
Behavioral inhibition and anxiety disorders: Multiple levels of a resilience process

KATHRYN AMEY DEGNAN AND NATHAN A. FOX

University of Maryland

Abstract

Behavioral inhibition is reported to be one of the most stable temperamental characteristics in childhood. However, there is also evidence for discontinuity of this trait, with infants and toddlers who were extremely inhibited displaying less withdrawn social behavior as school-age children or adolescents. There are many possible explanations for the discontinuity in this temperament over time. They include the development of adaptive attention and regulatory skills, the influence of particular styles of parenting or caregiving contexts, and individual characteristics of the child such as their level of approach–withdrawal motivation or their gender. These discontinuous trajectories of behaviorally inhibited children and the factors that form them are discussed as examples of the resilience process.

Throughout research on children's personality or temperament there is a considerable focus on the stability of these individual characteristics and their continuity over time. In fact, one of the most stable temperamental indices reported is a child's response to uncertainty or novelty, known as behavioral inhibition (Fox, Henderson, Marshall, Nichols, & Ghera, 2005; Kagan & Moss, 1962). Research on children's longitudinal profiles of inhibited behavior has focused on the heterotypic continuity between infant negative reactivity to novelty, toddler behavioral inhibition, and childhood social reticence (Fox et al., 2005; Rothbart & Bates, 2006). Many studies indicate that infants who are negatively reactive to novelty are more likely to remain inhibited in childhood than nonreactive infants (Marshall & Stevenson-Hinde, 1998; Sanson,

Pedlow, Cann, Prior, & Oberklaid, 1996) and behaviorally inhibited toddlers are more likely to display social reticence in childhood than noninhibited toddlers (Fox, Henderson, Rubin, Calkins, & Schmidt, 2001; Rubin, Burgess, & Hastings, 2002). In addition, behaviorally inhibited children and adults are at increased risk for internalizing disorders, such as anxiety (Biederman et al., 2001; Gar, Hudson, & Rapee, 2005; Gladstone, Parker, Mitchell, Wilhelm, & Malhi, 2005). Throughout this work, though, there is evidence for discontinuity or instability in behavioral inhibition, with some infants and toddlers who are extremely inhibited displaying less withdrawn social behavior as school children and a lower incidence of anxiety disorders in adolescence. This discontinuity may be thought of as an intriguing example of the resilience process. The research literature extant suggests a number of factors that may contribute to either continuity or discontinuity. Among the factors that have been studied are cognitive processes involved in the modulation of emotion (such as attention and inhibitory control), parenting behaviors, and contextual changes in the child's life. Identifying factors that contribute to this resilience

This work was supported by two grants from the National Institutes of Health (HD32666 and HD17899) to Nathan A. Fox.

Address correspondence and reprint requests to: Kathryn Amey Degnan, University of Maryland, 3304 Benjamin Building, College Park, MD 20742; E-mail: kdegnan@umd.edu.

process is not only interesting from a theoretical perspective but also has important applied clinical implications. There is a heightened incidence of anxiety disorders among behaviorally inhibited children (Biederman et al., 1990, 2001; Perez-Edgar & Fox, 2005). Thus, identifying factors that lead to discontinuity of extreme patterns of behavioral inhibition may serve to develop interventions that may address the incidence of psychopathology in this population.

Behavioral inhibition refers to one's initial negative emotional and motor reactivity to novelty (Kagan, Reznick, Clarke, Snidman, & Garcia Coll, 1984). When assessed in toddlerhood, it is also described as vigilant and withdrawn behavior in response to novel people and situations (Calkins, Fox, & Marshall, 1996; Kagan, Reznick, Snidman, Gibbons, & Johnson, 1988). Overall, infant negative reactivity to novelty, behavioral inhibition, and preschool social reticence all have been described as forms of the same underlying temperamental apprehension to novelty (Fox, Henderson, Rubin et al., 2001; Kagan & Snidman, 1991). Kagan and others (Fox, Henderson, & Marshall, 2001; Kagan, 2001) have speculated that enhanced amygdala activation to novelty and activation of "fear" circuitry may underlie this avoidance of novel stimuli (see Davis, 1986; LeDoux, Iwata, Cicchetti, & Reis, 1988). Thus, inhibited behaviors such as avoidance or freezing in the face of novelty represent coping mechanisms by which this fearful reaction is decreased. However, coping with fear through avoidance actually may reinforce the associated physiological responses and behaviors leading to continued behavioral inhibition and social wariness (Fox, Henderson, & Marshall, 2001; Rothbart, Derryberry, & Posner, 1994). Thus, infants who consistently display extreme distress to novelty may continue to display this pattern of behavior as behaviorally inhibited toddlers and socially reticent children, whereas children with less extreme reactivity to novelty may be more likely to decline in this behavior over time (Marshall & Stevenson-Hinde, 1998; Stevenson-Hinde & Shouldice, 1995). Furthermore, some children with extreme distress to novelty also may decline in this behavior over time because of one or more within child or extrinsic factors present in their environment.

Indeed, among the many longitudinal studies of behavioral inhibition there is evidence for both continuity and discontinuity in these behavioral profiles. In an effort to describe the developmental trajectories of behaviorally inhibited children, researchers have followed both unselected samples and samples selected for inhibited behavior from infancy through middle childhood or adolescence (see Table 1 for a list of selected works). Studies following unselected samples from infancy to toddlerhood have shown modest stability in measures of negative reactivity to novelty and behavioral inhibition (mean $r = .29$; Arcus & McCartney, 1989; Bronson & Pankey, 1977; Park, Belsky, Putnam, & Crnic, 1997; Putnam & Stifter, 2005), whereas samples selected for a higher prevalence of infant reactivity and inhibition have found an average of 55% of infants to maintain stability and 38% to show a decline in inhibition by toddlerhood (Calkins et al., 1996; Garcia Coll, Kagan, & Reznick, 1984; Kagan & Snidman, 1991). In addition, among unselected and selected samples, stability between behavioral inhibition in infancy and early childhood ranges from .18 to .52, and 30–70% of inhibited infants are classified as consistently inhibited into early childhood (Broberg, 1993; Fox, Henderson, Rubin et al., 2001; Henderson, Fox, & Rubin, 2001; Henderson, Marshall, Fox, & Rubin, 2004; Kagan et al., 1984; Kagan, Snidman, & Arcus, 1998; Kerr, Lambert, Statin, & Klackenberg-Larsson, 1994; Resnick et al., 1986; Sanson et al., 1996). From toddlerhood to early childhood, unselected samples show modest stability in inhibition (mean $r = .26$; Rubin, Burgess, & Hastings, 2002; Zhengyan, Huichang, & Xinyin, 2003) whereas a sample selected for toddler inhibition showed more moderate stability ($r = .52$; Kagan, Reznick, & Snidman, 1987). Within early childhood, Rubin, Hastings, Stewart, Henderson, and Chen (1997) found that 46% of toddlers that were inhibited to novel adults, toys, and laboratory situations were also inhibited toward novel peers. Moreover, studies examining the stability of behavioral inhibition across early to middle childhood have shown moderate stability (mean $r = .51$; Asendorpf, 1990, 1994; Degnan, Henderson, Fox, & Rubin, in press; Marshall & Stevenson-Hinde, 1998) and about 44% of

Table 1. Longitudinal studies of behavioral inhibition

Citations	Sample	Ages of Assessment (years)					Factors Influencing Stability
		0-1	2-3	4-5	6-12	≥13	
Arcus & McCartney (1989)	U		•				Siblings, daycare
Asendorpf (1990)	U			•	•		Familiarity of peers
Asendorpf (1994)	U			•	•		Intelligence, social competence
Broberg (1993)	U	•	•	•			Daycare
Bronson & Pankey (1977)	U	•	•				Learning effects
Calkins & Fox (1992)	U	•	•				
Calkins et al. (1996)	S	•					
Degnan et al. (in press)	S	•		•	•		Maternal behavior, maternal personality
Fox, Henderson, Rubin, et al. (2001)	S	•	•	•			Frontal EEG asymmetry, daycare
Garcia-Coll et al. (1984)	S	•	•				
Henderson et al. (2001)	S	•		•			Frontal EEG asymmetry, gender
Henderson et al. (2004)	S		•	•			Heart period
Kagan et al. (1984)	S		•	•			Heart rate variability
Kagan et al. (1987)	S		•	•			
Kagan et al. (1988)	S		•	•	•		Heart rate
Kagan & Snidman (1991)	S	•	•				
Kagan et al. (1998)	S	•	•	•			Gender
Kerr et al. (1994)	S		•	•	•	•	Gender
Marshall & Stevenson-Hinde (1998)	S			•	•		Heart period
Park et al. (1997)	U	•	•				Infant positivity, maternal behavior
Pfeifer et al. (2002)	S		•	•	•		
Putnam & Stifter (2005)	U	•	•				
Reznick et al. (1986)	S		•	•			
Rubin et al. (1997)	U		•				Maternal behavior
Rubin et al. (1989)	U			•	•		
Rubin, Burgess, & Hastings (2002)	U		•	•			Maternal behavior
Sanson et al. (1996)	U	•	•	•			
Scarpa et al. (1995)	U		•	•	•		
Stevenson-Hinde & Shouldice (1995)	U			•	•		Reporter vs. observer
Zhengyan et al. (2003)	U		•	•			

