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The Development of Executive Functioning and Theory of Mind:

A Comparison of Chinese and U.S. Preschoolers

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Abstract

Preschoolers' theory-of-mind development follows a similar age trajectory across many cultures. To determine whether these similarities are related to similar underlying ontogenetic processes, we examined whether the relation between theory of mind and executive function commonly found among U.S. preschoolers is also present among Chinese preschoolers. Preschoolers from Beijing, China (N = 109), were administered theory-of-mind and executive-functioning tasks, and their performance was compared with that of a previously studied sample of U.S. preschoolers (N = 107). The Chinese preschoolers out-performed their U.S. counterparts on all measures of executive functioning, but were not similarly advanced in theory-of-mind reasoning. Nonetheless, individual differences in executive functioning predicted theory of mind for children in both cultures. Thus, the relation between executive functioning and theory of mind is robust across two disparate cultures. These findings shed light on why executive functioning is important for theory-of-mind development.

Over the preschool years, children's understanding of their own and other individuals' mental states—that is, their *theory of mind*—goes though an important transition that is often indexed by their emerging understanding of false belief (Wellman, Cross, & Watson, 2001). Recent findings show considerable cross-cultural synchrony in the age at which children gain facility with false-belief reasoning (Callaghan et al., 2005). It is not clear, however, whether this cross-cultural developmental synchrony can be attributed to universal developmental processes.

Within Western cultures, several factors have been shown to affect the developmental timetable of false-belief and related theory-of-mind concepts. One factor believed to be particularly important is executive functioning (Carlson & Moses, 2001; Moses, 2001; Perner & Lang, 1999). Several studies of Western children have shown that their performance on false-belief and other theory-of-mind tasks can be predicted from tasks that tap executive-functioning skills such as response inhibition, cognitive conflict resolution, and working memory (Carlson, Moses, & Hix, 1998; Davis & Pratt, 1995; Frye, Zelazo, & Palfai, 1995; Hughes, 1998; Perner & Lang, 2000). These relations typically persist even when factors such as age and verbal ability are controlled. To begin to assess whether this

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developmental pathway might be universal, we examined whether the relation between executive function and theory of mind also holds in children from Beijing, China.

This population is of theoretical interest because there are reasons to believe that Chinese preschoolers may show more mature patterns of executive functioning than U.S. preschoolers. First, cultural psychologists have noted that Chinese parents expect children as young as 2 years old to master impulse control, whereas U.S. parents do not expect such mastery until the preschool years (Chen et al., 1998; Ho, 1994; Wu, 1996). Impulse control is also more highly valued and encouraged in Chinese preschool settings than in U.S. preschool settings (Tobin, Wu, & Davidson, 1989). Thus, Chinese children may have many culturally defined opportunities to exercise and practice executive-functioning skills. A second line of evidence comes from the fields of genetic medicine and population genetics. The 7-repeat allele of the dopamine receptor gene (DRD4) has been associated with attention-deficit hyperactivity disorder (ADHD; Faraone, Doyle, Mick, & Biederman, 2001; Swanson et al., 1998). Phenotypically, ADHD is associated with poor performance on executive-function tasks (Schachar, Tannock, Marriott, & Logan, 1995). Intriguingly, the 7-repeat allele is very rare in East and South Asia (including China), having a population prevalence of just 1.9%, compared with 48.3% in the Americas (Chang, Kidd, Kivak, Pakstis, & Kidd, 1996). For these reasons, then, Chinese children may have an advantage in executive functioning.

We are aware of no studies in which Chinese and U.S. preschoolers' executive-functioning skills have been compared directly. Thus, an important question addressed in the present study is whether executive functioning is indeed advanced in Chinese relative to U.S. preschoolers, and, if so, whether a relation between executive functioning and theory of mind exists for Chinese preschoolers despite this difference.

A Chinese-U.S. comparison may also help resolve the debate concerning two competing explanations of the relation between theory of mind and executive functioning (see Moses, 2001). According to the *expression* account, children who fail false-belief tasks do so not because they lack an understanding of false belief, but because of the peripheral executive demands that these tasks pose. For instance, to answer a false-belief test question correctly, children have to inhibit a prepotent tendency to report the true state of affairs and instead focus on an abstract, nonobvious mental state, all the while holding in mind the events that have transpired. According to this account, as children's executive skills develop sufficiently to negotiate these critical task demands, they are able to express their otherwise latent theory-of-mind understanding (see, e.g., Carlson et al., 1998).

