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Longitudinal Relations between Behavioral Inhibition and Social Information Processing: Moderating Role of Maternal Supportive Reactions to Children's Emotions

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Abstract

Utilizing multiple measures of interpretive biases, the current study examined the roles of toddlers' behavioral inhibition (BI) and maternal supportive reactions to children's negative emotions in relation to children's interpretive biases across middle to late childhood. Toddlers' BI was measured during several laboratory tasks ($n = 248$) at 2 and 3 years of age. Mothers reported on their reactions to children's negative emotional expressions when children were 7 years old ($n = 203$), and children's interpretations of social cues were assessed at 7 and 10 years of age ($ns = 179$ and 161 , respectively). Toddlers with high levels of BI expressed less positivity towards social engagement with unfamiliar peers during discussion of ambiguous social situations. Further, children with high BI were less likely to attribute the cause of negative social situations to external factors, particularly when mothers were less accepting of children's negative emotional displays. Findings are discussed in terms of cognition related to the interpretation of ambiguous and threat-related social situations among temperamentally at-risk children.

Behavioral inhibition (BI) is a temperament characterized by high levels of vigilance and fear reactivity in response to novel situations and stimuli (Fox et al., 2005), which has shown to be moderately stable across early childhood (Fox et al., 2001; Stevenson-Hinde & Shouldice, 1995). As they age, behaviorally inhibited children tend to display socially reticent and withdrawn behaviors during interactions with peers and to be relatively at high risk for development of anxiety problems and in particular social anxiety (Biederman et al, 2001; Chronis-Tuscano et al., 2009; Degnan & Fox, 2007). The way that behaviorally inhibited children process social cues in their environment may be one potential mechanism that contributes to the development of anxiety among these children (Perez-Egddgar et al., 2010).

The social information-processing (SIP) model (Crick & Dodge, 1994) explains how variability in children's processing of emotional/social information, when they are confronted with ambiguous social situations, may predict differences in their subsequent behavioral responses. According to the SIP model, children go through multiple steps before

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enacting a behavioral response. These steps include encoding and interpretation of social cues, clarification of social goals, accessing and constructing a physiological or behavioral response (e.g., increased heartrate), and finally evaluating the consequences of their behavioral response. Because of its circular nature, the first two steps of SIP are particularly important as they can disrupt the cycle of maladaptive SIP patterns and influence subsequent behavioral responses. In fact, maladaptive encoding and interpretation of social cues (i.e., negative or less positive encoding and interpretation of social cues), has shown to be pertinent to understanding externalizing behavior problems (Crick and Dodge, 1994) and internalizing behavior problems including anxiety problems (e.g., Burgess, Wojslawowicz, Rubin, Roser-Krasnor, & Booth-LaForce, 2006; Field & Field, 2013; Jarcho et al., 2013). For instance, a number of studies have reported that anxious children may be more likely to have negative interpretation of social situations compared to non-anxious children (Barrette, Rapee & Dadds, 1996; Bogel & Zigterman, 2000; Waters, Craske, Bergman & Treanor, 2008).

The encoding and interpretation of social cues as positive and benign may be particularly important for children who are temperamentally at-risk for maladaptive behavioral outcomes (i.e., anxiety) and cognitive biases, such as behaviorally inhibited children (White et al., 2016). Specifically, evidence suggests that inhibited children show fear responses in situations that are novel, unpredictable and unfamiliar, display sensitivity toward social exclusion and rejection, and show less enthusiasm for involvement in such situations (Degnan & Fox, 2007; Pérez-Edgar & Guyer, 2014 Roth, Fresco, & Heimberg, 2006). These behavioral responses are possibly linked to underlying cognitions and cognitive biases, including negative or less positive interpretation of social cues, among behaviorally inhibited children.

Although attention biases towards negative and away from positive social cues have been reported in children with high levels of BI (Perez-Edgar et al., 2010; White, Helfinstein, & Fox, 2010; White et al., 2011), only a few studies have examined how inhibited children interpret ambiguous or negative social cues and situations -- particularly using a longitudinal design. For example, biases in attributing the cause for a given event have been reported among shy children such that these children have shown to use less external and more internal/personal (relating to their dispositional characteristics) causes to explain social failures or potentially negative social situations (Rubin, Coplan & Bowker, 2009; Wichman, Coplan, & Daniels, 2004). Dodd, Hudson, Morris & Wise (2012) also examined the relation between BI and threat-related interpretive biases; however, no difference between inhibited and non-inhibited children was found in this study. Given the paucity of research in this area, the goal of current study was to examine the longitudinal relation between toddlers' BI and their interpretive biases during late childhood. It was expected that toddlers with high BI display less positive interpretation of social situations (i.e., less positivity towards social engagement and outcome of social situation) during discussion of ambiguous social situations. Because shy children have been reported to use fewer external attributions in explaining negative social situations (even though such strategy when dealing with negative situations may be an adaptive process for these children), we also examined whether toddlers' differences in BI was predictive of children's use of external attributions.

