

Shyness, Inhibitory Control, and Social Support Seeking in Preschoolers: Role of Familiar and Unfamiliar Contexts

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The risk potentiation model of cognitive control posits that inhibitory control may heighten the risk for problematic outcomes among some temperamental styles characterized by high reactivity. Because shyness is a temperamental style defined as wariness and heightened reactivity to social novelty, we examined whether the interaction between shyness and inhibitory control predicted social support seeking differently depending on context using a between-subjects design. Typically developing preschoolers ($N = 167$, 52% female, $M_{\text{age}} = 4.05$ years, $SD_{\text{age}} = .77$ years) were observed during a model building task that included a familiar (i.e., with their mother) or unfamiliar (i.e., with a novel adult female) social context. In the unfamiliar context, shyness was negatively associated with social support seeking at relatively high levels of inhibitory control, in line with the risk potentiation model of control. However, in the familiar context, we found that shyness was positively associated with social support seeking at relatively high levels of inhibitory control. These results suggest that high levels of inhibitory control may potentiate social fear for preschoolers who are also shy and that these relations may depend on contextual factors.

Keywords: shyness, inhibitory control, context, behavior, social fear

Shyness is a moderately stable temperamental characteristic that refers to wariness, inhibition, and anxiety in unfamiliar social contexts (Buss, 1986; Cheek & Buss, 1981; Karevold et al., 2012; Sanson et al., 1996). Shy children presumably view social novelty as threatening and may have a difficult time regulating their fear and anxiety in social contexts. Indeed, shy children exhibit physiological profiles associated with stress reactivity and greater behavioral anxiety when faced with social challenges. For example, 7-year-old shy children exhibited greater increases in heart rate and anxious behavior during a self-presentation task compared to

nonschy children (Schmidt et al., 1999). Shyness also has been associated with a high and steeply increasing trajectory of behavioral avoidance in novel social situations during the preschool period (Hassan & Schmidt, 2021), and shy children have been found to speak less in unfamiliar social situations (Asendorpf & Meier, 1993; Crozier & Perkins, 2002). These behavioral correlates are frequently interpreted as a consequence of shy children's fear in social contexts.

At the level of social relationships, although some studies have failed to find direct relations between shyness and negative social outcomes such as peer rejection peers' responses during childhood (Fordham & Stevenson-Hinde, 1999; Morneau-Vaillancourt et al., 2021), other studies have found that shyness was positively associated with peer difficulties (Coplan et al., 2008). Shyness and related constructs also have been consistently correlated with increased risk for internalizing problems (Chronis-Tuscano et al., 2009; Findlay et al., 2009), especially symptoms of social anxiety disorder characterized by a fear of negative evaluation (Chronis-Tuscano et al., 2009; Clauss & Blackford, 2012; Heiser et al., 2003, 2009; Hirshfeld-Becker et al., 2007; Poole et al., 2017, 2020; Sandstrom et al., 2020). Together, these studies suggest that shyness is associated with behavioral avoidance in novel social situations, interpersonal difficulties, and internalizing problems presumably because of shy children's social fear. However, not all shy children go on to experience these difficulties, so it is important to examine moderating factors that might help explain this heterogeneity. One possible moderator is self-regulation.

Self-regulation broadly encompasses the affective, behavioral, cognitive, and physiological processes which function to modulate reactivity and support goal-directed behavior (McClelland et al., 2010; Rothbart & Bates, 2006). Children's capacity to employ

This article was published Online First September 15, 2022.

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The present study was supported by a Dissertation Research Award from the Society of Clinical Child and Adolescent Psychology division of the American Psychological Association, an Elizabeth Munsterberg Koppitz Child Psychology Graduate Student Fellowship from the American Psychological Foundation, a Dissertation Research Award from the American Psychological Association, and a Social Sciences and Humanities Research Council of Canada (SSHRC) Vanier Doctoral Scholarship awarded to Raha Hassan, and operating grants from the Natural Sciences and Engineering Research Council of Canada (NSERC) and SSHRC awarded to Louis A. Schmidt. We thank Christina Brook for her statistical consultation, and Annie Mills, Jennifer Mullen, Sadie Neufeld, and Erica Rodrigues for their assistance with recruitment, data collection, data entry, and behavioral coding, and the families for their participation.

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regulatory strategies at different levels of self-regulation is of critical importance to their adaptive functioning. For example, children with relatively higher levels of effortful control and related constructs may be more effective at building and maintaining positive social relationships with those around them than children with relatively lower levels of effortful control (Eisenberg et al., 2010; Wilson, 2003). Emotion regulation (Graziano et al., 2007) and behavioral regulation (Ponitz et al., 2009) also have been implicated in positive academic outcomes for kindergarteners and negatively associated with behavioral problems and mental health difficulties across childhood (Eisenberg et al., 2009, 2010).

Despite the positive associations between self-regulation and various psychosocial outcomes, there is an emerging literature suggesting that some components of self-regulation may be maladaptive depending on individual differences in temperament. For example, the risk potentiation model of control posits that controlled cognitive processes such as inhibitory control—the capacity to inhibit a dominant response in favor of a subordinate response—may heighten the risk for socioemotional and psychological problems, and social fear in the context of temperamental styles characterized by heightened reactivity to sensory stimuli such as shyness (Henderson et al., 2015; Henderson & Wilson, 2017).

As highlighted by Henderson and her colleagues (Henderson et al., 2015; Henderson & Wilson, 2017), children with temperamental styles characterized by sensitivity to novelty are presumed to also have a reactive default mode of processing brought on by a developmental history of easily and automatically orienting toward a perceived threat. Here, attention is frequently drawn away from tasks when threat, novelty, or conflict between goals and environmental cues are detected. To help regulate the emotions associated with reactivity to novelty and maintain goal-directed behavior, the controlled processing network is frequently recruited. Rather than regulating the fear, the processes associated with inhibitory control, including holding rules in mind and closely monitoring and modifying behavior in response to goals, may keep children fixated on the attention-grabbing environmental cue rather than flexibly returning attention to the goal of the task (Fox et al., 2021). The reactive mode of responding paired with the controlled mode of responding frequently activated presumably creates a positive feedback loop where shy children with high inhibitory control may spend more time monitoring their environment and perceive higher levels of social threat in benign social situations resulting in more anxiety and fear. One behavioral consequence of this positive feedback loop is that shy children with high inhibitory control fail to engage flexibility with their environment and display more rigid behavioral responses in social situations.