Note: U, unselected; S, selected.

inhibited preschoolers maintained their inhibition into middle childhood (Scarpa, Raine, Venables, & Mednick, 1995). Finally, a few studies have found that approximately 30–40% of inhibited children show stability from toddlerhood to middle childhood (Kagan et al., 1988; Pfeifer, Goldsmith, Davidson, & Rickman, 2002), whereas one study found that almost all children classified as inhibited in infancy were also inhibited in adolescence (96%; Kerr et al., 1994) and

one study has shown modest stability from 7 to 10 years of age ($r = .30$; Rubin, Hymel, & Mills, 1989). Overall, these studies have shown that children who are negatively reactive in infancy or behaviorally inhibited in toddlerhood are likely to be inhibited at later ages, especially if they are extremely inhibited or reactive. However, even in samples selected for higher rates of inhibition, almost a third of behaviorally inhibited infants and toddlers were less inhibited

later in childhood (e.g., Calkins et al., 1996; Fox, Henderson, Rubin et al., 2001; Kagan, Reznick et al., 1988; Kagan, Snidman et al., 1998; Kagan & Snidman, 1991; Pfeifer et al., 2002; Reznick et al., 1986). In addition, among unselected samples, almost 50% of inhibited children show discontinuity in behavioral inhibition across childhood and adolescence (e.g., Kerr et al., 1994; Sanson et al., 1996; Scarpa et al., 1995). As seen in Table 1, numerous studies conducted over the past 2 decades have examined stability and continuity in behavioral inhibition across infancy, childhood, and even into adolescence. The variability in the levels of stability across these studies suggests that factors either inherent to the child or to their environment may have a profound influence on a resilience process that alters these trajectories over time.

In addition to exploring the longitudinal trajectories of temperamental inhibition, research has examined inhibited behavior as a direct predictor of anxiety disorders (Gar et al., 2005). In fact, many of the characteristics of behavioral inhibition, such as social withdrawal, negative affect, and vigilance are used to describe certain anxiety disorders (American Psychological Association, 2007). For example, the *DSM-IV* (American Psychiatric Association, 1994) diagnostic criteria for social anxiety includes a persistent fear of social situations, intense anxiety, and distress in response to the feared situations, and avoidance of the feared situations. Research on the relation between behavioral inhibition

and anxiety disorders has also discovered links between the two constructs (see Table 2 for a listing of selected works), as children's levels of behavioral inhibition are significantly related to their symptoms of social anxiety (e.g., Coplan, Wilson, Frohlick, & Zelenski, 2006; van Brakel, Muris, Bogels, & Thomassen, 2006). In addition, behaviorally inhibited children are more likely to have a diagnosis of social anxiety or phobias than noninhibited children (Biederman et al., 1990, 2001), and adolescents and adults are more likely to have social phobia or anxiety disorders when they are classified as having a high level of inhibited behavior in childhood (Gladstone & Parker, 2005; Gladstone et al., 2005; Hayward, Killen, Kraemer, & Taylor, 1998; Schwartz, Snidman, & Kagan, 1999). Finally, behavioral inhibition also has been shown to relate to child anxiety problems, even after controlling for the effects of maternal anxiety (Shamir-Essakow, Ungerer, & Rapee, 2005). Despite these overall trends, some behaviorally inhibited children do not develop anxiety disorders later in life. For example, Gladstone and colleagues (2005) found that 58% of highly inhibited children did not show diagnosable rates of social phobia in adulthood, and 28% did not show any diagnosable anxiety disorder. Another study found that 83% of children with behavioral inhibition did not have social anxiety disorder, although this was compared to 95% of a noninhibited subgroup (Biederman et al., 2001). Finally, Schwartz and

Table 2. Studies examining links between behavioral inhibition (BI) and internalizing disorders

Citations	Sample	Ages of Assessment (years)					Factors Influencing BI-Anxiety Relations
		0-1	2-3	4-5	6-12	≥13	
Biederman et al. (2001)	S		•	•			Parental diagnosis
Bosquet & Egeland (2006)	S	•		•			Emotion regulation
Coplan et al. (2006)	U			•	•		Behavioral activation
Fox, Henderson, Rubin et al. (2001)	S	•	•	•			
Gladstone et al. (2005)	S					•	
Gladstone & Parker (2005)	S					•	
Rubin et al. (1989)	U				•		
Rubin, Burges, & Hastings (2002)	U		•	•			
Shamir-Essakow et al. (2005)	S			•			
van Brakel et al. (2006)	U				•	•	Attachment, parenting behavior

Note: U, unselected, S, selected.

colleagues (1999) found that 39% of inhibited toddlers did not evidence any social anxiety in adolescence.

Whereas studies examining longitudinal samples have shown there to be continuity between behavioral inhibition, social withdrawal, and clinical anxiety disorders throughout childhood, adolescence, and adulthood, there is also a great deal of discontinuity in these patterns (e.g., Fox, Henderson, Rubin et al., 2001; Gar et al., 2005; Rubin, Burgess, & Hastings, 2002; Gladstone et al., 2005; Schwartz et al., 1999). Because inhibited behavior is posited to stem from underlying temperamental biases, display continuity, and increase risk for anxiety disorders, this discontinuity may be evidence of resilience processes. Luthar, Cicchetti, and Becker (2000) have defined the resilience process as achieving positive adaptation despite experiencing significant threat, adversity, or risk. Although temperament has not been typically thought of as a domain where resilience could have an influence, having a temperamental bias to react negatively to novelty is considered to be a risk factor for social withdrawal and anxiety disorders. Therefore, inhibited children who do not manifest these problems and develop adaptive social behavior are considered part of the resilience process. Resilience also is suggested to result from mechanisms and factors that lead to competent adaptation, known as protective effects, rather than from individual characteristics or extraordinary circumstances (Cicchetti & Garmezy, 1993; Luthar et al., 2000; Masten, 2001). Luthar et al. (2000) has even discussed different types of protective effects, where a protective effect leads to positive adaptation in general, a protective-stabilizing effect prevents declines in positive adaptation, a protective-enhancing effect leads to greater positive adaptation the greater the risk is, and a protective-reactive effect leads to positive adaptation, but less so when risk is high. Specifically, parent-child relationships, child cognition, and self-regulation may all foster adaptive development in both adverse and normative settings (Masten & Coatsworth, 1998). Furthermore, it has been argued that the resilience process may not reflect unique protective effects, but rather a system of factors that sustain competence even under the threat of adversity

or risk (Masten, 2001; Masten & Coatsworth, 1998). It may be when these important resources and systems are absent or are compromised that maladaptive development occurs. In addition, factors and mechanisms that may foster adaptation for one population may not lead to competence for another population. From this framework, young children who are extremely inhibited and at risk for anxiety disorders serve as examples of the resilience process when they display less withdrawn social behavior as school children and a lower incidence of anxiety disorders as adolescents and adults. Given the lack of research focused on the discontinuity of child internalizing problems, knowledge regarding what protective factors and mechanisms support this positive adaptation and how they contribute to the resilience process is sparse (Gar et al., 2005). Thus, exploring this discontinuity and the factors or processes that ameliorate fear and avoidance to the unfamiliar may further the definition of behavioral inhibition and its developmental trajectories. In addition, examining the resilience process across multiple levels of analysis will greatly enhance our understanding of biology and context in the development of adaptive social behavior. It is important to note that what is considered a protective factor or mechanism for inhibited children may not lead to positive adaptation for children who are not inhibited.

Factors Leading to Resilience

Although an initial, involuntary reaction to the unfamiliar may persist, both endogenous and exogenous factors help decrease the observable nature and functional interference of behavioral inhibition and anxiety problems. Specifically, intervening factors that contribute to children's ability to alter their inhibited nature may be inherent to a resilience process, whereby children's temperamental trajectories will change over time. Furthermore, these intervening factors may stem from biological, cognitive, and social processes throughout childhood. Rothbart's model of temperament supports this contention by proposing two components that contribute to multiple longitudinal patterns of inhibition: reactivity and regulation (Rothbart & Derryberry, 1981). Reactivity is defined as

the behavioral and physiological excitation, responsiveness, or arousal of an individual, and regulation is defined as the neural or behavioral processes that alter an individual's level of reactivity (Rothbart, Ahadi, & Evans, 2000). Theoretically, regulation occurs at the physiological, attentional, emotional, or behavioral level, and matures later in development than emotional reactivity (Davidson, Putnam, & Larson, 2000). It is described as the child's gradual progression from reliance on caregivers to modulate arousal toward the acquisition of independent regulatory skills (Calkins, 1994; Kopp, 1982). Through physiological, behavioral, and contextual factors, children first develop context-dependent strategies to regulate arousal, which later develop into a formal repertoire of skills used to actively regulate emotions and behavior in a variety of contexts (Calkins, 1994; Calkins & Degnan, 2006). Thus, the ability to regulate reactivity to novelty in multiple settings contributes to a resilience process by allowing for positive social skills to develop and leads to decreases in inhibited and anxious behavior over time. Although internal factors such as children's lower levels of temperamental reactivity and inhibitory control may account in part for the ability to develop regulatory skills and discontinuity in behavioral inhibition (Kagan & Snidman, 1991), external factors, such as parenting and the caregiving context, also may influence the stability of behavioral inhibition and its concomitants (Fox, Henderson, Rubin et al., 2001; Posner & Rothbart, 2000; Rubin & Burgess, 2002).