In the SIP model, the way that children respond to and interpret challenging social cues is influenced by not only their individual characteristics but also by mental and emotional schemes that are built upon their stored memories of past events and experiences with others (e.g., parents and peers). For instance, children with history of maltreatment and/or those who have been exposed to caregivers' expressions of negative emotions and hostility were found to have maladaptive SIP patterns (e.g., attend to negative social cues, interpret cues as hostile or negative) (Dodge, Lansford, Burks, Pettit, Bates, Fontaine, Price, 2002; Ziv, 20012). Further, a growing number of studies have highlighted the importance of parents' transmission of non-verbal (e.g., expression of anxiety and fear in response to non-threatening or ambiguous situations) and verbal (negative interpretation of situations) information in relation to children's maladaptive SIP patterns (Creswell, Cooper & Murray, 2010; Creswell, O'Connor & Brewin, 2006; Lester, Field & Cartwright-Hatton, 2012; Ooi, Dodd & Walsh, 2015). For example, children of mothers who show threat-related interpretive biases are more likely to show negative biases interpreting ambiguous social situations (Creswell & O'Connor, 2006).

Nonetheless, we know little about how supportive parenting, which promotes emotion regulation and understanding, may shape or buffer against children's interpretive biases. In their integrated model of emotional processes and cognition, Lemerise and Arsenio (2000) suggested that individual differences in affective experiences -- including regulation, expressions and understanding of emotions-- influence differences in the processing of social and emotional information. Thus, parents' socialization practices that help children develop effective strategies to regulate their emotions, understand emotions in themselves and others, and express emotions in effective ways (when faced with challenging social situations) may have positive influences on various steps of the SIP model. In the current study, we focused on parents' supportive reactions to children's expression of negative emotions, an important aspect of parents' emotion socialization (Hurrel, Hudson, Schniering, 2015), and its relations to BI and interpretive biases.

According to Fabes, Poulin, Eisenberg, Madden-Derdich (1990), supportive and positive reactions to children's affective expressions include responses when parents 1) accept and encourage children's display of negative emotions (*expressive encouragement*), 2) help the child solve the problem by offering strategies to cope (*problem-focused responses*) or 3) help the child feel better (e.g., comforting the child to help him/her shift attention away from the distressing event; *emotion-focused*). Parents' supportive reactions, particularly problem-focused and expressive encouragement reactions, are associated with children's higher emotional competence, and better regulatory abilities and understanding of emotional cues in the environment (Jones, Eisenberg, & Fabes, 2002; McElwain, Halberstadt, & Volling, 2007; Strayer & Roberts, 2004).

Specifically, parenting strategies that acknowledge and accept children's negative emotions (and in particular fear) help facilitate the discussion of negative emotions between parents and children, during which children can express their feelings and parents can provide explanations to help children understand and deal with these negative emotions (Fivush, Berlin, McDermott, & Sales, 2010). As a result, children of parents who employ this strategy may better understand emotions in themselves and others and learn to regulate their

emotions by attributing positive meanings and explanations to potentially negative social situations (Hurrell et al., 2015; Jones et al., 2002). Parental acceptance and encouragement of children's negative emotional expressions appear to be more beneficial in promoting self-regulation when used in response to children's fear expressions than other types of emotional expressions such as anger (Jones et al., 2002). Similarly, parents' responses that focus on helping children find and solve the problem that has caused negative emotions are useful in fostering problem-solving skills. Using these problem-solving skills during challenging social situations may be effective in reducing children's negative beliefs and enhancing later adaptive processing of stressful situations (Dunne & Askew, 2013; Gerull & Rapee, 2002). In contrast to problem-focused and expressive encouragement reactions, not much evidence exists for the associations between parental comforting responses and children's regulation and positive social functioning. In fact, parents' comforting responses may negatively affect children's self-regulatory abilities as children who are frequently comforted by parents may not learn how to regulate and manage their own negative emotions and effectively cope with stressful social situations (Jones et al., 2002). Overall, parent's problem-focused and expressive encouragement reactions to a child's emotions (but not parental comforting reactions) may influence how the child processes subsequent emotional information in their environment (e.g., how they interpret social cues). These two types of reactions may be particularly important for behaviorally inhibited children who are at-risk for showing high reactivity in response to socially challenging, novel and stressful situations (Gerull & Rapee, 2002; Walker, Henderson, Degnan, Penela, & Fox, 2014).

To extend the limited longitudinal research on the relations between children's BI and interpretive bias, in the current study we examined the associations of BI during toddlerhood to children's different aspects of interpretive biases across middle and late childhood. Additionally, we examined whether maternal problem-focused and expressive encouragement reactions to child's negative emotions would buffer against inhibited children's maladaptive interpretive biases.

