NIH Public Access
Author Manuscript
Dev Psychol. Author manuscript; available in PMC 2011 September 1.

Published in final edited form as:
Dev Psychol. 2010 September ; 46(5): 1192–1205. doi:10.1037/a0020616.

Early Temperamental and Family Predictors of Shyness and Anxiety

Michele M. Volbrecht, M.S. and
Department of Educational Psychology, University of Wisconsin–Madison

H. Hill Goldsmith, Ph.D.
Department of Psychology, University of Wisconsin–Madison

Abstract

With a sample of 242 twins (135 girls, 107 boys) studied longitudinally, behavioral inhibition (BI) and inhibitory control (IC) measured at 3 years, as well as early and concurrent family process variables, were examined as predictors of shyness and of anxiety symptoms approximately four years later. Structured observational data from laboratory and home contexts were used in conjunction with parent and experimenter ratings. A key goal was to extend previous findings of the positive relationship between early BI and anxiety development by incorporating the consideration of IC and family process variables. Using hierarchical linear modeling with REML estimation to adjust for twin dependency, early BI (b =.37, p <.01), IC (b =.14, p <.05), and concurrent lower family stress (b = −.22, p <.05), predicted shyness during middle childhood. Findings were similar for parent-rated and laboratory-based shyness measures. Anxiety symptoms were predicted by BI (b =.14, p <.05), early negative family affect (b =.20, p <.05), and family stress in middle childhood (b =.26, p <.05). These findings clarify the relative importance of temperament and family factors in the development of both shyness and anxiety symptoms during childhood.

For a variety of reasons, children inhibit their behavior in certain situations. Behavioral inhibition (BI) refers to wariness in regards to novel people, objects, or situations (Kagan, Snidman, Kahn, & Towsley, 2007). Individuals can be inhibited toward the unfamiliar in this classic sense, but they can also be inhibited as a result of social-evaluative concerns based on the fear of being rejected or neglected by others (Asendorpf, Denissen, & van Aken, 2008). Whereas inhibition refers to both social and non-social situations, shyness is a narrower construct that is described as wariness when confronted with novel social situations and/or self-conscious behavior in perceived social-evaluative settings (Rubin, Coplan, & Bowker, 2009). Therefore, as with inhibition, shyness is elicited by both novel and familiar social situations. Children's lack of social interaction can result from either active isolation, a process where peers reject and/or exclude children from social situations, or social withdrawal (the aspect focused on in this study) whereby the child himself or herself elects not to engage in social interaction (Rubin et al., 2009). While the experience of shyness in moderation is considered typical, excessive childhood inhibition can foreshadow adjustment problems.

Publisher's Disclaimer: The following manuscript is the final accepted manuscript. It has not been subjected to the final copyediting, fact-checking, and proofreading required for formal publication. It is not the definitive, publisher-authenticated version. The American Psychological Association and its Council of Editors disclaim any responsibility or liabilities for errors or omissions of this manuscript version, any version derived from this manuscript by NIH, or other third parties. The published version is available at www.apa.org/pubs/journals/dev

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Both early inhibition more broadly and shyness specifically have been empirically coupled with the development of anxiety (Rapee, Kennedy, Ingram, Edwards, & Sweeney, 2005; Schwartz, Snidman, & Kagan, 1999; Van Ameringen, Mancini, & Oakman, 1998). In moderation, anxiety is a natural part of the human experience; in the extreme, it can impair functioning. A proposed, normative developmental progression of types of anxiety includes separation anxiety (usual onset, 6–22 months); stranger anxiety (6–24 months); fear of unfamiliar peers (20–29 months); anxieties related to animals, darkness, and imaginary creatures (2–6 years); school-related anxiety (3–6 years); and fear of injury and harm (8–16 years) (Scarr & Salapatek, 1970). Evolutionarily, the development of fears promotes withdrawal of the individual from predators and other harmful situations (Bowlby, 1973) and provides a signal of danger to conspecifics. Yet, common childhood fears can sometimes manifest as anxiety disorders, which are among the most prevalent psychiatric illnesses in children, adolescents, and adults (Pennington, 2002).

While shyness and clinical symptoms of anxiety are related, they are by no means synonymous. Although extremely shy children are more likely to experience anxiety symptoms, many shy children do not have anxiety issues. Furthermore, many children who suffer from clinical symptoms of anxiety only exhibit moderate levels of shyness. Therefore, while shyness and anxiety are positively related, they are not components of a single underlying construct (Rapee, 2010). In the current study, we examine both shyness and clinical symptoms of anxiety as outcome variables.

Gender differences in shyness and anxiety

The literature on gender differences in aspects of inhibition throughout development is somewhat mixed. Some studies find little evidence to support significant gender differences in inhibition, shyness, and social withdrawal (Rubin, et al., 2009) and anxiety (Cohen et al., 1993; Schniering, Hudson, & Rapee, 2000) throughout childhood and adolescence. However, other research shows that gender differences gradually become apparent across childhood, with girls appearing more fearful and anxious than boys beginning in preschool and becoming clearly more anxious during adolescence (Roza, Hofstra, van der Ende, & Verhulst, 2003; Zahn-Waxler, Shirtcliff, & Marceau, 2007).

Family factors associated with the development of shyness and anxiety

Children whose parents have an anxiety disorder are at an increased risk for developing internalizing behavior problems themselves (Hettema, Neale, & Kendler, 2001). Mothers who have difficulty with stress and anxiety are more likely to have shy or anxious children (Hastings, Nuselovici, Rubin, & Cheah, 2010), regardless of whether the transmission is genetic, experiential, or interactive. While some of this risk can be explained by genetic influences, shyness or anxiety is also more likely because of the uncertain environment created by an anxious parent for the child. In a sample of genetically identical (monozygotic) twin pairs, internalizing problem behaviors were predicted by discordant parental feelings coupled with a chaotic home environment (Asbury, Dunn, Pike, & Plomin, 2003). A chaotic home moderated the relationship between parents' differential feelings toward each twin and anxiety symptoms. It is important to note, however, that children of anxious parents may appear more inhibited themselves because these parents may over-report their children's anxiety symptoms. When emotionally distressed parents are reporting on their own children's internalizing, their ratings are likely to be inflated, especially for daughters (Krain & Kendall, 2000).

Parenting itself is reliably yet modestly associated with internalizing behavior problems in childhood (McLeod, Wood, & Weisz, 2007). Highly anxious parents may have poor adaptive coping skills, which could lead to modeling avoidance, rejection, and/or over-

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

control. These parenting behaviors could increase anxiety in children (Ginsburg & Schlossberg, 2002). A meta-analytic review found a substantial association between child anxiety and parental control (d =.58) (van der Bruggen, Stams, & Bögels, 2008). Features of parenting are also associated with behavioral inhibition and socially withdrawn behavior. The inhibited behavior of withdrawn children whose caregivers are intrusive, controlling, and overprotective is enabled (see review by Rubin et al., 2009). This relationship is likely bidirectional in nature wherein overprotective caregivers promote withdrawn behaviors and in turn withdrawn behaviors elicit controlling parenting. Coplan, Arbeau, and Armer (2008) found that the relation of temperamental shyness and socio-emotional adjustment in kindergarten was stronger when mothers were characterized as high in neuroticism, threat sensitivity, and over-protectiveness as opposed to mothers who were agreeable and practiced authoritative parenting.

The marital relationship also contributes to children's development of internalizing symptoms. Aspects of the marital relationship such as conflict and quality are predictive of future anxiety problems in children (Bögels & Brechman-Toussaint, 2006). The higher the conflict and lower the quality of a marital relationship, the more likely it is that children will experience anxiety problems. Both marital disruption within the last two years and marital conflict significantly predicted young children's levels of anxiety four years later, after controlling for their initial anxiety ratings (Jekielek, 1998). Additionally, four-year-olds' anxiety levels can be predicted by their parents' marital satisfaction 3 years earlier (McHale & Rasmussen, 1998).

In addition to parental factors, a family's socioeconomic status can also impact children's development of shyness and anxiety symptoms. The link between economic disadvantage and children's adjustment difficulties is well researched (Ackerman, Brown, & Izard, 2004; McLoyd, 1998; Mistry, Vandewater, Huston, & McLoyd, 2002). Adults with low social capital and socioeconomic status are at a greater risk for mental health problems (Phongsavan, Chey, Bauman, Brooks, & Silove, 2006). Children are at an increased risk for the development of internalizing behavior problems if they are living in households with low socioeconomic status (Cicchetti & Toth, 1998; Turner & Butler, 2003). Experiencing poverty within the first five years of life is associated with higher maternal reported depression and anxiety scores (Spence, Najman, Bor, O'Callaghan, & Williams, 2002).

Early temperamental contributions to shyness and anxiety

Temperament refers to reactivity and regulation evident in behavioral dimensions, many of which are affective in nature (Goldsmith, Buss, Plomin, Rothbart, Thomas, & Chess, 1987; Rothbart & Derryberry, 1981). Within the reactivity domain, an early temperamental disposition toward behavioral inhibition (BI) shows continuity with later shyness and increases children's vulnerability to anxiety symptoms (Kagan & Snidman, 1999). The social component of BI is largely synonymous with the concept of shyness. Thus, the investigation of whether BI predicts later shyness is primarily an evaluation of temperamental stability. Children rated as shy were approximately four times more likely to have anxiety problems in adolescence than children who were not classified as shy (Prior, Smart, Sanson, & Oberklaid, 2000). A stable tendency toward BI is a risk factor for psychopathology, particularly anxiety disorders (Essex, Klein, Slattery, Goldsmith & Kalin, 2010; Fox et al., 2005). Kagan, Snidman, Zentner, and Peterson (1999) showed that highly reactive 4-month-olds were three times more likely to display symptoms of anxiety at age 7 than their minimally reactive counterparts. Most adults with social anxiety disorder report being shy and socially reserved throughout their childhood (Stemberger, Turner, & Beidel, 1995). Thus, substantial evidence suggests that an early, inhibited temperament is a risk factor for the development of social anxiety (Biederman, Hirshfeld-Becker, & Rosenbaum, 2001; Schwartz, Snidman, & Kagan, 1999).

