Published in final edited form as:
Dev Sci. 2011 March ; 14(2): 319–326. doi:10.1111/j.1467-7687.2010.00977.x.

Observant, Nonaggressive Temperament Predicts Theory of Mind Development

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Abstract

Temperament dimensions influence children's approach to and participation in social interactive experiences which reflect and impact children's social understandings. Therefore, temperament differences might substantially impact theory of mind development in early childhood. Using longitudinal data, we report that certain early temperament characteristics (at age 3) – lack of aggressiveness, a shy-withdrawn stance to social interaction, and social-perceptual sensitivity – predict children's more advanced theory-of-mind understanding two years later. The findings contribute to our understanding of how theory of mind develops in the formative preschool period; they may also inform debates as to the evolutionary origins of theory of mind.

Our focus is the influence of temperament on theory-of-mind development during childhood. Temperament is a large, multidimensional construct, and its relation to theory of mind (a large, multidimensional achievement) is likely to be complex and bidirectional. Our aim is more specific and hypothesis-driven, inspired by provocative new research and theory on the domestication of dogs and their resultant social-cognitive skills.

Theory of mind, broadly construed, encompasses mentalistic understandings of self and others (Harris 2006). In the human case it includes infants' understanding of intentional agents, which underpins pointing, gaze-following, proto-conversation and the like. These early skills predict later childhood understanding of how mental states – thoughts, intentions, beliefs, desires – shape people's actions (e.g., Wellman, Lopez-Duran, LaBounty, & Hamilton 2008). The demonstration of robust, early-developing theory-of-mind achievements in children worldwide – in traditional and nontraditional, western and nonwestern societies (e.g., Wellman, Cross, & Watson 2001) – has led to tremendous interest in the ontogenetic and evolutionary origins of theory of mind.

Temperament encompasses "constitutionally based individual differences in emotional, motor, and attentional reactivity and self-regulation" (Rothbart & Bates 1998, p. 109). Temperament differences, along varied dimensions of temperament, are apparent in infancy with continuity and change occurring over development. Temperament variation influences children's social interactions and social adjustment (among other things) especially in the preschool years (Rothbart & Bates 1998). Because social interactions contribute to and shape childhood theory-of-mind understandings (e.g., Astington & Baird 2005), children's social-interactive temperaments might also influence their acquisition of theory of mind. For example, because increased participation in social interactions can inform children about persons and minds, then even negative interactions (e.g., aggression) might aid children's theory-of-mind development. If so, then aggressive-externalizing temperament might positively predict later theory of mind; and shy-withdrawn temperament might negatively predict later theory of mind. Equally, however, perhaps heated, reactive social interactions (as in aggression) are negatively related to later, more sophisticated theory-of-mind understanding, whereas a shy-observant, less reactive approach to social interaction could conceivably aid children in more reflectively understanding others and, in comparison, themselves. These remain speculative possibilities because almost nothing is known about the developmental relations between theory of mind and temperament. This is our specific focus: Whether and how temperament differences predict and shape theory-of-mind understandings.

To reiterate, potential relations between temperament and theory of mind are surely complex, here we offer a more focused, hypothesis-driven initial investigation. We report developmental research with human children, but comparative research on theory-of-mind abilities in dogs inspired our initial hypotheses and specific foci. In brief, dogs are surprisingly good at reading the social and communicative signals of others (humans and conspecifics). For example, they easily read where someone points to show them food, where someone is gazing, and understand the referential meaning of various words and gestures (Hare & Tomasello, 2005; Kamininski, Call, & Fischer, 2004). Dogs do so in controlled situations where a person might walk toward one location but point to another, they avoid forbidden food when the person's eyes are open but not when closed, they interpret gaze as referential when it is directed at an object/location but not when someone is gazing off in space above that object/location (Hare, et al., 2005; Soproni, Miklósi, Topál, & Csányi, 2001). Dogs read such social-communicative intentions correctly on the first trials of novel tasks, and do so as puppies.

These skills resemble in several ways those of human infants, who correctly read points, gestures, and eye-gazes, engage in communicative interactions, and otherwise actively share intentional meanings with others by their first birthdays (Harris, 2006). These skills contrast with the inabilities of wolves and chimpanzees on similar tasks. Chimpanzees prove capable of reading others' intentions and attentional reference in situations of competition over food and resources (Hare & Tomasello, 2004), but are poor in comparison to dogs (let alone humans) in cooperative-communicative situations (Hare & Tomasello 2005; Povinelli & Eddy 1996).