Over the last 2 decades, there has been an increase in studies examining the moderating role of inhibitory control in the relation between behavioral inhibition—a construct conceptually and empirically related to shyness (e.g., Poole et al., 2017, 2018; Schmidt et al., 1997)—and psychological and social maladjustment. Two separate studies found that behavioral inhibition was only positively associated with symptoms of prospective social (Thorell et al., 2004) and general (White et al., 2011) anxiety at relatively high levels of inhibitory control assessed using cognitive laboratory tasks during early childhood. Another study using a longitudinal assessment of inhibitory control operationalized as performance on the Go/Nogo task measured at 5, 7, and 10 years

found that behavioral inhibition measured in toddlerhood was only positively associated with prospective symptoms of social anxiety measured at 12 years at steep or moderately steep slopes of inhibitory control performance (Troller-Renfree et al., 2019). A different study examining social fear, rather than behavioral inhibition, also found that social fear was only positively associated with prospective anxious behaviors with peers at age 5 at relatively high levels of inhibitory control measured at age 2 (Brooker et al., 2016).

A similar pattern of results has been found when using shyness rather than behavioral inhibition as the predictor. For example, in a sample of preschoolers, shyness was negatively associated with parent-reported prosocial behaviors and popularity at high levels of parent-reported inhibitory control and positively associated with teacher-reported regulated school behaviors at low levels of inhibitory control (Sette et al., 2018). It is important to note, however, that a different study using a sample of preschoolers failed to find that maternal report of inhibitory control moderated the association between shyness and observed social behavior in two different social contexts in the laboratory (Hassan et al., 2020). Differences between Hassan and colleagues and the other aforementioned studies may be due to observed versus parent-reported inhibitory control, and parent-reported versus observed social behavior.

Studies that have used neurophysiological indices of controlled processes also provide support for the risk potentiation model of control. One cross-sectional study of 9–13-year-old children found that at relatively high levels of the N2 amplitude (i.e., an electrocortical correlate of cognitive control) in response to incongruent trials during a cognitive task, shyness was associated with a negative attributional style, poor perceptions of social acceptance, and symptoms of social anxiety (Henderson, 2010). Other studies have since used a longitudinal design and found that behavioral inhibition measured in toddlerhood was only associated with higher levels of prospective social reticence (Lamm et al., 2014) and higher social withdrawal and lower assertiveness at age 7 (Lahat et al., 2014) at relatively higher levels of the N2 amplitude in response to incongruent trials during a cognitive task. A more recent study conducted during early childhood found when children exhibited relatively large baseline-to-task decreases in EEG theta/beta ratio from baseline to a social stressor, presumably indicative of relatively high neurocognitive control, shyness was cross-sectionally related to trait and state social anxiety (Poole et al., 2021). Together, these studies, using behavioral and neural indices of cognitive control, provide support for the risk potentiation model of control, suggesting that inhibitory control may increase the risk for psychosocial difficulties through potentiation of fear across childhood in the context of temperamental styles marked by reactive modes of responding such as shyness.

While these studies provide us with important information about the double-edged sword of inhibitory control in the context of shyness and related constructs, they do not clarify the influence of contextual factors. Specifically, because shyness is defined as wariness in the context of social novelty, the risk potentiation model of control may depend on contextual familiarity (Buss, 1986; Cheek & Buss, 1981; Karevold et al., 2012; Sanson et al., 1996). If contextual familiarity impacted the interaction between shyness and inhibitory control in predicting social behavior, such that the risk potentiation model was only applicable in unfamiliar contexts,

this finding would have implications for practice and theory. Practically, it would suggest that the adaptiveness of inhibitory control for shy children could be manipulated by increasing contextual familiarity, potentially improving shy children's social relationships and psychological outcomes. Theoretically, it would bring greater specificity to the risk potentiation model of control and suggest that the positive feedback loop initiated by the interaction between reactive and default modes of processing described by Henderson and her colleagues is not a forgone conclusion (Henderson et al., 2015; Henderson & Wilson, 2017). Rather, these findings would indicate that the negative impact of inhibitory control for shy children occurs because of modifiable contextual factors rather than instantiated processing patterns occurring indiscriminately.

Although no study to date, to our knowledge, has manipulated familiarity to determine whether the moderating role of inhibitory control differs in familiar versus unfamiliar contexts, other studies have found that direct relations between shyness and socioemotional outcomes may differ based on familiarity factors. For example, one early study found that shyness was negatively associated with helping behaviors observed in the laboratory (i.e., an unfamiliar context) but not in the home (i.e., a more familiar context) during the preschool period (Stanhope et al., 1987). Another study found that inhibited preschoolers were more likely to engage in dyadic interactions with a peer in their homes rather than outside the home when compared to noninhibited children (Coplan et al., 2009). One speculation explaining these results may be that parents were more likely to organize social events in the home because the familiarity would reduce stress for the inhibited child, suggesting that parents may perceive their inhibited children as more comfortable and less anxious in familiar compared to unfamiliar contexts. An earlier study that more directly examined whether familiarity influences shy children's outcomes found that although shy children spent less time in conversation in unfamiliar situations compared to nonshy children, there were no between-group differences in familiar situations (Asendorpf & Meier, 1993). Because some relations between shyness and social behavior appear to differ based on context, the negative impact of inhibitory control on shy children's outcomes may also depend on contextual familiarity.