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Regulatory features of temperament likely interact with BI in producing anxiety symptoms, according to recent theorizing (Rothbart, 2004) and some empirical results (Caspi, Moffitt, Newman, & Silva, 1996). Strong emotional regulatory skills may serve as a protective factor in the development of anxiety disorders, as suggested by the finding that better emotional regulation in preschool was negatively associated with childhood anxiety (Bosquet & Egeland, 2006). One commonly studied, regulatory feature of temperament is inhibitory control (IC), the ability to inhibit performing a prepotent, response or action in favor of behaving according to a given set of instructions or rules (Rothbart, 1989). IC emerges around age 2, and continues to mature throughout childhood (Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996; Rothbart, 1989). Over time, IC skills become increasingly related to executive functioning, as children must suppress thought processes that are irrelevant to the immediate task (Carlson, Davis, & Leach, 2005).

The inference from some recent research, therefore, is that children who show strong emotion regulation skills, which at younger ages is indexed by their IC, are less likely to develop anxiety problems. However, in some studies children between the ages of 6 and 9 years with internalizing behavior problems (i.e., primarily anxiety) scored low on impulsivity and high on regulation measures (Eisenberg et al., 2005). Eisenberg and colleagues observed that children who are high in inhibitory control may appear socially withdrawn; these overly controlled children may be identified as having internalizing problems. Likewise, behaviorally inhibited children can acquire an adaptive predisposition toward IC indirectly through their lowered impulsivity (Aksan & Kochanska, 2004). In summary, IC may figure into multiple developmental pathways toward anxiety problems and may interact with BI in some cases. Strong emotion regulation skills can reduce anxiety, but very high inhibitory control might set a child on a course toward anxiety; the prevalence, relevant ages, and temperamental and gender-based contributions to these two pathways remain to be fully elucidated.

The Present Study

Children's temperamental reactivity (e.g., BI) and regulation (e.g., IC) and family factors such as socioeconomic status and emotional negativity are implicated in the later development of childhood shyness and anxiety symptoms. Because shyness shares behavioral features with anxiety, we studied both outcomes with a common set of temperamental and family predictors. Because methods of assessing shyness and anxiety sometimes yield inconsistencies, we employed both parental reports and laboratory-based measures.

With a longitudinal sample of twin pairs, the developmental course of shyness and anxiety symptoms was examined from 3 to 7–8 years of age. We studied both child temperament and family variables. When parent report is central to both child predictor (temperament) and child outcome measures, predictive associations are suspect. Addressing this important methodological problem, we further studied the shyness outcome with both temperamental predictors and outcomes derived from both parental report and observational measures.

Based on the literature examining the development of inhibition, we tested several hypotheses: (a) We expected the finding that an early behaviorally inhibited temperament can predict variation in both shyness and anxiety during middle childhood would be replicated; (b) The hypothesis that *lower* levels of IC as toddlers, indicative of poor emotion regulation skills, would predict higher childhood anxiety and shyness was compared against the rival hypothesis that *higher* levels of IC would reflect over-control and thus higher anxiety and shyness; (c) Exposure to significant levels of either early negative affect in the family environment or having a mother with heightened trait levels of stress reactivity would have predicted greater shyness and anxiety symptoms in middle childhood and, furthermore,

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

that family environment would have predicted child anxiety even when maternal stress reactivity was statistically controlled; (d) Experiencing concurrent stress in the family would have been related to variation in shyness and anxiety symptoms.

Interactions among significant main effects were also pursued. (e) Behaviorally inhibited children who also experience significant levels of family stress or family negative affect were expected to have greater shyness and anxiety than children who experience only one of these family risks. Moreover, children who were behaviorally inhibited and exhibited poor inhibitory control skills were expected to have higher shyness and anxiety.

Method

Participants

Participants were 242 (135 girls, 107 boys) twins (121 pairs) studied longitudinally at 3 (*M* = 3.04 yrs, *SD* = 0.06) and approximately 7 years (*M* = 7.51 yrs, *SD* = 0.78) of age. There were 44 pairs of MZ and 77 pairs of DZ (44 same-sex) twins. Our sample was a longitudinally followed group from a larger twin study of social and emotional development that began in infancy and continued to age 3 years (Lemery-Chalfant, Goldsmith, Schmidt, Arnesion, & Van Hulle, 2006). The current sample comprised all children in the larger study who were studied at age 3 years and followed up approximately four years later with the measures to be described below. Participants in the original, larger study were recruited during infancy from Wisconsin state birth records, *Mothers of Multiples* groups, media coverage and advertisements on local television, in newspapers, doctors' offices, the Internet, and referral from other parents. The current sample was mainly Caucasian (95 %) with the remainder African-American (1.7%), Asian-American (1.7%), Hispanic (0.8%), and American Indian (0.8%). At the time of the twin's birth the average age of the father was 34.20 years (*SD* = 5.49), and mothers' average age was 32.57 years (*SD* = 5.22). Most participants were from intact middle class families, with the mother and father each completing on average 15 years of formal schooling (33.2% of fathers and 33.3% of mothers were college graduates).

Procedure

Children visited the laboratory at age 3 years, where we conducted the preschool Laboratory Temperament Assessment Battery (Lab-TAB) episodes (Goldsmith, Reilly, Lemery, Longley, & Prescott, 1999). Upon arriving at the laboratory, parents were given questionnaires to complete and return within two weeks. Approximately 4 years later, we visited families in their homes to conduct middle childhood Lab-TAB episodes (Goldsmith, Reilly, Lemery, Longley, & Prescott, 1993) as well as to collect additional parental report questionnaires. From the home-based observation, one fear episode was examined. A detailed description of the measures follows; see Table 1 for the complete list.

Questionnaire measures

Behavioral inhibition (BI) and inhibitory control (IC)—Shortened forms of The Children's Behavior Questionnaire (CBQ; Rothbart, Ahadi, Hershey, & Fisher, 2001) were employed at 3 and 7 years. The present study used 10-item versions of the fear (FE), shyness (SH), and inhibitory control (IC) scales. The CBQ is a parent-report instrument that assesses temperament in children ages 3 to 8 years. Using a 7-point scale, mothers and fathers independently decided whether or not each item was true or untrue (1 = extremely untrue, 7 = extremely true) of their child within the past six months. To assess BI at 3 years, both non-social and social aspects of inhibition were considered by analyzing the nonsocial FE and social SH scales of the CBQ. The IC scale of the CBQ was also used at age 3. At age 7, only the SH scale was employed. In our sample, the internal consistency reliability (α) for the

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

mothers' scales was .68 (IC, 3 years),.82 (FE, 3 years),.87 (SH, 3 years), and .90 (SH, 7 years). For fathers, the alphas were .75 (IC, 3 years),.72 (FE, 3 years),.91 (SH, 3 years), and .88 (SH, 7 years).

Anxiety symptoms—The outcome of anxiety symptoms at age 7 years was measured using two scales from The Health and Behavior Questionnaire (HBQ; Essex et al., 2002): Separation Anxiety (SA, 10 items) and Overanxious (OA, 12 items). The HBQ is a parent-report measure that primarily targets DSM-IV symptoms. The HBQ instrument was originally intended for use with children younger than 7 years. Therefore, developers of the HBQ chose SA and OA to capture children's anxiety as these are among the most common forms of anxiety during this developmental period. We also did not include an aspect of social anxiety, although it is developmentally relevant for the outcome age of our sample, as the HBQ was not modified for use in this study. We used the responses from the primary caregiver in this analysis. Primary caregivers were defined as the family-identified adult who spends the most time with the twins; in our sample this was usually the mother. Alpha coefficients in our sample were .76 for SA and .68 for OA.

Mothers' stress reactivity—Mothers' personality traits were assessed when children were 25 months old with the Multidimensional Personality Questionnaire: (MPQ; Tellegen, 1982; Tellegen & Waller, 1995). The stress reaction scale (SR; alpha =.89 in this sample) was the focus of this study because it measures anxiety proneness. Children resemble their mothers in anxiety due to genetic and/or environmental factors (Eaves et. al, 1997; Eley et al., 2003). Therefore, this maternal personality trait was included in the current study to distinguish whether children's anxious outcomes reflect characteristics of their mothers versus their family functioning in general, or whether effects of family functioning are significant when maternal anxiety proneness is controlled.

Family environment—To assess the emotional environment in the home, we used Halberstadt's (1986) Family Expressiveness Questionnaire (FEQ), completed by the primary caregiver, at the 3-year assessment. The FEQ is comprised of 40 scenarios involving emotional expression in the family as a whole. The caregiver was asked to consider both twins and to rate such items such as: "Blaming one another for family troubles" on frequency of occurrence within the family on a 9-point scale (1 = not at all, to 9 = very frequently). We used only the two negative aspects of family expressiveness for which we computed α =.78 for negative dominant behaviors and α =.68 for negative submissive behaviors. Additionally at 3 years, primary caregivers completed a Likert-scale version of the Child Rearing Practices Report (CRPR; Block, 1965). The CRPR includes items that tap child-rearing attitudes, values, behaviors, and goals applied to the family as a whole. We modified the Block's original Q-sort format to ask caregivers to rate their child-rearing attitudes on a 6-point scale from 1 = strongly disagree to 6 = strongly agree. An example item is, "I believe that children should be seen and not heard." We used the 3-item Negative Affect to Child (α =.58), the 3-item Rational Guidance (α =.47), the 9-item Authoritarian Control (α =.64), the 2-item Control by Anxiety (α =.41), and the 3-item Control by Guilt (α =.47) scales. The effect of the modest reliability of some of these scales was ameliorated by using them as parts of a composite measure of family negative affect at 3 years, described below.