An alternative account is that executive functioning may be necessary for the very emergence of children's theory-of-mind concepts. Mental states are abstract entities whose relations to the world are not immediately transparent, particularly when the mental states do not correspond with reality (as in false-belief tasks). Research has suggested that exposure to opportunities for reflecting on the discrepancy between mental states and reality is important for theory-of-mind development (Brown, Donelan-McCall, & Dunn, 1996). Developmental gains in executive functioning may provide children with improved abilities to both engage in and capitalize on these everyday experiences. Note that this account holds that domain-general executive skills might be necessary but not sufficient for the emergence of theory-of-mind concepts; exposure to relevant experiences is also crucial (Moses, Carlson, & Sabbagh, 2004).

According to the expression hypothesis, as children's executive-functioning skills increase, so too should their ability to negotiate the peripheral cognitive demands associated with theory-of-mind tasks. If Chinese children are advanced in executive functioning relative to

U.S. children, the expression account predicts that these advances would lead to a similar cross-cultural advantage in theory-of-mind development. Although previous research has shown a similar trajectory of theory-of-mind development in mainland Chinese and U.S. preschoolers (e.g., Lee, Olson, & Torrance, 1999; see Liu, Wellman, Tardif, & Sabbagh, 2004, for a review), most of these studies have relied on limited sample sizes and a restricted battery of measures. These limitations may have obscured small but significant cross-cultural differences.

Carlson and Moses (2001) conducted one of the most definitive studies establishing the relation between executive skills and theory-of-mind development in U.S. children. To meet the goals of our study, we collected data from a sample of Chinese preschoolers using the same relevant tasks as Carlson and Moses, administering the tasks in the same manner. These Chinese data were then compared with the U.S. data collected by Carlson and Moses to determine (a) if the ontogenetic relation between executive functioning and theory of mind found in the United States also holds in China, and (b) whether possible cross-cultural differences in performance on executive-functioning tasks predict cross-cultural differences in theory-of-mind development. Answering these questions will help inform a cross-culturally valid theoretical account of the relation between executive functioning and theory of mind.

METHOD

Participants

Participants were 109 preschoolers (59 boys) from Beijing, China, ages 36 to 59 months (M = 48.28 months, SD = 6.78). Children's ages were calculated to the day from birth records provided to the preschool where the children were tested. Because of the “one child” policy in China, all the Chinese children had no siblings. Although no systematic demographic data were collected, the preschool serviced a middle-class urban neighborhood in Beijing.

The U.S. comparison group (Carlson & Moses, 2001) consisted of 107 children (51 boys) ages 36 to 59 months (M = 47.36 months, SD = 5.34). The slight differences between the two samples in age and sex distribution were not statistically significant. The U.S. participants had zero to five siblings (M = 1.32, SD = 0.94) and were drawn from a predominantly White, middle-class university community in the Pacific Northwest.

For many analyses, the combined samples were split into three roughly equal-sized age groups: (a) 3.5-year-olds (n = 72; range: 36–44 months, M = 41.15), (b) 4-year-olds (n = 76; range = 45–51 months, M = 47.38), and (c) 4.5-year-olds (n = 68; range = 52–59 months, M = 55.38). All the children were monolingual in either Mandarin Chinese or English.

Procedure

Full details of the procedure can be found in Carlson and Moses (2001). Here, we provide a brief description of each task and how it was scored.

Children in both countries were tested individually in two videotaped sessions that lasted approximately 45 min and were about a week apart. U.S. children were tested in a playroom in an on-campus laboratory, and Chinese children were tested in a quiet room in their preschool. The measures consisted of a test of verbal ability, five theory-of-mind tasks, and seven executive-functioning tasks. The order of tasks in each session was fixed and the same for both samples (see Table 1).

Measures

Verbal Ability—Verbal ability was measured with the Peabody Picture Vocabulary Test–Revised (Dunn & Dunn, 1981) in the U.S. group and with the core vocabulary scale of the Wechsler Preschool and Primary Scale of Intelligence–Revised (Wechsler, 1989) in the Chinese group. Because different measures were used for the two groups, raw scores from each measure were converted to age equivalents using U.S. norms. We used a single standard to ensure that potential population differences in verbal ability would not be muted by using culturally defined age equivalents.