There are multiple possible explanations for the discontinuity in this temperamental tendency over time. One possibility is that the discontinuity is the result of measurement error, where more infants and children are labeled as negatively reactive and behaviorally inhibited than the ones that actually have this temperamental bias. Another possibility is that the development of adaptive attention and regulatory skills, supported by particular styles of parenting or caregiving contexts, and gender of the child contributes to a resilience process by influencing the longitudinal trajectories of behavioral inhibition across childhood. These explanations are not necessarily mutually exclusive. In some cases, early measurements may result in false positive

results. For instance, errors might occur when a child is assessed on a day when their schedule is inconsistent or they are feeling ill. In these cases, they might be negatively reactive to stimuli that would not typically elicit this kind of reaction. However, in other cases, behaviorally inhibited children may develop adaptive skills that assist with the display of more socially appropriate behavior as they get older. The current discussion focuses on how both extrinsic and intrinsic factors including parenting styles, caregiving contexts, psychophysiology, executive attention, inhibitory control, and child gender contribute to resilience processes as they impact the trajectories of behaviorally inhibited children (Figure 1).

Extrinsic factors

Although an infant's fearful temperament may in and of itself lead to greater inhibitory control and biased attention to threat, features of the early caregiving environment can modulate these pathways. Indeed, evidence from animal and human studies reveals the importance of contextual factors on the plasticity of social developmental outcomes (Hane & Fox, 2007). In addition, maternal perceptions of infant temperament are influenced by the infant's temperamental extremes within various types of interactions (Hane, Fox, Polak-Toste, Ghera, & Guner, 2006). For instance, Hane et al. (2006) found that infant negativity was most prominent to mothers during routine caregiving, whereas infant positivity was most prominent during play.

Maternal behavior. From birth, adults engage and disengage infant's attention to alter their arousal levels. States of engaged attention are linked to infant positive affect and greater arousal in general, and adults who are sensitive to an infant's need to disengage attention help reduce this arousal before it becomes overwhelming (Gottman, Katz, & Hooven, 1997). Similarly, adults who are aware of an infant's frequent negativity or distress might help by distracting the infant from the source of distress. Through this cyclical process of attentional

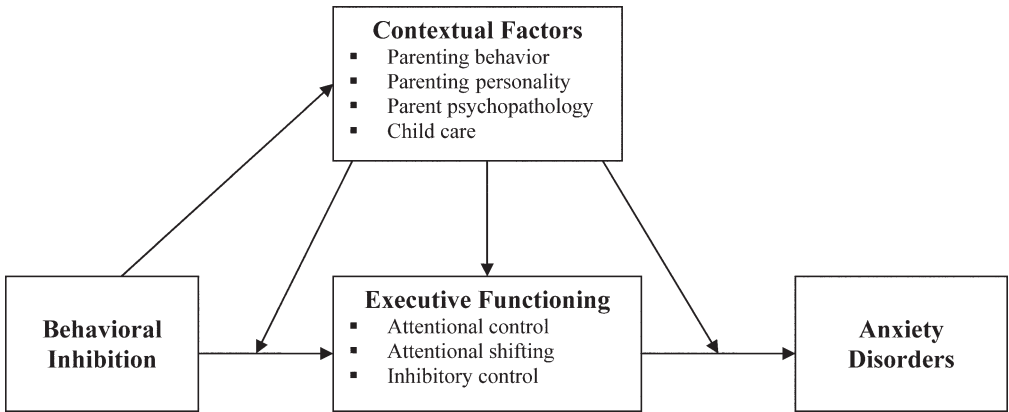


Figure 1. The pathway from behavioral inhibition to anxiety disorders: possible intervening factors supporting a resilience process.

engagement and disengagement, infants learn how to use their attention to regulate their emotions and behavior (Fox et al., 2005). This is just one example of how maternal behavior can contribute to resilience by influencing the development of attention and in turn influencing children's trajectories of inhibited behavior.

In addition to maternal influence on attentional control, research has found specific parenting behaviors associated with the continuity or discontinuity of behavioral inhibition. In general, oversolicitous or intrusive parenting is associated with toddler inhibition and preschool social reticence (Rubin, Burgess, & Hastings, 2002; Rubin, Cheah, & Fox, 2001; Rubin et al., 1997) and maternal acceptance, warmth, sensitivity, and responsiveness are associated with less inhibited, more socially adaptive behavior (Park et al., 1997; Wood, McLeod, Sigman, Hwang, & Chu, 2003). For example, mothers who are more sensitive to their behaviorally inhibited children may reduce behavioral inhibition by increasing self-esteem and decreasing negative affect (Fox et al., 2005). Belsky, Fish, and Isabella (1991) found that infants who had positive interactions with their mothers demonstrated less negative affect over a period of 6 months.

An alternative viewpoint is that sensitive parenting may maintain inhibited behavior by catering to the child's fears and suggesting that extreme fearfulness is not something one

can change (Kagan, 1994; Park et al., 1997). This proposal has been supported by research finding that parents who are overly warm and solicitous tend to have children who maintain their behaviorally inhibited tendencies across childhood (Degnan et al., in press; Rubin, Burgess, & Hastings, 2002). Some research also has suggested that this oversolicitousness includes an intrusive, overcontrolling quality, whereas other work suggests that inhibition is related to lower intrusiveness (Park et al., 1997; Rubin et al., 1997; van Brakel et al., 2006). Overall, parents who guide their children to engage socially may protect their children from developing more extreme patterns of social anxiety (Wood et al., 2003) by decreasing their attentional bias to threat and promoting exploration and social activity in their children (Fox et al., 2005). In addition, parenting behaviors may change over time and be influenced by other factors in the environment such as siblings (Arcus & McCartney, 1989). Investigations into the role of parenting on the discontinuity of behavioral inhibition and anxiety disorders should examine parenting behavior across time as it could be the alterations in this behavior throughout childhood that contributes to the resilience process.

Parents' behavioral interaction with their inhibited children over time also influences their broader relationship. When parents react to their inhibited children by protecting and guarding them from their fears, the child's fears

are reinforced and even heightened. Repetitive interactions like this may lead to differential relationship or attachment patterns. It is conceivable that maternal efforts to minimize their children's fears may appear sensitive in nature and might lead to a secure attachment relationship. However, parents' constant effort to guard children from fearful situations might actually put a great deal of strain on the relationship. In fact, research has shown that insecure attachment is linked to higher levels of child and adolescent anxiety disorders, especially for those children who were previously behaviorally inhibited (Shamir-Essakow et al., 2005; van Brakel et al., 2006). However, this work is limited, and research is needed to clarify the roles of maternal behavior and the mother-child attachment relationship on the resilience process for behaviorally inhibited children.

Child care history. Another context in which children are exposed to different caretaking behaviors is nonparental child care. Throughout infancy and toddlerhood, different forms of child care could influence the resilience process by changing the environment in which the child is developing. Within the child care context, children may gain experience interacting with peers in a variety of situations and then apply those skills to situations outside of child care. This experience with peers may be particularly important for behaviorally inhibited children, as they might not have access to these types of interactive situations otherwise. Therefore, inhibited children who are exposed to peer interaction early on may learn and develop stronger social approach strategies and become less inhibited over time. In fact, Fox, Henderson, Rubin et al. (2001) found that infants who showed high negative emotionality at 4 months of age were less likely to become inhibited as toddlers when they were placed in nonparental child care environments with one or more non-sibling children for 10 hr or more per week. In addition, Arcus and colleagues have shown that children who attended nonparental child care or experienced instability in their child care status were less likely to display stability in inhibition across toddlerhood (Arcus & McCartney, 1989). Furthermore, socially withdrawn preschoolers given the opportunity to interact with other

children seem to decrease their inhibited behavior (Furman, Rahe, & Hartup, 1979) and treatment approaches that include peers seem to be effective for decreasing rates of internalizing symptoms (Greco & Morris, 2001). Overall, peer interaction typically is necessary for competent social development (Rubin, Bukowski, & Parker, 1998) and providing these interactions may assist inhibited children in particular. However, another study by Broberg (1993) did not find an effect of nonparental child care on the stability of inhibited behavior through 40 months of age. Therefore, additional work may be necessary to truly elucidate the role of context and peer interaction in this resilience process for behaviorally inhibited children. Perhaps specific contextual characteristics of the child care environments have different effects depending on the child's initial level of social behavior (i.e., different types of protective effects).

