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RESEARCH ARTICLE

Social versus non-social behavioral inhibition: Differential prediction from early childhood of long-term psychosocial outcomes

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Abstract

Behavioral inhibition (BI) is a temperamental style characterized by cautious and fearful behaviors in novel situations. The present multi-method, longitudinal study examined whether young children's observed and parent-reported BI in social versus non-social contexts predicts different long-term psychosocial outcomes. Participants (N = 279) were drawn from a longitudinal study of socioemotional development. BI in social contexts ("social BI") was measured via children's observed wariness toward unfamiliar adults and peers at 24 and 36 months and parents' reports of children's social fear/shyness at 24, 36, and 48 months. BI in non-social contexts ("non-social BI") was measured via children's observed fearful responses to masks and novel toys, and parents' reports of children's distress to non-social novelty at 9 months and non-social fear at 48 months. At 15 years, anxiety was assessed via adolescent- and parent-reports, and global internalizing and externalizing problems were assessed via parent-reports. Confirmatory factor analysis showed that a two-factor model fit the BI data significantly better than a single-factor model, providing evidence for the dissociation of BI in social versus non-social contexts. Social BI was uniquely associated with adolescent social anxiety, whereas non-social BI was specifically associated with

adolescent separation anxiety. Neither social BI nor non-social BI predicted global internalizing and externalizing problems, providing evidence for the specific relations between BI and anxiety problems. Together, these results suggest that young children's inhibited responses in social versus non-social situations predict different subtypes of anxiety problems in adolescence, highlighting the multifaceted nature of BI and the divergent trajectories of different anxiety problems.

KEYWORDS
anxiety, behavioral inhibition, individual differences, longitudinal, social, temperament

1 | INTRODUCTION

Behavioral inhibition (BI) is a temperamental style characterized by cautious and fearful behaviors in unfamiliar and novel situations (Kagan, 1989). Compared with noninhibited children, children who are behaviorally inhibited show more fear, wariness, and avoidance toward novel stimuli (Kagan, 1989, 1997). These behavioral tendencies have a complex neurobiology (Dilalla et al., 1994; Smoller et al., 2003; Smoller et al., 2001) and are moderately stable from toddlerhood to middle childhood (Broberg et al., 1990; Kerr et al., 1994; Pfeifer et al., 2002; Scarpa et al., 1995). Over the past decades, a wealth of research has demonstrated that early individual differences in BI carry downstream effects on social and emotional development. Children who are behaviorally inhibited tend to have more social problems (e.g., rejection, victimization) and academic difficulties (e.g., school avoidance) in later childhood (Rubin et al., 2009; Walker et al., 2014). In adolescence and adulthood, a history of childhood BI predicts higher rates of anxiety problems, particularly social anxiety (for reviews, see Clauss & Blackford, 2012; Sandstrom et al., 2020). Despite the strong links between BI and social anxiety, not all BI children develop anxiety disorders (Chronis-Tuscano et al., 2009; Fox et al., 2001).

Traditionally, children's inhibited behaviors are assessed across both social and non-social contexts (Fox et al., 2001; Kagan et al., 1984; Pfeifer et al., 2002). However, a growing literature suggests that children's inhibited responses to novel social and non-social stimuli are not highly correlated. Using laboratory tasks and behavioral observations, studies have found non-significant correlations between inhibited responses in social (e.g., stranger approach) and non-social (e.g., mechanical dog, jack-in-the-box, unknown apartment) situations in children aged 2–60 months (range of correlations: 0.00–0.35) (Buss et al., 2004; Kochanska, 1991; Majdandžić & Van Den Boom, 2007; Rubin et al., 1997; Scarr & Salapatek, 1970; Talge et al., 2008). Factor analyses on retrospective self-reports of childhood BI have also shown dissociations between recalled social BI and non-social BI (Neal et al., 2002; Reznick et al., 1992; Schofield et al., 2009; Van Amerigen et al., 1998), and similar dissociations have been found in parent- and teacher-reports of children's inhibited behaviors (Bishop et al., 2003). Together, these studies suggest that children's inhibited behaviors in social and non-social contexts are at the very least moderately dissociable.

The dissociation of BI in social and non-social contexts suggests that these two forms of early inhibition may predict different developmental outcomes. Indeed, past research suggests that children's inhibited responses in social versus non-social contexts are correlated with different behavioral and emotional traits (Brooker et al., 2016; Dyson et al., 2011; Geng et al., 2011; Kertes et al., 2009; Kochanska & Radke-Yarrow, 1992; van Brakel et al., 2004). For example, using laboratory assessments of BI, Dyson et al., 2011) found that social BI in preschool was positively associated with concurrent parent-reports of shyness, inhibition with peers and adults, and social phobia. By contrast, non-social BI was positively associated with fearfulness and specific phobia in non-social contexts. Using parents' reports of their children's social/non-social fear, Brooker et al., 2016) found that higher social (but not non-social) fear across toddlerhood and preschool was associated with greater social anxiety at age 5. Even in studies that showed significant associations between social and non-social BI in retrospective self-reports of childhood temperament, only social BI predicted later social phobia and shyness (Neal et al., 2002; Poole et al., 2017; Van Ameringen et al., 1998).

The studies reviewed above provide evidence that young children's inhibited responses to social versus non-social novelty are associated with different behavioral traits (particularly different types of anxiety). However, it remains unclear whether variations in children's BI across social versus non-social contexts have long-term implications for psychosocial outcomes beyond childhood. Although studies using retrospective self-reports of childhood social/non-social BI have found preliminary evidence for differential long-term outcomes (Neal et al., 2002; Poole et al., 2017; Schofield et al., 2009; Van Ameringen et al., 1998), retrospective self-reports are susceptible to recall and reporting biases (Herman & Koran, 1998; Margraf et al., 1987; Sato & Kawahara, 2011). Hence, to elucidate the long-term consequences of social and non-social BI, longitudinal research with multiple methodologies and measurements is needed. The current study aimed to fill this gap by systematically examining whether inhibited responses toward social versus non-social novelty in early childhood predict different psychosocial outcomes at 15 years of age.