In several recent papers, Hare and Tomasello (2005; Hare, 2007) argue that the human-like social-communicative skills of dogs, resembling the initial theory-of-mind capacities of human infants, represent a case of convergent evolution traceable to the domestication of dogs in their long history within human communities. Specifically, they propose a social-emotional "reactivity" temperament hypothesis whereby wild canines that were less fearful of and nonaggressive toward humans were selected by domestication processes over generations. A product of that process was dog's social-communicative capacities of a more human-like sort.

A critical piece of evidence comes from research with a rare population of domesticated foxes selectively bred on a simple criterion – whether they less fearfully and nonagressively tolerated approach and handling by humans (Belyaev, 1979). Other, control foxes continued to be bred randomly in this regard. After generations, the focal population displays little fear or aggression to humans, naturally enough, but additionally shows other signs of dog-like domestication. Crucially, fox kits from this population, tested on basic pointing and gaze following tests, were as skilled as age-matched puppies in using human social cues (Hare et

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al. 2005). Control foxes performed poorly (although as well as domesticated foxes on a non-social cognition task).

By extension, parallel or similar temperament factors might aid children in the ontogenetic achievement of theory of mind. Of course, there is a big difference between "in evolution, X caused Y" and "in ontogeny, X causes Y." Yet one can inspire hypotheses about the other. Thus, Hare and Tomasello (2005, p. 443) proposed: "One further way to test this [reactivity] hypothesis is to examine individual differences in social problem-solving with respect to temperament." In short, the relation of temperament to social reasoning is intriguing at several levels, but largely unaddressed. In the human case an important yet unexplored question concerns whether children with certain types of temperaments become more skilled than others in social understanding. Using longitudinal data, we addressed this question by examining the longitudinal predictive contribution of several specifically chosen temperament dimensions for the achievement of a key theory-of-mind milestone in the preschool years – false belief understanding. In particular, following the above reasoning we hypothesized that certain forms of social-emotional reactivity (e.g., aggressiveness) would interfere with childhood development of theory of mind, and a less reactive more observant temperament would enhance theory-of-mind understanding.

Method

Overview

Children were tested at 3.5 and again at 5.5 years. Temperament subscales measuring aggressiveness, fearfulness, shy-withdrawn characteristics, and perceptual sensitivity were our focus. The first two are directly referred to in the social-emotional reactivity hypothesis drawn from the dog research. Shyness-withdrawal is a clearly related dimension, and moreover is central to most discussions of childhood temperament. Conceivably it might influence theory-of-mind development in either of two ways. On one hand shyness-withdrawal might indicate a fearfulness of others, in which case it should hypothetically relate negatively to developing theory-of-mind insights. Alternatively, shyness-withdrawal might indicate a more quietly observant stance to human interactions, which could positively predict theory-of-mind insights. A socially observant temperament might also manifest itself as a heightened sensitivity to others' movements, voices, faces – a sensitivity encompassed in part in temperament subscales of perceptual sensitivity.

Our measure of theory of mind is a battery of false belief tasks. Explicit false belief understanding is a milestone, universal theory-of-mind achievement of the preschool years (Wellman, et al. 2001), and is the most commonly used measure in research examining individual differences in theory of mind during the preschool years (e.g., Cutting & Dunn, 1999; Hughes, et al., 2005; Perner, Ruffman, & Leekham, 1994).

If the focal social-emotional temperament measures predict later theory of mind, are they appropriately convergent and discriminate? That is, do many temperament measures predict later theory of mind, or only a focal few? And, do the focal temperament measures predict later theory-of-mind performance specifically, or non-theory-of-mind achievements as well, more indiscriminately? To address such control questions several additional temperament measures were included at 3.5 years, and several non-theory-of-mind cognition measures were included at 5.5 years.

Participants

Children participated in the first two waves of a longitudinal project investigating early behavioral development (Olson, et al., 2005). Because an initial focus of this project was the development of externalizing problems, children represented a range of externalizing symptom severity, measured by parents' response on Achenbach's (1992) Child Behavior Checklist. Children who had severe cognitive impairments or severe health problems were excluded from the study.