The effect of nonparental childcare may also be affected by the personality of parents who choose nonparental child care versus parental child care (Clarke-Stewart & Allhusen, 2002; Fox, Henderson, Rubin, et al., 2001). For instance, a mother who herself exhibits social wariness may be less likely to place a behaviorally inhibited child in child care (NICHD, 1997). In turn, this decision might limit the child's range of experiences and lead to greater continuity of inhibited behavior (Fox, Henderson, Rubin, et al., 2001; Rubin & Burgess, 2002; Rubin, Burgess, & Coplan, 2002). In contrast, mothers who are socially adept may be more likely to place behaviorally inhibited children in nonparental child care, thus exposing them to vital social interaction for positive social adaptive behavior. Of course, this positive effect of child care may only exist in positive, supportive child care environments (Clarke-Stewart & Allhusen, 2002; Gazelle, 2006). A recent study found that inhibited children were more likely to be placed in child care settings with smaller child-adult ratios and more positive caregiver-child interactions (Sussman, Crowell, Phillips, Hane, & Fox, 2007). Thus, whether directly or indirectly, early nonparental child care might influence children's trajectories of behavioral inhibition and anxiety disorders throughout development leading to a

resilience process. Further work needs to examine the specific peer interactions within these settings to help determine whether it is the additional caregiver interaction, the additional peer interaction, or a combination of the two that contributes most directly to the child's behavioral inhibition trajectory.

Maternal personality. Moreover, although maternal personality may have an influence on child care decision making, it also might be directly related to the discontinuity of child behavioral inhibition itself. For instance, recent work has suggested that maternal neuroticism or negativity is related to greater stability in children's behavioral inhibition (Degnan et al., in press), whereas researchers have found that maternal extraversion is related to less child internalizing behavior problems (Rosenbaum et al., 1988). There are many reasons why maternal extraversion or general personality may influence this resilience process. One possibility is that children may model their mother's positive affect and approach motivation. Another possibility is that mothers high in extraversion may respond to their children's emotions in a qualitatively different way than parents who are withdrawn themselves. For example, mothers who are more extraverted, agreeable, or positive tend to display more adaptive parenting behavior, such as warmth and support (Belsky, Crnic, & Woodworth, 1995; Manglesdorf, Gunnar, Kestenbaum, Lang, & Andreas, 1990). In addition, parents of behaviorally inhibited children have reported their children to be highly vulnerable (Shamir-Essakow, Ungerer, Rapee, & Saffier, 2004). Therefore, maternal extraversion might lead a parent to support and encourage their own child's exploration, as opposed to protecting and guarding their behaviorally inhibited child.

Mothers' personality traits also may influence children's outcomes through the specific parenting behaviors they display (Brook, Tseng, Whiteman, & Cohen, 1998; Cummings & Davies, 1994; Fish & Stifter, 1993; Kochanska, Clark, & Goldman, 1997). For instance, mothers who are extraverted and positive may attempt to use their children's negative experiences to teach them adaptive regulatory skills. Research on anxious mothers has shown that they are more

likely to display negative affect and overcontrol and less likely to display positive affect or grant autonomy during parent-child interaction (Ginsburg, Grover, & Ialongo, 2004; Moore, Whaley, & Sigman, 2004). Furthermore, Ginsburg et al. (2004) found that among anxious mothers, the level of autonomy granting to their first-grade children was significantly associated with their children's levels of anxiety. Given these findings, parents who are more extraverted, display positive affect, and support children's autonomy may decrease children's risk of developing anxiety disorders by arming them with the tools necessary to develop positive social relationships.

All in all, exogenous factors such as maternal behavior, personality, and child care context may work in concert to influence trajectories of behavioral inhibition across childhood. In addition, work examining these relations has been limited. Thus, future studies need to explore the various possible resilience processes that these contextual factors may be involved in. For instance, investigations need to determine what maternal behaviors, in which situations, truly help children overcome their immediate fears while learning how to regulate these fears in the future. In addition, specific factors inherent to nonparental child care that can allow children to become more social need to be explored. Attempting to answer some of these questions will greatly enhance our understanding of behavioral inhibition and its role in the contextual world.

Intrinsic factors

Although contextual factors such as maternal behavior and child care may directly influence the resilience process for behaviorally inhibited children, they also may influence other child factors that in turn affect the trajectories of behavioral inhibition and anxiety problems. For instance, maternal factors might influence children's physiology and attentional and inhibitory control, which then influence whether children maintain or decline their behavioral inhibition (Hane & Fox, 2007). In addition, endogenous factors such as motivational bias to approach or withdraw, executive functioning,

and gender might directly influence the resilience process regardless of context.

Motivational bias to approach or withdraw (electroencephalogram [EEG] asymmetry). Recent research has focused on neural factors that may be influenced by the environment to influence child socioemotional outcomes. One measure that has been used in the study of infant temperament, the EEG, is low-level electrical activity recorded off the scalp, which is related to cortical activity (Stern, Ray, & Quigley, 2001). It has been hypothesized that a child's general type of motivation (avoidance vs. approach) is associated with asymmetries in frontal EEG activity, but that the intensity of emotion is associated with generalized activation of both frontal regions (Dawson, 1994). In applying EEG to the study of emotion, Fox and Davidson (Davidson & Fox, 1982, 1989; Fox & Davidson, 1986, 1987, 1988) examined whether differences in hemispheric asymmetry are markers for individual differences in emotionality in infancy, and argued that infants who show a characteristic right-sided frontal activation may have a lower threshold for experiencing negative emotion (Davidson & Fox, 1989; Fox & Davidson, 1991). More recently, this work has been extended to examine differences among behaviorally inhibited and uninhibited children. Data from multiple longitudinal cohorts of infants and children suggest that infants who are negatively reactive to novelty are more likely to exhibit greater relative right frontal activation (Calkins et al., 1996), and children who continue to show inhibited and shy behavior in childhood also display greater right frontal asymmetry (Fox, Schmidt, Calkins, Rubin, & Coplan, 1996). In contrast, infants who are high in motor activity and positive emotion typically do not display right frontal asymmetry (Calkins et al., 1996). In fact, whereas right frontal activation has been linked to active withdrawal, negative affect, fear, and anxiety, left frontal activation has been linked to active approach, positive affect, exploration, and sociability (Fox, 1994).

Although greater right frontal EEG asymmetry has typically been linked to higher levels of behavioral inhibition, there is also evidence for the effects of left frontal EEG asymmetry on the continuity in behavioral inhibition over time.

A study examining the continuity between negative reactivity to novelty at 9 months of age and social wariness at 4 years of age found that these behavioral measures were only related over time when children showed right frontal EEG asymmetry at 9 months of age (Henderson et al., 2001). When children showed left frontal EEG asymmetry as infants, their negative reactivity in infancy did not correlate with their level of social wariness in preschool. In addition, at 4 years of age, children who displayed solitary-passive or reticent behavior with peers were found to have greater right frontal EEG asymmetry (Henderson et al., 2004). Given that left frontal EEG asymmetry has been linked to approach, positive affect, and sociability (Fox, 1994), this biological characteristic may influence the development of stable inhibited tendencies that could lead to serious social and psychopathological difficulties throughout childhood. Overall, infants who display negative reactivity in response to novelty may be at an increased risk for internalizing disorders; however, having a biological motivation for approach may contribute to the resilience process by overcoming their initial reactivity, adopting skills to regulate that reactivity, and demonstrating positive social behaviors.

Although the temperament literature typically discusses the reactivity and regulation systems, the approach-withdrawal motivational system associated with EEG asymmetry also may have implications for children's behavioral inhibition. For many children, the reactivity and motivation systems may act in synchrony, with children who are negatively reactive to novelty being more withdrawal oriented (i.e., right frontal EEG asymmetry). However, some children may exhibit a stronger motivational system that helps them lessen their negative reactivity to novelty. For instance, a child could experience a greater amount of negative affect and worry when entering a new situation and at the same time be motivated to engage in social interaction to decrease these feelings of distress. This motivation has been suggested to stem from left frontal EEG asymmetry (Fox, 1994), and may also support the development of skills for regulating the initial reactive tendencies. Recently, Rothbart and Bates (2006) have discussed the potential reactivity-regulation interactive effects

on child social–emotional outcomes. However, less attention has been focused on the possible role of the motivational system in these outcomes. Although behaviorally inhibited children may typically display right frontal EEG asymmetry (Calkins et al., 1996; Fox et al., 1996), those that display left frontal EEG asymmetry from an early age may be an intriguing example of the resilience process.

Temperamental reactivity and regulation (cardiac measures). In addition to frontal EEG, measures of cardiac reactivity, such as heart rate (HR) and heart period (HP; time between heart beats) are related to levels of child behavioral inhibition. In general, children with greater emotional reactivity and anxiety to novel people, places, and events would be expected to evidence greater physiological reactivity. Kagan and colleagues (Garcia Coll et al., 1984; Kagan et al., 1984, 1988) have found among their samples that children with the most stable and most extreme behavioral inhibition across childhood also displayed higher and more stable HR at each time point than children with less stable or less behavioral inhibition. In addition, children who maintain higher inhibition from 4 to 7 years of age have been found to have lower HP than those children who did not maintain their inhibited behavior over time (Marshall & Stevenson-Hinde, 1998). More recently, researchers also found that preschool children who displayed solitary–passive behavior with peers and evidenced lower HP were the most inhibited in the laboratory in toddlerhood (Henderson et al., 2004).