To investigate whether social and non-social BI are dissociable constructs, we assessed these two forms of inhibition using both behavioral and parent-reported questionnaire measures (Lahat et al., 2014; Suarez et al., 2021; Troller-Renfree et al., 2019). The use of

behavioral observations allowed us to reduce reporter biases and systematically examine children's responses in well-controlled experimental settings. As such, children's facial, vocal, and bodily responses to both social and non-social novelty were observed in the laboratory to assess social/non-social BI. For social BI, children's inhibited behaviors during interactions with an unfamiliar adult and with an unfamiliar peer were observed at 24 and 36 months (Degnan et al., 2014; Fox et al., 2001). For non-social BI, children's reactivity toward unfamiliar objects – masks and an unpredictable toy – was assessed at 9 months (Goldsmith & Rothbart, 1999; Hane et al., 2006). Although BI is typically measured during toddlerhood, young infants' reactivity to novelty is considered a precursor to BI (Fox et al., 2001, 2015; Kagan & Snidman, 1991; Kagan et al., 1998). Similar behavioral paradigms (i.e., stranger interaction and novel objects) have been used in past research to assess social and non-social BI, respectively (Brooker et al., 2016; Dyson et al., 2011; Kertes et al., 2009; Kochanska & Radke-Yarrow, 1992).

In addition to behavioral tasks, parents' reports of children's typical levels of wariness in novel social and non-social situations were also collected. Parents can provide valuable insights into children's inhibited behaviors in daily life, because they have extensive experience with their child across a wide range of settings. For social BI, we assessed parents' perception of children's social fearfulness (e.g., fear toward strangers) and shyness at 24, 36, and 48 months. For non-social BI, we assessed parents' perception of children's distress to novelty (e.g., novel food or liquid) at 9 months, and fear toward non-social stimuli (e.g., loud noises) in everyday situations at 48 months. These parent-reported measures have been used to distinguish social versus non-social BI in prior studies (Brooker et al., 2016; Dyson et al., 2011; Geng et al., 2011; Gensthaler et al., 2013; Kertes et al., 2009). Because measures at different ages were used for social (24, 36, and 48 months) versus non-social (9 and 48 months) BI, we conducted a supplementary analysis to test whether differential effects between social and non-social BI were attributable to this asymmetry (see Discussion and Supporting Information [SI]).

Given the strong links between early BI and social anxiety later in development (for reviews, see Clauss & Blackford, 2012; Fox et al., 2005; Sandstrom et al., 2020), we were particularly interested in whether social/non-social BI predicts specific types of anxiety in adolescence. To this end, we conducted a comprehensive assessment of adolescent anxiety problems using both parent- and adolescent-reports of social anxiety, generalized anxiety, somatic/panic disorder, separation anxiety, and school avoidance (Dirks et al., 2014). To explore whether social/non-social BI specifically predicts anxiety, but not global emotional or behavioral problems, we also collected parent-reports of adolescents' internalizing and externalizing problems.

We used a confirmatory factor analytic approach to examine whether the construct of BI is best represented by a two-factor (social/non-social BI) structure. Given past research showing the dissociation between social and non-social BI, we predicted that the behavioral and parent-reported measures of social and non-social BI would load onto two correlated but independent latent factors. Next, we explored whether social and non-social BI differentially predict socioemotional outcomes at 15 years. Given that social and non-social BI have been shown to be specifically associated with children's anxiety in social and non-social contexts (respectively), we predicted that social BI would uniquely predict social anxiety at 15 years, whereas non-social BI would predict non-social anxiety problems (e.g., somatic/panic disorder, generalized anxiety, or separation anxiety). Finally, to test the specificity of the links between BI and anxiety, we examined the relations between social/non-social BI and global emotional and behavioral problems. We predicted that social and non-social BI would not be associated with global internalizing and externalizing problems in adolescence.

Research Highlights

- Early inhibited responses in either social or non-social contexts differentially predicted specific types of anxiety at 15 years.
- Inhibited behavior in a social context specifically predicted parent- and child-reported social anxiety at age 15 years.
- Inhibited behavior in a non-social context specifically predicted separation anxiety.
- Early inhibited behavior specifically predicted adolescent anxiety problems, but not global internalizing/externalizing problems, providing evidence for the specific links between inhibited behavior and anxiety.

2 | METHOD

2.1 | Participants

Participants were part of a larger cohort of children ($N = 291$, 53.61% female) participating in a longitudinal study of child temperament and socioemotional development (Degnan et al., 2015; Hane et al., 2008; Miller et al., 2019). Families were recruited from a metropolitan area in the Mid-Atlantic region of the United States using commercially available mailing lists. At 4 months of age, 779 infants were screened for degree of reactivity to novel auditory and visual stimuli (Calkins et al., 1996; Fox et al., 2001). Of these children, 291 were selected to participate in the larger longitudinal study, including 116 negative reactive (i.e., higher negative affect, higher motor arousal, lower positive affect), 106 positive reactive (i.e., higher positive affect, higher motor arousal, lower negative affect), and 69 control group infants. A detailed description of the recruitment and screening processes was provided by Hane et al. (2008). Maternal ethnicity was self-reported as 69.42% White, 16.49% Black, 7.22% Hispanic, 3.09% Asian, and 3.44% other; 0.34% of mothers did not report ethnicity. Maternal education was self-reported as 41.92% college graduates, 35.74% graduate school graduates, 16.15% high school graduates, and 5.50% other; 0.69% did not report education.

Of the 291 children, 12 children were missing data on all measures of interest to the current study and were excluded from the final sample (see SI 1 Table S1 for sample size of each measure). These children did not differ from children in the final sample (N = 279) in terms of gender, χ^2 (1, N = 291) = 0.00, $p > 0.05$, or maternal education, χ^2 (3, N = 289) = 4.61, p = 0.203. However, children with missing data on all measures of interest were more likely to have non-White mothers, χ^2 (1, N = 290) = 19.35, $p < 0.001$. Power analyses showed that the final sample size (N = 279) provided a power (1 – β) of 0.92 to detect the hypothesized small to medium correlations ($\rho s \geq 0.20$) between early inhibited responses and socioemotional functioning in adolescence; these effect sizes were estimated based on past research examining the links between early BI and long-term socioemotional outcomes in an independent sample (Tang et al., 2020).