Primary caregivers also completed two additional home environment measures as part of the follow-up, age 7–8 phase: The Life Experiences Survey (LES, Sarason, Johnson, & Siegel, 1978) and The Confusion, Hubbub, and Order Scale (CHAOS; Matheny, Wachs, Ludwig, & Phillips, 1995). The LES assessed the occurrence and perceived level of negative or positive impact (−3 to +3 scale) of life events within the past year. Because the LES summary score represents a formative rather than a latent variable, alpha is not an appropriate reliability

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

measure. The CHAOS examined the degree of environmental disorder and confusion in the home using 15 true/false items. We estimated CHAOS reliability as alpha =.75.

Socioeconomic status—We measured families' socioeconomic status (SES) with a modified version of the Hollingshead index (1957) on three occasions: study entry (M = 48.77, SD = 10.611, N = 242), 30-months (M = 49.67, SD = 10.167, n = 120), and age 7 (M = 49.40, SD = 8.75, n = 172). The Hollingshead index takes into account caregivers' levels of education and current occupations.

Ratings by experimenters

After the 3-year laboratory visit, two child experimenters separately rated children's fearfulness and social engagement on 5-point scales. Scores of "5" indicated a child with little to no fear and several instances of social interaction, respectively. Since experimenter ratings were moderately correlated for both fearfulness (r =.53, p <.01) and social engagement (r =.43, p <.01), scores were averaged to create one fearfulness and one social engagement score. Social engagement scores were reversed so that higher values reflected more inhibited children.

Approach/avoidance and shyness were observed and scored by two experimenters when they first met the children in their homes at the follow-up assessment. The two observers did not observe children's behavior in the same situation. Rather, the two experimenters had different duties and interacted with the children in different contexts during home visit. Both behaviors were coded using 0–4 scales. For approach/avoidance, a score of "0" = signified high levels of approach behavior while a "4" was assigned to a child with high avoidance behavior. On the shyness scale, a "0" indicated no signs of vocal, facial, or postural wariness and a "4" signified frank and clear-cut signs of shyness. Scores provided by the two experimenters were moderately correlated for approach/avoidance (r =.58, p <.01) and shyness (r =.59, p <.01) and therefore averaged.

After the follow-up home visit, experimenters rated an additional global measure of shyness based on their overall observations. Shyness was rated using a 5-point scale where "5" indicated extreme instances of shyness. Two experimenters (in most cases) provided ratings, which were correlated (r =.67, p <.01), and therefore averaged. Principal components analysis (PCA) of these three experimenter-rated variables (at follow-up) resulted in one component score for social fear, which accounted for 66.86% of the total variance.

Observational measures

BI and fear—At the 3-year laboratory visit, two Lab-TAB episodes were designed to elicit a range of individual differences in BI and social fear: Risk Room and Stranger Approach, respectively. Risk Room, modeled after Kagan, Reznick, and Gibbons (1989), instructs children to play with the following objects without intrusion from parents or experimenters: a canvas tunnel, a set of steps leading to a small platform above a mattress, a wooden balance beam, a carpeted incline along one side of the room, a black cardboard box with a jagged hole in it, and a large gorilla mask mounted on a cardboard pedestal. Parents were instructed to sit in the corner of the room, read a magazine, and remain affectively neutral; experimenters were not present. Children were permitted to explore the objects in the room without intrusion from parents or experimenters. The episode was divided into a 5-minute exploration phase, used in these analyses, and a second phase during which the experimenter prompted the child to explore novel objects. During the first minute, when novelty was most salient, the following variables were coded every 10 seconds; latencies to play, and the total lengths of time engaged in play with the first through the sixth object, degree of approach to

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

parent and tentativeness, facial sadness and fearful affect; subsequently these variables were coded every 30 seconds.

During the Stranger Approach episode, an unfamiliar male confronted the child (who was alone) in an experiment room in a manner that involved both physical and verbal approach with a non-threatening but not overly friendly demeanor for approximately 1.5 min. The Stranger episode was divided into nine scoring segments during which the following variables were scored: vocal distress, activity decrease, approach behaviors, avoidance behaviors, gaze aversion, verbal hesitancy, and nervous fidgeting. Latency to the child's first fear response and overall facial sadness and facial fear (0–3 scale) were scored as well.

The follow-up home visit at age 7–8 included Storytelling, a Lab-TAB assessment of social-fear or shyness. During the Storytelling episode, children were asked to stand and describe what they did the previous day in front of the non-responsive experimenter and camera operator (two different people). Children were prompted to continue talking after each 30-second period of silence. There was always at least one prompt given; some children received numerous prompts. Once the child was given at least one prompt, the episode was terminated upon another 30-second period of silence. The duration, therefore, was from slightly over a minute to 12 minutes (M = 2.56 minutes). Coders rated duration of speech, presence of whispered speech, presence of nervous smiling, and frequency of dysfluencies and hesitations during 10-second coding segments throughout the entire episode. Latencies to begin speaking, to the first fidgeting behavior, and to the first fear response were also scored.

IC—Snack Delay and Dinky Toys are two 3-year Lab-TAB episodes, based on research of Kochanska and her colleagues (1996), used to measure IC. In the Snack Delay episode, children had to wait varying lengths of time (5, 10, 0, 20, 0, and 30 second trials) to eat an M&M placed under a clear plastic cup. A bell rung by the experimenter signaled that the child had permission to eat the M&M. Latencies were recorded for fidgeting, distracting, and touching or eating the M&M in each non-zero trial segment. The degree of fidgeting and distraction were also scored.

The Dinky Toys episode gave children two opportunities to choose a single toy from a clear plastic container filled with several attractive toys (i.e. small plastic animals, tops). Each of the two opportunities to choose a toy represented a separate coding segment. Before each coding segment, an initial approach toward the toys was rated. Latencies to touch and choose a toy, style of touching, following directions, and total impulsivity were also scored.

For all of the behavioral scoring, care was taken to ensure that reliability between coders and master coders (highly trained staff members) was maintained throughout. Kappa values for all of the scored behaviors were required to be greater or equal to .70. To monitor coder drift, at least 10% of the cases were double coded by a master coder. Discrepancies were resolved by conference. The coding strategy called for coders to code only one member of a twin pair. When circumstances required that a coder view and score both cotwins from videotape (for instance, only one coder who had been trained to reliability might have been available for a few remaining pairs in a given episode) we required that multiple weeks pass before scoring the cotwin. In the episode with the most cases in which both twins were scored by the same coder, the average interval that passed between scoring the two cotwins was 21 weeks.

Composite variable formation

For each behavioral episode, means, peaks, and latencies were computed across trials for the entire episode for every variable of interest. We then z-transformed the data to establish the

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

same metric for each of the variables. To approximate a normal distribution and invert the sign to be consistent with the other variables, latency values were transformed to speed values by computing the inverse of the square root of latency. If a behavior did not occur, the latency to that behavior was assigned as the maximum duration (in seconds) plus 1 for the episode. Principal component analysis (PCA) was used to form all of the behavioral composites, and Table 2 shows the composition of each principal component, with the exception of Snack Delay.

Behavioral inhibition—Overall behavioral composite scores were made for 3-year behavioral inhibition based on the Risk Room and Stranger Approach episodes. For each episode mean, peak, and speed scores were computed for each variable across coding segments. We used PCA to form composite scores for each episode. The Risk Room composite was based on the following variables from the first phase of the episode: approach parent, tentativeness of play, total time not playing, total objects not played with, and the speed to play with an object. Because speeds to play with each of the five objects were highly correlated, an average speed to play was created. Scores from the second phase of Risk Room, when stimuli were not as novel, were not used.

Before constructing a composite for the Stranger Approach episode, the variables of verbal hesitancy, distress vocals, and approach were transformed to reduce skewness. The Stranger Approach episode resulted in two composite scores, which together accounted for 54.87% of the variance in the data. The first component score represented an active/expressive fear with high positive loadings on distress vocalizations and avoidance as well as a high negative loading on verbal hesitancy. The second component score reflected a more inhibited/withdrawn quality of fear; it had high positive loadings for activity decrease and verbal hesitancy and a high negative loading on approach.

Inhibitory control—A composite score was made for the 3-year Dinky Toys episode based on a PCA. All variables of this episode were utilized with the exception of latency to touch, which showed little variance (79.8% of the children touched a toy/s within the first three seconds of the episode). Formation of the Snack Delay composite was not as straightforward. An initial PCA indicated three components (cumulatively accounting for 80% of the variance) rather than one. The first component reflected the eat/touch aspect of the episode as there were high positive loadings for latency to eat and touch the snack and eating the snack early. The distract variables loaded positively on the second component, while child prompt variables loaded positively on the third component. The child prompt variables did not covary with the other variables, since a child prompting the experimenter to “ring the bell” so that the snack can be eaten preempts the other IC behaviors from occurring. That is, prompters could not engage in distraction from the experimenter or the stimuli, nor were they eating or touching the snack early. Nevertheless, child prompting is a rational candidate for indicating lower IC. Therefore, an algorithm to create one Snack Delay composite was derived using three overall means that were created by averaging variables with primary loadings on the aforementioned component scores of eat/touch and distract (which were significantly intercorrelated) and child prompt.