The Present Study

The goal of the present study was to examine the specificity of the risk potentiation model of control in typically developing preschoolers in familiar and unfamiliar contexts using a between-subjects design. To this end, social support seeking behaviors were coded while preschoolers built a model with either a novel female research assistant (i.e., unfamiliar context) or with their mother (i.e., familiar context). A composite measure of inhibitory control was derived using three different indicators of inhibitory control. To determine whether the results were specific to more social behaviors versus other nonsocial behaviors, we also coded children's persistence in building the model. We elected to focus specifically on preschoolers because of the increases in self-regulatory processes that are occurring during this period (Dennis et al., 2007; Geeraerts et al., 2021; Klenberg et al., 2001; Kochanska et al., 1996; Schoemaker et al., 2014; Williams et al., 1999) and to increase comparability with other studies examining the moderating role of inhibitory control on the relation between

shyness or related constructs and psychosocial outcomes (Brooker et al., 2016; Hassan et al., 2020; Sette et al., 2018; Thorell et al., 2004; White et al., 2011).

Consistent with previous studies that have used an unfamiliar context to study the moderating role of controlled processes on the relation between shyness and related constructs and psychological or socioemotional outcomes (Brooker et al., 2016; Henderson, 2010; Lahat et al., 2014; Lamm et al., 2014; Poole et al., 2021; Sette et al., 2018; Thorell et al., 2004; Troller-Renfree et al., 2019; White et al., 2011), we predicted that shyness would be negatively associated with social support seeking at high levels of inhibitory control. We also predicted that shyness would no longer be negatively related to social support seeking at high levels of inhibitory in the familiar context, because shyness largely originates and is maintained by social novelty (Buss, 1986; Cheek & Buss, 1981; Karevold et al., 2012; Sanson et al., 1996).

The analyses in the present study were therefore confirmatory rather than exploratory. However, the inclusion of persistence during the building task was exploratory rather than confirmatory, and therefore we did not make specific predictions about directionality for this measure. On one hand, we reasoned that shyness may be positively associated with persistence only in the unfamiliar condition at high levels of inhibitory control because shy and overcontrolled children may be more likely to follow directions to avoid negative social judgment from the unfamiliar adult. On the other hand, persistence is not a highly social behavior compared to social support seeking and may therefore be a less relevant outcome when examining the interaction among shyness, inhibitory control, and contextual familiarity.

Method

Participants

Participants were 167 three- to five-year-old typically developing children ($n_{female} = 87$, $M_{age} = 4.05$ years, $SD_{age} = .77$ years) and their mothers who were recruited from the Child Database in the Department of Psychology, Neuroscience & Behaviour at McMaster University in Ontario, Canada. These participants were from a larger study of 184 participants, but the procedure for the model building task used to manipulate familiarity was not finalized until participant 17, so 167 had the potential to contribute data to the present study. The child database used to recruit participants contained the names and contact information of parents of healthy, full-term newborn infants recruited from hospitals across the greater Hamilton metropolitan area who consented to be contacted in the future about infant and child studies conducted at McMaster University. These children were identified by parents as 85.6% White, 3% South Asian, .6% Chinese, 1.2% Black, 1.8% Latin American, and some parents did not identify with any of these racial categories (e.g., Middle Eastern, Mixed Race; 6.6%) or preferred not to answer (1.2%). Of the reporting parents (typically the mother), 85.6% reported having a college diploma or higher; and 57% reported a mean household income of over \$100,000 in Canadian dollars. Below, we report how we determined our sample size, all data exclusions, manipulations, and measures in the study.

Procedure

Children and a parent (typically the mother) participated in the present study at the Child Emotion Laboratory. The child, parent, and one female experimenter began in a room together. While the child played with a puzzle, the experimenter explained the study procedures to the mother. After written parental consent and verbal child assent were obtained, the parent left the room to complete a series of questionnaires. While in a separate room, the parent could view their child on a closed-circuit computer monitor. The child first completed the Flanker task from the National Institute of Health (NIH) Cognitive Battery for preschool-aged children (Zelazo et al., 2013), followed by a Lego model toy building task, with either an adult female stranger (unfamiliar condition) or their mother (familiar condition), before completing the Dinky Toys task (Kochanska et al., 1996). For condition consistency, the two participants who were accompanied to the laboratory by their fathers were assigned to the unfamiliar condition. The procedures are described in more detail below. Families received a \$15 gift card, two small toys, and a *Junior Scientist* certificate for their participation. All procedures were approved by the McMaster Research Ethics Board.

Parent-Report Measures

Children's Behavior Questionnaire (CBQ)

Shyness and inhibitory control were parentally reported using the 6-item shyness subscale and the 14-item inhibitory control subscale from the CBQ (Rothbart et al., 2001). Statements were rated by parents on a scale ranging from 1 (*never*) to 7 (*always*). A sample item from the shyness scale includes "Acts shy around new people", and a sample item from the inhibitory control scale includes "Is good at games like 'Simon Says,' 'Mother, May I?' and 'Red Light, Green Light.'" The shyness ($\alpha = .89$) and inhibitory control consistency ($\alpha = .82$) scales demonstrated good internal consistency.

Demographics

A demographics questionnaire was also completed by the parent who brought the child into the laboratory.

Behavioral Tasks and Measures

NIH Toolbox Flanker Task and Measure

Inhibitory control was also indexed using the Flanker task from the NIH Cognitive Battery for preschoolers. During this task, children were first presented with a row of fish and were instructed to press the button that matched the direction that the middle fish was pointing. This task consisted of congruent trials where all the fish were facing the same direction and incongruent trials where all the fish were facing the opposite direction from the middle fish. The Flanker task consisted of four teaching trials using fish as stimuli where two were congruent and two were incongruent; 25 trials using fish as stimuli where 16 were congruent and 9 were incongruent; and 25 trials using arrows as stimuli where 16 were congruent and 9 were incongruent. During the practice trials, children had to correctly respond to three out of four trials to move to the fish testing trials. If they failed to meet this criterion, they were

exposed to a maximum of three more practice trials, and testing was terminated if they did not meet the passing criteria during any of those practice trials. Of the 167 children, 17 failed to pass the teaching trials, and all these children were 3 years of age. If the children responded correctly to 5 out of the 9 incongruent trials using fish as stimuli, they advanced to the final testing phase where arrows were used instead of fish. Scores were automatically computed by the NIH Toolbox using a two-vector system incorporating accuracy and reaction time (RT) for those who were accurate 80% or more of the time. The scoring system is described in more detail elsewhere (Zelazo et al., 2013). Age corrected percentiles computed by the NIH Toolbox were used for ease of interpretation where higher scores were indicative of relatively higher accuracy and speed compared to demographically matched peers.