2.2 | Procedure

Social and non-social BI were assessed via behavioral observations and parent-reports during infancy and early childhood (see SI 1 Figure S1 for timeline of study measures). Social BI measures included two behavioral tasks and two parent-reported questionnaires. At 24 and 36 months, children's behaviors during interactions with an unfamiliar adult and with an unfamiliar peer were observed in the laboratory, and parent-reports of children's social fear on the Toddler Behavior Assessment Questionnaire (TBAQ 1994 Version; Goldsmith, 1996) were collected. At 48 months, parent-reports of children's shyness on the Children's Behavior Questionnaire (CBQ; Rothbart et al., 2001) were collected. Similar to social BI, non-social BI measures included two behavioral tasks and two parent-reported questionnaires. At 9 months, children's fear and avoidance responses to masks and an unpredictable toy were observed in the laboratory, and parent-reports of children's distress to novelty on the Infant Behavior Questionnaire (IBQ; Rothbart, 1981) were collected. At 48 months, parent-reports of children's fearful responses to novel, non-social stimuli on the CBQ fear subscale were collected.

Psychosocial outcomes were assessed at 15 years using the Screen for Child Anxiety-Related Disorders (SCARED; Birmaher et al., 1999; Birmaher et al., 1997) and the Child Behavior Checklist (CBCL/6–18; Achenbach & Rescoral, 2001). Participants' social phobia, generalized anxiety, somatic/panic problems, separation anxiety, and school phobia were reported by both parents and children on the SCARED. Participants' global behavioral and emotional problems were reported by parents on the CBCL internalizing and externalizing subscales. The study was conducted with written informed consent obtained from a legal guardian and verbal/written assent obtained from child participants. Parents received monetary compensation and children received a gift for participation at each assessment. All procedures were approved by the institutional review board at the associated university.

2.3 | Measures

2.3.1 | Behavioral observation

Fear tasks (masks and unpredictable toy)

Children's behavioral responses to non-social novelty were examined at 9 months using the fear episodes of the Laboratory Temperament Assessment Battery (Lab-TAB; Goldsmith & Rothbart, 1999), which have been used by past research to assess children's BI in non-social contexts (Brooker et al., 2016; Dyson et al., 2011). Consistent with the Lab-TAB guidelines, children sat in a highchair in front of a table, and mothers sat behind children and remained uninvolved throughout the study. During the masks episode, the experimenter placed on the table a large cardboard screen with a door, and then displayed an old man mask and a clown mask through the door. The presentation of each mask was 10 s in length. During the unpredictable toy episode, the experimenter placed a long track in front of children. Then a remote-controlled dog moved rapidly down the track toward the child, stopped 15 cm directly in front of the child, and sat down for 10 s. If the child reached for the toy, the dog moved slightly back, out of the child's reach. The entire procedure was repeated two more times for a total of three trials; each trial lasted 10 s (Hane et al., 2006).

Children's BI was assessed by rating the intensity of vocal distress (from 0 [No distress] to 3 [Definite non-muted crying]) and intensity of escape (from 0 [No escape behavior or social referencing] to 3 [Vigorous escape behavior]) (Hane et al., 2006). Total scores were calculated by averaging standardized rating scores across measures and episodes; higher scores indicated higher BI. A second independent coder rated a subset of the data (14.0% for masks and 13.3% for unpredictable toy). Cohen's weighted kappas (Cohen, 1968) between the two raters ranged from 0.86 to 1.00 for the masks episode and from 0.80 to 0.95 for the unpredictable toy episode. Mean kappas for masks and unpredictable toy were 0.92 and 0.87, respectively.

Behavioral inhibition toward an adult stranger

Children's inhibited responses toward an adult stranger were observed at 24 and 36 months in the laboratory. Children were presented with an unfamiliar person (experimenter), who entered the study room and sat quietly on the floor for 1 min without making any eye contact. The experimenter then played with a toy dump truck for 1 min, and invited children to play with the toy together for 1 min. Mothers stayed in the study room during the task and were asked to refrain from initiating interactions with children. BI was coded based on time spent in proximity to mothers, latency to vocalize, and latency to touch the toy (Calkins et al., 1996; Fox et al., 2001; Kagan et al., 1984). A composite measure of BI toward an adult stranger was calculated by averaging standardized scores across measures and age groups. A second independent coder scored a subset of the data (18.9% of 24-month-olds and 10.5% of 36-month-olds). At 24 months, intraclass correlation coefficients (ICCs) between the two raters were 0.91 for duration of proximity to mothers, 0.77 for latency to vocalize, and 0.85 for latency to touch the

toy. At 36 months, ICCs were 0.93 for duration of proximity to mothers, 0.95 for latency to vocalize, and 1.00 for latency to touch the toy.

Social wariness toward an unfamiliar peer

Children's social wariness toward an unfamiliar peer was observed in the laboratory during a free play task at 24 and 36 months (Degnan et al., 2014). Children were introduced to an unfamiliar peer in the hallway and then entered the study room with the peer. Mothers stayed in the study room and were instructed to refrain from initiating interactions with children. During the free play task, children were allowed to play with a variety of age-appropriate toys scattered across the floor for 10 min. Children's wariness (hesitancy to play with the toys) and unfocused/unoccupied behaviors (time spent disengaged from any activity) were rated in 2-min epochs using a Likert scale from 1 (None observed in epoch) to 7 (Observed throughout epoch). A second independent coder rated 16%–36% of the sample at each age; ICCs ranged from 0.73 to 0.94 ($M = 0.82$). Social wariness scores were calculated by averaging ratings of wariness and unfocused/unoccupied behavior across epochs at each age (Degnan et al., 2014). A composite measure of social wariness was calculated by averaging standardized social wariness scores across the 24- and 36-month assessments.