Method

Participants

Families and their children who participated in the current study were part of a larger study of temperament and adaptation, living in a metropolitan area in the United States. Families who had a full-term born infant with no serious perinatal history or illness ($N = 779$) were prescreened via phone and brought into the lab at 4 months for their infants' temperament screening. The required number of children who were screened, to ensure sufficient number of children in each temperament group, was determined using power analysis and previous work (Fox, Henderson, Rubin, Calkins & Schmidt, 2001). The screening involved assessing infants' reactivity, including motor (e.g., frequency of arm waves and leg kicks), positive (e.g., frequency of smiling) and negative (e.g., frequency of crying) reactivity in response to social/non-social visual and auditory stimuli.

Three temperament groups were created based on this screening and using the following procedure. The first hundred infants were selected to comprise the criterion group. Children in the first temperament group were those whose mean scores on negative and motor

reactivity were above, and mean scores on positive reactivity were below the means scores of children in the criterion group (named *negative reactive*; $N = 105$). The second group included infants whose mean scores on positive and motor reactivity were above, while mean scores on negative reactivity were below the mean of criterion group (*positive reactive*; $N = 103$). The third temperamental group (*control group*; $N = 83$) included children whose members were below the mean cut-offs on negative affect, positive affect and motor reactivity. The final sample of children were representative of a wide range of temperament observed in other community samples, and the number of children in each group exceeded those reported in previous work.

The participants included in the current study were a subsample of two-hundred and ninety-one infants (132 males and 159 females) were asked to participate in the study at later time points based on their classification into three temperamental groups. The majority of children in the final sample were Caucasian (64.30%), but African American, Asian, and Hispanic ethnicities also were represented comprising 14.1%, 2.1%, and 3.4% of the sample, respectively. Some of the participants (16.1%) reported more than one ethnic background. The distribution of maternal education in the current sample was as follows: 49.2% of mothers had a college degree, 35.9% had a graduate degree, 10.5% had a high school diploma, and 4.4% had other types of education. The majority of parents (90.7% of sample) were married at initial recruitment; no data regarding family income were collected from participants.

Procedure

Following the 4-month assessments, mothers brought their children to the lab at 2 and 3 years of age to participate in a series of tasks to assess children's BI. When children were 7 and 10 years of age, they came again for lab assessments and their interpretive biases in response to ambiguous social situations were assessed. At the 7-year assessment, mothers also were asked to report on the strategies that they used in response to children's negative emotions.

Measures

Observational measure of BI—At 2 and 3 years of age, children participated in three episodes involving novel non-social (tunnel, robot) and social situations (interaction with an unfamiliar adult). In the stranger episode, an unfamiliar experimenter walked into the same room with the mother and child, sat in a corner for one minute and then started playing with a truck for another minute before inviting the child to play with the toy (lasting for 1 minute). Next, the experimenter turned on a robot, making unanticipated movements and sounds, and left it in the room for two minutes. Lastly, the child was introduced to a popup tunnel and was asked to crawl through it. Although mothers were present in the room, they were asked to stay uninvolved during all episodes. Children's behaviors and responses, coded during the three episodes, included (1) latency to approach the unfamiliar adult, enter the tunnel, or touch the truck/robot, (2) duration of time spent in proximity to the mother, and (3) latency to vocalize (Kagan, Reznick, & Snideman, 1987; Fox et al, 2001). Similar to previous studies (Lamm et al., 2014; Walker et al., 2014; White et al., 2017), these behaviors were standardized and averaged within each task, then averaged across task within each age

point to compute BI composites at 2 and 3 year assessments ($ns = 224$ and 197 ; Range = -1.04 – 1.89 and -1.14 – 1.71 , $Ms = .00$ and $-.01$, $SDs = .50$ and $.59$, for BI composites at 2 and 3 years of age, respectively). Finally, the BI composites across the 2 and 3-year assessments were averaged to compute the final BI composite score. All children who had a BI score at either the 2 and/or 3- year assessment were included in the analyses; higher scores reflected higher BI ($n = 248$; $M = -.01$, $SD = .46$). The inter-rater reliabilities for 20% of cases ranged from .84 to .89 and from .97 to .99 for behaviors at the 2- and 3-year lab assessments, respectively. The alpha reliabilities for the composites at 2- and 3-year lab assessments were .87 and .98 ($r = .33$, $p < .001$).