Dinky Toys Task and Measure

Inhibitory control was also indexed using a modified version of the Dinky Toys task (Kochanska et al., 1996). During this task, the experimenter and child were seated cross-legged across from each other on the floor. The child was presented with a box of attractive toys and told to indicate using their words which toy they would like while keeping their hands on their lap. Once the experimenter slid the box over to the child, she gave the child up to two reminders to keep their hands on their lap before the child either told the researcher what toy they wanted or grabbed the toy. This task was repeated twice for reliability purposes and children's performance was averaged across trials. The child was allowed to switch the toy at the end of the task if they wished.

Children's behavior was subsequently coded from videos by independent coders on a zero to five-point scale (Kochanska et al., 1996). A zero represented the child grabbing a toy out of the container, a one represented the child touching the toys in the container, but not taking one out, a two represented the child pointing to the toys, a three represented the child removing their hands from the lap, a four represented the child's hands twitching or moving, but not leaving the lap, and a five represented the child not moving their hands from the lap at all during the task where children displayed the full range of behaviors from zero to five [$M (SD) = 1.77 (1.79)$]. The independent coders obtained excellent interrater reliability on 15% of the total videos ($\kappa = .99$).

Model Building Task

Before the start of the study, the child was randomly assigned to either an unfamiliar (i.e., with a female adult stranger) or a familiar (i.e., with the mother) condition for the Lego model building task. The mother or the female adult stranger was shown how to build this model in a separate room, while the child was completing the NIH cognitive battery. Following completion of the NIH battery, the child's mother or the female adult stranger entered the room and began modeling how to build either an ice-cream cone for the three-year-old participants or an alligator for the 4- and five-year-old participants using Lego blocks following a standardized script. The mother or the stranger was given a script to follow with pictures depicting each step of construction to reduce differences in the builder's familiarity with Lego model construction. After the stranger or mother demonstrated how to construct the model for the child, the stranger or mother presented the child with a clear bag full of the Lego pieces required to build the model, plus

several other distractor pieces. This task was designed to elicit social support seeking from the children. Given the distractor pieces, it was expected that building the model would be challenging but possible for most children and that this difficulty would elicit direct or indirect social support seeking with the stranger or mother. The stranger or mother then told the child to make a model just like the one that had just been built for them. The mother and stranger were both instructed to do their best to allow the child to complete the model independently. The child was given a maximum of 15 minutes before the original female experimenter returned and praised the child for the model that was built.

Model Building Behavioral Coding

Computerized coding of behaviors during the building phase of the task was conducted using Behavioral Observation Research Interactive Software (BORIS; Friard & Gamba, 2016) by independent coders who were blind to the hypotheses of the study. Behaviors were only coded during the building phase and not during the teaching phase to minimize differences in the teaching style of the adult in the different conditions. BORIS allows for the assignment of keyboard buttons to specific behaviors so coders can turn a behavior “on” and “off” to capture the number of seconds children spent engaging in a behavior. The videos were coded for positive affect (smiling, laughing, joking), asking for help (by seeking proximity, touching, or verbally asking for help), and gaze toward the mother or stranger to collectively capture social support seeking, and persistence to capture on-task building behavior. These behaviors were not mutually exclusive. For example, children could be working on the task while asking for help while displaying positive affect. Acceptable to excellent interrater reliability was established on 10% of the videos for positive affect ($\kappa = .68$), social support seeking ($\kappa = .98$), gaze ($\kappa = .98$), and persistence ($\kappa = .99$). To account for differences in the amount of time taken to build the Lego model, a proportion score for each behavior was created by dividing the total number of seconds spent engaging in each of the aforementioned behaviors by the total building task time.

Composite Measures

Inhibitory Control Composite

An inhibitory control composite score was derived from parental report and performance on the dinky toys and Flanker tasks. A confirmatory factor analysis supporting the use of a composite of inhibitory control using these three indicators has been previously published in a separate paper examining the curvilinear relation between inhibitory control and avoidant social behaviors with an unfamiliar peer (Hassan & Schmidt, 2022). Given the inclusion of a 3-way interaction in the present study, our relatively limited sample size, and the greater number of participants required for structural equation modeling, we elected to use an observed rather than latent variable of inhibitory control. All three variables were significantly, positively correlated ($r_s > .17$, $p_s < .045$), and so scores for all three measures were z -scored and summed. Higher values on this composite represented relatively higher levels of inhibitory control.

Social Support Seeking Composite

A social support seeking composite score was derived from children’s scores of positive affect, asking for help, and gaze toward the mother or stranger. All three variables were significantly, positively correlated ($r_s > .24$, $p_s < .004$), and so all three scores were z -scored and summed. Higher values on this composite represented relatively higher levels of social support seeking.

Statistical Analyses

We used a one-way between-subjects analysis of covariances (ANCOVAs) to determine whether there was equality of shyness and inhibitory control across the familiar and unfamiliar conditions and whether there were mean-level differences in social support seeking and persistence across the conditions, controlling for children’s age and sex. To determine whether the interaction between shyness and inhibitory control in predicting social support seeking and persistence depended on contextual familiarity, we used a multiple linear regression, including the main effects of shyness, familiarity condition, and inhibitory control, the three two-way interactions (i.e., shyness \times familiarity condition, shyness \times inhibitory control, and familiarity condition \times inhibitory control), and the single three-way interaction (i.e., shyness \times familiarity condition \times inhibitory control), controlling for children’s age and sex. The dependent measure was either social support seeking or persistence. All analyses were conducted in SPSS Version 26. The data supporting the findings reported below are available upon request. The study was not preregistered.