2.3.2 | Questionnaires

Distress to novelty

Maternal reports of infant behaviors on the IBQ distress to novelty subscale (Rothbart, 1981) were collected at 9 months. Mothers rated the frequency of specific infant behaviors occurring during the previous week using a Likert scale from 1 (Never) to 7 (Always), with an additional option for "Does not apply." The distress to novelty subscale consists of 16 items assessing children's distress to sudden changes in the environment and latency of movement toward intense or novel stimuli. Sample items include "When given a new food or liquid, how often did the baby accept it immediately [reverse coded]," and "How often during the last week did the baby cry or show distress at a loud sound (e.g., blender, vacuum cleaner, etc.)?" To create a measure of non-social BI, we excluded 5 items identified by past research as assessing infants' responses in novel social situations (Goldsmith, 1996; Rothbart, 1981). Compared with other infant temperament measures, the IBQ has demonstrated high reliability and construct validity (Rothbart & Goldsmith, 1985). In the current study, the Cronbach's alpha coefficient of internal consistency for the subscale was 0.73. Total scores were calculated by averaging ratings on all items in the subscale, omitting items marked as "Does not apply".

Social fearfulness

Maternal reports of children's behavior and temperament on the social fearfulness subscale of the TBAQ (1994 Version; Goldsmith, 1996) were collected at 24 and 36 months. The TBAQ shows good psychometric properties for use with 16- to 36-month-old children (Goldsmith, 1996), and has been utilized in past research to assess children's BI in social contexts (Brooker et al., 2016). Mothers rated the frequency of specific behaviors as they occurred in the past month using a Likert scale from 1 (Never) to 7 (Always), with an additional option for "Does not apply." The social fearfulness subscale consists of 19 items assessing children's withdrawal, shyness, and fearful responses to novel social situations. Sample items include "When your child was approached by a stranger when you and she/he were out, how often did your child show distress or cry," and "When s/he saw other children while in the park or playground, how often did your child approach and immediately join in play [reverse coded]?" In the current sample, the Cronbach's alpha coefficient of internal consistency for the social fearfulness subscale was 0.83 at 24 months and 0.88 at 36 months. Total scores were calculated by averaging ratings on all items in the subscale, omitting items marked as "Does not apply." A composite score was calculated by averaging standardized total scores across the 24- and 36-month assessments.

Shyness and fear

Maternal reports of children' temperament on the shyness and fear subscales of the CBQ (Rothbart et al., 2001) were collected at 48 months. Mothers rated children's reactions to daily situations within the past weeks on a Likert scale from 1 (Extremely untrue) to 7 (Extremely true), with an additional option for "Not applicable." The shyness and fear subscales have been used in past research as measures of social and non-social BI, respectively (Brooker et al., 2016; Geng et al., 2011; Kertes et al., 2009). The shyness subscale consists of 13 items assessing children's inhibited responses and discomfort in social situations; sample items include "[My child] gets embarrassed when strangers pay a lot of attention to her/him." The fear subscale consists of 12 items assessing children's negative affect in response to threatening non-social situations; sample items include "[My child] is afraid of loud noises." In the current study, the Cronbach's alpha coefficient of internal consistency was 0.93 for the shyness subscale and 0.73 for the fear subscale. Total scores were calculated by averaging ratings on all items in the subscales, omitting "Not applicable" responses.

Anxiety problems

At 15 years, mothers and children independently filled out the SCARED, a commonly used instrument for assessing DSM-defined anxiety disorders (Birmaher et al., 1999; Birmaher et al., 1997). The questionnaire consists of five subscales (41 items), including social phobia (7 items), generalized anxiety disorder (9 items), somatic/panic symptoms (13 items), separation anxiety (8 items), and school phobia (4 items) subscales. Participants' recent anxiety symptoms were rated on a Likert scale from 0 (Almost never) to 2 (Often). Ratings on items in different subscales were summed for parent- and child-reports separately. The Cronbach's alpha coefficient of internal consistency was 0.93 for parent-reports and 0.92 for child-reports. For each subscale, a total score of 25 is thought to indicate the presence of clinically significant anxiety (Birmaher et al., 1997). Past research suggests that parent- and child-reports on the SCARED capture meaningfully different aspects of anxiety symptoms in children (Behrens et al., 2019; Bowers et al., 2020). Following common practice used in multiple prior papers from our group (Guyer et al., 2008; Michalska et al., 2017;

Shechner et al., 2017), we calculated composite scores for different subscales by averaging standardized total scores across parent- and child-reports. By incorporating both parents' and children's perspectives, these composite scores provide more comprehensive measures of children's anxiety problems. Supplementary analyses using data separately from parent- and child-reports found similar results (see SI 2 Figures S2 and S3).

Emotional and behavioral problems

Children's emotional and behavioral problems were rated by mothers at 15 years using the CBCL (Achenbach & Rescoral, 2001), a well-established measure of psychosocial functioning for children aged 6–18 years. The CBCL consists of 113 items rated on a Likert scale from 0 (Not true) to 2 (Very true). In the current study, we focused on composite scores on internalizing problems (anxious/depressed, withdrawn/depressed, and somatic complaints) and externalizing problems (rule-breaking behavior and aggressive behavior). Composite scores were calculated by summing ratings on all items across constituent subscales; higher scores indicated greater degrees of behavioral and emotional problems. The Cronbach's alpha coefficient of internal consistency was 0.88 for internalizing problems and 0.87 for externalizing problems.

2.3.3 | Analytic plan

Data analyses were performed using R (version 4.1.1; packages in SI 3). For questionnaire data, total scores were considered missing if participants completed less than 80% of the items (Bowers et al., 2020; Havewala et al., 2022). We first performed confirmatory factor analyses to explore the structure of BI. To test whether the hypothesized two-factor (social and non-social BI) structure best fit the data, the two-factor model was compared with a single-factor (BI) model, an orthogonal two-factor model, and a two-level model (see SI 4 Figures S4, S5, S6, and S7 for schematic diagrams of different models). Model fit indices were examined, including root mean square error of approximation (RMSEA), comparative fit index (CFI), Tucker–Lewis index (TLI), and standardized root mean residual (SRMR). RMSEA values under 0.06 (upper confidence interval under 0.08), SRMR values under 0.08, and CFI and TLI values over 0.95 are considered to indicate a good fit (Hu & Bentler, 1999; Little, 2013).