False-Belief Battery

Location False-Belief Tasks: In one task (Wimmer & Perner, 1983), children were asked where a puppet thought his ball was, after it was moved in his absence. The second task was an "explicit" version (Wellman & Bartsch, 1988) in which children were told that a boy thought a cat was in one place although it was really in another and were then asked where the boy would look for the cat. The score for location false belief was the total correct from both tasks (0–2).

Contents False-Belief Task: For this task (Gopnik & Astington, 1988), the children were shown that a familiar box had unfamiliar contents and then were asked (a) what they had thought was inside before the box was opened and (b) what someone else who had not seen the contents would think was inside (score: 0–2).

Deceptive-Pointing Task: For this task (Carlson et al., 1998), children were instructed to trick an experimenter about an object's location by pointing to an alternative location. Two trials were administered (score: 0–2).

Appearance-Reality Task: On each trial of the appearance-reality task (Flavell, Green, & Flavell, 1986), the children were shown an object that looked like one thing but was revealed to be another (e.g., a sponge that looked like a rock). They were then asked again what the object looked like and what it really was. Two trials were administered (score: 0–2).

Executive-Function Battery

Day/Night Stroop Task: For 16 trials of the day/night Stroop task (Gerstadt, Hong, & Diamond, 1994), the children were instructed to say "day" when they saw a picture of a moon and "night" when they saw a picture of a sun. The score was the proportion correct.

Grass/Snow Stroop Task: For 16 trials of the grass/snow Stroop task (Carlson & Moses, 2001), the children were instructed to point to a green color chip when the experimenter said the word "snow" and to a white color chip when the experimenter said "grass." The score was the proportion correct.

Bear/Dragon Task: For this task (Reed, Pien, & Rothbart, 1984), the children were instructed to do what they were told by the nice bear (e.g., "touch your nose"), but not to do what they were told by the mean dragon. In China, this task was recast as the panda/lion task because of positive cultural associations with dragons. Children were scored for extent of compliance (0–3) on five dragon (or lion) trials (range: 0–15).

Dimensional-Change Card Sort: For this task (Frye et al., 1995), the children were instructed to sort cards that varied on two dimensions. First they were asked to sort according to one criterion (shape), and then they were asked to sort by a different criterion

(color). The score was the number of correct postswitch sorts that clearly indicated the child was following the new rule (range: 0–3).

Tower-Building Tas: For this task (Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996), the children were asked to help the experimenter build a tower with cubic wooden blocks by alternating turns in placing the blocks. There were two trials, and the children were scored on the average proportion of blocks placed by the experimenter (range: 0–.5).

KRISP (Kansas Reflection-Impulsivity Scale for Preschoolers): On each trial of this measure (Wright, 1971), the children were shown a target picture and then asked to identify an exact match to the target from an array of four to six similar pictures. Ten trials were administered, and the children were scored on the number of correct responses (range: 0–10).

Whisper Task: For this task (Kochanska et al., 1996), the children were sequentially shown pictures of familiar and unfamiliar cartoon characters and asked to whisper the characters' names. The score was the average quality of whisper (0 = regular speaking, 1 = mixed voice, 2 = whisper) in response to known characters (range: 0–2).

Task Translation—Cross-cultural comparisons are most valid when the protocols are as similar as possible (e.g., Callaghan et al., 2005). The English-language scripts used by Carlson and Moses (2001) were first translated into Mandarin Chinese by two native Mandarin speakers who were certified by the Chinese government as fluent and literate in English as a second language. The translations were then back-translated to English by another Chinese-English bilingual speaker. Two native English speakers unfamiliar with Mandarin then compared the back-translations with the original English-language scripts, to check for accuracy. Substantive differences (i.e., true changes in meaning) were rectified through discussion, and the resulting translated scripts were used to administer the tasks. For all translations of false-belief tasks, the Mandarin term *yiwei* was used for the English term *think*, because it is most often used to denote a belief that might be false (Lee et al., 1999).

RESULTS

Dependent measures from all tasks were standardized across the entire data set, collapsing across country and age. All analyses were performed on the standardized data.

Preliminary Analyses

The verbal mental ages of the Chinese and U.S. samples were nearly identical (U.S.: M = 54.02 months, SD = 11.74; Chinese: M = 53.47 months, SD = 11.74). Thus, verbal ability was not included in analyses that involved cross-cultural comparisons. However, verbal ability was retained as a control in the within-culture analyses investigating the relation between executive functioning and theory of mind.