These effects of cardiac reactivity may result from their relation to children's ability to regulate their emotions and behavior, as lower HR and higher HP may be related to greater emotion regulation or inhibitory control. In fact, research has shown that HR variability at the frequency of breathing, or vagal tone (VT), is related to measures of emotion regulation. Although vagal stimulation delays the onset of the heart beat, lengthening the HP, vagal withdrawal shortens the time period between beats or speeds up the HR (Porges, Doussard-Roosevelt, & Maiti, 1994). Under stress or challenge, respiratory sinus arrhythmia (RSA; the accessible measure of VT) typically decreases

from baseline (vagal withdrawal), and this decrease has been modestly related to emotion regulation behaviors in infancy and childhood (Calkins, 1997; Calkins & Dedmon, 2000). In addition, children who display vagal withdrawal to challenge appear less negatively reactive and exhibit higher levels of social approach (Stifter & Corey, 2001). Therefore, children who are able to withdraw their VT and decrease their HR during challenge may be able to regulate their fearful and anxious reactions to novelty. In fact, this physiological regulatory mechanism along with greater left frontal EEG asymmetry or approach motivation may contribute to the resilience process by helping to discontinue a child's behavioral inhibition trajectory and decrease their risk for an anxiety disorder over time.

Executive functioning: Inhibitory control and executive attention. Including processes such as executive attention and inhibitory control, executive functioning serves as a macro construct encompassing different underlying constructs that work in concert to solve a problem (Zelazo, Carter, Reznick, & Frye, 1997). In addition, these concepts of inhibitory (behavioral) and attentional control have been implicated in theories of regulation (Rothbart & Bates, 2006). Over time, infants and children gradually develop the capacity to regulate their reactive tendencies and become increasingly independent from external support (Kopp, 1982). Although early in development infant emotional reactivity is largely based on influences from the limbic system (Panksepp, 1998), with age and cortical development, cognitive control capacities, such as inhibitory control and executive attention, increase and allow for greater influence over more basic temperamental reactivity (Rueda et al., 2004). Behaviorally inhibited children who are able to utilize certain cognitive skills to flexibly focus and shift attention may be more likely to evidence the resilience process and develop socially adaptive behavior.

Normatively, behavioral inhibition serves to increase vigilance and attention to threatening environmental cues (LeDoux, 2000). Similar to reactivity to novelty, individuals also show differences in sensory orienting. These differences

have been connected to the posterior attention system, which begins functioning early in life (Derryberry & Rothbart, 1997). Throughout the literature, children who are behaviorally inhibited or anxious have been shown to look longer at instances of threat or novelty (MacLeod & Mathews, 1988; Wells & Matthews, 1994). In addition, Perez-Edgar and Fox (2005) found that during an emotional stroop task, shy children attended more and responded more quickly to negative cues than positive ones. These findings have been suggested to reflect either a greater vigilance to threat or an inability to disengage from threat (Derryberry & Reed, 1994). Thus, learning to intentionally control this attentional bias should allow children to regulate their inhibited or anxious behavior over time (Derryberry & Reed, 2002).

Voluntary or executive attentional control is a higher order cognitive process than attentional orienting. It is associated with a more anterior attention system, which leads to greater flexibility to focus and shift attention (Posner & Rothbart, 1998). In addition, the ability to disengage attention from threat may allow for greater self-regulation of thought, behavior, and emotion. Attentional control may be particularly difficult for behaviorally inhibited children, especially those displaying social reticence (Fox et al., 2005). During peer interaction, these children spend most of their time watching the other children (i.e., onlooker behavior) or disengaging from the group completely (i.e., solitary behavior; Coplan, Rubin, Fox, Calkins, & Stewart, 1994). This fixation is not only ineffective at decreasing wariness, but may also increase inhibition and anxiety over time as children are overwhelmed by their fear and unable to regulate these emotions (Fox et al., 2005; Derryberry & Rothbart, 1988). In fact, anxious adults with good attentional control are better able to shift their attention away from threatening stimuli compared to anxious adults with poor attentional control (Derryberry & Reed, 2002). In addition, children high on behavioral inhibition have been characterized as having lower levels of attentional control (Muris & Dietvorst, 2006). Therefore, inhibited or anxious children who develop attentional control may display the resilience process by decreasing their tendency for fear and anxiety over

time. In fact, this ability seems to be particularly important for the regulation of shyness. A study by Eisenberg, Shepard, Fabes, Murphy, and Guthrie (1998) found that shy children who were low in attention shifting had greater internalizing symptoms, whereas children who were better at attention shifting showed discontinuity in these problems over time.

Another construct often discussed in relation to executive functioning and cognitive control is inhibitory control, defined as the ability to inhibit responses to certain stimuli while pursuing a particular goal (Carlson & Moses, 2001). Frequently, greater inhibitory control is linked to fewer externalizing behavior problems; however, less work has examined its role in internalizing behavior problems such as behavioral inhibition and anxiety disorders. Whereas greater inhibitory control is suggested to be protective for children with externalizing behavior problems, it may be a risk factor for those with internalizing behavior problems (Kooijmans, Scheres, & Oosterlaan, 2000). For instance, Henderson and colleagues recently found that behaviorally inhibited children with greater inhibitory control on a delay task were more likely to display social reticence at 4 years of age (Henderson & Martin, 2004). In another study, high levels of 2-year behavioral inhibition and 4-year inhibitory control on a go-no-go task was shown to predict higher levels of preschool anxiety problems, whereas higher behavioral inhibition combined with lower inhibitory control predicted greater preschool externalizing problems (Osher, Martin McDermott, Degnan, Dubin, & Fox, 2007). Using similar measures at 5 years of age, Thorell, Bohlin, and Rydell (2004) found that greater levels of both behavioral inhibition and inhibitory control predicted greater social anxiety. However, the opposite was found in a study of 8- to 10-year-olds, in which greater mother-reported inhibitory control was related to fewer internalizing and externalizing problems (Lengua, 2003). Furthermore, a different type of inhibitory control measure, emotional regulation to a frustrating event, has been found to mediate the relation between neonatal reactivity and childhood anxiety disorders (Bosquet & Ege-land, 2006), such that children that stayed focused on the task and controlled their emotional

impulses were less likely to develop anxiety problems from their infant reactivity.

Given the limited range of studies that have examined the relation between inhibitory control and internalizing behavior problems, and the inconsistencies of the existing work, the role of inhibitory control needs to be examined more fully in future investigations. Although this ability to control impulses may enhance regulatory efforts for some children, it may exacerbate other children's natural tendencies to focus their attention on threatening stimuli. Therefore, behaviorally inhibited children with less inhibitory control may actually fare better than those with greater inhibitory control in the development of socially adaptive behavior. Future studies should aim to explore the exact mechanisms and processes that lead attentional and inhibitory control to alter children's emotional reactivity and how these processes contribute to the resilience process for those that are highly inhibited and anxious early on.

Gender. Common to many social outcomes, gender is another potential influence on the trajectories of behavioral inhibition and anxiety. In fact, some data suggest that stability in inhibited behavior is particularly evidenced by boys. In a study by Kagan et al. (1998), a greater percentage of boys that were negatively reactive in infancy (46% boys, 7% girls) were also inhibited in toddlerhood. In another study, infant negative temperament was only significantly related to 4-year social wariness for boys, whereas a significant relation over time was not found for girls (Henderson et al., 2001). Stevenson-Hinde and Shouldice (1995) also reported greater consistency in maternal ratings of sons' fears than daughters' fears from 4 to 7 years of age, although, girls reported being more worried about family members and boys reported being more worried about performance. Overall, fearfulness and anxiety may be more acceptable for girls, and parents may react to boys' fearfulness with greater concern and intrusiveness (Park et al., 1997). However, in a Swedish sample, whereas boys and girls were not significantly different on levels of behavioral inhibition at 16 years of age, girls who had greater inhibition by adolescence and boys who had the lowest inhibition by adolescence

showed more stability across childhood (Kerr et al., 1994). Despite this one finding, however, studies have been somewhat consistent in finding boys to show greater stability in behavioral inhibition across childhood. Therefore, being female may be an influential factor in the discontinuity of child behavioral inhibition and anxiety, although, perhaps as girls continue into adolescence this effect begins to act as a risk factor. In fact, Kerr et al. (1994) found similar stability for boys and girls through age 6. Only the stability estimates from age 7 to 16 were significantly different by gender. In addition, more work is needed to establish how gender affects this resilience process. One possibility is that parents act more concerned and overprotective of boys that appear inhibited and thus, contribute to the continuity in this behavior over time. Another possibility is that stability is greater for behavioral extremes that are not considered gender appropriate. Then, conceivably, this effect would disappear in less westernized cultures where it is appropriate for boys to display inhibited behavior and anxiety. Studies like this need to be conducted in order to truly understand the role of gender in the behavioral inhibition resilience process.