To explore whether social and non-social BI predict different psychosocial outcomes at 15 years, we used structural equation modeling (SEM) to examine the relations between social/non-social BI and adolescent anxiety problems, and between social/non-social BI and global internalizing/externalizing problems. The use of SEM allowed us to test the relations between latent predictors (social and non-social BI) and outcome measures while controlling for shared variance and measurement error (Weston & Gore Jr, 2006). For comparison, we also conducted supplementary analyses using a correlational approach (see SI 5 Table S2 and Figure S8) and a person-centered approach (see SI 6 Tables S3 and S4 and Figures S9, S10, and S11).

3 | RESULTS

3.1 | The structure of BI: Confirmatory factor analysis

To examine whether early BI measures were best represented by a correlated two-factor (social and non-social BI) structure, we compared the two-factor model with three alternative models. Because Little's MCAR test (Little & Rubin, 1987) suggested that the data missing completely at random (MCAR) assumption was not violated, $\chi^2(146) = 141$, $p = 0.61$, full information maximum likelihood (FIML) estimation was used to account for missing data (Enders & Bandalos, 2001). This allowed us to include all participants with data on one or more variables (as opposed to list-wise deletion), maximizing the available data. Importantly, we found similar results in sensitivity analyses with a correlational approach (see SI 5), which uses pairwise deletion, and a person-centered approach (see SI 6), which uses missing data imputation, suggesting that our results are robust to different methods of handling missing data.

The hypothesized two-factor model consisted of two correlated but independent (social and non-social BI) factors (see Table 1). A confirmatory factor analysis found that this model yielded excellent model fit, RMSEA = 0.000, 90% CI [0.00, 0.06], CFI = 1.00, TLI = 1.00, SRMR = 0.035. All indicators showed significant positive factor loadings, with standardized coefficients ranging from 0.26 to 0.78. This correlated two-factor model fit the data significantly better than a single-factor model with all measures loading on one (BI) factor, $\chi^2(1) = 7.44$, $p = 0.006$, and better than an orthogonal two-factor model which did not allow the social and non-social BI latent factors to covary, $\chi^2(2) = 16.27$, $p < 0.001$. Finally, we tested a two-level model with social BI and non-social BI as first-order factors and overall BI as a second-order factor (see SI 4). Conceptually, this model assumed that children' inhibited responses across social and non-social contexts are influenced by a general BI factor. Different from the correlated two-factor model, this model accounted for the hierarchical nature of the data. Results showed that this two-level model did not fit the data better than the correlated two-factor model, $\chi^2(1) = 0.003$, $p = 0.959$; we, therefore, selected the correlated two-factor model for its parsimony. Taken together, these results provide evidence that the construct of BI is best represented by two correlated, yet distinct, factors, and that there is shared variance among social and non-social BI.

3.2 | Predicting 15-year psychosocial outcomes from social/non-social BI

We next used two structural models to test our core hypothesis that social and non-social BI would predict different aspects of psychosocial functioning at 15 years. In the first model, social and non-social BI were specified as predictors of adolescent anxiety problems, including social phobia, generalized anxiety disorder, somatic/panic disorder,

TABLE 1 Confirmatory factor analysis on social/non-social BI measures.

Latent factor	Indicator	*B*	*SE*	CI lower	CI upper	*β*
Social BI	Behavioral inhibition toward an adult stranger (observed)	0.32***	0.06	0.20	0.45	0.38
	Social wariness toward an unfamiliar peer (observed)	0.29***	0.06	0.17	0.41	0.36
	Social fearfulness (TBAQ; parent-report)	0.69***	0.07	0.55	0.83	0.76
	Shyness (CBQ; parent-report)	0.96***	0.10	0.77	1.16	0.78
Non-social BI	Fear toward non-social stimuli (masks & unpredictable toy; observed)	0.17*	0.07	0.04	0.31	0.26
	Distress to novelty (IBQ; parent-report)	0.24***	0.07	0.10	0.38	0.39
	Fear (CBQ; parent-report)	0.52***	0.12	0.28	0.76	0.57

Abbreviations: BI, behavioral inhibition; *B*, unstandardized estimate; *SE*, standard error; CI, 95% confidence interval; *β*, standardized estimate
*$p < 0.05$.
***$p < 0.001$.