Sample Size Calculation

The sample size was determined by conducting a power analysis in G*Power for linear regression (Faul et al., 2007). Although no study, to our knowledge, has examined the three-way interaction among shyness, self-regulation, and a binary third variable, we used the average effect size ($f^2 = .40$) from three previous studies that examined the moderating role of self-regulation in the relation between shyness and socioemotional outcomes and that reported effect sizes (Henderson, 2010; Poole et al., 2021; Sette et al., 2018). This power analysis revealed that for our objective of examining the two-way interaction between shyness and inhibitory control in predicting social behavior, we would require a minimum sample size of 35 participants (Power = .80, $\alpha = .05$). Given that the three-way interaction including shyness, inhibitory control, and the binary variable depicting context will be decomposed into two two-way interactions between shyness and inhibitory control in the familiar and unfamiliar context, we noted that a minimum sample size of 35 participants per context would be required. After imputation (described below), we were adequately powered with 83 children in the familiar condition and 84 children in the unfamiliar condition.

Missing Data

Of the 167 children, 3 were missing data on the shyness measure, 17 were missing data on the inhibitory control composite measure, 10 were missing data on social support seeking, and 6 were missing data on persistence. Because some children overlapped on missing data for the variables of interest, there were a

total of 138 children with complete data. Reasons for missing data included children refusing to complete the visit, parents failing to complete the questionnaire, children not passing the teaching phase of the Flanker task, video recording software technical difficulties, or outlier scores (i.e., > 3 *SDs* above or below the mean) on measures of inhibitory control, social support seeking, or persistence. Children with missing data on at least one variable did not differ from children with complete data based on sex, $\chi^2(1) = .60, p = .439$, maternal education level, $t(164) = -.81, p = .417$, or household income, $t(147) = -.97, p = .335$. However, missingness was associated with mean-level differences in age, $t(165) = -2.32, p = .022$, such that children with missing data on at least one variable ($M_{\text{age}} = 3.75$ years, $SD_{\text{age}} = .61$ years) were significantly younger than children with complete data ($M_{\text{age}} = 4.11$ years, $SD_{\text{age}} = .78$ years).

Little's test of Missing Completely at Random (MCAR) was not significant, $\chi^2 = 581.71, df = 482, p = .12$, suggesting that patterns of missing data did not violate the assumption that data were missing completely at random. To leverage the complete sample ($N = 167$) and avoid the biased parameter estimates that can occur with pairwise or listwise deletion missing data were imputed using the expectation-maximization algorithm (Schafer & Graham, 2002).

Results

Descriptive Statistics

Table 1 depicts the means, standard deviations, ranges, and intercorrelations among study variables separately for the familiar and unfamiliar condition. Of note, shyness was significantly positively correlated with persistence in the unfamiliar ($r = .30, p = .036$) and familiar ($r = .23, p = .034$) condition. Social support seeking was positively correlated with persistence only in the familiar condition ($r = .35, p = .001$).

Preliminary Analyses

To ensure that there was equality across conditions in shyness and inhibitory control, we used two separate one-way ANCOVAs with familiarity condition as the between-subjects factor, with shyness and inhibitory control as the dependent measures, and children's age and sex as covariates. We found that there were no mean level differences in shyness, $F(1, 163) = .15, p = .705, \eta^2 = .001$ or inhibitory control, $F(1, 133) = .08, p = .776, \eta^2 = .001$, across familiarity conditions.

To determine whether there was a main effect of contextual familiarity on children's social support seeking and persistence, we used two separate one-way ANCOVAs, with familiarity condition as the between-subjects factor, and social support seeking and persistence as the dependent measures, and children's age and sex as covariates. We found a significant effect of familiarity condition on children's social support seeking, $F(1, 163) = 18.92, p < .001, \eta^2 = .104$, where children sought more support from their mother ($M = .73, SE = .24$) than from the stranger ($M = -.72, SE = .23$). There were no mean level differences in persistence across familiarity contexts, $F(1, 163) = .54, p = .465, \eta^2 = .003$, suggesting that children were equally likely to spend time trying to build the model with their mother and the stranger.

Shyness \times Inhibitory Control \times Context Familiarity Interaction in Predicting Social Support Seeking

To determine whether the interaction between shyness and inhibitory control in predicting social support seeking depended on contextual familiarity, we used a multiple linear regression, controlling for children's age and sex. The complete model was significant, $F(9, 157) = 5.62, p < .001$, and accounted for 24% of the variance in social support seeking. We found a significant three-way interaction among shyness, familiarity condition, and inhibitory control ($B = .44, p < .001$). Figure 1 depicts this interaction visually, and Table 2 presents the statistical information for the complete model.

To interpret the three-way interaction, we conducted simple slopes analyses where we examined the relation between shyness and social support seeking at low and high values of inhibitory control separately in the familiar and unfamiliar context (Aiken & West, 1991; Dawson & Richter, 2006). Consistent with predictions made by the risk potentiation model of control, when children were in the presence of a stranger in the unfamiliar context, shyness was negatively associated with observed social support seeking at relatively high levels of inhibitory control ($B = -.56, p = .041$) and unrelated to social support seeking at relatively low levels of inhibitory control ($B = -.30, p = .240$). In contrast, when children were in the presence of their mother in the familiar context, shyness was positively associated with social support seeking at relatively high levels of inhibitory control ($B = .53, p = .009$), and unrelated to social support seeking at relatively low levels of inhibitory control ($B = -.40, p = .093$).