Preliminary Age × Country × Sex analyses of variance (ANOVAs) showed that sex was a significant or near-significant predictor of performance on many of the tasks. Girls tended to outperform boys on the theory-of-mind and executive-functioning tasks. Sex did not interact with age or country in any of these analyses. Nonetheless, we included sex as a covariate in our analyses to ensure that main effects of country or age could not be attributed to, or obscured by, effects of sex.

Executive-Functioning Analysis

A 3 (age) × 2 (country) multivariate analysis of covariance (MANCOVA) with the standardized scores from the executive-functioning tasks as the dependent measures and sex as a covariate revealed a significant main effect of age, $F(14, 388) = 5.65$, $p < .01$, $\eta^2 = .34$, and a significant main effect of country, $F(7, 193) = 4.32$, $p < .01$, $\eta^2 = .14$. The Age × Country interaction was not significant. The main effects of age and country for each of the executive-functioning tasks are illustrated in Figure 1. Follow-up univariate Age × Country analyses of covariance (ANCOVAs; see Table 2) showed that children's performance improved significantly with age in all tasks except the whisper and day/night Stroop tasks, and Chinese children significantly outperformed U.S. children on all seven of the executive-functioning tasks.

Executive-functioning measures collapsed across country formed a reliable scale (Cronbach's $\alpha = .73$). Thus, we averaged the standardized scores from the seven measures to form a single executive-functioning aggregate. An Age × Country ANCOVA with the aggregate as the dependent measure powerfully captured the principal findings from the tests involving the single tasks (see Fig. 1 and Table 2). Perhaps most striking was that in the aggregate, Chinese children's performance was consistently on par with that of U.S. children who were on average 6 months older.

Theory-of-Mind Analysis

A 3 (age) × 2 (country) MANCOVA with standardized performance on the five false-belief tasks as dependent measures and sex as a covariate showed a significant main effect of age, $F(8, 412) = 10.34$, $p < .01$, $\eta^2 = .31$, but no significant main effect of country, $F(4, 205) = 1.02$, n.s. The Age × Country interaction was also not significant. The effects for each theory-of-mind task are summarized in Figure 2. Follow-up univariate Age × Country ANCOVAs (see Table 2) showed a uniformly robust age effect, and no task showed a significant main effect of country. Thus, despite the Chinese preschoolers' advantage in executive functioning, we found no evidence that they were different from their U.S. counterparts in theory-of-mind reasoning.

The theory-of-mind measures formed a reliable scale (Cronbach's $\alpha = .74$), and the standardized measures were averaged to form one aggregate. An Age × Country ANCOVA corroborated the findings from the MANCOVA and the individual-task ANCOVAs (see Fig. 2 and Table 2). Even with the potentially more sensitive aggregate measure, we found no evidence for a Chinese advantage in theory-of-mind reasoning.

Relations Between Executive Functioning and Theory of Mind

Our final question concerned whether the relation between theory-of-mind reasoning and executive function would hold for Chinese preschoolers, as well as U.S. preschoolers. We found that both in raw correlations and in partial correlations controlling for age, sex, and verbal ability, the executive-function aggregate measure was related to the theory-of-mind measure in the U.S. sample, $r(99) = .63$, $p < .001$, and $r_{partial}(96) = .386$, $p < .001$, and in the Chinese sample, $r(103) = .59$, $p < .001$, and $r_{partial}(99) = .393$, $p < .001$. Thus, despite the cross-cultural differences in the development of executive functioning, the ontogenetic relation between executive functioning and theory of mind was robust and virtually identical across the two cultures.

DISCUSSION

Earlier studies have consistently found a relation between executive functioning and theory of mind in Western cultures. The findings from the current study clearly demonstrate for the

first time that this ontogenetic link is also present in Chinese preschoolers. This generalization is particularly striking given that the Chinese children demonstrated more mature levels of executive functioning than their U.S. counterparts. This finding suggests that some of the underlying processes that contribute to the development of preschoolers' theory of mind are similar across cultures.

Cross-Cultural Differences in Executive Functioning

Chinese preschoolers' performance on executive-functioning tasks was clearly advanced relative to that of their age-matched U.S. counterparts. Given that the Chinese and U.S. preschoolers showed no differences in their verbal ability or their theory-of-mind scores, these findings suggest that Chinese children may be specifically advanced in executive functioning. As noted previously, this advantage may stem from both sociocultural and genetic factors.