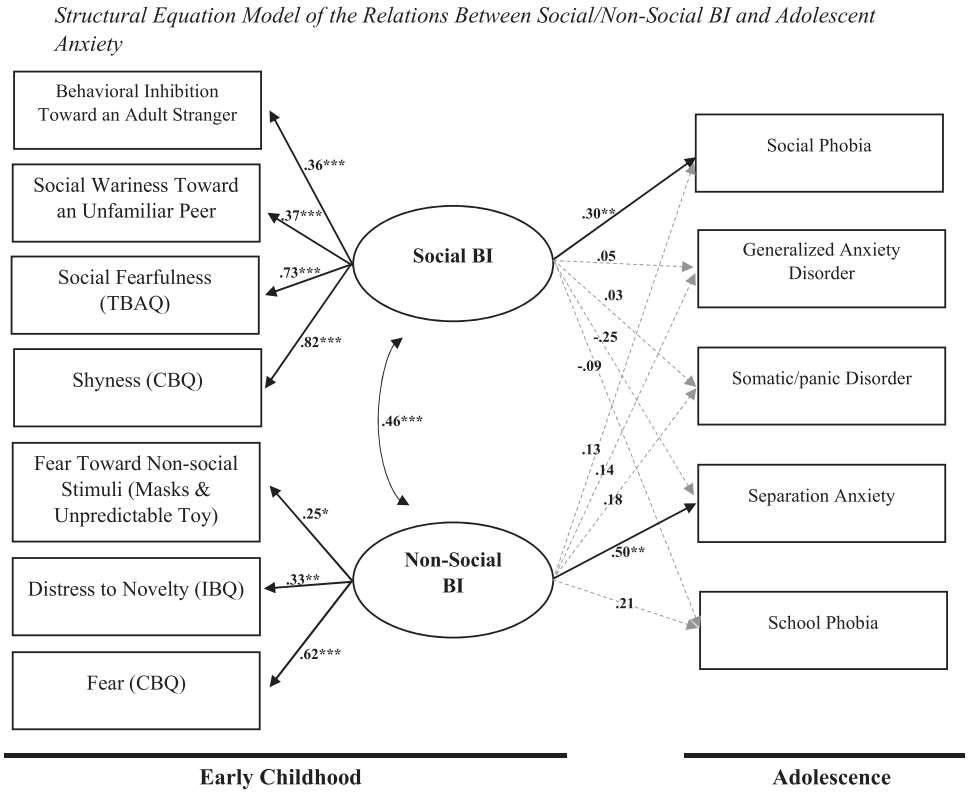

FIGURE 1 Structural equation model of the relations between social/non-social BI and adolescent anxiety. Note: Covariances between anxiety measures are not shown in this figure. All path coefficients are standardized. Solid arrows indicate statistically significant relations. Dashed arrows indicate non-significant relations. BI, behavioral inhibition. *$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

separation anxiety, and school phobia. The model showed good model fit, RMSEA = 0.008, 90% CI [0.00, 0.04], CFI = 1.00, TLI = 1.00, SRMR = 0.039. As shown in Figure 1 and Table 2, higher social BI specifically predicted higher social phobia in adolescence, whereas higher non-social BI predicted higher separation anxiety. No other paths from social/non-social BI to 15-year anxiety problems were significant. These results suggest that, when the common variance between social and non-social BI and between various types of anxiety is controlled, social BI

TABLE 2 Structural equation model predicting adolescent anxiety from social/non-social BI.

Variable	Path	Variable	*B*	*SE*	CI lower	CI upper	*β*
Regressions							
Social BI	→	Social phobia	0.27**	0.10	0.07	0.46	0.30
Social BI	→	Generalized anxiety disorder	0.04	0.11	−0.17	0.25	0.05
Social BI	→	Somatic/panic disorder	0.02	0.10	−0.17	0.22	0.03
Social BI	→	Separation anxiety	−0.21	0.13	−0.46	0.04	−0.25
Social BI	→	School phobia	−0.07	0.10	−0.27	0.12	−0.09
Non-social BI	→	Social phobia	0.11	0.13	−0.15	0.37	0.13
Non-social BI	→	Generalized anxiety disorder	0.12	0.14	−0.16	0.39	0.14
Non-social BI	→	Somatic/panic disorder	0.15	0.13	−0.10	0.40	0.18
Non-social BI	→	Separation anxiety	0.42**	0.16	0.11	0.73	0.50
Non-social BI	→	School phobia	0.17	0.13	−0.08	0.42	0.21
Covariances							
Social BI	↔	Non-social BI	0.46***	0.13	0.20	0.71	0.46
Social phobia	↔	Generalized anxiety disorder	0.40***	0.06	0.27	0.52	0.59
Social phobia	↔	Somatic/panic disorder	0.31***	0.06	0.20	0.43	0.47
Social phobia	↔	Separation anxiety	0.24***	0.06	0.12	0.37	0.40
Social phobia	↔	School phobia	0.24***	0.05	0.14	0.35	0.39
Generalized anxiety disorder	↔	Somatic/panic disorder	0.41***	0.06	0.28	0.53	0.59
Generalized anxiety disorder	↔	Separation anxiety	0.27***	0.07	0.13	0.40	0.42
Generalized anxiety disorder	↔	School phobia	0.27***	0.06	0.16	0.38	0.42
Somatic/ panic disorder	↔	Separation anxiety	0.29***	0.07	0.16	0.42	0.47
Somatic/ panic disorder	↔	School phobia	0.34***	0.06	0.23	0.45	0.54
Separation anxiety	↔	School phobia	0.25***	0.07	0.12	0.38	0.43

Abbreviations: BI, behavioral inhibition; *B*, unstandardized estimate; *SE*, standard error; CI, 95% confidence interval; *β*, standardized estimate.
**$p < 0.01$.
***$p < 0.001$.

and non-social BI predict different types of anxiety problems in adolescence (see SI 5 for correlation analysis showing that, when the common variance between social and non-social BI and between various types of anxiety was not controlled, 15-year somatic/panic disorder was predicted by non-social BI but not social BI; see also SI 6 for results from a person-centered approach).

To examine the specificity of the relations between social/non-social BI and adolescent anxiety, we tested an additional structural model. Here, social BI and non-social BI were specified as predictors of global internalizing and externalizing problems in adolescence. The model showed good model fit, RMSEA = 0.000, 90% CI [0.00, 0.05], CFI = 1.00, TLI = 1.00, SRMR = 0.041. As predicted, none of the paths from social and non-social BI to global internalizing and externalizing problems reached significance, *ps* > 0.389 (see Figure 2). These results suggest that social/non-social BI specifically predicts adolescent anxiety problems, but not global internalizing or externalizing problems