Shyness—The Storytelling episode resulted in two separate fear components that were similar to those for the 3-year stranger episode. The active/expressive facet of fear was composed of high positive loadings on nervous fidgeting, speed to fidget, dysfluencies/ hesitations, and speed to speak as well as a large negative loading for percent time not speaking. The withdrawn/inhibited component had high positive loadings on speed to first fear, bodily fear, avoidance, and percent time not speaking and a negative loading for speed to begin speaking.

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Formation of the predictor variables

Predictor variables were formed at the level of the child (level-1) and the level of the family (level-2). All variables (with the exception of sex) were z-scored, placing them on a similar metric for purposes of comparison and combination and to better approximate a normal distribution. Z-scoring also created meaningful zeros for the variables as a value of "0" represented the average score for that particular variable. Principal components analysis (PCA) generated all of these predictors except sex, SES, mothers' MPQ stress reaction, and family stress during middle childhood. Table 3 provides the composition of each principal component.

Composition of predictor variables at the individual level (level-1)

Child's inhibitory control—Mothers' and fathers' 3-year CBQ Inhibitory Control scale scores as well as the Snack Delay and Dinky Toys behavioral composites (discussed above) were used to create the measure of child's inhibitory control. The CBQ scale scores were z-scored to be on the same metric as the behavioral composites. Both of the behavioral composites were reverse-scored (multiplied by −1) so that high scores reflected high IC, as in the CBQ. The single component solution accounted for 44.86% of the variance.

Child's behavioral inhibition—The 3-year behavioral inhibition measure was based on nine variables: the experimenter-ratings of fearfulness and social engagement, mothers' and fathers' CBQ scores for the Fear and Shyness scales, and the behavioral composites of Risk Room and Stranger Approach, as described above. The experimenter-rated scores were reversed such that high scores reflected high fear and low social engagement. PCA of these variables resulted in a 1-component solution accounting for 30.03% of the variance.

Composition of predictor variables at the family level (level-2)

Average socioeconomic status—The scores computed using an updated version of Hollingshead's (1957) index were based on parents' education levels and occupations. Because the scores measured at study entry, 30 months, and the age 7–8 follow-up were highly correlated (range =.68 –.74), they were averaged into one overall SES score.

Mothers' stress reaction—Self reported responses from the MPQ Stress Reaction scale represented the sole measure of mothers' trait levels of responsiveness to stress, or anxiety proneness.

Negative family affect during early childhood—A PCA of the 2 FEQ scales and the 5 CRPR scales resulted in a 2-component solution, explaining a cumulative 57.24% of the variance. We only used the first (non-rotated) component, which explained 35.05% of the variance, as a predictor.

Family stress during middle childhood—The following variables were averaged to create a measure of negative family affect during middle childhood: the sum of the 18 most relevant family stressors from the LES, mothers' perceived negative impact in regards to all 60 life events listed on the LES, and the CHAOS scale score. The 18 "most relevant" items on the LES were judged as family stressors that particularly affected children (e.g. divorce, moving, parent incarcerated). Items that were excluded were those judged not to affect young children, or to affect them only indirectly (e.g. financial issues), as well as those that could be considered specific to one child and not both twins (e.g. illness). Correlations among these three middle childhood assessments of family stress are as follows:.15 for number of negative life events and CHAOS score,.32 for perceived negative impact of life events and CHAOS score, and .43 for the number of negative life events and the perceived

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

negative impact of all LES events. Based on the conceptual similarity of these constructs as well as their pattern of correlations, they were averaged into one comprehensive score of family stress during middle childhood.

Twin BI and Twin IC aggregated to the family level—To test our hypothesis about interactions, family level variables of BI and IC were constructed. An average of the BI score for both twins in each family was computed as a family-level measure of the twins' BI. The IC variable was also aggregated up to the level of the family using the same method. The use of these family level variables to test interactions is described below.

Formation of the outcome variables

Two outcome variables were explored. We examined the temperament construct of shyness as well as the more clinical outcome of HBQ anxiety symptoms.

Shyness—A PCA of the follow-up maternal CBQ shyness scale (loading =.84), the paternal CBQ shyness scale (loading =.88), the experimenter-rated social fear composite (loading =.69), and the Storytelling inhibited composite (loading =.32), formed a measure of the child's shyness at follow-up. The first (non-rotated) component, accounted for 50.94% of the variance.

Anxiety disorder symptoms—The 2 HBQ scales (Separation Anxiety and Overanxious, r =.61) were averaged to create an outcome measure of anxiety. Differential prediction of the subtypes of anxiety was sacrificed in the interest of parsimony.

Method-specific variables for shyness models

The 3-year temperament predictors of IC and BI as well as the shyness outcome measure were also constructed to be method-specific for a child/observer and a parent based model of shyness. Again, PCA was used to create all these method-specific variables. For the model of child- or observer-based shyness, the IC predictor was created using a PCA that only contained the measures from the Lab-TAB Dinky Toys and Snack Delay episodes. The BI child/observer predictor principal component consisted of the composites from Risk Room, Stranger Approach, and experimenter-rated fear and social engagement. The parent based model predictors of IC and BI were created using PCAs with the 36-month CBQ responses from both mom and dad separately for inhibitory control (IC predictor) and fear and shyness (BI predictor). We also split the shyness outcome by method, creating a child/observer based outcome from the Storytelling episode composites and the experimenter rating of social fear at follow-up and a parent based outcome solely from the CBQ Shyness responses.

Statistical approach

Despite the probable importance of genetic factors and the ability to address genetic and environmental variance with a twin sample, in the present paper, we only addressed phenotypic issues with our twin sample data, which is a common practice by investigators in the current literature (e.g., Kashy, Donnellan, Burt, & McGue, 2008; Kendler, Myers, & Zisook, 2008). Moreover, since the social-emotional development of twins is comparable to that of singletons (Deneault et al., 2008; Johnson, Krueger, Bouchard, & McGue, 2002) our sample is as valuable as one of non-twin siblings for examining phenotypic relationships between anxiety and family factors.

Multilevel linear regression was employed in primary data analyses to explore the predictors of children's outcomes of shyness and anxiety. We used hierarchical linear modeling (HLM) software (Raudenbush, Bryk, Cheong, Congdon, & duToit, 2004) for all multilevel linear models. A 2-level random intercept model was used to investigate each outcome. Multilevel

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

modeling is a more appropriate tool for twin data than multiple regression when some predictors occur at the family level. Even with only two individuals per group, parameter estimates are biased if observations at the group level are assumed to be independent of one another. That is, HLM models adjust for twin dependency by accounting for the nesting of twins within families and yield parameter estimates with appropriate error estimates.

Unfortunately, it is not statistically appropriate to test cross level-interactions given the dyadic nature of the dataset. With only 2 individuals per group (2 twins in each family) there are not enough degrees of freedom available to both test interactions across levels (i.e., child inhibition x family negative affect) and also treat the predictor effects of individual variables as random. Doing so would underestimate standard errors, and it is unknown the extent to which these errors would be incorrect (Hox, 2002; Kenny, Kashy, & Cook, 2006). However, by aggregating variables originally at level 1 (BI, IC) up to the family level (as done in a subset of our analyses) the interactions of "sibship level" of BI and IC with other variables at level 2 (e.g., family negative affect, family stress) can be examined appropriately.

Missing values replacement

Missing data were estimated using SPSS Missing Value Analysis expectation maximization (EM) algorithms (Dempster, Laird, & Rubin, 1977) at various levels of data analysis. Data were imputed within a single episode or measure, within the formation of a predictor or outcome variable of interest, and also among the set of predictors themselves. No outcome variables were imputed on the basis of predictor variables. On average 6.2% (*SD* = 4.23%) of the laboratory data was missing. Specifically, 13.6% of the cases were missing the 3-year stranger episode because of technical or practical problems or because parents refused its administration. Family data was missing for 23.05% (*SD* = 12.21%) of the cases. The vast majority of the missing data in our study represented absent father CBQ responses (on average 34.6% of cases). Fathers either elected not to participate, or were not present. In these instances, we had the CBQ responses from the mother. Additionally, 6.85% (*SD* = 3.18%) of cases did not have experimenter-rated scores. Because arguments can be made for and against missing values imputation, subsequent regressions were performed on datasets with and without MVA-imputed variables among the seven predictors. The two sets of analyses yielded virtually identical results, and therefore data are only presented for the sample with imputed data.

Results

Associations among predictors and outcomes

Before hierarchical modeling, we computed correlations between the predictors and the two internalizing outcome measures (Table 4). The majority of the intercorrelations among the predictors were moderate (*M* =.15, *SD* =.12), ranging from −.46 to .30. Higher IC skills were associated with being female, coming from a family with higher than average SES, and experiencing lower levels of negative family affect during early childhood. A behaviorally inhibited temperament was correlated with the mother reporting being highly reactive to stressors (i.e., anxiety prone). Maternal reactivity to stress was expectably associated with greater negative family affect and family stress and surprisingly associated with the mother having a girl as the target child. Families with higher SES also reported lowered negative family affect during early childhood and experiencing lower stress concurrently.

Correlations among the predictors and two outcome measures are also depicted in Table 4. As predicted, behaviorally inhibited children were more likely to express a shy temperament in middle childhood. Family stressors (negative family affect during early childhood, concurrent family stress, and mothers' stress reaction) were positively associated with

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

anxiety. Unexpectedly, family stress during middle childhood was negatively correlated with shyness. Interestingly, IC, sex, and family SES were not significantly associated with either of the outcome variables. The two outcome variables were uncorrelated (r =.05) and are therefore correctly conceptualized as distinct.