Summary and Conclusions

Although numerous research efforts have focused on the heterotypic continuity of behavioral inhibition and anxiety, there are many examples of discontinuity. On average, 30% of infants who are negatively reactive to novelty and up to 50% of behaviorally inhibited toddlers do not display behavioral inhibition in toddlerhood or later childhood. In addition, 30 to 80% of highly inhibited children neglect to develop internalizing disorders through adulthood. From a resilience perspective, these children, who are extremely inhibited early on and at risk for an anxiety disorder but seem to adapt socially and decline in their avoidance of novel stimuli, are positively adapting in the face of adversity or risk (Luthar et al., 2000). However, there is limited research examining the discontinuous nature and possible intervening factors involved in child internalizing problems (Gar et al., 2005). Thus, exploring this discontinuity more directly

and the endogenous and exogenous factors that help ameliorate the fear and avoidance to the unfamiliar may further define behavioral inhibition and its resilience process.

Although the initial, involuntary reaction to the unfamiliar may persist, there may be factors that help decrease the observable nature and functional interference of behavioral inhibition and anxiety problems. Furthermore, these factors probably stem from biological, cognitive, and social processes throughout childhood. Developing the ability to regulate reactivity to novelty within multiple settings allows children to develop positive social skills and decrease in inhibited and anxious behavior over time. Although internal factors such as children's lower levels of temperamental reactivity may account, in part, for the development of regulatory skills and the discontinuity in behavioral inhibition (Kagan & Snidman, 1991), external factors, such as executive functioning, parenting, the caregiving context, psychophysiology, and gender also may influence the stability of behavioral inhibition and its concomitants (Fox, Henderson, Rubin, et al., 2001; Posner & Rothbart, 2000; Rubin & Burgess, 2002).

Furthermore, literature on resilience typically has focused on more contextual risk factors such as poverty or maltreatment and the positive adaptation that is displayed despite these risks or adversity. Less work has examined temperamental biases as potential risk factors that

may also evidence a resilience process. The discussion above has highlighted multiple factors across multiple levels of analysis that may have an impact on the trajectories of behaviorally inhibited children. However, the roles of additional contextual factors in the broader ecological environment have not been extensively studied in regard to behavioral inhibition. Theorists have frequently suggested that the existence of multiple risk factors lead to heightened problematic outcomes (Cicchetti & Garmezy, 1993; Luthar et al., 2000). Therefore, behaviorally inhibited children who are also living in an ecological context that adds additional risks for social withdrawal and anxiety might need additional protective factors in order to truly benefit from a resilience process.

Throughout the last few decades, researchers have provided a multitude of empirical and theoretical information on the neural underpinnings, emotional and behavioral sequelae, and psychopathological outcomes for child behavioral inhibition (Fox et al., 2005). However, there are still issues that present a challenge to current researchers in this area. One of these issues is an understanding of the factors that contribute to discontinuity or resilience in behaviorally inhibited populations. Although the current discussion highlights a few of these constructs, future research is needed to fully understand their role in this developmental resilience process.

References

- American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.
- American Psychological Association. (2007). *APA dictionary of psychology*. Washington, DC: Author.
- Arcus, D., & McCartney, K. (1989). When baby makes four: Family influences in the stability of behavioral inhibition. In J. S. Reznick (Ed.), *Perspectives on behavioral inhibition* (pp. 197–218). Chicago: University of Chicago Press.
- Asendorpf, J. B. (1990). Development of inhibition during childhood: Evidence for situational specificity and a two-factor model. *Developmental Psychology, 26*, 721–730.
- Asendorpf, J. B. (1994). The malleability of behavioral inhibition: A study of individual developmental functions. *Developmental Psychology, 30*, 912–919.
- Belsky, J., Crnic, K., & Woodworth, S. (1995). Personality and parenting: Exploring the mediating role of transient mood and daily hassles. *Journal of Personality, 63*, 905–929.
- Belsky, J., Fish, M., & Isabella, R. (1991). Continuity and discontinuity in infant negative and positive emotionality: Family antecedents and attachment consequences. *Developmental Psychology, 27*, 421–431.
- Biederman, J., Hirshfeld-Becker, D. R., Rosenbaum, J. F., Herot, C., Friedman, D., Snidman, N., et al. (2001). Further evidence of association between behavioral inhibition and social anxiety in children. *American Journal of Psychiatry, 158*, 1673–1679.
- Biederman, J., Rosenbaum, J. F., Hirshfeld, D. R., Faraone, S. V., Bolduc, E. A., Gersten, M., et al. (1990). Psychiatric correlates of behavioral inhibition in young children of parents with and without psychiatric disorders. *Archives of General Psychiatry, 47*, 21–26.
- Bosquet, M., & Egeland, B. (2006). The development and maintenance of anxiety symptoms from infancy through adolescence in a longitudinal sample. *Development and Psychopathology, 18*, 517–550.
- Broberg, A. G. (1993). Inhibition and children's experiences of out-of-home care. In K. H. Rubin & J. B. Asendorpf (Eds.), *Social withdrawal, inhibition, and*

- shyness in childhood (pp. 151–176). Chicago: University of Chicago Press.
- Bronson, G. W., & Pankey, W. B. (1977). On the distinction between fear and wariness. *Child Development, 48*, 1166–1183.
- Brook, J. S., Tseng, L. J., Whiteman, M., & Cohen, P. (1998). A three-generation study: Intergenerational continuities and discontinuities and their impact on the toddler's anger. *Genetic, Social, and General Psychology Monographs, 124*, 335–351.
- Calkins, S. D. (1994). Origins and outcomes of individual differences in emotion regulation. *Monographs of the Society for Research in Child Development, 59*, 53–72.
- Calkins, S. D. (1997). Cardiac vagal tone indices of temperamental reactivity and behavioral regulation in young children. *Developmental Psychobiology, 31*, 125–135.
- Calkins, S. D., & Dedmon, S. E. (2000). Physiological and behavioral regulation in two-year-old children with aggressive/destructive behavior problems. *Journal of Abnormal Child Psychology, 28*, 103–118.
- Calkins, S. D., & Degnan, K. A. (2006). Temperament in early development: Implications for childhood psychopathology. In R. Ammerman (Ed.), *Comprehensive handbook of childhood psychopathology* (pp. 64–84). New York: Wiley.
- Calkins, S. D., & Fox, N. A. (1992). The relations among infant temperament, security of attachment, and behavioral inhibition at twenty-four months. *Child Development, 63*, 1456–1472.
- Calkins, S. D., Fox, N. A., & Marshall, T. R. (1996). Behavioral and physiological antecedents of inhibited and uninhibited behavior. *Child Development, 67*, 523–540.
- Carlson, S. M., & Moses, L. J. (2001). Individual differences in inhibitory control and children's theory of mind. *Child Development, 72*, 1032–1053.
- Cicchetti, D., & Garmezy, N. (1993). Prospects and promises in the study of resilience. *Development and Psychopathology, 5*, 497–502.
- Clarke-Stewart, K. A., & Allhusen, V. D. (2002). Nonparental caregiving. In M. H. Bornstein (Ed.), *Handbook of parenting* (2nd ed., Vol. 3, pp. 215–252). Mahwah, NJ: Erlbaum.
- Coplan, R. J., Rubin, K. H., Fox, N. A., Calkins, S. D., & Stewart, S. L. (1994). Being alone, playing alone, and acting alone: Distinguishing among reticence and passive and active solitude in young children. *Child Development, 65*, 129–137.
- Coplan, R. J., Wilson, J., Frohlick, S. L., & Zelenski, J. (2006). A person-oriented analysis of behavioral inhibition and behavioral activation in children. *Personality and Individual Differences, 41*, 917–927.
- Cummings, E. M., & Davies, P. T. (1994). Maternal depression and child development. *Journal of Child Psychology and Psychiatry, 35*, 73–112.
- Davidson, R. J., & Fox, N. A. (1982). Asymmetrical brain activity discriminates between positive and negative affective stimuli in human infants. *Science, 218*, 1235–1237.
- Davidson, R. J., & Fox, N. A. (1989). Frontal brain asymmetry predicts infants' response to maternal separation. *Journal of Abnormal Psychology, 98*, 127–131.
- Davidson, R. J., Putnam, K. M., & Larson, C. L. (2000). Dysfunction in the neural circuitry of emotion regulation—A possible prelude to violence. *Science, 289*, 591–594.
- Davis, M. (1986). Pharmacological and anatomical analysis of fear conditioning using the fear-potentiated startle paradigm. *Behavioral Neuroscience, 100*, 814–824.
- Dawson, G. (1994). Frontal electroencephalographic correlates of individual differences in emotion expression in infants: A brain systems perspective on emotion. *Monographs of the Society for Research on Child Development, 59*, 135–151.
- Degnan, K. A., Henderson, H. A., Fox, N. A., & Rubin, K. H. (in press). Predicting social wariness in middle childhood: The moderating roles child history, maternal personality and maternal behavior. *Social Development*.
- Derryberry, D., & Reed, M. A. (1994). Temperament and the self-organization of personality. *Development and Psychopathology, 6*, 653–676.
- Derryberry, D., & Reed, M. A. (2002). Anxiety-related attentional biases and their regulation by attentional control. *Journal of Abnormal Child Psychology, 111*, 225–236.
- Derryberry, D., & Rothbart, M. K. (1988). Arousal, affect, and attention as components of temperament. *Journal of Personality and Social Psychology, 55*, 958–966.
- Derryberry, D., & Rothbart, M. K. (1997). Reactive and effortful processes in the organization of temperament. *Development and Psychopathology, 9*, 633–652.
- Eisenberg, N., Shepard, S. A., Fabes, R. A., Murphy, B. C., & Guthrie, I. K. (1998). Shyness and children's emotionality, regulation, and coping: Contemporaneous, longitudinal, and across-context relations. *Child Development, 69*, 767–790.
- Fish, M., & Stifter, C. A. (1993). Mother parity as a main and moderating influence on early mother infant interaction. *Journal of Applied Developmental Psychology, 14*, 557–572.
- Fox, N. A. (1994). Dynamic cerebral processing underlying emotion regulation. *Monographs of the Society for Research in Child Development, 59*, 152–166.
- Fox, N. A., & Davidson, R. J. (1986). Taste-elicited changes in facial signs of emotion and the asymmetry of brain electrical activity in human newborns. *Neuropsychologia, 24*, 417–422.
- Fox, N. A., & Davidson, R. J. (1987). Electroencephalogram asymmetry in response to the approach of a stranger and maternal separation in 10-month-old infants. *Developmental Psychology, 23*, 233–240.
- Fox, N. A., & Davidson, R. J. (1988). Patterns of brain electrical activity during facial signs of emotion in 10-month-old infants. *Developmental Psychology, 24*, 230–236.
- Fox, N. A., & Davidson, R. J. (1991). Hemispheric asymmetry and attachment behaviors: Developmental processes and individual differences in separation protest. In J. L. Gewirtz & W. M. Kurtines (Eds.), *Interactions with attachment* (pp. 147–164). Hillsdale, NJ: Erlbaum.
- Fox, N. A., Henderson, H. A., & Marshall, P. J. (2001). The biology of temperament: An integrative approach. In C. A. Nelson & M. Luciana (Eds.), *The handbook of developmental cognitive neuroscience* (pp. 631–645). Cambridge, MA: MIT Press.
- 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*, 1–21.