Of 241 children who participated in the project, 204 had data for both waves. Children who did not participate in the second wave did not differ significantly from others in terms of age, SES, IQ, or inhibitory control. Of these children, 146 (86 boys, 60 girls) had data for all focal variables analyzed in the present investigation. Compared with children who were excluded due to missing data, children in the final sample were older, $t(202) = 6.81$, $p < .001$. Average ages were 38 months (range 33–45) at Wave 1, and 70 months (range 60–80) at Wave 2.

Procedures

At Wave 1, mothers completed a series of questionnaires which included pre-validated measures of child temperament. Two years later, children participated in a laboratory session of several tasks, including ToM as well as assessments of IQ and inhibitory control (IC), a dimension of executive function that assesses developing ability to refrain from responding in various motor/attentional tasks. These are the key tasks and variables; but mothers also completed similar questionnaires at Wave 2, and children completed a similar ToM task at Wave 1 as well.

Measures

Temperament—At Wave 1, mothers completed two often-used measures of children's behavior: the Child Behavior Checklist/Ages 2–3 (CBCL/2–3; Achenbach, 1992), and the Children's Behavior Questionnaire (CBQ; Rothbart, et al. 2001). For the CBCL, mothers rate their child on 99 items that describe behavior over the prior two months, using a 3-point scale ("0" = not true; "1" = somewhat or sometimes true; "2" = very true or often true of the child). The two CBCL subscales focal for the current study concern aggressive and withdrawn behavior. The 15-item *aggressive* subscale includes items such as "Hits others," "Temper tantrums or hot temper," and "Gets in many fights." Children's scores were summed across the 15 items, $\alpha = 87$. The 14-item *withdrawn* subscale includes items such as "Avoids looking others in the eye," "Doesn't get involved with others," and "Doesn't know how to have fun, acts like a little adult." Children's scores were summed across the 14 items, $\alpha = .74$.

For the CBQ, mothers rate 141 items describing their child's reactions to various situations, using a 7-point scale (ranging from "1" = Extremely untrue, to "7" = Extremely true). The CBQ includes several validated temperament subscales, three focal to our study. The 13-item *shyness* subscale includes items like "Gets embarrassed when strangers pay a lot of attention to her/him," "Sometimes seems nervous when talking to adults s/he has just met," and "Sometimes prefers to watch rather than join other children playing" – $\alpha = 93$. The CBQ's 13-item *fearfulness* subscale includes items like "Is afraid of loud noises," "Is afraid of the dark," and "Is afraid of burglars or the 'boogie man' " – $\alpha = .72$. The 13-item *perceptual sensitivity* subscale includes items such as "Seems to notice parents' facial expressions," "Usually comments if someone has an unusual voice," and "Notices when parents wear new clothing" – $\alpha = .75$. Because they were to rate 141 items (several of which appeared redundant, e.g., "Is afraid of the dark" and "Is not afraid of the dark") mothers occasionally omitted some CBQ items. These missing items (less than 3% overall) were imputed from item means.

As expected, *shy* temperament from the CBQ and *withdrawn* behavior from the CBCL were significantly correlated ($r = 0.25$, $p < .01$). So for economy and to limit multicollinearity between predictors, we collapsed these into a composite *shy-withdrawn* measure.

Theory of mind—Because children's emerging understanding of false beliefs is a hallmark of ToM development during the preschool years, we measured ToM with false-belief tasks. These included some that require predictions and others that require explanations (Bartsch & Wellman, 1989); this combined measure, or others similar to it, have been used in many individual-difference studies of theory of mind (e.g. Cutting & Dunn, 1999; Dunn, 1995; Ruffman, et al. 2002). In brief, children were shown vignettes where the location of a desired object was switched, unknown to the story protagonist. For three false-belief prediction tasks children predicted where the protagonist would look for the object and for three false-belief explanation tasks children were shown where the protagonist did search for his/her object and asked to explain that action. A ToM summary score was computed as the number of stories (out of 3) for which the child correctly explained the protagonists' mistaken action on the basis of their false belief (e.g., by saying the protagonist thought it was in the original location, or did not know it had been switched) plus the number of stories (of 3) for which the child accurately predicted the protagonists' misguided behavior (for a maximum score of 6). (The same procedure was used at Wave 1 but with 4 prediction and 4 explanation tasks.)