Maternal supportive emotion socialization—At the 7-year assessment, mothers reported on their supportive emotion-related socialization behaviors and strategies using the following three subscales of the Coping with Children’s Negative Emotions Scale: expressive encouragement, problem-focused, and emotion-focused reactions (Fabes et al., 1990). Each subscale included 12 items and all items were rated using a 7-likert scale (1 = very unlikely to 7 = very likely). Examples of items included: “If my child is about to appear in a recital or sports activity and becomes visibly nervous about people watching him/her, I would encourage my child to talk about his/her nervous feelings” for the expressive encouragement subscale ($M = 4.80$, $SD = 1.09$), “If my child is panicky and can’t go to sleep after watching a scary TV show, I would help my child think of something to do so that he/she can get to sleep (e.g., take a toy to bed, leave the lights on)” for the problem-focused subscale ($M = 5.79$, $SD = .63$), and “I would do something fun with my child to help him/her forget,” for the emotion-focused reaction subscale ($M = 5.53$, $SD = .81$). The Cronbach’s alphas for the subscales reflecting mothers’ supportive reactions ranged from .75 to .89. Indicators of supportive reactions were positively correlated with each other ($rs = .41$ and $.49$, for relations from expressive encouragement strategy to problem-focused and emotion-focused strategies, respectively, and $r = .61$, for the relation between problem- and emotion-focused strategies). However, indicators were not combined, but considered as moderators in separate analyses.

Children’s external attribution—At 7-year lab assessment, children listened to audio recordings of 4 stories about a child being confronted by peer *relational provocations* (e.g., “You see some of your classmates playing tag at recess and ask them if you can play, too. One of the kids says you can’t play with them.”) or *instrumental provocations* (e.g., “You are building a sand castle at the beach and another child comes over and steps on it.”). The stories were adapted from the Ambiguous Scenario Questionnaire (Barrette et al., 1996; Creswell, Murray & Cooper, 2014), and were indicative of potentially negative social situations.

Following each story, children were asked to indicate, “what they think the story means.” Children’s responses to this question were coded by two trained research assistants for whether they were reflective of external attributions (i.e., child thought the situation was due to a contextual or situational factor that is outside themselves) or internal attributions (i.e., the child attributed the cause of situation to her/his characteristics). The number of times that the child attributed the cause of a potentially negative social situation to external factors

across the four scenarios was calculated. This score was used as the final variable (Range: 0–4; $M = 1.58$, $SD = 1.05$). The inter-rater reliability (Kappa) calculated for external attribution responses for 27% of the cases across two coders was .77.

Children's positive interpretation of ambiguous situations—Children came to the laboratory at 10 years of age to participate in a number of tasks including two laboratory tasks to assess interpretive bias. In the first task, the experimenters read two stories to children involving ambiguous social situations with an unfamiliar, same-sex peer (e.g., “During school Mary/Eric tells you that she wants to talk to you and she asks if you can meet her after school”), and two stories involving a group of unfamiliar, same sex peers (e.g., “You look around your classroom and notice that Chris, Will and Mike/ Emily, Mia and Jacquie are all laughing”). The ambiguous situations used were adapted from similar previous work (Bogels & Zigterman, 2000; Waters et al., 2008; White et al., 2016). Children were then asked to indicate whether the story would end up in a good, bad or neutral way. The number of times children said that the story would end up with a good outcome was counted across the 4 stories and was used as a measure of children's positive interpretation and assessment of ambiguous situations (hereafter called *social optimism bias*; Range: 0–4; $M = 1.26$, $SD = 1.02$).

Mothers and children also discussed the ambiguous situations involving an unfamiliar peer or a group of unfamiliar peers. This task was adapted from a similar task involving non-social items (Muris, van Zwol, Huijding, & Mayer, 2010; Remmerswaal, Muris, Mayer, & Smeets, 2010). A general (neutral) description about an unfamiliar peer or a group of unfamiliar peers of the same age and sex was given to mothers (e.g., “Mary/Eric is 9 years old;” “Mary/Eric has dark brown hair;” “Emily, Mia, and Jacquie/Chris, Will, and Mark are 9 years old;” “Emily, Mia, and Jacquie/Chris, Will, and Mark have dark brown hair”). Mothers then were given a series of 4 ambiguous prompts regarding a social scenario (e.g., “Your child encounters Mary/Eric on her way home from school”) about the unfamiliar peer(s). Mothers were asked to discuss with their child what would likely happen if their child was in the situation described. Children's responses for all scenario were coded using the following procedure by two trained coders (intra-class correlations between coders = .94). For each scenario, the child's overall interpretation was coded as being 1) neutral/in-between if the child expressed both negative and positive feelings and interpretation about being in the situation, 2) positive if the child expressed excitement/enthusiasm about being in the situation with, and 3) negative if the child clearly expressed lack of excitement/enthusiasm about being in the situation. A “not available” code was given if there was not enough information to assess the interpretation (e.g., the child was unfocused or bored; coders could not understand child's statements). The number of scenarios for which the child expressed enthusiasm about potential social interaction with peer(s) was counted across the 4 scenarios (hereafter called *positivity towards social engagement*; Range: 0–4; $M = 1.89$, $SD = 1.47$).