A legitimate concern of the present analysis is the age range at follow-up. Although the average age was 7.51 years with a *SD* of only 0.78, the range of ages for the anxiety outcome was 6.01 to 9.78 years. We computed correlations of age at follow-up with both outcomes. Correlations were −.02 for shyness and .12 for anxiety. Therefore, we concluded that age at follow-up assessment was not significantly associated with either of our outcomes, and neither initial nor follow-up age were controlled in the subsequent analyses, partly because age at follow-up was likely correlated with difficulty of recruiting families, which might have been confounded with some predictors (and thus controlling for "age" could remove valid, predictable variance).

Hierarchical linear modeling (HLM)

We used HLM models to examine main effects on shyness and anxiety symptom outcomes. For shyness, we separated the predictors into two additional models: child/observer based and parent based. The results are presented with robust standard errors, which protect against violations of normality among the random effects. These estimates result in more accurate significance tests and confidence intervals (Hox, 2002). The intercept values for the models (γ_{00}) refer to the average level of the anxiety outcome when all of the predictor variables are zero. Since all of the predictors except sex were z-scored, a '0' represents the average score for that predictor. Here, the intercepts represent the expected level of those outcomes at age 7–8 for a male with average levels of IC and BI at 3 years, whose mother experiences an average level of stress reactivity, and who comes from a family of average SES, early negative affect, and later family stress. We estimated 2-level random intercept models with 242 twins at level-1 and 121 families at level-2.

Predictors of Shyness & Anxiety: main effects

Table 5 depicts the results of the models for the outcome of shyness using restricted maximum likelihood (REML) estimation. The t-ratio is a test statistic, which refers to the estimate divided by its standard error. In the multisource shyness model, lower levels of family stress in middle childhood and BI and IC at 3 years significantly predicted shyness at follow-up. The estimates of the variance at level-1, σ^2 =.75 and level-2, τ^2 =.12 yielded an intraclass correlation coefficient of ρ_I =.12/.87 =.14. This reflects the amount of the variance (14%) in children's level of shyness that lies at the family level. Models predicting shyness based on child/observer and parent derived predictors showed a very similar pattern of results to the multisource model. Lower levels of family stress in middle childhood and BI at 3 years predicted higher child/observer based and parent reported child shyness (see lower panels of Table 5).

The model using HLM with REML estimation for the prediction of anxiety is presented in Table 6. Negative family affect during early childhood, family stress, and BI were the significant predictors of anxiety in the model. Based on the variance at level-1 (σ^2 =.39) and level-2 (τ^2 =.37) the intraclass coefficient was .49; meaning 49% of the variance in children's anxiety lies at the family level.[1,2] Scatterplots of bivariate associations of each

[1]As for within-level 1 interactions, we were also interested in the specific hypothesis that high inhibitory control skills act as a protective factor against shyness and/or anxiety symptom development in children who are behaviorally inhibited at age 3. Conversely, low inhibitory control skills might increase shyness and/or anxiety in behaviorally inhibited toddlers. We tested this within-level 1 interaction for each of the outcome variables, but found no significant interactions.

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

significant predictor with anxiety (not shown) indicated that associations were not due to outliers for high anxiety; instead, the moderate associations appeared to hold throughout the range of the variables.

Discussion

Results supported our first hypothesis that a behaviorally inhibited temperament at age 3 would predict variation in both shyness and anxiety at age 7. The second hypothesis that lower levels of early IC would increase middle childhood anxiety and shyness was not supported, but the rival hypothesis, derived from Eisenberg et al.'s (2005) research that higher levels of IC would predict higher shyness did receive support. The third, multiple part, hypothesis was supported in that experiencing negative affect in the family during early childhood predicted anxiety, yet having a mother with heightened stress reaction did not predict either shyness or anxiety as expected. Negative affect in the family predicted later anxiety even when maternal stress reaction was statistically controlled, as hypothesized. As expected, the main effects of a concurrent stressful family environment predicted variation in shyness and anxiety symptoms. Unexpectedly, higher levels of family stress were associated with less shyness, suggesting perhaps that such stressors elicit more outgoing behavior as a form of coping, at least in the largely middle class families in this sample.

Turning to more detailed comments on some of the findings, early BI, as noted above, was a significant predictor of shyness in middle childhood, which replicates other literature (Fox et al., 2005; Kagan & Snidman, 1999). Our measure of BI had a strong social component, as exemplified by the fact that the loadings of the CBQ shyness scale were higher than those for the CBQ fear scale in the PCA that formed our BI predictor. Therefore, the finding that the highly socially based BI measure predicted shyness is unsurprising.

Higher IC in childhood significantly predicted later shyness in the multisource model (and this finding was confined to the multisource model, which generally yielded stronger predictions than the two, method-specific models). While we entertained an alternative prediction that problems in regulating prepotent responses (low IC) might predict difficulties in social engagement, the results that we obtained suggest that a more important predictive relationship applies for the other pole of IC: children with a history of higher BI may be over-regulated, with this over-regulation leading to, or manifest as, later shyness, or increased inhibition in social situations (Eisenberg et al., 2005). Zahn-Waxler et al. (2007) suggest that such over-regulation might be associated with risk for depression later in development (during adolescence), especially in females. One interpretation of our result in the context of the literature is that IC may enter into multiple–at least two–pathways toward the development of anxiety. Prior studies might have contained different proportions of children representing these pathways. Moreover, the nature of the resulting anxiety problems in the two pathways may differ in subtle ways that research has not yet specified.

Of the four family level predictors we examined, concurrent family stress was the only one to significantly predict both shyness and anxiety outcomes. Interestingly, stress in the family predicted higher child anxiety but lower child shyness, a finding that highlights the importance of distinguishing shyness from anxiety. Children might be on heightened alert, and thus more anxious, when their immediate environments are highly stressful. Conversely, children from docile families may not be pressed to develop their assertiveness, resulting in

[2]Using REML, additional models explored potential predictors of shyness and anxiety using the variables of BI and IC aggregated up to the family level to permit statistically legitimate--see the Method section--examination of cross-level interactions. The only significant interaction was the prediction of shyness from twin BI by family stress. Given a high average level of BI among the twins and a stressful family environment, the child is less likely to be shy. All of the main effects involved in the interactions tested retained significance or approached significance.

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

a more reserved, shy temperament (see Arcus, 2001, and Hastings et al., 2010, for related discussion). The direction of these effects is uncertain because family stress was concurrently measured with the outcome. In addition to family stress, early negativity in the family was also significant in the model predicting anxiety (but not shyness). For an early family functioning measure to predict a child outcome when concurrent family stress as well as a relevant maternal personality trait are statistically controlled hints at a long-lasting effect of early experience, which is a noteworthy finding when the experiences are not extreme.

No significant gender effects were observed, perhaps because participants were followed up during pre-adolescence, before gender differences for anxious behavior become pronounced (Rutter, Caspi, & Moffitt, 2003). Moreover, early BI and shyness also failed to show pronounced gender differences. These results are generally consistent with those of a meta-analysis examining gender differences in childhood temperament, which revealed only small effect sizes favoring girls for fear (Else-Quest, Hyde, Goldsmith, & Van Hulle, 2006).

Contrary to previous literature (Cicchetti & Toth, 1998; Spence, et al., 2002; Turner & Butler, 2003), SES was not a significant predictor of either of the outcomes studied. The family level variables examined, especially SES and mothers' stress reaction, might have been less useful predictors because families in this sample were primarily middle class. Had our sample been more socioeconomicaly diverse and included more families living in poverty or near-poverty, a significant effect of SES on the shyness or anxiety outcomes might have emerged. The families were not particularly high risk; rather, they represented a typical population of families in reporting an average of 4.51 (SD = 5.66) on the LES negative impact scale. This value is very similar to norms reported for males (M = 4.66, SD = 4.36) and females (M = 5.64, SD = 6.43) (Sarason et al., 1978).

Another facet of our results is the outcomes obtained from the three shyness models that predicted the overall multisource shyness outcome, the child/observer-based outcome, and parent-reported outcome. Given that the inter-informant agreement on ratings of child shyness is often low (Majdandzic, van den Boom, & Heesbeen, 2008; Pfeifer, Goldsmith, Davidson, & Rickman, 2002), it is of particular interest that similar conclusions regarding children's shyness can be drawn based on either child/observer or parent-rated data, as well as from the multisource model.

Study strengths and limitations

This study has obvious strengths concerning its design and measurement. The multisource approach to measuring various predictor and outcome variables should enhance validity because it incorporated observational, parental-report, and experimenter-report measures. This multisource approach allowed the temperament predictors (BI, IC) and outcome to be split based on type of assessment in the shyness model. We employed a longitudinal design, permitting us to examine development over approximately a four-year time period. Also, we examined both anxiety and shyness as outcomes to allow specificity in prediction.

A limitation of this study is that the sample was not at high risk for clinical problems, and therefore the results may not generalize to high-risk populations. Importantly, the families were not particularly affluent either, as they represented the population of a midsized city and its surrounding suburban and rural areas. Another limiting feature of the present study was that we did not examine children post-puberty and into adolescence, when anxiety issues are more clearly identifiable and problematic (Luby et al., 2002; Silverman, 1993). Lastly, some of our predictors were examined concurrently (family stress in middle childhood) or contained components that occurred at the same time (average SES) as our

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

outcomes. In these cases prediction is purely statistical and causal interpretation is hazardous.