To further interpret the results of the three-way interaction, we also conducted slope differences tests following recommendations reported elsewhere (Dawson & Richter, 2006). The difference between the slopes depicting the relation between shyness and

Table 1

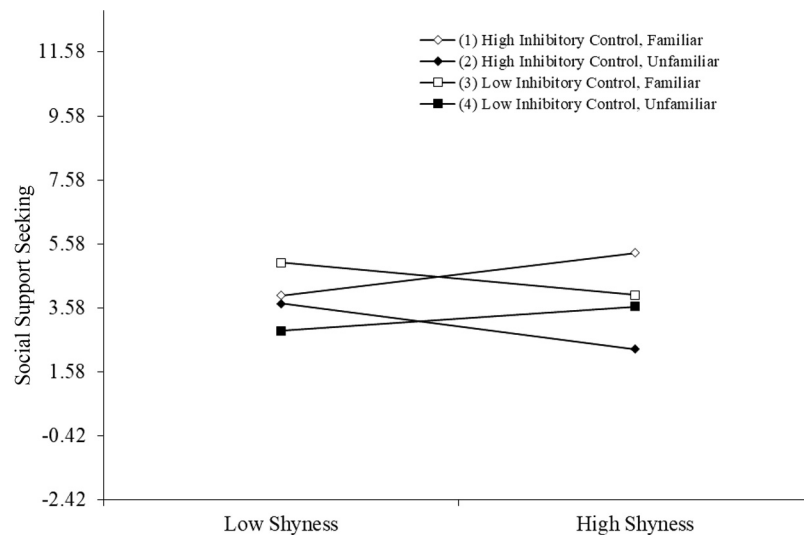
Pearson's Correlations, M (SD), and Range for Study Measures Separated by Familiarity Condition

Variables	1	2	3	4	<i>M</i> (<i>SD</i>) Unfamiliar	Range Unfamiliar	<i>M</i> (<i>SD</i>) Familiar	Range Familiar
1. Shyness	—	-.01	-.02	.30*	3.47 (1.24)	1.17 to 6.67	3.40 (1.20)	1 to 6
2. Inhibitory control	-.03	—	-.05	-.14	-0.07 (1.84)	-3.47 to 4.06	0.07 (2.20)	-5.42 to 5.03
3. Social support seeking	.11	-.03	—	-.03	-0.71 (2.20)	-2.42 to 12.86	0.72 (2.23)	-2.42 to 7.98
4. Persistence	.23*	-.07	.35**	—	49.50 (9.67)	9.36 to 71.76	48.05 (12.79)	8.36 to 82.87

Note. Intercorrelations among study variables for the unfamiliar condition and familiar condition fall above and below the midline, respectively.

* $p < .05$. ** $p < .01$.

Figure 1
Interaction of Shyness, Familiarity Context, and Inhibitory Control in Predicting Social Support Seeking During a Toy Building Task



Note. Values are plotted at one standard deviation above and below the mean of inhibitory control in the unfamiliar and familiar condition. Slopes 1 and 2 are significant.

social support seeking were not significantly different in the familiar, high inhibitory control context and the unfamiliar, low inhibitory control context, $t = .72, p = .474$. Similarly, the difference between the slopes depicting the relation between shyness and social support seeking in the familiar, low inhibitory control context and the unfamiliar, high inhibitory control context were non-significant, $t = -.45, p = .651$. The difference between the slopes depicting the relation between shyness and social support seeking in the familiar and unfamiliar low inhibitory control contexts was just above statistical significance, $t = -1.20, p = .051$. All other slopes were significantly different from each other ($ps \leq .025$).

Shyness \times Inhibitory Control \times Context Familiarity Interaction in Predicting Persistence

We also examined if shyness, inhibitory control, and contextual familiarity predicted persistence in working on the building task. The complete model was significant, $F(9, 157) = 6.03, p < .001$, and accounted for 27% of the variance in persistence. However, the three-way interaction among shyness, familiarity condition, and inhibitory control was not significant ($B = .01, p = .981$). Table 3 presents the statistical information for the complete model.

Discussion

We examined whether the risk potentiation model of cognitive control depended on contextual familiarity (Henderson et al., 2015; Henderson & Wilson, 2017). More specifically, we examined whether the moderating role of inhibitory control on the relation between shyness and observed social support seeking differed during a building task with their mom (i.e., a familiar context) versus a novel adult female research assistant (i.e., an unfamiliar context). We found a three-way interaction among shyness, familiarity

condition, and inhibitory control in predicting social support seeking, but not task persistence. In the unfamiliar condition, we found that shyness was negatively associated with social support seeking at high levels of inhibitory control in keeping with the risk potentiation model of control (Henderson et al., 2015; Henderson & Wilson, 2017). In the familiar condition, we found that shyness was positively associated with social support seeking at high levels of inhibitory control. These results suggest that the “double-edged sword” of inhibitory control on social behavior may depend on both temperamental style and contextual familiarity.

Across the sample, we found that children engaged in higher levels of social support seeking from their mother than from an unfamiliar research assistant. Stranger wariness appears to first emerge in infancy (Brooker et al., 2013; Waters et al., 1975). Although infants and toddlers appear to display higher levels of stranger wariness (operationalized as lower levels of social engagement) than preschool-aged children (e.g., Greenberg & Marvin, 1982), preschool-aged children still exhibit social wariness. It is important to note, however, that the level of wariness may be influenced by individual differences in temperamental or physiological factors (Buss, 2011; Buss et al., 2013). Given the familiarity of mothers and the presumably frequent interactions preschoolers have with them, higher levels of social support seeking from mothers compared to a novel research assistant likely reflect higher levels of familiarity and comfort in response to mother and potential stranger wariness in response to the research assistant. In other words, these results are likely indicative of developmentally appropriate and expected wariness toward a stranger.

