



PAPER

Introspection on uncertainty and judicious help-seeking during the preschool years

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Abstract

Little is known about the mechanisms underlying a ubiquitous behavior in preschoolers, help-seeking. We tested the hypothesis that preschoolers' awareness of their own uncertainty is associated with help-seeking. Three-, 4-, and 5-year-olds ($N = 125$) completed a perceptual identification task twice: once independently and once when they could request help from a confederate whose competence level was manipulated. Consistent with our hypothesis, participants sought help more frequently on trials for which, when required to answer independently, they expressed lower confidence. Children in the bad-helper condition were slower to respond after receiving help than those in the good-helper condition. Finally, females and children with more advanced theory of mind were more likely to seek help, identifying additional factors that relate to help-seeking.

Research highlights

- Preschoolers as young as 3 years report being more certain when they provide accurate compared to inaccurate responses.
- Preschoolers' uncertainty relates to their decisions to seek help.

Introduction

Help-seeking is a ubiquitous behavior in early childhood. Young children routinely ask for help when faced with physical or mental obstacles (Benenson & Koulazarian, 2008; Honig & Wittmer, 1985; Stipek, Recchia, McCintic & Lewis, 1992). Yet, little is known about the mechanisms driving this behavior during the preschool years. Identification of these mechanisms is important since effective help-seeking is critical to strategic learning (Ames, 1983; Nelson-Le Gall, 1985; Newman, 1991, 1994, 1998).

Many factors might influence young children's help-seeking (e.g. they may think that a shared experience is more enjoyable or inclusive). The main goal of the present

research was to examine the relation between preschoolers' help-seeking behavior and their ability to introspect on their own uncertainty. It has been proposed that awareness of ignorance or uncertainty may support bids for help in formal education settings (Nelson-Le Gall, Kratzer, Jones & DeCooke, 1990), but even younger children seem to respond to uncertainty. For example, infants are more likely to follow parental instruction (Tamis-LeMonda, Adolph, Lobo, Karasik, Ishak *et al.*, 2008) and preschoolers engage in heightened social imitation (Miller & Thelen, 1986) when faced with uncertain outcomes. The present research builds on these findings and uses a metacognitive framework to directly examine the connection between awareness of uncertainty and help-seeking in preschool-aged children.

Introspection on uncertainty and help-seeking: a metacognitive approach

The metacognitive framework (Flavell, 1979) distinguishes between metacognitive monitoring (i.e. introspection on one's own cognitive processes) and metacognitive control (i.e. strategic regulation of behavior to optimize

cognitive performance; Nelson & Narens, 1990, 1994). Paradigms based on this framework are particularly useful when studying young children's introspections as they typically elicit discrete cognitive acts (e.g. perceptual or mnemonic decisions) and specific introspective judgments about them (e.g. assessing uncertainty about response accuracy). This is preferable to requiring that young children respond to open-ended questions about their mental states, which may be constrained by verbal ability in early childhood. These judgments are then related to subsequent behavior, such as withdrawing answers (Krebs & Roebbers, 2010) or opting out of responding (Lyons & Ghetti, 2013; Marazita & Merriam, 2004), to draw inferences about whether young children act on the basis of their introspective judgments.

Metacognitive research with preschoolers has demonstrated that even young children are conscious of their ongoing mental states and, in some contexts, behave strategically in response to their introspections. Three-, 4-, and 5-year-olds report greater subjective uncertainty for inaccurate versus accurate responses on perceptual and lexical identification tasks (Ghetti, Hembacher & Coughlin, 2013; Lyons & Ghetti, 2011, 2013; see also Cherney, 2003, for similar conclusions in a naturalistic setting). Furthermore, their feelings of uncertainty appear to underlie some behaviors indicating a strategic regulation of accuracy. For example, Lyons and Ghetti (2013) had 3-, 4-, and 5-year-olds complete a perceptual identification task in two sessions. In a forced-report session, participants were required to respond on each trial (which involved identifying a target object in one of two degraded images). Confidence judgments were then elicited for each selection. In a free-report session, test trials were identical to the forced-report session with the exception that participants could select an 'I-don't-want-to-pick' option if they did not want to commit to an answer. Results indicated that preschoolers were more likely to skip trials for which, when forced to respond during their forced-report session, they had reported feeling uncertain. This effect was statistically reliable in 3-year-olds, but was more robust in older preschoolers, indicating an age-related strengthening of the connection between introspection on uncertainty and decision-making. The judicious withholding of uncertain perceptual decisions resulted in improvements in accuracy from the forced-report to the free-report session. Together, this research demonstrates that preschoolers monitor their uncertainty and engage in forms of strategic behavior in response to their introspections. However, as noted, it has yet to be examined whether uncertainty monitoring is similarly connected to help-seeking during early childhood. The goal of the present research is to begin to examine this possibility.