Before drawing a strong conclusion on Chinese-U.S. differences in executive functioning, it is important to consider whether the tasks used truly imposed the same executive demands across the two cultures. Our battery measured executive functioning by requiring children to inhibit prepotent or dominant responses (Carlson & Moses, 2001). Of course, we cannot be entirely sure that the prepotency of the responses required in these tasks was psychometrically equivalent across cultures. However, it seems likely that most of the executive demands—including inhibiting the prepotent associations tested in the Stroop-like tasks (e.g., the association between sun and day in the day/night Stroop task), inhibiting the use of one rule to follow a different one in the card-sort task, and inhibiting the tendency to do what one is told in the bear/dragon task—would be applicable across cultures. Moreover, the fact that all the tasks showed a significant main effect of culture gives us some reason to believe that the observed advantage in executive functioning is not an artifact of task bias somehow providing an advantage to the Chinese preschoolers.

No Cross-Cultural Differences in Theory of Mind

The second clear finding was that there were no cross-cultural differences in performance on the battery of theory-of-mind tasks. This finding is consistent with the results of previous research comparing Mainland Chinese with U.S. preschoolers in theory-of-mind development (Lee et al., 1999; Liu et al., 2004). More generally, these findings are consistent with those showing that children from multiple cultures typically show more similarities than differences when tested with appropriately designed theory-of-mind tasks (Callaghan et al., 2005). Indeed, the present study provides added weight to these findings through the use of a large sample size and a relatively large battery of tasks. Given these improvements over previous research, and the similar findings, it seems unlikely that the failure to find a cross-cultural difference in theory-of-mind development can be attributed to problems of tasks, measurement, or statistical power.

Relation Between Executive Functioning and Theory of Mind

The finding that Chinese children's advances in executive functioning were not mirrored by similar advances in theory of mind has important implications for explaining the relation between executive function and theory of mind. In particular, the expression account predicts that as children's executive skills become sufficient to enable them to negotiate the executive demands inherent in theory-of-mind tasks, children should be able to express their latent knowledge. However, this was clearly not the case for the Chinese children in the present study, who showed advanced abilities at inhibiting prepotent responses in the executive-function tasks, but no similar advantage on theory-of-mind tasks.

Perhaps the most compelling demonstration of this general point comes from a cross-cultural comparison of the performance of the two younger age groups. Four-year-old U.S. preschoolers showed strong performance on theory-of-mind tasks, thereby demonstrating that they had the executive skills necessary to express their theory-of-mind concepts. However, 3.5-year-old Chinese preschoolers had executive skills on par with the U.S. 4-year-olds, and yet still showed poor theory-of-mind performance. Clearly, attaining a particular level of executive functioning was not by itself sufficient to yield strong theory-of-mind performance. These findings join others in showing that the relation between executive functioning and theory-of-mind development is unlikely attributable to the executive demands posed by theory-of-mind tasks (e.g., Perner, Lang, & Kloo, 2002).

Nonetheless, the robust cross-cultural correlations suggest that there is an integral ontogenetic relation between executive functioning and theory of mind. This finding poses a puzzle: Why does advanced executive functioning predict advanced theory of mind within a culture, but not between cultures? We believe that one possible answer lies in the emergence hypothesis outlined earlier. According to this hypothesis, domain-general executive-functioning skills enable children to more fully capitalize on domain-specific experiential factors to foster the conceptual developments necessary for theory of mind. Accordingly, it may be that despite their superior executive skills relative to U.S. children, Chinese children did not show an advance in theory of mind because they have less exposure to the kinds of experiential factors that have been shown to be important for theory-of-mind development. Nonetheless, because the domain-general executive factors interact with domain-specific experiential factors within each culture, individual differences in executive functioning predict individual differences in theory of mind.

One relevant experiential factor known to differ between the United States and China is number of siblings. Studies have shown that preschoolers' theory-of-mind performance can be predicted by the number of older siblings living in their household (e.g., Ruffman, Perner, Naito, Parkin, & Clements, 1998). Although the precise mechanism by which this effect occurs is not fully understood, most researchers believe that siblings provide an opportunity for young children to discuss other individuals' mental states (Brown et al., 1996). If so, Chinese preschoolers, who by law have no siblings, may have fewer opportunities to have discussions about mental states than their U.S. counterparts. Unfortunately, a comparison of Chinese preschoolers with U.S. singletons was not possible in the current study because there were only 12 U.S. singletons in our sample. Nonetheless, this potential experiential difference may explain, at least in part, why Chinese children are not advanced in theory of mind even though they have superior executive skills. More generally, answering the question of how executive functioning interacts with experience in determining the course of theory-of-mind development is a crucial next step in understanding the ontogeny of this foundational social skill.