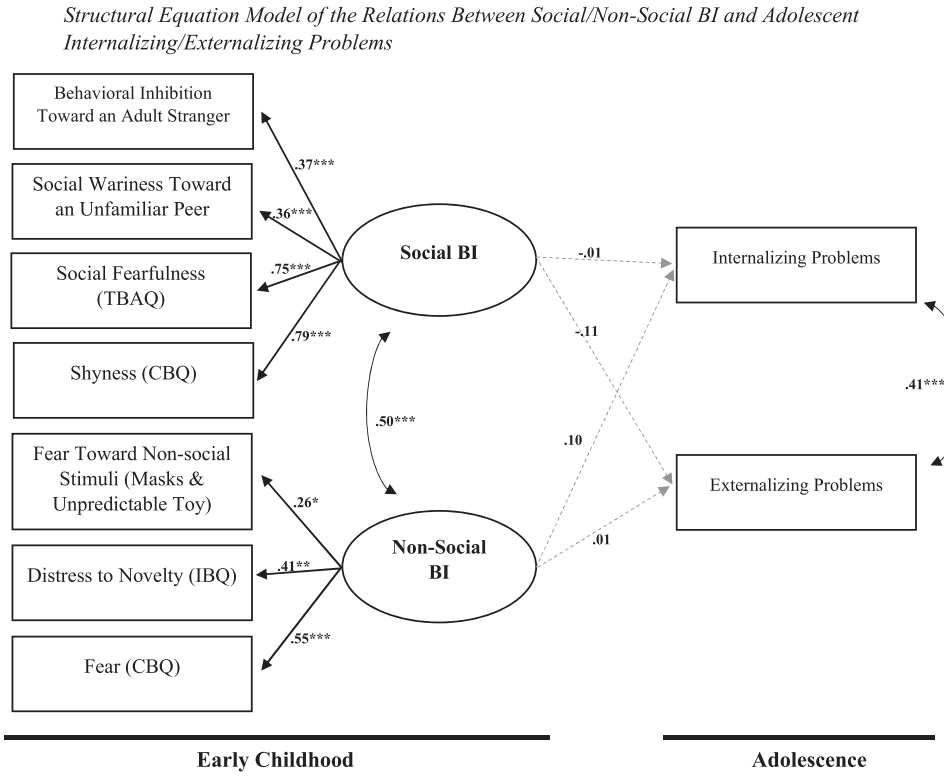

FIGURE 2 Structural equation model of the relations between social/non-social BI and adolescent internalizing/externalizing problems. Note: All path coefficients are standardized. Solid arrows indicate statistically significant relations. Dashed arrows indicate non-significant relations. BI, behavioral inhibition. $^{*}p < 0.05$. $^{**}p < 0.01$. $^{***}p < 0.001$.

(but see SI 7 Table S5 for suggestive evidence that social BI may predict attention-deficit/hyperactivity problems).

4 | DISCUSSION

The current study examined the long-term consequences of early BI in social versus non-social contexts. Consistent with past research showing a dissociation between social and non-social BI, we found that a correlated two-factor (social and non-social BI) model fit the data significantly better than a single factor (BI) model or an orthogonal two-factor model. These findings suggest that, although there is common variance between social and non-social BI, these two aspects of BI are moderately dissociable. With respect to developmental outcomes, results showed that social and non-social BI differentially predicted psychosocial functioning in adolescence. Specifically, when the shared variance between social and non-social BI and between various types of anxiety was controlled, adolescent social anxiety was specifically predicted by social BI. By contrast, adolescent separation anxiety was predicted by non-social (but not social) BI. Finally, neither social BI nor non-social BI predicted global internalizing or externalizing problems, providing evidence for the specific relations between social/non-social BI and anxiety problems.

The current study found new evidence for the relative independence of children's inhibited responses in social versus non-social contexts. These findings contribute to an emerging literature showing the multifaceted nature of BI (e.g., Buss et al., 2004; Majdandžić & Van Den Boom, 2007; Neal et al., 2002; Schofield et al., 2009; Talge et al., 2008). We note that the constructs of social and non-social BI are not necessarily mutually exclusive. On the one hand, children's inhibited responses to social stimuli may be affected by a general tendency to show wariness across social *and* non-social contexts. On the other hand, although non-social BI tasks (e.g., masks and unpredictable toy) were designed to measure non-social fear, these tasks still involved a social component (i.e., the experimenter; van Brakel et al., 2004). Hence, it is unsurprising that we found shared variance between social and non-social BI. That said, the dissociation of social and non-social BI in factor analyses suggests that our measures successfully tapped at least some unique aspects of children's inhibited responses in social versus non-social contexts.

This (partial) dissociation between social BI and non-social BI allowed us to better disentangle the complex relations between BI and anxiety problems. BI is considered one of the greatest risk factors for anxiety, and among all types of anxiety problems BI is most strongly associated with social anxiety (Chronis-Tuscano et al., 2009; for reviews, see Clauss & Blackford, 2012; Pérez-Edgar & Guyer, 2014; Sandstrom et al., 2020). What explains the stronger links between BI and social anxiety? Considering that BI studies tend to include tasks assessing children's wariness in social contexts (Sandstrom et al., 2020), it is possible that the stronger relations between early BI and

later social anxiety are attributable to this shared social component. Consistent with this idea, past research has found stronger correlations between BI and social (vs. non-social) anxiety when only the social aspect of BI was measured (Muris et al., 2011). Similarly, Zeytinoglu et al. (2022) found that social wariness to unfamiliar peers at 7 years specifically predicted social anxiety but not generalized anxiety at 15 years. Together, these findings suggest that there is a unique link between inhibited behaviors in social contexts and subsequent social anxiety.

The findings of the current study provide further evidence for this unique link. On the one hand, correlational analysis (see SI 5) showed that both social BI and non-social BI were significantly correlated with social anxiety, suggesting that social anxiety is related to a general tendency to show inhibited responses across social and non-social contexts. However, when the common variance between social and non-social BI and between various types of anxiety was accounted for, only social BI predicted adolescent social anxiety (see also SI 6 for similar results from a person-centered approach). These results suggest that adolescent social anxiety is predicted by both a general tendency to show inhibited responses across social and non-social contexts (i.e., the shared variance between social and non-social BI), as well as a more specific tendency to be cautious and fearful toward social novelty.

Interestingly, when the common variance between social and non-social BI and between various types of anxiety was accounted for, non-social BI was uniquely associated with separation anxiety. These findings are in line with clinical research showing the distinct phenotypes between social anxiety and separation anxiety (Pine, 2007; Pine et al., 2005; Pine et al., 2005). Separation anxiety is characterized by developmentally inappropriate and excessive anxiety concerning separation from home or attachment figures (American Psychiatric Association, 2013). While other anxiety disorders tend to increase with age, the overall rates of separation anxiety disorder typically peak before adolescence and generally decrease throughout the adolescent period (Birmaher et al., 1997; Compton et al., 2000; Essau et al., 2002; Ogliari et al., 2006; Su et al., 2008). That said, later-onset separation anxiety is not rare (Bögels et al., 2013) – the lifetime prevalence of adult separation anxiety disorder was estimated to be between 5% and 10% (Beesdo et al., 2009; Pine et al., 1998; Shear et al., 2006), and past research has found limited developmental changes in symptoms experienced by individuals with separation anxiety from 4 to 15 years (Allen et al., 2010). We note that previous studies have documented a link between BI and separation anxiety in early childhood (Broeren et al., 2013; Paulus et al., 2015). Our findings add to this literature by showing that children sensitive to non-social (vs. social) novelty are particularly likely to develop symptoms of separation anxiety disorder, suggesting that individuals with separation anxiety symptoms may be more concerned about non-social threat (e.g., loud noises) than social threat (e.g., strangers) in the environment. Indeed, past research has found that individuals with separation anxiety report higher levels of extraversion than do individuals with social phobia (Silove et al., 2010), suggesting that non-social (rather than social) threat may be the main source of distress for these individuals. To test this hypothesis, future research should examine whether individuals with social phobia versus separation anxiety show differential responses to social versus non-social threat.