Prior research has demonstrated that young children are surprisingly sophisticated when it comes to their help-related behaviors. A preference for helpers over non-helpers has been reported during infancy (Hamlin, Wynn & Bloom, 2007; but see Scarf, Imuta, Colombo, & Hayne, 2012), and even 2-year-olds actively help individuals who appear uncertain or unable (Beier, Over & Carpenter, 2014). Furthermore, preschoolers tend to ask for help when they need it (Nelson-Le Gall & Gumerman, 1984) and from competent adults (Edwards & Lewis, 1979; Pasquini, Corriveau, Koenig & Harris, 2007). These latter findings suggest that preschoolers are aware that levels of knowledge are relevant in the pursuit of new information. This, and the fact that they use uncertainty monitoring to guide their behavior in other scenarios (Lyons & Ghetti, 2013), raises the possibility that uncertainty monitoring may also relate to their decisions to seek help. An empirical demonstration of this possibility is important because seemingly judicious help-seeking behaviors may still be independent of introspective acts. For example, young children could simply observe and then learn the association between failing to achieve a goal and subsequent requests for help.

A secondary goal of the present research was to examine other factors that may influence children's help-seeking decisions, such as their perceptions of available help. An increasingly vast literature demonstrates that preschoolers prefer to learn from reliable compared to ignorant sources. For example, 3- to 5-year-olds are more likely to accept a statement that contradicts their belief when that statement comes from a knowledgeable informant (Robinson & Whitcombe, 2003). Young children are also less likely to trust a speaker when s/he engages in behaviors suggesting uncertainty (Jaswal & Malone, 2007), and even 3-year-olds display selective trust in knowledgeable versus ignorant informants (Koenig & Harris, 2005; Pasquini *et al.*, 2007). Interestingly, the majority of studies that show an emerging ability to assess informant competence in preschoolers have used paradigms in which a less-competent informant was directly contrasted with a more-competent informant within subjects (e.g. Jaswal & Neely, 2006; Koenig, 2012; Koenig & Harris, 2005). This is noteworthy because direct comparisons between more- and less-competent informants may highlight differences in knowledge levels resulting in relative competence judgments. However, in the real world, young children may not always have the opportunity to observe multiple knowledge levels; they may have to determine whether to ask an informant (e.g. a teacher) for help based on what they know about that informant alone, resulting in an absolute, not a relative, competence assessment. In a study that required absolute competence assessments, Jaswal and Malone (2007)

found that 3-year-olds who experienced a confident-seeming informant were more likely to accept information from that informant compared to children who experienced an unconfident-seeming informant. This suggests that young children are able to make absolute competence assessments at least in response to expressions of confidence. The present research examines children's ability to make an absolute assessment based on a helper's accuracy history, and also asks whether children's assessments of their own uncertainty might interact with the perceived competence of an available helper.

A final question concerns individual variables that may be associated with the propensity to seek help. Although our central hypothesis is that uncertainty monitoring will relate to the selection of individual trials for which help is requested, there may be additional variables that influence an overall propensity to ask for help. Here, we asked whether a general understanding that people can hold diverse or false beliefs about a reality (i.e. theory of mind; Wellman, Cross & Watson, 2001) may be associated with an increased tendency to ask for help; a more sophisticated understanding of these principles may result in increased awareness that a helper may have additional knowledge that is unavailable to the child. To date, no study has examined the association between children's conceptual understanding of mind and their help-seeking behaviors.

