temperament and Development*. Brunner/Mazel, New York.
- Todd, R.M., Cunningham, W.A., Anderson, A.K., Thompson, E., 2012. Affect-biased attention as emotion regulation. *Trends in Cognitive Sciences* 16 (7), 365–372.
- Wichmann, C., Coplan, R.J., Daniels, T., 2004. The social cognitions of socially withdrawn children. *Social Development* 13 (3), 377–392.
- White, L.K., McDermott, J.M., Degnan, K.A., Henderson, H.A., Fox, N.A., 2011. Behavioral inhibition and anxiety: the moderating roles of inhibitory control and attention shifting. *Journal of Abnormal Child Psychology* 39 (5), 735–747.
- Williams, L.R., Degnan, K.A., Perez-Edgar, K.E., Henderson, H.A., Rubin, K.H., Pine, D.S., Steinberg, L., Fox, N.A., 2009. Impact of behavioral inhibition and parenting style on internalizing and externalizing problems from early childhood through adolescence. *Journal of Abnormal Child Psychology* 37 (8), 1063–1075.
- Zentner, M., Bates, J.E., 2008. Child temperament: an integrative review of concepts, research programs, and measures. *International Journal of Developmental Science* 2 (1), 7–37.