It is important to point out that although not the focus of the study, we also found that age was negatively associated with both social support seeking and persistence. The negative relation between age and social support seeking was expected. As children

Table 2

Three-Way Interaction Among Shyness, Inhibitory Control, and Familiarity Condition in Predicting Social Support Seeking During a Toy Building Task, Controlling for Children's Age and Sex

Predictor	Unstandardized β	SE	Standardized β	R^2	p
Step 1				.08	
Age	-0.78	0.23	-0.26		<.001
Sex	-0.49	0.35	-0.11		.165
Step 2				.17	
Age	-0.79	0.22	-0.26		<.001
Sex	-0.41	0.34	-0.09		.227
Shyness	0.02	0.13	0.01		.893
Inhibitory control	-0.01	0.09	-0.01		.887
Familiarity context	1.44	0.33	0.31		<.001
Step 3				.18	
Age	-0.81	0.22	-0.26		<.001
Sex	-0.39	0.35	-0.08		.263
Shyness	-0.28	0.43	-0.15		.514
Inhibitory control	-0.27	0.33	-0.24		.413
Familiarity context	0.77	0.98	0.17		.433
Shyness \times Inhibitory Control	0.06	0.06	0.20		.309
Shyness \times Familiarity Context	0.19	0.27	0.22		.475
Inhibitory Control \times Familiarity Context	0.03	0.17	0.05		.845
Step 4				.24	
Age	-0.81	0.21	-0.27		<.001
Sex	-0.38	0.34	-0.82		.259
Shyness	-0.32	0.42	-0.17		.437
Inhibitory control	2.11	0.73	1.82		.005
Familiarity context	-0.66	0.21	-0.17		.415
Shyness \times Inhibitory Control	-0.66	0.26	-2.10		.002
Shyness \times Familiarity Context	0.19	0.26	0.22		.461
Inhibitory Control \times Familiarity Context	-1.43	-0.44	-2.07		.001
Shyness \times Familiarity Context \times Inhibitory Control	0.44	0.12	2.37		<.001

Note. Females coded as 1, males coded as 2; Unfamiliar condition coded as 1, familiar condition coded as 2.

grow and become more independent, they may rely less on support from adults to complete tasks. It is less clear, however, why children in our sample displayed less persistence as they increased in age. One explanation is that older children in our sample realized the model was difficult to build and so they spent less time working on it whereas younger children were less able to judge the difficulty of the model relative to their abilities.

In the unfamiliar condition, we found that shyness was negatively associated with social support seeking at high levels of inhibitory control and unrelated to social support seeking at low levels of inhibitory control. These results are in line with previous studies that have examined the moderating role of a physiological, behavioral, or temperamental index of inhibitory control in the relation between shyness or related constructs and various psychosocial outcomes (Brooker et al., 2016; Henderson, 2010; Lahat et al., 2014; Lamm et al., 2014; Poole et al., 2021; Sette et al., 2018; Thorell et al., 2004; Troller-Renfree et al., 2019; White et al., 2011). Together, these studies converge with our findings to suggest that, at least in an unfamiliar context, higher levels of inhibitory control interfere with more positive and approach-related socioemotional and psychological outcomes, and in this case, observed social support seeking.

Of note, the slope difference test revealed that the relation between shyness and social support seeking was the same when children were in the unfamiliar condition and had relatively high inhibitory control and when the children were in the familiar condition and had relatively low inhibitory control. Similarly, the relation between shyness and social support seeking was the same when children were in the

familiar condition and had relatively high inhibitory control and when the children were in the unfamiliar condition and had relatively low inhibitory control. The equivalence between these slopes at different levels of inhibitory control and contextual familiarity further supports the assertion that the moderating role of inhibitory control in the relation between shyness and social support seeking depends on the familiarity of social partners.

One unique contribution of the present study was the inclusion of a familiar context to examine whether the risk potentiation model of control functions similarly in an unfamiliar and familiar context. In contrast to the results in the unfamiliar condition and predictions made by the risk potentiation model of control (Henderson et al., 2015; Henderson & Wilson, 2017), we found that shyness was positively associated with social support seeking at relatively high levels of inhibitory control in the familiar context. In this context, inhibitory control positively impacted shy children's social support seeking. Inhibitory control includes the ability to keep rules and a goal in mind and the ability to monitor and modify behavior in support of that goal. In the model building context, the goal was to replicate the model that was built by the adult. In the familiar context without the fear associated with social novelty, the processes associated with inhibitory control may facilitate social support seeking for the shy child so the child can achieve their goal of completing the task. Here, this may be more relevant for shy children rather than nonshy children because shy children may recall that the main research assistant will return and see what the child has built, and the shy child may be concerned about the negative evaluation of their performance.

Table 3

Three-Way Interaction Among Shyness, Inhibitory Control, and Familiarity Condition in Predicting Persistence During a Model Building Task, Controlling for Children's Age and Sex

Predictor	Unstandardized β	SE	Standardized β	R^2	p
Step 1				.21	
Age	-6.80	1.02	-0.46		<.001
Sex	0.49	1.57	0.02		.754
Step 2				.25	
Age	-6.43	1.03	-0.44		<.001
Sex	0.76	1.58	0.03		.634
Shyness	1.66	0.62	0.19		.008
Inhibitory control	-0.12	0.40	-0.02		.764
Familiarity context	-1.02	1.54	-0.05		.512
Step 3				.26	
Age	-6.51	1.04	-0.44		<.001
Sex	0.93	1.61	0.04		.565
Shyness	0.22	2.00	0.03		.911
Inhibitory control	-1.52	1.55	-0.27		.328
Familiarity context	-4.22	4.56	-0.19		.356
Shyness \times Inhibitory Control	0.17	0.29	0.11		.546
Shyness \times Familiarity Context	0.93	1.26	0.22		.458
Inhibitory Control \times Familiarity Context	0.52	0.78	0.16		.505
Step 4				.26	
Age	-6.51	1.04	-0.44		<.001
Sex	0.93	1.62	0.04		.566
Shyness	0.22	2.00	0.03		.912
Inhibitory control	-1.44	3.54	-0.26		.684
Familiarity context	-4.22	4.57	-0.19		.358
Shyness \times Inhibitory Control	0.15	1.01	0.10		.883
Shyness \times Familiarity Context	0.93	1.26	0.22		.460
Inhibitory Control \times Familiarity Context	0.48	2.11	0.14		.822
Shyness \times Familiarity Context \times Inhibitory Control	0.01	0.59	0.02		.981

Note. Females coded as 1, males coded as 2; Unfamiliar condition coded as 1, familiar condition coded as 2.