Additional measures—The CBQ includes several other temperament subscales. To consider temperament differences that theoretically (given a social-emotional reactivity perspective) should *not* link to ToM understandings we focused on *activity level* ("gross motor activity, including rate and extent of locomotion") and *attentional focusing* ("capacity to maintain attentional focus upon task-related channels" (Rothbart et al., 2001, p. 1406).

At 5.5 years children also received two sets of tasks that theoretically should encompass non-social, non-ToM cognition. One was Block Design from the WPPSI-R (Wechsler, 1989) and the other were three widely-used tasks measuring inhibitory control in preschoolers – Simon Says, Red/Green Sign, and Shapes – from the Kochanska, Murray, and Coy (1997) battery. WPPSI-R Vocabulary provided an often used measure of verbal IQ; the IC tasks constituted an inhibitory control composite.

Results

Means and variances for the key variables are shown in Table 1 along with zero-order correlations between the focal four temperament variables at Wave 1 and ToM performance at Wave 2. Those correlations provide suggestive background, but a more accurate picture of the contributions of temperament to ToM is achieved via regression analyses simultaneously including all focal temperament dimensions, so that their independent associations with ToM and their combined association with ToM can be determined.

A preliminary regression showed that several focal temperament dimensions concurrently predicted false-belief understanding at Wave 1 – for aggression, $\beta = -.21$, $t(138) = -2.10$, $p < .05$, and for shy-withdrawn, $\beta = .25$, $t(138) = 2.39$, $p < .05$. In the only other study that we found measuring temperament dimensions (one measure of aggressiveness and one of shyness in 5-year-olds) along with false belief understanding, Walker (2005) also found associations between these two temperament dimensions and false-belief, but she interpreted her effects in terms of theory of mind predicting temperament rather than vice versa. Of course, direction of effects are indeterminate in concurrent relations. Thus, our focal hypotheses and analyses concern the longitudinal prediction of theory of mind from earlier temperament characteristics.

Temperament Predicts Theory of Mind

A hierarchical regression analysis assessed the overall relationship between the focal temperament factors and later theory of mind controlling for earlier theory of mind and various other influences. Wave 1 theory of mind, gender, IQ (the combination of WPPSI vocabulary and block design), and inhibitory control (average performance on the three IC tasks) were entered at step 1 followed by shyness-withdrawal, aggression, fearfulness and perceptual sensitivity at step 2. These variables significantly predicted Wave 2 ToM-- $F(8,127)=2.74$, $p<.01$—with an overall $R^2 =.15$. All of the control variables were nonsignificant with the exception of inhibitory control ($\beta = .26$, $t(131)=2.96$, $p<.01$). The temperament variables predicted significant variance beyond these controls— *Fchange(*4,131)=3.06, $p<.05$. Moreover, three of the four temperament factors significantly predicted ToM: 3-year-olds' shyness-withdrawal ($\beta = .23$, $t(127) = 2.09$, $p < .05$) and perceptual sensitivity ($\beta = .17$, $t(127) = 1.97$, $p = .05$) significantly predicted a greater understanding of the mind at age five. Fearfulness did not significantly predict ToM, but 3-year-olds' aggressiveness predicted poorer ToM at age five ($\beta = -.24$, $t(127) = 2.23$, $p < .05$).

These results rule out several alternative interpretations for the link between early temperament and later theory of mind as well as clarifying the nature of that link. For example, it is known that ToM and temperament both correlate with IQ and with inhibitory control in the preschool years (for ToM, see Carlson & Moses, 2001; for temperament, see Rothbart et al., 2001; Kagan & Snidman, 2004). But, the three focal effects – the negative relation between early aggression and later ToM and the positive effects of shyness-withdrawal and perceptual sensitivity – were significant even controlling for Wave 2 IQ and IC at step 1. Similarly, because two of the focal temperament measures also predicted ToM at Wave 1, the longitudinal results might represent concurrent association between ToM and temperament at Wave 1 coupled with longitudinal stability of ToM. But, the temperament measures predicted Wave 2 ToM beyond any influence of Wave 1 ToM.