Attrition Analyses

A total number of 248 children had complete data across 2 and 3 years of age, 203 had complete data for 7-year maternal supportive reactions, and 202 children had complete data

across 7- and 10-year lab assessments. Reasons for missing data included families moving to other states, technical issues, and child's refusal during lab assessments. Children who attrited by 7 and 10 years of age were not different from those who participated in the study (across 2 and 3 years) in terms of observational measures of BI, $t(246, 246) = 1.00$ and $.00$, $ps = .32$ and 1.00 , respectively. To handle missing data, all the main longitudinal analyses were estimated using Robust maximum likelihood (MLR) estimation, which appropriately handles missing data (Enders, 2006).

Results

Data Analysis Plan

All analyses were conducted using SPSS Version 24.0. The first step of analysis involved screening variables for out of range values, checking the normality (only for continuous variables), and generating frequencies and descriptive statistics. Because the outcomes of interest in this study were count variables (number of stories) taking on positive, integer and discrete values, a series of Poisson regression analyses (with log link function) were estimated to test for the moderating role of maternal supportive reactions in relations between children's BI and the frequencies of outcome variables. The count variables often have positive skewness and violate the underlying assumptions of Ordinary Least Square (OLS) regression. Hence, treating these variables as continuous may result in biased estimates and standard errors (Coxe, West, & Aiken, 2009). The Poisson regression is used under the condition known as equidispersion when the conditional means and variances are the same or close in magnitude (Coxe et al., 2009). Examining the dispersion parameter showed that Poisson models are more appropriate than the Negative Binominal regression model, which is used when data is overdispersed (variances are much larger than means). Further, robust standard errors were estimated to account for any slight violations of this assumption (Cameron & Trivedi, 2009).

To examine our hypotheses, first, three Poisson regressions were tested with BI as predictor of three outcomes. Because of previously reported gender differences in interpretive biases and BI, gender was used as a covariate in all analyses (Burgess, Rubin, Cheah, & Nelson, 2001). Next, nine separate Poisson models were estimated (3 outcomes $\times$ 3 moderators) with BI, types of mothers' supportive reactions (i.e., expressive encouragement, problem-focused, and emotion-focused), and the interaction terms as predictors of the three outcomes. The predictors and moderators were mean-centered. The significant interaction(s) were probed using guidelines set forth by Aiken and West (1991). Specifically, models with a significant interaction effect were re-estimated twice by re-centering the moderator at one standard deviation above and below the moderator's mean, re-computing the interaction term, and entering these measures into the regression to assess the influence of the predictor at different levels of the moderator.

Because the Poisson regression estimates the logarithm of count variables, the estimated coefficients obtained from the model reflect one unit change (increase or decrease) in the natural logarithm of the outcome. To make the interpretation easier, regression coefficients often are translated into incident rate ratios (*IRRs*) by exponentiation of the unstandardized regression coefficients (e^b ; Hancock, Tapscott, & Hoaken, 2010; Moksony & Heged s,

2014). The *IRR* reflects the rate of increase/decrease in outcome for one unit increase/decrease in the predictor.

Preliminary analyses

Only one predictor variable was skewed: the scores of one mother on the use of expressive encouragement and problem-focused strategies were identified as outliers (indicated by standardized scores that were 3 standard deviations below the mean of the variable; Kline, 2010). This one subject was excluded in subsequent analyses.

The breakdown of number of stories (ranging from 0–4) by gender across three measures, i.e., external attribution, positivity towards engagement and social optimism bias, are reported in Table 1. No gender differences was observed in terms of positivity towards social engagement, social optimism bias, or external attributions, $\chi^2(4, 4) = 2.10, 3.76$ and 1.19 , $ps = .88, .44$ and $.71$, respectively.

The results of one-way multivariate analyses of variance (MANOVA) showed no significant differences for maternal supportive reactions and BI based on mothers' education or material status, Wilk's $\Lambda s = .92$ and $.95$, $F(381.28$ and $532.22) = .97$ and $.60$, $ps = .48$ and $.88$, respectively. Further, results of Kruskal-Wallis H tests (a rank-based nonparametric test equivalent to MANOVA) showed no differences in terms of external attribution at age 7, and positivity towards social engagement and social optimism bias at age 10 based on parents' marital status and maternal education, $X^2(3, 3, 4) = 5.39, 1.60$, and 2.87 , $ps = .15, .66$, and $.58$, respectively.

Children's early BI and indicators of maternal supportive reactions to children's emotions were not correlated, $rs = -.07, .00$, and $-.12$ ($ps = ns$) for relations of BI to expressive encouragement, problem-focused and emotion-focused strategies, respectively. The relations between BI, maternal behaviors, and count variables were tested using a series of Kendall's tau-b (τ_b) correlation analyses, a non-parametric test of associations between ordinal variables. Children's 10-year positivity towards social engagement and social optimism bias were correlated with each other, $\tau_b = .15$, $p = .03$, but were not correlated with 7-year external attribution, $\tau_b s = -.04$ and $.08$, $ps = .57$ and $.29$, respectively. BI was negatively related to children's positivity towards social engagement and social optimism bias (involving unfamiliar peers), $\tau_b s = -.18$ and $-.14$, $ps = .01$ and $.03$, respectively, but was not related to frequency of external attributions, $\tau_b = .00$, $p = .94$. Further, no direct associations were observed between indicators of maternal supportive reactions and the three outcome variables, $\tau_b s$ ranged from $.01$ to $.07$, $ps = ns$.