Implications and future directions

An obvious extension of the study would be to examine the genetic and environmental influences on both the outcomes and predictors. Extensive literature documents genetic influences on measures of behaviorally inhibited temperament (Gagne, Vendlinski, & Goldsmith, 2009) and the development of anxiety symptoms (Gregory & Eley, 2007). Most measures of child anxiety exhibit moderate heritability (Stevenson, Batten, & Cherner, 1992; Thapar & McGuffin, 1995; Topolski et al., 1997). Environmental risk factors are also involved in the generation of anxiety; for example, early traumatic experiences can generate an anxiety disorder in children (Pennington, 2002). Other environmental factors likely associated with the development of anxiety symptoms include negative school experiences, comparisons within the twin relationship, illness, accidents, negative parent-child relationships, and peer rejection (Asbury, Dunn, & Plomin, 2006). Genetically influenced susceptibility and environmental stressors likely interact in the development of anxiety symptoms. Recently, the gene by environment interaction approach to understanding the development of internalizing symptoms, such as anxiety, has been explored (Gregory, Lau, & Eley, 2008). Children who have a short 5HTT allele coupled with low social support have an increased risk for developing behavioral inhibition, for example (Fox, Henderson, Marshall, Nichols, & Ghera, 2005). Environmental risk factors are more strongly associated with internalizing outcomes for children at higher genetic risk, thus supporting a diathesis-stress model (Vendlinski, Lemery-Chalfant, Essex, & Goldsmith, 2009). This sample lends itself to modeling of the interplay of genetic and environmental factors because data are drawn from twins; however, its size is marginal for clearly distinguishing genetic and environmental effects in the context of possible developmental change and other moderating effects.

An important methodological implication of our results concerns the importance of multisource assessment in this genre of research. In this study, parental report and laboratory-based assessment yielded broadly similar outcomes, which is notable given the reservations often expressed about parental report methodology. Some results that we obtained should elicit more replication. For instance, the result that children with initially stronger inhibitory abilities are later more shy should be more thoroughly investigated to discern the conditions under which it holds. Our results also highlight distinctions between shyness and anxiety, constructs that share some behavioral manifestations, but which have different predictors in our study. Clearly, including both shyness and anxiety as constructs in future developmental studies holds merit.

References

Ackerman BP, Brown ED, Izard CE. The relations between persistent poverty and contextual risk and children's behavior in elementary school. Developmental Psychology. 2004; 40:467–377. [PubMed: 15238036]

Aksan N, Kochanska G. Links between systems of inhibition from infancy to preschool years. Child Development. 2004; 75:1477–1490. [PubMed: 15369526]

Arcus, D. Inhibited and uninhibited children: Biology in the social context. In: Wachs, TD.; Kohnstamm, GA., editors. Temperament in context. Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers; 2001. p. 43-60.

Asbury K, Dunn JF, Pike A, Plomin R. Nonshared environmental influences on individual differences in early behavioral development: A monozygotic twin differences study. Child Development. 2003; 74:933–943. [PubMed: 12795399]

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Asbury K, Dunn J, Plomin R. The use of discordant MZ twins to generate hypotheses regarding non-shared environmental influence on anxiety in middle childhood. Social Development. 2006; 15:564–570.

Asendorpf JB, Denissen JJA, van Aken MAG. Inhibited and aggressive preschool children at 23 years of age: Personality and social transitions into adulthood. Developmental Psychology. 2008; 44:997–1011. [PubMed: 18605830]

Biederman J, Hirshfeld-Becker DR, Rosenbaum JF. Further evidence of association between behavioral inhibition and social anxiety in children. American Journal of Psychiatry. 2001; 158:1673–1679. [PubMed: 11579001]

Block, JH. Test manual. Institute of Human Development, University of California; Berkeley: 1965. The Child Rearing Practices Report.

Bögels SM, Brechman-Toussaint ML. Family issues in child anxiety: Attachment, family functioning, parental rearing and beliefs. Clinical Psychology Review. 2006; 26:834–856. [PubMed: 16473441]

Bosquet M, Egeland B. The development and maintenance of anxiety symptoms from infancy through adolescence in a longitudinal sample. Development and Psychopathology. 2006; 18:517–550. [PubMed: 16600066]

Bowlby, J. Separation: Anxiety and anger. New York: Basic Books; 1973.

Carlson SM, Davis AC, Leach JG. Less is more: Executive function and symbolic representation in preschool children. Psychological Science. 2005; 16:609–616. [PubMed: 16102063]

Caspi A, Moffitt TE, Newman DL, Silva PA. Behavioral observations at age 3 years predict adult psychiatric disorders: Longitudinal evidence from a birth cohort. Archives of General Psychiatry. 1996; 53:1033–1039. [PubMed: 8911226]

Cicchetti D, Toth SL. The development of depression in children and adolescents. American Psychologist. 1998; 53:221–241. [PubMed: 9491749]

Cohen P, Cohen J, Kasen S, Velez CN, Hartmark C, Johnson J, et al. An epidemiological study of disorders in late childhood and adolescence: I. Age- and gender-specific prevalence. Journal of Child Psychology and Psychiatry. 1993; 34:851–867. [PubMed: 8408371]

Coplan RJ, Arbeau KA, Armer M. Don't fret, be supportive! Maternal characteristics linking child shyness to psychosocial and school adjustment in kindergarten. Journal of Abnormal Child Psychology. 2008; 36:359–371. [PubMed: 17899358]

Dempster AP, Laird NM, Rubin DB. Maximum likelihood from incomplete data via the EM algorithm. Journal of the Royal Statistical Society Series. 1977; 39:1–38.

Deneault J, Ricard M, Décarie TG, Morin PL, Quintal G, Boivin M, Tremblay RE, Pérusse D. False belief and emotion understanding in monozygotic twins, dizygotic twins, and non-twin children. Cognition and Emotion. 2008; 22:697–708.

Eaves LJ, Silberg JL, Meyer JM, Maes HH, Simonoff E, Pickles A, et al. Genetics and developmental psychopathology: 2. The main effects of genes and environment on behavioral problems in the Virginia Twin Study of Adolescent Behavioral Development. Journal of Child Psychology and Psychiatry. 1997; 38:965–980. [PubMed: 9413795]

Eisenberg N, Sadovsky A, Spinrad TL, Fabes RA, Losoya SH, Valiente C, Reiser M, Cumberland A, Shepard SA. The relations of problem behavior status to children's negative emotionality, effortful control, and impulsivity: Concurrent relations and prediction of change. Developmental Psychology. 2005; 41:193–211. [PubMed: 15656749]

Eley TC, Bolton D, O'Connor TG, Perrin S, Smith P, Plomin R. A twin study of anxiety-related behaviours in preschool children. Journal of Child Psychology and Psychiatry. 2003; 44:945–960. [PubMed: 14531577]

Else-Quest NM, Hyde JS, Goldsmith HH, Van Hulle CA. Gender differences in temperament: A meta-analysis. Psychological Bulletin. 2006; 132:33–72. [PubMed: 16435957]

Essex MJ, Boyce WT, Heim Goldstein L, Armstrong JM, Kraemer HC, Kupfer DJ. The MacArthur Assessment Battery Working Group. The confluence of mental, physical, social, and academic difficulties in middle childhood. II: Developing the MacArthur Health and Behavior Questionnaire. Journal of the American Academy of Child and Adolescent Psychiatry. 2002; 41:588–603. [PubMed: 12014792]

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Essex MJ, Klein MH, Slattery MJ, Goldsmith HH, Kalin NH. Early risk factors and developmental pathways to chronic high inhibition and social anxiety disorder in adolescence. American Journal of Psychiatry. 2010; 167:40–46. [PubMed: 19917594]

Fox NA, Henderson HA, Marshall PJ, Nichols KE, Ghera MM. Behavioral inhibition: Linking biology and behavior within a developmental framework. Annual Review of Psychology. 2005; 56:235–262.

Gagne, JR.; Vendlinski, MK.; Goldsmith, HH. The genetics of childhood temperament. In: Kim, Y-K., editor. Handbook of Behavioral Genetics. New York: Springer; 2009. p. 251-267.

Ginsburg GS, Schlossberg MC. Family-based treatment of childhood anxiety disorders. International Review of Psychology. 2002; 14:143–154.

Goldsmith HH, Buss AH, Plomin R, Rothbart MK, Thomas A, Chess S, et al. Roundtable: What is temperament? Four approaches. Child Development. 1987; 58:505–529. [PubMed: 3829791]

Goldsmith, HH.; Reilly, J.; Lemery, KS.; Longley, L.; Prescott, A. The Laboratory Temperament Assessment Battery (Technical Manual). University of Wisconsin–Madison; 1993.

Goldsmith, HH.; Reilly, J.; Lemery, KS.; Longley, S.; Prescott, A. Laboratory Temperament Assessment Battery, Preschool Version. (Technical Manual). University of Wisconsin–Madison; 1999.

Gregory AM, Eley TC. Genetic influences on anxiety in children: What we've learned and where we're heading. Clinical Child and Family Psychology Review. 2007; 10:199–212. [PubMed: 17503180]

Gregory AM, Lau JY, Eley TC. Finding gene-environment interactions for generalized anxiety disorder. European Archives of Psychiatry and Clinical Neuroscience. 2008; 258:69–75. [PubMed: 18297422]

Johnson W, Krueger RF, Bouchard TJ, McGue M. The personalities of twins: Just ordinary folks. Twin Research and Human Genetics. 2002; 5:125–131.

Halberstadt AG. Family socialization of emotional expression and nonverbal communication styles and skills. Journal of Personality and Social Psychology. 1986; 51:827–836.

Hastings, PD.; Nuselovici, JN.; Rubin, KH.; Cheah, CSL. Shyness, parenting, and parent-child relationships. In: Rubin, RH.; Coplan, RJ., editors. The development of shyness and social withdrawal. New York, NY: The Guilford Press; 2010. p. 107-130.

Hettema JM, Neale MC, Kendler KS. A review and meta-analysis of the genetic epidemiology of anxiety disorders. The American Journal of Psychiatry. 2001; 158:1568–1578. [PubMed: 11578982]

Hollingshead, AB. Privately published manuscript. New Haven, CT: 1957. Two-factor index of social position.