Conceivably our results might vary by gender. For example, girls might both be less aggressive and better at ToM tasks than boys. However, boys and girls performed equally on our ToM tasks—$t(144) = 0.95$, ns—and the predictive relationships between Wave 1 temperament and Wave 2 ToM was significant after controlling for gender in this analysis.

To further characterize the focal temperament relationships we ran a simple regression assessing the unique association between each dimension of children's temperament at age 3.5 and theory of mind at age 5.5, excluding the additional control variables. (Because seven children did not have measures of IQ or IC at Wave 2, and three were missing data on Wave 1 ToM, that reduced the sample size accordingly in the initial stepwise analysis. This further analysis thus has the additional advantage of including the data of all 146 children.) Three significant effects again emerged: shyness-withdrawal ($\beta = .30$, $t(141) = 3.05$, $p < .01$), aggressiveness ($\beta = -.34$, $t(141) = -3.48$, $p < .001$) and perceptual sensitivity ($\beta = .19$, $t(141) = 2.35$, $p < .05$). Together, our four focal dimensions of temperament – shyness-withdrawal, fearfulness, aggression, and perceptual sensitivity – explained a significant proportion of variance in later theory of mind, $R^2 = .11$, $F(4, 141) = 4.47$, $p < .01$. (Significant correlations larger than +/−.30, with resultant R^2s of .09 or better, are considered moderate in size; Cohen, 1988).

Confirmatory Analyses

Additional analyses confirm and strengthen these results. First, in separate regression analyses (each regression also including aggressiveness, perceptual sensitivity, and fearfulness), both shyness from the CBQ ($\beta = .18$, $t(141) = 2.13$, $p < .05$) and withdrawn behavior from the CBCL (β = .35, $t(141) = 2.77$, $p < .01$) at age 3 predicted ToM at age 5. This confirms our results using the aggregate shyness-withdrawal measure, and moreover provides cross-instrument validity for some of our measures.

Conceivably, many temperament measures, beyond those encompassed within a social-emotional reactivity perspective, might longitudinally predict later ToM. Or conceivably, the focal temperament measures might indiscriminately predict cognitive performance at Wave 2, rather than ToM more specifically. Table 2 presents data addressing and ruling out these various alternatives. The focal temperament measurements at Wave 1 predict Wave 2 ToM but do not predict Wave 2 block design nor performance on the IC tasks. Equally important, two Wave 1 temperament dimensions that should not (theoretically) predict social cognition--attentional focusing and activity level--do not predict Wave 2 ToM, but both do predict Wave 2 block design and/or IC.

It is also worth considering the possibility that Wave 1 ToM influences Wave 2 temperament dimensions. However, when controlling for Wave 1 temperament, betas for Wave 1 ToM predicting Wave 2 temperament were not significant (for *aggression* β = .03, for *perceptual sensitivity* β = .12, and for *shyness-withdrawal* β = .02, *p*s > .10). Moreover, Wave 2 temperament did not concurrently predict Wave 2 ToM (*aggression* β = .09, *perceptual sensitivity* β = .11, *shyness-withdrawal* β = .13, *p*s > .10). Thus, in cross-lagged analyses, Wave 1 temperament predicts Wave 2 ToM but Wave 1 ToM does not predict Wave 2 temperament.

As reflected in our title, the interpretation we favor for these data is that a nonaggressive, observant-withdrawn temperament in early life predicts later theory of mind. As a further, albeit post hoc, test of this interpretation we examined all 68 items from the focal CBQ and CBCL subscales, and identified a subset of 22 that, from their written content, seemed to refer to a child as nonaggressive and/or socially observant in a withdrawn-reflective fashion. These items included ones about aggression (does not "hit others", is not "selfish, but shares", does not "get into fights") scored so as to reflect lack of aggression; ones about social withdrawal ("acts shy around new people," "prefers to watch rather than join other children playing," "doesn't talk easily to new people"); and ones about sensitivity to others ("notices when parents wear new clothing," "comments if someone has an unusual voice," "comments when a parent has changed appearance"). These 22 items formed an internally consistent ad hoc temperament composite (α = .74) that significantly predicted Wave 2 ToM, $r(146) = .33$, $p < .0001$.