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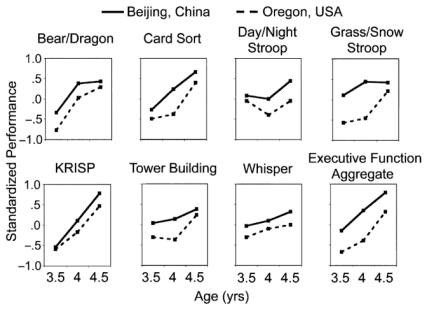

Fig. 1.

Chinese and U.S. preschoolers' standardized performance on the executive-function tasks, by age. Performance is graphed separately for each of the seven tasks, as well as the aggregate executive-function score. KRISP = Kansas Reflection-Impulsivity Scale for Preschoolers.

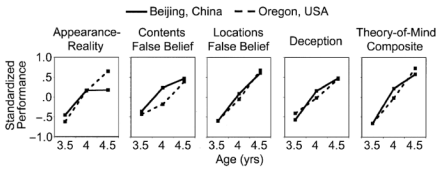

Fig. 2.

Chinese and U.S. preschoolers' standardized performance on the theory-of-mind tasks, by age. Performance is graphed separately for each of the four kinds of tasks, as well as the aggregate theory-of-mind score.

TABLE 1

Order of the Tasks in Each Testing Session

Session 1	Session 2
Language measure	Contents false belief
Day/night Stroop	Kansas Reflection-Impulsivity Scale for Preschoolers
Location false belief (standard)	Mental-state control (location)[b]
Pinball[a]	Bear/dragon
Mental-state control (contents)[b]	Deceptive pointing
	Tower building
Card sort	Motor sequencing[b]
Appearance-reality	Whisper
Gift delay[c]	Location false belief (explicit)
Pretend actions[b]	
Grass/snow Stroop	

[a]The pinball task was administered but excluded from analyses because a digital timer installed in the apparatus was damaged in transit from the United States to China.

[b]The mental-state-control tasks, pretend-actions task, and motor-sequencing task (all control tasks) were administered to the Chinese children to ensure cross-cultural procedural similarities, but analyses involving these tasks are not presented here.

[c]For the gift-delay task, children sat with their back turned to an experimenter, who was noisily wrapping a gift. The children were told not to peek. Because of cross-cultural differences surrounding the pragmatics and custom of gift giving (Hua, Wei, & Yuan, 2000), it seemed likely that the executive-functioning demands of this task were not well matched across cultures. Thus, the data from this task were not included.

TABLE 2

Summary of Age × Country Analyses of Covariance for the Executive-Function and Theory-of-Mind Tasks

Task	*MSE* (*df*)	*F*		
		Age (*df* = 2)	Country (*df* = 1)	Age × Country (*df* = 2)
Executive function				
Bear/dragon	0.83 (208)	19.13**	6.39**	0.42
Card sort	0.86 (209)	16.47**	7.53**	1.05
Day/night Stroop	0.95 (204)	2.68†	6.66**	0.64
Grass/snow Stroop	0.85 (206)	5.28**	22.44**	2.38
KRISP	0.73 (207)	30.06**	4.15*	0.62
Tower building	0.93 (209)	4.18*	6.55**	0.60
Whisper	0.98 (207)	1.71	3.82*	0.07
Aggregate	0.74 (207)	20.29**	21.70**	0.47
Theory of mind				
Appearance-reality	0.84 (209)	18.62**	0.42	1.92
Contents false belief	0.85 (208)	11.86**	2.87†	0.43
Location false belief	0.76 (209)	32.87**	0.06	0.27
Deceptive pointing	0.87 (209)	17.60**	0.03	0.62
Aggregate	0.71 (208)	38.69**	0.22	0.41

Note. KRISP = Kansas Reflection-Impulsivity Scale for Preschoolers.

† $p < .10$.

* $p < .05$.

** $p < .01$.