Relations among BI, parents' supportive reactions and interpretive biases

Poisson regression models were estimated to test the direct relations between BI and the measures of interpretive biases, as well as the moderating roles of the three indicators of maternal supportive reactions in the associations between BI and interpretive biases. Table 2 summarizes the coefficients, *IRRs*, deviance (a relative measure of model fit with smaller number showing a better fit; Cox et al. 2009; Moksony & Heged s, 2014), and the adjusted *p*-values following the Holm-Bonferroni correction, which was applied to control for familywise error rates in multiple hypothesis testing (Aickin & Gensler, 1996). Analyses

revealed that toddlers' BI predicted children's positivity towards social engagement with unfamiliar peer(s) at 10-years of age ([95%CI: $-.66, -.10$]; Pseudo R -square = .08), but it was unrelated to children's 7-year external attributions. The relation between BI and social optimism bias also was not significant after applying the multiple test correction procedure.

As seen in Table 2, the main effects of mothers' use of supportive strategies and their interaction with BI were not predictive of different aspects of children's interpretive biases, with one exception. The interaction between toddlers' BI and maternal use of expressive encouragement strategies in predicting external attributions was significant, ([95%CI: .07, .54]; Pseudo R -square = .12). Probing the interaction at 1SD above and below the mean of expressive encouragement reactions (see Figure 1) showed that when mothers used low levels of expressive encouragement, a one unit increase in BI decreased children's external attributions by a factor of $\exp(-.35) = .70$, representing a 30% decrease in the number of stories attributed to external factors. BI was not related to children's external attributions at high levels of mothers' expressive encouragement.

Discussion

The aims of the current study were to examine 1) whether early BI would predict children's interpretation and cognitions relating to unpredictable and ambiguous social situations with unfamiliar peers during middle and late childhood, and 2) if mothers' reactions to children's negative emotions would moderate these associations. Results showed that children with high levels of BI were less likely to show positivity towards social engagement. Further, children with high levels of BI whose mothers used low levels of expressive encouragement were less likely to use external attributions to explain potentially negative situations. BI was not directly predictive of social optimism bias or children's use of external attributions, and the main effects of maternal supportive strategies on different aspects of children's interpretive biases were not significant.

Children with high levels of BI in toddlerhood were less likely to show positivity towards social engagement during their discussions of ambiguous social situations with mothers in late childhood. Previous behavioral studies have shown that inhibited children display fear responses and less enthusiasm to be involved with unfamiliar peers during social interactions (Pérez-Edgar & Guyer, 2014). Our result suggest that inhibited children's bias in interpretations of novel situations as less positive or rewarding may underlie the lack of enthusiasm observed during social interactions among these children. Given the longitudinal nature of study, this result also indicates that cognitions related to children's positivity towards social engagement among inhibited children persist into late childhood. It should be noted that children's positivity towards social engagement was coded during the mother-child discussions of ambiguous social situations, and thus, the child's responses may have been influenced by mothers' interpretive biases and anxiety-linked cognitions. Indeed, a number of studies have highlighted the importance of maternal cognitive biases, anxious cognitions and perception of child's fear responses in predicting children's anxiety and patterns of maladaptive information processing (Barrett et al., 1996; Lester, Seal, Nightingale & Field, 2010; Lester et al., 2012). Thus, an alternative explanation for our result, regarding the negative relation between BI and children's positivity towards social

engagement during this discussion task, may be that children who are temperamentally at-risk (i.e., inhibited children) are more susceptible to maternal transmission of anxiety-linked cognitions

The relation between toddlers' BI and children's use of external attributions in middle childhood was moderated by maternal use of expressive encouragement. Specifically, when mothers reported to use low levels of strategies to encourage children's emotional expression, inhibited children were less likely to interpret negative social situations to be caused by external factors. Yet, BI was not associated with children's use of external attributions when mothers used a high level of strategies to encourage children's emotional expression. Previous research has shown that shy children are less likely to attribute the cause of negative situations to external factors. In addition, there is an abundance of evidence for the contributions of negative parenting behaviors, including hostility and lack of warmth, to children's interpretive biases (e.g., hostile attributions) and subsequent behavioral problems (e.g., Gomez & Gomez, 2000; Palmer & Hollin, 2000). Our result extended these lines of research by showing that it is important to consider both children's temperamental vulnerability and maternal socialization practices in predicting children's causal attributions.