Discussion

Early childhood temperament factors clearly predict children's later more advanced theory of mind. For typically developing children, the vast majority will achieve our focal theory of mind milestone – robust, explicit understanding of how actions stem from beliefs and false beliefs – by the time they are 6-years or so (Wellman et al., 2001). So more specifically, we have demonstrated that certain early childhood temperament factors predict whether children are quicker or slower to come to such theory-of-mind understandings. The specific temperament factors empirically linked to theory of mind largely reflect social-emotional reactivity. Other temperament factors (attentional focusing and activity level) do not predict later theory of mind. Moreover the social-emotional reactivity indices do not predict later non-social, non-theory-of-mind cognition.

The prediction from these temperament factors to theory of mind, while significant, is moderate, $R^2 = .11$. Complete prediction would be unexpected, because various other factors – such as children's exposure to parent-child conversation about persons (e.g., Ruffman et

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al., 2002), children's engagement in pretend play (e.g., Youngblade & Dunn, 1995), and the cultural-linguistic contexts in which children live (e.g., Liu et al., 2008) – influence preschool theory-of-mind development. We demonstrate that temperament additionally contributes to children's obtainment of theory-of-mind insights and does so significantly as well as robustly, remaining significant after IQ and inhibitory control are controlled for and after earlier theory-of-mind understandings are controlled for as well.

The nature of the temperament dimensions that emerged as predictive of theory of mind is revealing about theory-of-mind development, and may also be informative for an "emotional reactivity" hypothesis that has arisen from comparative research with dogs (Hare & Tomasello, 2005). That hypothesis suggests that, in the domestication of dogs, an important first step occurred where certain canines (that coexisted with humans, perhaps when foraging in human garbage and campsites) were selected because they were less fearful of and aggressive to humans. This domesticated temperament included as a byproduct more human-like social cognitions (probably enhanced via additional selective pressures, for example, when dogs accompanied humans during hunting or herding). Our data are generally consistent with a parallel proposal that less aggressive, less reactive and so more observant, temperament aids theory-of-mind achievement within human development.

But our more specific findings are additionally informative and force amendment or elaboration of any such hypothesis, at least as applied to human ontogenesis. In particular, nonaggressive but additionally shy-withdrawn and perceptually sensitive 3-year-olds tend to achieve more advanced theory-of-mind understandings by the time they are 5. And, in our data fearfulness made no contribution to theory of mind. Partly this may reflect that the CBQ fearfulness subscale emphasizes a generalized fearfulness (e.g., "is afraid of loud noises," and "is afraid of the dark") rather than a specific fearfulness in approaching others. Instead, as noted, our data emphasize that a shy-withdrawn temperament contributes to achieving theory-of-mind understandings. Our interpretation of this finding (as signaled earlier) is that shy-withdrawn temperament in our data captures less a *fearful*-shyness and rather a more watchful, observant withdrawal from the social fray (e.g. "sometimes prefers to watch rather than join other children playing"). Such a stance contributes to enhanced childhood social-cognitive understandings, and conversely aggressive behavior (encompassing a form of "heated", reactive social participation) negatively predicts childhood social-cognitive understanding.

Note in this regard that our theory-of-mind tasks, as is standard, do not assess children's employment of social-cognitive skills in ongoing interaction with others, but their more cognitive understanding of others' mental states and the actions those states produce. A shy-withdrawn stance to peer and adult interaction seems to benefit preschool achievement of such insights. This result is consistent with our additional finding that perceptual sensitivity (as a temperament dimension including such items as "notices parent's facial expressions" and "comments when someone has an unusual voice") also significantly contributes to children's theory-of-mind understandings.

These findings intriguingly relate to research that shows the richest parent-child conversations about emotions (referring to the causes, consequences, and connection of emotions to other mental states) occur not about current emotional upheavals but more reflectively about past emotional episodes (e.g., Dunn & Brown, 1994; Lagattuta & Wellman, 2002). An observant-reflective stance on human events might helpfully advance theory-of-mind understandings whether the stance is induced temperamentally or conversationally.