The present study

The main goal of the present study was to examine whether introspections on uncertainty relate to judicious help-seeking. In a paradigm modeled after Lyons and Ghetti (2013), 3-, 4-, and 5-year-olds completed two sessions of a perceptual identification task. During the *standard* session, they were asked to identify a target object in one of two degraded images and to then rate their confidence in their response on all trials. In a *help* session, they completed the same task using identical stimuli but, instead of being forced to respond on every trial, were given the option of seeking help from a confederate 'helper' by choosing the 'I-want-help' button. Session order was counterbalanced across participants, and participants never received feedback regarding the accuracy of their choice regardless of session type. This design reflects the idea that participants will experience consistent levels of uncertainty on individual trials across sessions, but will respond differently on the basis of their uncertainty due to the unique response options of each session type. This enables us to connect subjective reports of uncertainty in the standard session with bids for help in the help session.

We predicted that preschoolers would be most likely to seek help during help session trials for which, when required to respond during their standard session, they reported lower levels of confidence and were least accurate. Based on previous evidence (Lyons & Ghetti, 2013), we expected this behavior to be reliable in 3-year-olds and to show improvement during the preschool years. Furthermore, we expected confidence ratings and accuracy across trials for which help was requested to be higher in the help session (i.e. after help was received) compared to the same trials in the standard session (i.e. when children were forced to provide the answer independently), suggesting that children believed their helper's suggestions to be helpful for identifying accurate answers.

Finally, we examined whether individual differences in uncertainty monitoring (i.e. the correspondence between uncertainty and accuracy across trials) predicted individual gains in accuracy between the standard and help conditions. Because uncertainty judgments during the help session may have been influenced by an imperative to act further or to select a course of action (upon receiving helper feedback), individual differences in uncertainty monitoring were examined within the standard session only, consistent with previous literature (e.g. Koriat, Goldsmith, Schneider & Nakash-Dura, 2001; Lyons & Ghetti, 2013). In addition, age and inhibitory control were accounted for given that Lyons and Ghetti (2013) found that both inhibitory control and uncertainty monitoring independently predicted gains in accuracy from a standard to an opt-out condition. We note, however, that their study involved restraint behaviors for which inhibitory control might have been especially critical.

Our secondary goal was to examine whether preschoolers respond differently to helpers as a function of their competence. We manipulated the quality of the helper between participants to see whether young children would solicit more information from a more-competent to less-competent informant when only one helper is available, a situation requiring absolute assessments of competence. Thus, half of the children were offered help from a helper who had been witnessed as being 100% accurate and the remaining half were offered help from a helper who had been witnessed as being 50% accurate. We chose to have the less competent helper be 50% accurate given that this is chance performance and therefore more typical of a (not intentionally) bad helper in real life. We predicted that participants assigned a 'bad' helper would be more hesitant to seek help and relatively less confident in the answers provided by the helper compared to those assigned a 'good' helper. However, the absence of multiple informants as grounds for relative judgments suggests that these effects may be subtle.

The final goal of the present research was to examine whether conceptual understanding of mind, as indicated by diverse beliefs (Wellman & Bartsch, 1988), content false belief (Perner, Leekam & Wimmer, 1987) and explicit false belief (Siegal & Beattie, 1991), predicted the propensity to seek help. These theory-of-mind tasks assess children's ability to understand that another individual may have beliefs or desires that differ from their own (or reality), and that this individual will act accordingly. We reasoned that this ability may be particularly relevant within a help-seeking context; participants who understand that their mental state may differ from another's may be more apt to realize the potential benefits of seeking help. In this analysis, in addition to age, we accounted for sex because females are found to seek help more often than males even during the preschool years (e.g. McMullen & Gross, 1983; Thompson, Cothran & McCall, 2012; Thompson & Moore, 2000).