Hox, JJ. Multilevel analysis. Techniques and applications. Mahwah, NJ: Lawrence Erlbaum Associates; 2002.

Jekielek SM. Parental conflict, marital disruption, and children's emotional well-being. Social Forces. 1998; 76:905–936.

Kagan J, Reznick JS, Gibbons J. Inhibited and uninhibited types of children. Child Development. 1989; 60:838–845. [PubMed: 2758880]

Kagan J, Snidman N. Early childhood predictors of adult anxiety disorders. Biological Psychiatry. 1999; 46:1536–1541. [PubMed: 10599481]

Kagan J, Snidman N, Kahn V, Towsley S. The preservation of two infant temperaments into adolescence. Monographs of the Society for Research in Child Development. 2007; 72:1–75. [PubMed: 17661895]

Kagan J, Snidman N, Zentner M, Peterson E. Infant temperament and anxious symptoms in school age children. Development and Psychopathology. 1999; 11:209–224. [PubMed: 16506531]

Kashy DA, Donnellan MB, Burt SA, McGue M. Growth curve models for indistinguishable dyads using multilevel modeling and structural equation modeling: The case of adolescent twins' conflict with their mothers. Developmental Psychology. 2008; 44:316–329. [PubMed: 18331125]

Kendler KS, Myers J, Zisook S. Does bereavement-related major depression differ from major depression associated with other stressful life events? American Journal of Psychiatry. 2008; 165:1449–1455. [PubMed: 18708488]

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Kenny, DA.; Kashy, DA.; Cook, WL. Dyadic data analysis. New York: Guilford Press; 2006.

Kochanska G, Murray K, Jacques TY, Koenig AL, Vandegeest KA. Inhibitory control in young children and its role in emerging internalization. Child Development. 1996; 67:490–507. [PubMed: 8625724]

Krain AL, Kendall PC. The role of parental emotional distress in parent report of child anxiety. Journal of Clinical Child Psychology. 2000; 29:328–335. [PubMed: 10969417]

Lemery-Chalfant K, Goldsmith HH, Schmidt NL, Arneson CA, Van Hulle CA. Wisconsin twin panel: Current directions and findings. Twin Research and Human Genetics. 2006; 9:1030–1037. [PubMed: 17254447]

Luby J, Heffelfinger A, Measelle J, Ablow J, Essex M, Dierker L, Harrington R, Kraemer H, Kupfer D. Differential performance of the MacArthur HBQ and DISC-IV in identifying DSM-IV internalizing psychopathology in young children. Journal of the American Academy of Child and Adolescent Psychiatry. 2002; 41:458–466. [PubMed: 11931603]

Majdandzic M, van den Boom DC, Heesbeen DGM. Peas in a pod: Biases in the measurement of sibling temperament? Developmental Psychology. 2008; 44:1354–1368. [PubMed: 18793068]

Matheny AP, Wachs TD, Ludwig JL, Phillips K. Bringing order out of chaos: Psychometric characteristics of the confusion, hubbub, and order scale. Journal of Applied Developmental Psychology. 1995; 16:429–444.

McHale JP, Rasmussen JL. Coparental and family group-level dynamics during infancy: Early family precursors of child and family functioning during preschool. Development and Psychopathology. 1998; 10:39–59. [PubMed: 9524807]

McLeod BD, Wood JJ, Weisz JR. Examining the association between parenting and childhood anxiety: A meta-analysis. Clinical Psychology Review. 2007; 27:155–172. [PubMed: 17112647]

McLoyd VC. Socioeconomic disadvantage and child development. American Psychologist. 1998; 53:185–204. [PubMed: 9491747]

Mistry RS, Vandewater EA, Huston AC, McLoyd VC. Economic well-being and children's social adjustment: The role of family process in an ethnically diverse low income sample. Child Development. 2002; 73:935–951. [PubMed: 12038561]

Pennington, BF. The development of psychopathology: Nature and nurture. New York: The Guilford Press; 2002.

Pfeifer M, Goldsmith HH, Davidson RJ, Rickman M. Continuity and change in inhibited and uninhibited children. Child Development. 2002; 73:1474–1485. [PubMed: 12361313]

Phongsavan P, Chey T, Bauman A, Brooks R, Silove D. Social capital, socioeconomic status, and psychological distress among Australian adults. Social Science and Medicine. 2006; 63:2546–2561. [PubMed: 16914244]

Prior M, Smart D, Sanson A, Oberklaid F. Does shy temperament in childhood lead to anxiety problems in adolescence? Journal of the American Academy of Child and Adolescent Psychiatry. 2000; 39:461–468. [PubMed: 10761348]

Rapee, R. Temperament and the etiology of social phobia. In: Rubin, RH.; Coplan, RJ., editors. The development of shyness and social withdrawal. New York, NY: The Guilford Press; 2010. p. 277-299.

Rapee R, Kennedy S, Ingram M, Edwards S, Sweeney L. Prevention and early intervention of anxiety disorders in inhibited preschool children. Journal of Consulting and Clinical Psychology. 2005; 73:488–497. [PubMed: 15982146]

Raudenbush, S.; Bryk, A.; Cheong, YF.; Congdon, R.; duToit, M. HLM 6: Hierarchical linear and nonlinear modeling. Lincolnwood, IL: Scientific Software International, Inc; 2004.

Rothbart, MK. Temperament and development. In: Kohnstamm, GA.; Bates, JA.; Rothbart, MK., editors. Temperament in childhood. New York: Wiley; 1989. p. 187-247.

Rothbart MK. Commentary: Differentiated measures of temperament and multiple pathways to childhood disorders. Journal of Clinical Child and Adolescent Psychology. 2004; 33:82–87. [PubMed: 15028543]

Rothbart MK, Ahadi SA, Hershey KL, Fisher P. Investigations of temperament at three to seven years: The Children's Behavior Questionnaire. Child Development. 2001; 72:1394–1408. [PubMed: 11699677]

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Rothbart, MK.; Derryberry, D. Development of individual differences in temperament. In: Lamb, ME.; Brown, AL., editors. Advances in developmental psychology. Vol. 1. Hillsdale, NJ: Lawrence Erlbaum Associates; 1981. p. 37-86.

Roza SJ, Hofstra MB, van der Ende J, Verhulst FC. Stable prediction of mood and anxiety disorders based on behavioral and emotional problems in childhood: a 14-year follow-up during childhood, adolescence, and young adulthood. American Journal of Psychiatry. 2003; 160:2116–2121. [PubMed: 14638580]

Rubin KH, Coplan RJ, Bowker JC. Social withdrawal in childhood. Annual Review of Psychology. 2009; 60:141–171.

Rutter M, Caspi A, Moffitt TE. Using sex differences in psychopathology to study causal mechanisms: unifying issues and research strategies. Journal of Child Psychology and Psychiatry. 2003; 44:1092–1115. [PubMed: 14626453]

Sarason IG, Johnson JJ, Siegel JM. Assessing the impact of life changes: Development of the life experiences survey. Journal of Consulting and Clinical Psychology. 1978; 46:932–946. [PubMed: 701572]

Scarr S, Salapatek P. Patterns of fear development during infancy. Merrill Palmer Quarterly. 1970; 16:53–90.

Schniering CA, Hudson JL, Rapee RM. Issues in the diagnosis and assessment of anxiety disorders in children and adolescents. Clinical Psychology Review. 2000; 20:453–478. [PubMed: 10832549]

Schwartz CE, Snidman NS, Kagan J. Adolescent social anxiety as an outcome of inhibited temperament in childhood. Journal of the American Academy of Child and Adolescent Psychiatry. 1999; 38:1008–1015. [PubMed: 10434493]

Silverman, WK. DSM and classification of anxiety disorders in children and adults. In: Last, CG., editor. Anxiety across the lifespan: A developmental perspective. New York, NY: Springer Publishing Company; 1993. p. 7-36.

Spence SH, Najman JM, Bor W, O'Callaghan M, Williams GM. Maternal anxiety and depression, poverty and marital relationship factors during early childhood as predictors of anxiety and depressive symptoms in adolescence. Journal of Child Psychology and Psychiatry. 2002; 43:457–470. [PubMed: 12030592]

Stemberger RT, Turner SM, Beidel DC. Social phobia: An analysis of possible developmental factors. Journal of Abnormal Psychology. 1995; 194:526–531. [PubMed: 7673576]

Stevenson J, Batten N, Cherner M. Fears and fearfulness in children and adolescence: A genetic analysis of twin data. Journal of Child Psychology and Psychiatry. 1992; 33:977–985. [PubMed: 1400693]

Tellegen, A. Brief manual of the Multidimensional Personality Questionnaire. Department of Psychology, University of Minnesota; 1978/1982.

Tellegen, A.; Waller, NG. Exploring personality through test construction: Development of the Multidimensional Personality Questionnaire. In: Briggs, SR.; Cheek, JM., editors. Personality measures: Development and evaluation. Vol. 1. Greenwich, CT: JAI; 1995.

Thapar A, McGuffin P. Are anxiety symptoms in childhood heritable? Journal of Child Psychology and Psychiatry. 1995; 36:439–447. [PubMed: 7782407]

Topolski TD, Hewitt JK, Eaves LJ, Silberg JL, Meyer JM, Rutter M, Pickles A, Simonoff E. Genetic and environmental influences on child reports of manifest anxiety and symptoms of separation anxiety and overanxious disorders: A community-based twin study. Behavior Genetics. 1997; 27:15–28. [PubMed: 9145540]

Turner HA, Butler MJ. Direct and indirect effects of childhood adversity on depressive symptoms in young adults. Journal of Youth and Adolescence. 2003; 32:89–103.