Whereas BI was directly related to positivity towards social engagement, it was unrelated to social optimism bias (after applying multiple-test correction). Children's positivity towards social engagement was assessed during elaborated mother-child discussions (discussion-based measure), whereas children's social optimism bias reflecting child's positive interpretations of social outcomes in ambiguous social situations was assessed using a scale-based questionnaire. In the latter scale-based measure, children were asked to spontaneously interpret the ambiguous social situations, assessing children's automatic and immediate cognitions relating to interpretation of social cues. However, in the discussion-based measure, children were given the opportunity to reflect and modify their cognitions. Thus, lack of relation between BI and interpretive bias using the scale-based measure may indicate the significance of BI in reflective rather than immediate patterns of information processing.

Further, lack of interaction by parenting in models involving social optimism and positivity towards social engagement (compared to models for external attribution) may be due to the nature of the stories that were used across different tasks. The stories used to assess external attribution bias were indicative of potentially negative and threat-related social situations compared to the other two tasks, which included ambiguous stories. Thus, lack of interaction by parenting in the tasks that included ambiguous stories may suggest that parenting may be more effective in modifying children's biases pertaining to potentially negative and threat-related situations than ambiguous situations. This explanation; however, should be treated with caution because the discussion-based task that was used to assess children's positivity towards social engagement could have captured maternal influences on children's threat-related cognitions. Thus, differences in the role of parenting in the link between children's BI and interpretive biases across ambiguous and negative stories depicting social situations may be disentangled using a controlled experimental research design.

Finally, mothers' use of problem- and emotion-focused responses were not associated with children's processing of ambiguous social cues and they did not moderate the relations between BI and children's aspects of interpretive biases. Most of the items in the questionnaires measuring emotion- and problem-focused strategies reflected mothers' use of reactions to either affect the child's negative feelings by providing warmth (i.e., "comfort my child and try to get him/her to forget about the accident" for emotion-focused strategies) or to make the child refocus on a positive thought or another task, respectively. Indeed, there was little indication of emotional validation (recognition, understanding and acceptance of child's thoughts and internal fear), which is the first and most important aspect of emotional coaching facilitating regulation and understanding of emotions (Dunsmore, Booker, Ollendick, 2013). Thus, although these strategies may help children temporarily regulate their emotions and become calm, it may not help children to apply these coping skills to deal with emotionally-arousing situations as they occur later.

The current study has several strengths. First, to our knowledge, this is the first study to examine the longitudinal relations of early-identified BI to different aspects of children's interpretive biases across middle and late childhood, as well as parenting as a moderator. Understanding these longitudinal relations is particularly important given the moderate stability of BI across early childhood, with one study reporting that only 50% and 30% of children with high BI during infancy had high BI at 2 and 4 years of age, respectively (Fox et al., 2001). Further, the role of parents' supportive emotion coaching strategies was tested before the transition to adolescence when children are becoming less likely to disclose their challenges regarding emotional and social situations. Second, in the current study, we focused on children's BI, which has been less studied in relation to interpretive biases than other temperamental factors (e.g., anger proneness). Third, children's interpretive biases were assessed using scenarios that differed in both valence and the potential for threat.

Despite these strengths, there are several limitations to the current study that should be noted. The current study only focused on the level of children's positive interpretations of ambiguous situations and external attributions in explaining threat-related social situations involving unfamiliar peers, which may not be indicative of children's overall positive interpretation bias. For example, although shy children may show low excitement about being in social situations with unfamiliar peers, they may embrace social situations that involve familiar peers. In the current study, our focus was on unfamiliar peers because they are more salient in provoking fear responses in BI children than familiar peers. Thus, our result may not reflect children's overall interpretive biases or be generalizable to situations with familiar peers. Examining how children with BI interpret and discuss social situations involving familiar peers and how it may affect interpretive biases involving unfamiliar peers may be considered in future research. Second, the majority of the current sample was comprised mostly of Caucasian children from middle-class families, which limits the generalizability of our findings to participants from other populations with different ethnicity or socioeconomic backgrounds. Given evidence for differences in parents' emotion-related socialization practices across different cultures and socioeconomic status and their effects on children's socioemotional functioning (e.g., Change et al., 2003; Lareau, 2002; Tao, Zhou & Wang, 2010), testing the current models using participants from other ethnic groups and/or from different SES backgrounds is advised. Next, children understand

and learn about emotions and interpretation of social situations during interactions with mothers as well as other people in their environment (e.g., fathers, other caregivers, siblings, peers), and thus, future research must consider testing these hypotheses using reports from multiple sources. In addition, relying solely on mothers' reports of reactions to children's negative emotions may have confounded some of our results.