- Fox, N. A., Schmidt, L. A., Calkins, S. D., & Rubin, K. H., & Coplan, R. J. (1996). The role of frontal activation in the regulation and dysregulation of social behavior during the preschool years. *Development and Psychopathology*, 8, 89–102.
- Furman, W., Rahe, D. F., & Hartup, W. W. (1979). Rehabilitation of socially withdrawn preschool children through mixed-age and same-age socialization. *Child Development*, 50, 915–922.
- Gar, N. S., Hudson, J. L., & Rapee, R. M. (2005). Family factors and the development of anxiety disorders. In J. L. Hudson & R. M. Rapee (Eds.), *Psychopathology and the family* (pp. 125–145). New York: Elsevier.
- Garcia Coll, C., Kagan, J., & Reznick, J. S. (1984). Behavioral inhibition in young children. *Child Development*, 55, 1005–1019.
- Gazelle, H. (2006). Class climate moderates peer relations and emotional adjustment in children with an early history of anxious solitude: A child \times environment model. *Developmental Psychology*, 42, 1179–1192.
- Ginsburg, G. S., Grover, R. L., & Ialongo, N. (2004). Parenting behaviors among anxious and non-anxious mothers: Relation with concurrent and long-term child outcomes. *Child and Family Behavior Therapy*, 26, 23–41.
- Gladstone, G., & Parker, G. (2005). Measuring a behaviorally inhibited temperament style: Development and initial validation of new self-report measures. *Psychiatry Research*, 135, 133–143.
- Gladstone, G. L., Parker, G. B., Mitchell, P. B., Wilhelm, K. A., & Malhi, G. S. (2005). Relationship between self-reported childhood behavioral inhibition and lifetime anxiety disorders in a clinical sample. *Depression and Anxiety*, 22, 103–113.
- Gottman, J. M., Katz, L. F., & Hooven, C. (1997). *Meta-emotion: How families communicate emotionally*. Mahwah, NJ: Erlbaum.
- Greco, L. A., & Morris, T. L. (2001). Treating childhood shyness and related behavior: Empirically evaluated approaches to promote positive social interactions. *Clinical Child and Family Psychology Review*, 4, 299–318.
- Hane, A. A., & Fox, N. A. (2007). A closer look at the transactional nature of early social development: The relations among early caregiving environments, temperament, and early social development. In F. Santoianni & C. Sabatano (Eds.), *Brain development in learning environments: Embodied and perceptual advancements*. Newcastle-upon-Tyne: Cambridge Scholars Press.
- Hane, A. A., Fox, N. A., Polak-Toste, C., Ghera, M., & Guner, B. (2006). Contextual basis of maternal perceptions of infant temperament. *Developmental Psychology*, 42, 1077–1088.
- Hayward, C., Killen, J. D., Kraemer, H. C., & Taylor, C. B. (1998). Linking self-reported childhood behavioral inhibition to adolescent social phobia. *Journal of the American Academy of Child & Adolescent Psychiatry*, 37, 1308–1316.
- Henderson, H. A., Fox, N. A., & Rubin, K. H. (2001). Temperamental contributions to social behavior: The moderating roles of frontal EEG asymmetry and gender. *Journal of the American Academy of Child & Adolescent Psychiatry*, 40, 68–74.
- Henderson, H. A., Marshall, P. J., Fox, N. A., & Rubin, K. H. (2004). Psychophysiological and behavioral evidence for varying forms and functions of nonsocial behavior in preschoolers. *Child Development*, 75, 251–263.
- Henderson, H. A., & Martin, J. N. (2004). *Individual differences in the adaptiveness of self-control*. Paper presented at the Biennial Meeting of the International Society for Infant Studies, Chicago.
- Kagan, J. (1994). On the nature of emotion. *Monographs of the Society for Research in Child Development*, 59, 7–24.
- Kagan, J. (2001). Temperamental contributions to affective and behavioral profiles in childhood. In S. G. Hoffmann & P. M. Dibartolo (Eds.), *From social anxiety to social phobia: Multiple perspectives* (pp. 216–234). Needham Heights, MA: Allyn & Bacon.
- Kagan, J., & Moss, H. A. (1962). *Birth to maturity: A study in psychological development*. London: Wiley.
- Kagan, J., Reznick, J. S., Clarke, C., Snidman, N., & Garcia-Coll, C. (1984). Behavioral inhibition to the unfamiliar. *Child Development*, 55, 2212–2225.
- Kagan, J., Reznick, J. S., & Snidman, N. (1987). The physiology and psychology of behavioral inhibition in children. *Child Development*, 58, 1459–1473.
- Kagan, J., Reznick, J. S., Snidman, N., Gibbons, J., & Johnson, M. O. (1988). Childhood derivatives of inhibition and lack of inhibition to the unfamiliar. *Child Development*, 59, 1580–1589.
- Kagan, J., & Snidman, N. (1991). Temperamental factors in human development. *American Psychologist*, 46, 856–862.
- Kagan, J., Snidman, N., & Arcus, D. (1998). Childhood derivatives of high and low reactivity in infancy. *Child Development*, 69, 1483–1493.
- Kerr, M., Lambert, W. W., Stattin, H., & Klackenberglarsson, I. (1994). Stability of inhibition in a Swedish longitudinal sample. *Child Development*, 65, 138–146.
- Kochanska, G., Clark, L. A., & Goldman, M. S. (1997). Implications of mothers' personality for their parenting and their young children's developmental outcomes. *Journal of Personality*, 65, 387–420.
- Kooijmans, R., Scheres, A., & Oosterlaan, J. (2000). Response inhibition and measures of psychopathology: A dimensional analysis. *Child Neuropsychology*, 6, 175–184.
- Kopp, C. B. (1982). Antecedents of self-regulation: A developmental perspective. *Developmental Psychology*, 18, 199–214.
- LeDoux, J. E. (2000). Emotion circuits in the brain. *Annual Review of Neuroscience*, 23, 155–184.
- LeDoux, J. E., Iwata, J., Cicchetti, P., & Reis, D. J. (1988). Different projections of the central amygdaloid nucleus mediate autonomic and behavioral correlates of conditioned fear. *Journal of Neuroscience*, 8, 2517–2529.
- Lengua, L. J. (2003). Associations among emotionality, self-regulation, adjustment problems, and positive adjustment in middle childhood. *Applied Developmental Psychology*, 24, 595–618.
- Luthar, S. S., Cicchetti, D., & Becker, B. (2000). The construct of resilience: A critical evaluation and guidelines for future work. *Child Development*, 71, 543–562.
- MacLeod, C., & Mathews, A. (1988). Anxiety and the allocation of attention to threat. *Quarterly Journal of Experimental Psychology*, 40, 653–670.
- Mangelsdorf, S., Gunnar, M., Kestenbaum, R., Lang, S., & Andreas, D. (1990). Infant proneness-to-distress temperament, maternal personality, and mother-infant attachment: Associations and goodness of fit. *Child Development*, 61, 820–831.
- Marshall, P. J., & Stevenson-Hinde, J. (1998). Behavioral inhibition, heart period, and respiratory sinus arrhythmia