Van Ameringen MV, Mancini C, Oakman JM. The relationship of behavioral inhibition and shyness to anxiety disorder. The Journal of Nervous and Mental Disease. 1998; 186:425–431. [PubMed: 9680044]

van der Bruggen CO, Stams GJJM, Bögels SM. Research review: The relation between child and parent anxiety and parental control: A meta-analytic review. Journal of Child Psychology and Psychiatry. 2008; 49:1257–1269. [PubMed: 18355216]

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Vendlinski, M.; Lemery-Chalfant, K.; Essex, M.; Goldsmith, HH. A systematic approach for detecting genetic risk by experience interaction for childhood internalizing problems. 2009. Manuscript under editorial review

Zahn-Waxler C, Shirtcliff EA, Marceau K. Disorders of childhood and adolescence: Gender and psychopathology. Annual Review of Clinical Psychology. 2007; 4:275–303.

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

Table 1

Study Measures

Type of Assessment	Name of Measure	Citation	Target Study Variable(s)	Age(s) at Assessment
Questionnaire, parental report	Children's Behavior Questionnaire	(Rothbart et al., 2001)	BI, Shyness, IC	36 yrs, 7–8 yrs
	Health and Behavior Questionnaire	(Essex et al., 2002)	Children's anxiety symptoms	7–8 yrs
	Multidimensional Personality Questionnaire	(Tellegen, 1982)	Mothers' stress reaction	25 mos
	Family Emotional Expressiveness Questionnaire	(Halberstadt, 1986)	Negative family affect in early childhood	3 yrs
	Child Rearing Practices Report	(Block, 1965)	Negative family affect in early childhood	3 yrs
	Confusion, Hubbub, and Order Scale	(Matheny et al., 1995)	Family stress in middle childhood	7–8 yrs
	Life Experiences Survey	(Sarason et al., 1978)	Family stress in middle childhood	7–8 yrs
	Hollingshead index score		Socioeconomic status	birth, 30 mos, 7–8 yrs
Experimenter Ratings	Post laboratory visit ratings		BI	3 yrs
	Initial approach; Post home visit ratings		Shyness	7–8 yrs
Observational, Laboratory (Lab-TAB)	Risk Room; Stranger Storytelling	(Goldsmith et al., 1999) (Goldsmith et al., 1993)	BI, Shyness	3 yrs 7–8 yrs
	Snack Delay; Dinky Toys	(Goldsmith et al., 1999)	IC	3 yrs

NIH-PA Author Manuscript NIH-PA Author Manuscript NIH-PA Author Manuscript

Table 2

Formation of Behavioral Composites via Principal Component Analysis

Behavioral Episode Composites									
Risk Room-3 years (BI)		**Stranger-3 years (BI)**			**Dinky Toys-3 years (IC)**		**Storytelling-7–8 years (shyness)**		
Measures and PC loadings		**Measures and PC loadings**			**Measures and PC loadings**		**Measures and PC loadings**		
	1st PC		**1st PC**	**2nd PC**		**1st PC**		**1st PC**	**2nd PC**
Approach parent	.66	Global Facial Fear	.38	.73	IA-Mean	.30	Speed to first fear response	.21	.80
Tentativeness of play	.81	Activity Decrease	−.15	.68	ST-Mean	.75	Bodily fear	.01	.65
Total time spent not playing	.77	Approach	.28	−.35	LC-Mean	.82	Avoidance	.42	.46
# Objects Not Played With	.80	Vocal Distress	.82	.09	FD-Mean	.74	Nervous fidgeting	.76	.00
Average speed to play with objects	−.79	Verbal Hesitancy	−.65	.56	TI-Mean	.79	Speed to fidget	.73	.00
		Avoidance	.64	.34	IA-Peak	.32	Percent time not speaking	−.50	.48
					ST-Peak	.74	Dysfluency/hesitation	.29	.12
					LC-Peak	.83	Speed to begin speaking	.53	−.30
					FD-Peak	.72			
					TI-Peak	.78			
					Speed-Mean LC	−.75			
					Speed-Peak LC	−.73			

Note. IA = Initial Approach, ST = Style of Touching, LC = Latency to Choose, FD = Follows Directions, TI = Total Impulsivity

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

Table 3

Formation of Predictor Composites via Principal Component Analysis

Predictor Composites					
Level One (for multisource shyness and anxiety)				Level Two	
IC		BI		Negative Family Affect- EC	
Measures with 1st PC loadings		Measures with 1st PC loadings		Measures with 1st PC loadings	
Dinky Toys-Comp	.61	Risk Room-Composite	.48	FEQ: Negative Dominant	.78
Snack Delay-Comp	.61	E-rated (3 yrs): Fearfulness	.68	FEQ: Negative Submissive	.46
CBQ (3 yrs): IC	.74 (m)	E-rated (3 yrs): Social Engagement	.65	CRPR: Authoritarian Control	.50
	.71 (f)	Stranger: Active Fear (1st PC)	−.30	CRPR: Negative Affect to Child	.65
		Stranger: Inhibition (2nd PC)	.27	CRPR: Rational Guidance	−.39
		CBQ (3 yrs): Fear	.46 (m)	CRPR: Control by Anxiety	.67
			.30 (f)	CRPR: Control by Guilt	.61
		CBQ (3 yrs): Shyness	.78 (m)		
			.72 (f)		

Note. m = mother, f = father, E = experimenter, EC = early childhood, MC = middle childhood

NIH-PA Author Manuscript NIH-PA Author Manuscript NIH-PA Author Manuscript

Table 4

Correlations among the Predictor and Outcome Variables

	Predictors							Outcomes	
	IC	**BI**	**Sex[a]**	**Average SES**	**Mom's Stress Reaction**	**Negative Family Affect-EC**	**Family Stress-MC**	**Multisource Shyness**	**Anxiety**
IC	---	.11	.30**	.15*	.04	−.21**	−.05	.10	.05
BI		---	.07	.06	.14*	.01	−.02	.41**	.08
Sex[a]			---	.07	.22**	.04	−.11	.03	.10
Average SES				---	−.11	−.46**	−.16*	.02	−.08
Mom's Stress Reaction					---	.29**	.30**	.02	.21**
Negative Family Affect- EC						---	.22**	.02	.23**
Family Stress- MC							---	−.16*	.27**
Multisource Shyness								---	.05

Note: EC = Early Childhood, MC = Middle Childhood,

[a]females = 1; males = 0;

*p <.05,

**p <.01

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Table 5

Hierarchical Linear Main Effects Models Predicting Shyness at Age 7

Model Predicting Multisource Shyness (with robust standard errors)			
Fixed Effect	**Coefficient**	***SE***	**T-ratio**
γ_{00} = Intercept	0.08	0.11	0.79
Family Level Variables			
γ_{01} = Mother's Stress Reaction	−0.03	0.08	−0.43
γ_{02} = Average SES	−0.04	0.09	−0.43
γ_{03} = Negative Family Affect- EC	0.06	0.08	0.85
γ_{04} = Family Stress- MC	−0.22	0.09	-2.48^{*}
Child-Level Variables			
γ_{10} = Sex	−0.16	0.16	−1.01
γ_{20} = 3-yr IC	0.14	0.07	2.09^{*}
γ_{30} = 3-yr BI	0.37	0.07	5.72^{**}
Model Predicting Child/Observer Based Shyness (with robust standard errors)			
Fixed Effect	Coefficient	*SE*	T-ratio
γ_{00} = Intercept	0.00	0.11	0.02
Family Level Variables			
γ_{01} = Mother's Stress Reaction	−0.03	0.08	−0.42
γ_{02} = Average SES	−0.01	0.11	−0.12
γ_{03} = Negative Family Affect- EC	0.00	0.12	0.00
γ_{04} = Family Stress- MC	−0.20	0.08	-2.54^{*}
Child Level Variables			
γ_{10} = Sex	−0.01	0.13	−0.07
γ_{20} = 3-yr IC	0.08	0.08	1.04
γ_{30} = 3-yr BI	0.13	0.07	1.86^{+}
Model Predicting Parent Reported Shyness (with robust standard errors)			
Fixed Effect	Coefficient	*SE*	T-ratio
γ_{00} = Intercept	0.10	0.11	0.86
Family Level Variables			
γ_{01} = Mother's Stress Reaction	0.01	0.09	0.11
γ_{02} = Average SES	0.01	0.09	0.12
γ_{03} = Negative Family Affect- EC	0.00	0.09	0.01
γ_{04} = Family Stress- MC	−0.16	0.09	-1.93^{+}
Child Level Variables			
γ_{10} = Sex	−0.16	0.17	−1.00
γ_{20} = 3-yr IC	−0.01	0.08	−0.18
γ_{30} = 3-yr BI	0.36	0.07	4.90^{**}

Note. EC = Early Childhood, MC = Middle Childhood

$^{+}p < .10$,

$^{*}p < .05$,

$^{**}p < .01$

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Table 6

Hierarchical Linear Main Effects Model Predicting Anxiety at age 7

Model Predicting Anxiety (with robust standard errors)			
Fixed Effect	**Coefficient**	***SE***	**T-ratio**
γ_{00} = Intercept	−0.11	0.12	−0.96
Family Level Variables			
γ_{01} = Mother's Stress Reaction	0.01	0.10	0.09
γ_{02} = Average SES	−0.04	0.10	−0.41
γ_{03} = Negative Family Affect- EC	0.20	0.09	2.24*
γ_{04} = Family Stress- MC	0.26	0.11	2.34*
Child Level Variables			
γ_{10} = Sex	0.16	0.14	1.14
γ_{20} = 3-yr IC	0.00	0.06	−0.02
γ_{30} = 3-yr BI	0.14	0.07	1.97*

Note. EC = Early Childhood, MC = Middle Childhood

* $p < .05$