Our theory of mind focus concerns advances within the preschool years as measured by "standard" preschool false-belief tasks. Theory of mind development begins in infancy, and some recent research claims infants—at 12 to 15 months—already have an awareness that actors act on the basis of false beliefs (e.g., Onishi & Baillargeon, 2005). It is not yet clear how to best interpret these infant "false belief" findings or how to integrate them with the preschool ones. Regardless, something definite and important is happening in children's theory-of-mind understandings in the preschool years. Variability in false-belief understanding as measured in the preschool years predicts several key childhood competences, such as how and how much children talk about people in everyday conversation, their engagement in pretense, their social interactional skills and consequently their interactions with and popularity with peers (Astington & Jenkins 1995; Lalonde & Chandler 1995; Watson, Nixon, Wilson & Canage, 1999) and that variability overlaps with but is distinctively different from executive function and IQ advances during the preschool years (e.g., our data; Carlson & Moses 2001). Such findings confirm theory of mind's significance and relevance during the preschool years as indexed by preschool false-belief tasks. Our data now show that these important preschool theory-of-mind understandings are influenced by specific temperament characteristics.

Temperament itself, and particularly aggressive and shy-withdrawn behavior, undoubtedly have a neurohormonal substrate (e.g., Kagan & Snidman, 2004). And domesticated foxes evidence related neurohormonal changes in comparison to their undomesticated counterparts (Belyaev, 1979). Thus phylogenetically, human theory of mind might depend in part on "domestication" of the human neurohormonal, stress-related system that mediates interaction with conspecifics (Hare & Tomasello, 2005). At the same time, the findings we report suggest important cognitive and social-interactive mechanisms through which temperament might influence theory of mind in human childhood. A nonaggressive, observant-reflective stance on social interactions could certainly provide enhanced opportunities for coming to understand how actions and expressions are shaped by persons' underlying mental states. The immediate fray of social interaction might often be a relatively more difficult arena for children to extract such regularities, because in online interactions (especially aggressive ones) overt behavior and emotion themselves can loom so large. This speculation now seems worthy of future research. Neither this speculation nor our findings should be taken to downplay the documented debilitating effects of extreme shyly-withdrawn or socially-fearful behavior (Kagan & Snidman, 2004).

In sum, specific early temperament characteristics – lack of aggressiveness, a shy-withdrawn stance to interacting with others, and perceptual sensitivity – predict children's more advanced theory-of-mind understanding later in the preschool years. These findings certainly contribute to our understanding of how theory of mind develops in the formative preschool period, and may also contribute to comparative-evolutionary debates as to the distinctive character and evolutionary origins of human theory of mind.

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Table 1

Descriptive Statistics and Zero-order Correlations

	M	(SD)	3 Range	Correlation to Wave 2 ToM
Wave 1 ToM	1.65	(2.08)	0 – 8	
Wave 2 ToM	4.13	(1.80)	0 – 6	
Wave 1 Aggressiveness	8.95	(5.37)	0 – 24	−.16 [1]
Wave 1 Fearfulness	46.77	(10.82)	20 – 76	.07
Wave 1 Perceptual Sensitivity	64.29	(9.81)	32 – 89	.16[1]
Wave 1 Shyness	46.55	(16.01)	13 – 88	.14[1]
Wave 1 Withdrawal	3.57	(2.81)	0 – 13	.02

Note. $n = 146$, except for Wave 1 ToM for which n = 143.

[1] $p \leq .08$

Table 2

Wave 1 Temperament Dimensions Predicting Social-Cognition (Wave 2 ToM)) and Non-social Cognition (Wave 2 Block Design and IC)

Wave 1 Temperament	**Wave 2 ToM (*n* = 143)**	**Wave 2 Block Design (*n* = 130)**	**Wave 2 IC (*n* = 145)**
Shy-Withdrawn[a]	.268*	−.052	.056
Perceptual Sensitivity[a]	.186*	−.098	.077
Aggressiveness[a]	−.297**	−.111	−.086
Fearfulness[a]	.004	−.038	−.114
Attentional Focusing	.052	.221*	.298**
Activity Level	−.062	−.142	−.238*

Note. The above coefficients are standardized betas.

[a]These variables were entered into regressions simultaneously. For regressions predicting Wave 2 ToM, the beta represents the relationship between Wave 1 temperament dimensions and Wave 2 ToM while controlling for Wave 1 ToM.

*$p < .05$,

**$p < .01$.