The current study joins past research in highlighting the importance of context in evaluating children's inhibited responses. For instance, Buss and colleagues have shown that young children who display dysregulated fear (i.e., high fear in low threat situations) are particularly likely to develop social withdrawal, social reticence, and social anxiety later in life (Buss, 2011; Buss et al., 2013, 2018, 2021). In addition, dysregulated fear in toddlerhood predicted social withdrawal in childhood through protective parenting (Kiel & Buss, 2014), and predicted separation anxiety through maternal intrusive behaviors (Maag et al., 2021). Our findings add to this line of research by showing that, aside from situation intensity (high vs. low threat), situation type (social vs. non-social) also has profound implications for interpreting children's inhibited responses. That said, we note that social/non-social and high/low threat situations are not orthogonal to each other in the testing battery, and, similar to the current study, the tasks used in the dysregulated fear literature have not always been evenly distributed across ages. Our findings also shed light on how clinical interventions may affect different anxiety problems. For example, Liu et al., 2018) found that training BI children to shift attention away from threat (attention bias modification; ABM) reduced separation anxiety but not social anxiety. These results, in conjunction with the findings of the current study, suggest that ABM may have more influence on BI children's non-social (vs. social) responses.

The results of this study should be interpreted in light of a few limitations. First, because the sample was not drawn from a clinical population, the generalizability of our findings should be tested in future studies with clinically anxious individuals. That said, we note that 34.57% of the participants in the current study reached the clinical cutoff (≥25) for child-reported total SCARED scores, and 11.24% of the participants reached the clinical cutoff for parent-reported total SCARED scores in adolescence. Thus, our findings do provide some insights into how social/non-social BI may predict clinically meaningful anxiety problems. Second, considering that both BI and 15-year outcome measures included parent-reports, the links between BI and outcomes measures might be partially attributable to common method variance (but see SI 8 for evidence that the unique relation between social BI and adolescent social anxiety cannot be explained by common method variance). We, therefore, call for future studies to explore the long-term outcomes of social/non-social BI using different reporters (e.g., teachers) and more measures. Third, because the SCARED does not measure specific phobia (e.g., animal phobia, blood-injection-injury phobia), we were unable to examine whether social/nonsocial BI predicts this anxiety diagnosis. Considering the prevalence of specific phobia (Bernstein et al., 1996) and its potential links with non-social BI, we call for future studies to examine these relations using more comprehensive measures of anxiety. Finally, because the original longitudinal project was not designed to compare children's inhibited responses in social versus non-social contexts, the measures used in the current study were collected at different ages between social and non-social BI (see SI 1). Relatedly, some of the measures (i.e., Lab-TAB and IBQ) used in the current study were collected at age 9 months,

which is relatively young considering that BI is typically measured during toddlerhood. We note that young infants' reactivity to novelty is considered a precursor to BI (Fox et al., 2001, 2015; Kagan & Snidman, 1991; Kagan et al., 1998), and that the confirmatory factor analysis results confirmed that there was meaningful overlap between the three measures of non-social BI. Hence, we consider the inclusion of these 9-month measures justifiable. In addition, our main findings still held when the CBQ shyness and fear subscales (both collected at 48 months) were used as proxies for social and non-social BI (see SI 9 Table S6), suggesting that the differential correlations between social and non-social BI were not fully attributable to age differences between social and non-social BI measures and the use of 9-month measures in non-social BI. That said, future studies should replicate the effects found in the current study using age-matched social/non-social BI measures from toddlerhood.

Our study represents an early step toward understanding the nature of young children's inhibited responses in social versus non-social contexts. It remains to be explored whether different aspects of BI are associated with different cognitive and neural mechanisms. For instance, individual differences in BI are thought to be associated with differences in amygdala functioning (Filippi et al., 2022; Fox et al., 2005; Kagan, 2012). Does amygdala reactivity predict children's inhibited responses in social contexts, non-social contexts, or both? It is possible that heightened amygdala reactivity to novelty represents a general characteristic of high reactive infants. This enhanced reactivity may become more focused on unfamiliar individuals, as the social world of peers takes on a larger influence during development.

Future studies should also explore whether the links between BI and anxiety problems are moderated by biological, cognitive, and environmental factors. For example, past research has found that maternal caregiving plays an important role in moderating the links between BI and socioemotional development (Degnan & Fox, 2007; Degnan et al., 2010; Liu & Pérez-Edgar, 2019). Behaviorally inhibited children with intrusive, overprotective, and insensitive mothers are more likely to develop socioemotional problems (Bayer et al., 2021; Coplan et al., 2008; Crockenberg & Leerkes, 2006; Degnan et al., 2008; Rankin Rubin et al., 2002; Williams et al., 2009). Future studies should examine whether different dimensions of parenting affect specific (e.g., social vs. non-social) aspects of BI, and whether parenting styles moderate the links between social/non-social BI and social/non-social anxiety. Answers to these questions will shed further light on the nature of social/non-social BI and the development of anxiety.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Per National Institutes of Health (NIH) rules, the data used in the current study have been uploaded to the NIMH Data Archive (NDA). The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

The study was conducted with written informed consent obtained from legal guardians and verbal/written assent obtained from child participants. All procedures were approved by the Institutional Review Board at the University of Maryland.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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