It is important to note that we are framing social support seeking positively during the building phase because the task was designed to be challenging for children, so asking for help, smiling, and gazing toward the mother or unfamiliar experimenter were considered developmentally appropriate behaviors in this context. These results are consistent with studies that have examined the influence of self-regulation more broadly (Eisenberg et al., 2009, 2010; Graziano et al., 2007; Ponitz et al., 2009; Wilson, 2003), outside of reactive temperamental styles, on children's socioemotional outcomes, and suggest that the risk potentiation model of control may be context-specific. Further, because the three-way interaction among shyness, inhibitory control, and familiarity context was not a significant predictor of persistence during the building task, our results appear to be specific to social behaviors rather than task behaviors.

In the first article to formally introduce the risk potentiation model of cognitive control, Henderson et al. (2015) reviewed another model that can be used to make predictions about the influence and interaction of reactive (i.e., shyness) and controlled (e.g., inhibitory control) processes on the development risk for psychological and socioemotional problems. The "overgeneralized control model" proposes that the automatic response biases observed in individuals with reactive temperamental styles lead to overgeneralized orienting responses in addition to the activation of controlled processes in unnecessary contexts (Henderson et al., 2015). Through associative learning, this process may lead to inappropriate use of controlled processes and overgeneralized mode of automatic orientating in contexts that do not call for these

responses (i.e., overgeneralization). The differences we observed in the adaptiveness of inhibitory control depending on a familiar versus unfamiliar context challenge this hypothesis. Although the present study cannot directly test whether shy children can differentiate between low and high-threat contexts, our results do suggest that, at minimum, the interaction of shyness and inhibitory control on children's social support seeking was not completely overgeneralized and does appear to depend on context.

Strengths, Limitations, and Future Directions

The present study had several strengths, including the use of a relatively large sample and the extension of a burgeoning contemporary developmental theory of shyness and self-regulation (Brooker et al., 2016; Hassan et al., 2020; Henderson, 2010; Henderson et al., 2015; Henderson & Wilson, 2017; Lahat et al., 2014; Lamm et al., 2014; Poole et al., 2021; Sette et al., 2018; White et al., 2011) to different contexts using a between-subjects design experimentally manipulating contextual familiarity, and the use various indices of inhibitory control and observed social behavior. However, notwithstanding these strengths, the results should be interpreted within their limitations.

First, shyness was parent reported rather than directly observed, so the responses may have been subject to bias. However, the questionnaire we used in the present study to measure shyness is widely used and known to be reliable (Rothbart et al., 2001). Second, our sample was primarily White, and the mean household income was relatively high, so our results may not be

generalizable to children from more socioeconomically disadvantaged homes and ethnically diverse backgrounds. Third, although conducting the study in a laboratory setting with a structured building task may be considered a strength because we had control over construct operationalization and consistent procedures across the different experimental conditions, there is a natural trade-off between the control we have in the laboratory and ecological validity. As such, it will be important to replicate the results from the present study using different conceptualizations of familiarity in the classroom, the child's everyday environment outside of the classroom, or in the laboratory with children's peers and with less structured social tasks to increase ecological validity. It would also be helpful to replicate these results using behavioral observations of shyness in a more ethnically and socioemotionally diverse sample of preschoolers, using a longitudinal design in multiple contexts to chart the developmental course of these processes in different contexts.

Conclusions and Implications

The goal of the present study was to test the risk potentiation model of cognitive control in different contexts. In an unfamiliar context, shyness was only negatively associated with social support seeking at relatively high levels of inhibitory control, consistent with the risk potentiation model of control. In a familiar context, shyness was only positively associated with social support seeking at relatively high levels of inhibitory control. This three-way interaction was not related to differences in children's persistence during the model-building task.

The present findings have implications for theory. Theoretically, our results provide support for the risk potentiation model in unfamiliar contexts and suggest that familiarity reduces the negative impact of inhibitory control in the context of shyness (Henderson et al., 2015; Henderson & Wilson, 2017). It also challenges the overgeneralized control model because the impact of inhibitory control on the shy-social support seeking relation was not the same across contexts (Henderson et al., 2015). The present results need to be replicated, and if successfully replicated, we could infer that the negative impact of inhibitory control for shy children is influenced by modifiable contextual factors rather than instantiated processing patterns (i.e., dispositional, temperamental) that occur across contexts. Further, the present study also provides support for heterogeneity in both shyness and self-regulation by demonstrating that 1) shyness is not always associated with lower levels of approach-related social behavior, 2) approach-related social behavior may depend on both inhibitory control and context, and 3) inhibitory control can be facilitative or interfere with approach-related social behavior depending on both temperament and context.

The present study also has practical implications. The preschool period is an important developmental time because self-regulation is rapidly developing (Dennis et al., 2007; Geeraerts et al., 2021; Klenberg et al., 2001; Kochanska et al., 1996; Schoemaker et al., 2014; Williams et al., 1999), and children have yet to enter formal schooling. Although school entry can be an exciting time for many children, there is some evidence suggesting that it may be particularly difficult for shy children (Coplan et al., 2008). This is not surprising because shy children display wariness and fear in the context of social novelty (Buss, 1986; Cheek & Buss, 1981;

Karevold et al., 2012; Sanson et al., 1996), and school entry is marked by new people and social situations. Given sufficient replication across different contexts, the results from the present study suggest that increasing contextual familiarity may increase the likelihood that shy children with relatively high levels of inhibitory control will engage with their social environment. This knowledge can be then used by parents, peers, and teachers to help set shy children on a positive socioemotional trajectory.

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Received January 18, 2022

Revision received July 11, 2022

Accepted July 21, 2022 ■