- in young children. *Developmental Psychobiology*, 33, 283–292.
- Masten, A. S. (2001). Ordinary magic. Resilience processes in development. *American Psychologist*, 56, 227–238.
- Masten, A. S., & Coatsworth, J. D. (1998). The development of competence in favorable and unfavorable environments. Lessons from research on successful children. *American Psychologist*, 53, 205–220.
- Moore, P. S., Whaley, S. E., & Sigman, M. (2004). Interactions between mothers and children: Impacts of maternal and child anxiety. *Journal of Abnormal Psychology*, 113, 471–476.
- Muris, P., & Dietvorst, R. (2006). Underlying personality characteristics of behavioral inhibition in children. *Child Psychiatry and Human Development*, 36, 437–445.
- NICHD Early Childcare Research Network. (1997). Familial factors associated with the characteristics of nonmaternal care for infants. *Journal of Marriage and Family*, 59, 389–408.
- Osher, J. E., Martin McDermott, J. N., Degnan, K. A., Dubin, A. H., & Fox, N. A. (2007). *The interactive effects of temperament and inhibitory control on maladaptive preschool behavior*. Paper presented at the Biennial Meeting of the Society for Research in Child Development, Boston.
- Panksepp, J. (1998). *Affective neuroscience*. New York: Oxford University Press.
- Park, S., Belsky, J., Putnam, S., & Crnic, K. (1997). Infant emotionality, parenting, and 3-year inhibition: Exploring stability and lawful discontinuity in a male sample. *Developmental Psychology*, 33, 218–227.
- Perez-Edgar, K., & Fox, N. A. (2005). Temperament and anxiety disorders. *Child Adolescent Psychiatry Clinics of North America*, 14, 681–706.
- Pfeifer, M., Goldsmith, H. H., Davidson, R. J., & Rickman, M. (2002). Continuity and change in inhibited and uninhibited children. *Child Development*, 73, 1474–1485.
- Porges, S. W., Doussard-Roosevelt, J. A., & Maiti, A. K. (1994). Vagal tone and the physiological regulation of emotion. *Monographs of the Society for Research in Child Development*, 59, 167–187.
- Posner, M. I., & Rothbart, M. K. (2000). Developing mechanisms of self-regulation. *Development and Psychopathology*, 12, 427–441.
- Putnam, S. P., & Stifter, C. A. (2005). Behavioral approach-inhibition in toddlers: Prediction from infancy, positive and negative affective components, and relations with behavior problems. *Child Development*, 76, 212–226.
- Reznick, J. S., Kagan, J., Snidman, N., Gersten, M., Baak, K., & Rosenberg, A. (1986). Inhibited and uninhibited children: A follow-up study. *Child Development*, 57, 660–680.
- Rosenbaum, J. F., Biederman, J., Gersten, M., Hirshfeld, D. R., Meminger, S. R., Herman, J. B., et al. (1988). Behavioral inhibition in children of parents with panic disorder and agoraphobia. A controlled study. *Archives of General Psychiatry*, 45, 463–470.
- Rothbart, M. K., Ahadi, S. A., & Evans, D. E. (2000). Temperament and personality: Origins and outcomes. *Journal of Personality and Social Psychology*, 78, 122–135.
- Rothbart, M. K., & Bates, J. E. (2006). Temperament. In W. Damon & N. Eisenberg (Eds.), *Handbook of child psychology: Vol. 3. Social, emotional, and personality development* (6th ed.). 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* (pp. 37–86). Hillsdale, NJ: Erlbaum.
- Rothbart, M. K., Derryberry, D., & Posner, M. I. (1994). A psychological approach to the development of temperament. In J. E. Bates & T. D. Wachs (Eds.), *Temperament: Individual differences at the interface of biology and behavior* (pp. 83–116). Washington, DC: American Psychological Association.
- Rubin, K. H., Bukowski, W., & Parker, J. (1998). Peer interaction, relationships, and groups. In N. Eisenberg (Ed.), *Handbook of child psychology: Vol. 3. Social, emotional, and personality development* (5th ed., pp. 619–700). New York: Wiley.
- Rubin, K. H., & Burgess, K. B. (2002). Parents of aggressive and withdrawn children. In M. H. Bornstein (Ed.), *Handbook of parenting: Vol. 1. Children and parenting* (2nd ed., pp. 383–418). Mahwah, NJ: Erlbaum.
- Rubin, K. H., Burgess, K. B., & Coplan, R. J. (2002). Social withdrawal and shyness. In P. K. Smith & C. H. Hart (Eds.), *Blackwell handbook of childhood social development* (pp. 329–352). Malden, MA: Blackwell.
- Rubin, K. H., Burgess, K. B., & Hastings, P. D. (2002). Stability and social-behavioral consequences of toddlers' inhibited temperament and parenting behaviors. *Child Development*, 73, 483–495.
- Rubin, K. H., Cheah, C. S. L., & Fox, N. A. (2001). Emotion regulation, parenting, and display of social reticence in preschoolers. *Early Education and Development*, 12, 97–115.
- Rubin, K. H., Hastings, P., Stewart, S., Henderson, H. A., & Chen, X. (1997). The consistency and concomitants of inhibition: Some of the children, all of the time. *Child Development*, 68, 467–483.
- Rubin, K. H., Hymel, S., & Mills, R. S. (1989). Sociability and social withdrawal in childhood: Stability and outcomes. *Journal of Personality*, 57, 237–255.
- Rueda, M. R., Fan, J., McCandliss, B. D., Halparin, J. D., Gruber, D. B., Lercari, L. P., et al. (2004). Development of attentional networks in childhood. *Neuropsychologia*, 42, 1029–1040.
- Sanson, A., Pedlow, R., Cann, W., Prior, M., & Oberklaid, F. (1996). Shyness ratings: Stability and correlates in early childhood. *International Journal of Behavioral Development*, 19, 705–724.
- Scarpa, A., Raine, A., Venables, P. H., & Mednick, S. A. (1995). The stability of inhibited/uninhibited temperament from ages 3 to 11 years in Mauritian children. *Journal of Abnormal Child Psychology*, 23, 607–618.
- Schwartz, C. E., Snidman, N., & Kagan, J. (1999). Adolescent social anxiety as an outcome of inhibited temperament in childhood. *Journal of the American Academy of Child & Adolescent Psychiatry*, 38, 1008–1015.
- Shamir-Essakow, G., Ungerer, J. A., & Rapee, R. M. (2005). Attachment, behavioral inhibition, and anxiety in preschool children. *Journal of Abnormal Child Psychology*, 33, 131–143.
- Shamir-Essakow, G., Ungerer, J. A., Rapee, R. M., & Safier, R. (2004). Caregiving representations of mothers of behaviorally inhibited and uninhibited preschool children. *Developmental Psychology*, 40, 899–910.
- Stern, R. M., Ray, W. J., & Quigley, K. S. (2001). *Psychophysiological recording* (2nd ed.). New York: Oxford University Press.
- Stevenson-Hinde, J., & Shouldice, A. (1995). 4.5 to 7 years: Fearful behaviour, fears, and worries. *Journal of Child Psychology and Psychiatry*, 36, 1027–1038.

- Stifter, C. A., & Corey, J. M. (2001). Vagal regulation and observed social behavior in infancy. *Social Development, 10*, 189–201.
- Sussman, A. L., Crowell, N. A., Phillips, D. A., Hane, A. A., & Fox, N. A. (2007). *Temperament, gender, and selection into high-quality child care*. Manuscript submitted for publication.
- Thorell, L. B., Bohlin, G., & Rydell, A. (2004). Two types of inhibitory control: Predictive relations to social functioning. *International Journal of Behavioral Development, 28*, 193–203.
- van Brakel, A. M. L., Muris, P., Bogels, S. M., & Thomassen, C. (2006). A multifactorial model for the etiology of anxiety in non-clinical adolescents: Main and interactive effects of behavioral inhibition, attachment, and parental rearing. *Journal of Child and Family Studies, 15*, 569–579.
- Wells, A., & Matthews, G. (1994). *Attention and emotion: A clinical perspective*. Hillsdale, NJ: Erlbaum.
- Wood, J. J., McLeod, B. D., Sigman, M., Hwang, W. C., & Chu, B. C. (2003). Parenting and childhood anxiety: Theory, empirical findings, and future directions. *Journal of Child Psychology and Psychiatry, 44*, 134–151.
- Zelazo, P. D., Carter, A., Reznick, J. S., & Frye, D. (1997). Early development of executive function: A problem-solving framework. *Review of General Psychology, 1*, 1–29.
- Zhengyan, W., Huichang, C., & Xinyin, C. (2003). The stability of children's behavioral inhibition: A longitudinal study from two to four years of age. *Acta Psychologica Sinica, 35*, 93–100.