Further, children's positivity towards social engagement was assessed during mother-child discussions, and thus maternal factors such as mothers' anxiety or interpretation biases could have influenced children's final responses pertaining to positivity towards engagement with the unfamiliar peer. Lastly, when testing children's use of external attributions at 7 years in explaining the cause of potentially negative social situations, we did not distinguish between children's positive and negative external attributions, as BI children were thought to be prone internal (vs external) attributions. However, the external attributions made by children could have included hostile attributions (e.g., explaining the cause of a child being rejected in a play as meanness of the unfamiliar peer rather than interpreting it as the game can only have a number of players). Given that hostile attribution bias may be one underlying mechanism explaining why children with temperamental vulnerability display social reticence and poor social competence, the distinction between positive and negative external attributions should be made in future research.

The current study contributes to the limited research examining the relation between BI and children's interpretive biases, while focusing on the role of mothers' emotion-related socialization strategies on this relation. The results of this study revealed that children with high BI may have less positive cognitions towards social engagement, which may underlie their tendency to withdraw from and to be less involved in unfamiliar and novel social interactions. Additionally, our results indicated that mothers' use of strategies that encourage children's negative emotional expressions during middle childhood may buffer against BI children's tendency to use fewer external attributions. This result is particularly important as during middle and late childhood parent-child communication and relationships decline because children may be reluctant to discuss and talk about their emotions and challenges with parents than with peers (Moretti & Peled, 2004). Further, children may be relatively at-risk for developing interpretive biases as novel social interactions and relationships become more salient in their lives and their sensitivity towards social exclusion increases (Fuhrmann, Knul, Blakemore, 2015; Masten et al., 2009). Thus, findings from this study may have significant implications for intervention programs, including parenting intervention programs, which try to reduce children's maladaptive patterns of information processing and ultimately the occurrence of behavior problems.

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Figure 1.
Moderating role of maternal use of expressive encouragement (EE) in the relation between behavioral inhibition (BI) and external attributions

Table 1
The Percentage of Females and Males Endorsing 0–4 Scenarios Across different tasks.

	Positivity Towards Social Engagement		Social Optimism Bias		External Attribution	
	Male (N = 70)	Female (N = 78)	Male (N = 77)	Female (N = 84)	Male (N = 80)	Female (N = 99)
0	29%	22%	21%	29%	18%	14%
1	19%	21%	38%	39%	34%	33%
2	17%	13%	26%	25%	29%	34%
3	20%	23%	12%	5%	15%	15%
4	16%	22%	4%	2%	5%	3%

Table 2
Poisson Regression Models for Prediction Of Interpretive Biases from BI and Maternal Supportive Reactions.

Outcome	Positivity Towards Social Engagement					Social Optimism Bias					External Attribution				
	<i>b</i>	<i>SE</i>	<i>p</i> ^a	<i>IRR</i>	<i>Deviance</i>	<i>b</i>	<i>SE</i>	<i>p</i> ^a	<i>IRR</i>	<i>Deviance</i>	<i>b</i>	<i>SE</i>	<i>p</i> ^a	<i>IRR</i>	<i>Deviance</i>
BI	-.39**	.14	.00	.68	203.64	-.30	.14	.12	.74	160.71	-.08	.12	.99	.93	154.38
Gender	.14	.13	.57	1.15		-.16	-.16	.39	.21		.04	.10	.68	1.04	
Moderator: Expressive Encouragement					175.88					135.61					135.60
BI	-.37*	.15	.02	.69		-.30	.16	.12	.74		-1.50*	.59	.04	.22	
Expressive Encouragement	.07	.05	.48	1.08		.05	.06	.96	1.04		.07	.05	.54	1.07	
BI × Expressive Encouragement	.21	.11	.18	1.25		-.12	.12	.64	.88		.30*	.12	.03	1.35	
Gender	.17	.12	.57	1.19		-.19	.14	.39	.83		.03	.10	.81	1.03	
Moderator: Problem-Focused					176.36					136.46					139.16
BI	-.36*	.16	.02	.70		-.28	.16	.16	.75		-.07	.12	.99	.93	
Problem Focused	.19	.13	.48	1.20		.08	.12	.96	1.08		-.03	.08	.74	.97	
BI × Problem Focused	.07	.29	.99	1.07		-.01	.28	.98	.99		.34	.22	.26	1.41	
Gender	.18	.13	.57	1.19		-.18	.14	.39	.83		.00	.10	.97	1.00	
Moderator: Emotion-Focused					179.17					135.14					140.19
BI	-.38*	.15	.02	.68		-.24	.16	.16	.79		-.09	.12	.99	.72	
Emotion-Focused	.02	.09	.83	1.02		.11	.08	.63	1.11		.08	.07	.54	.92	
BI × Emotion-Focused	.13	.19	.99	1.14		-.32	.19	.27	.72		.06	.18	.76	1.06	
Gender	.16	.13	.57	1.18		-.18	.14	.39	.83		.02	.11	.87	1.02	

Notes.

* $p < .05$,

** $p < .01$.

IRR = Incident Rate Ratio; BI = Behavioral Inhibition.

^a p values represent adjusted p -values following Holm's p -value correction.