Method

Participants

One hundred and twenty-five children participated in this study, including 43 3-year-olds (22 boys and 21 girls, $M = 42.93$ months, $SD = 2.81$), 39 4-year-olds (18 boys and 21 girls, $M = 53.87$ months, $SD = 3.03$), and 43 5-year-olds (21 boys and 22 girls, $M = 66.14$ months, $SD = 3.09$). An additional 10 participants were excluded due to performance at or below chance on the perceptual identification trials completed independently; these children were distributed across the three age groups (three 3-year-olds, two 4-year-olds, and five 5-year-olds). Seventy-one percent of participants were European

American, 7% were Asian, 5% were Hispanic, 2% were African American, and 15% were of mixed ethnicity. Although socioeconomic status varied, the majority of participants were from upper middle-class families and had at least one parent with some college education. All participants were from Northern California, fluent in English, and without known cognitive impairment. Recruitment occurred at local community events. Participants received a small toy (valued at \$5 or less) as a token of appreciation at the end of each experimental session.

Materials

Perceptual identification task and pictorial stimuli

Participants completed a perceptual identification task in which they identified which of two degraded line drawings depicted a target object; responses were scored 0 if incorrect and 1 if correct. Stimuli were presented side-by-side on a touch-screen monitor under two experimental conditions described in the procedure section. The same 20 test trials were used within each experimental condition so that trial-level comparisons could be made between participants' responses. Pictorial stimuli for this task included 40 line drawings of objects from Cycowicz, Friedman, Rothstein and Snodgrass (1997). Only objects whose labels are typically known to 3-year-olds were used (based on Lyons & Ghetti, 2011, and age-of-acquisition norms; Morrison, Chapell & Ellis, 1997).

Line drawings were degraded using an automated program that removed a specific number of random pixels from each image (Figure 1). Within each age group, the percentage of pixels removed from every picture was the same; this prevented children from using

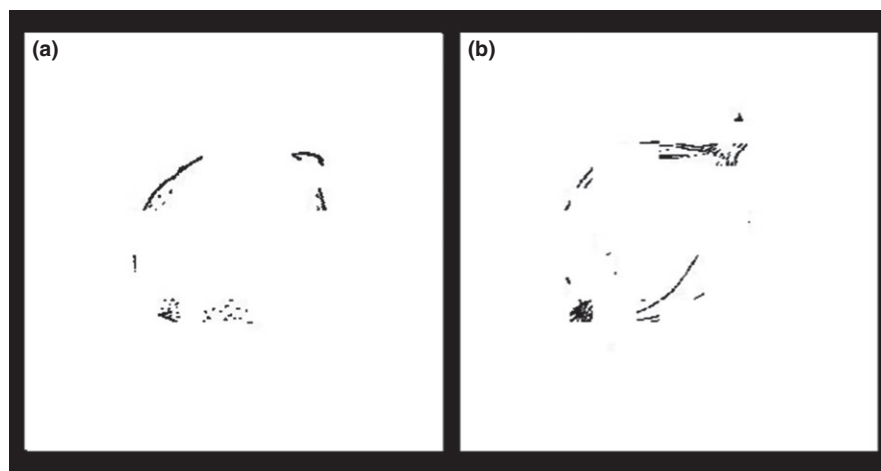


Figure 1 Sample degraded images used for perceptual identification task: (a) lemon, (b) onion.

the amount of perceptual degradation as the basis of their uncertainty judgments. Based on extensive piloting and previous research with this stimulus set (Lyons & Ghetti, 2013), different numbers of pixels were removed for each age group to achieve comparable task difficulty across ages; 20% of pixels were removed for 3-year-olds, 30% for 4-year-olds, and 40% for 5-year-olds.

All line drawings were split into two sets of 20 drawings counterbalanced for complexity, familiarity, and frequency (Cycowicz *et al.*, 1997). Participants trained on the perceptual identification task with set 1 and were tested with set 2, or vice versa. The target and foil within each pair of line drawings were counterbalanced across participants.

Confidence judgments

Ratings of subjective uncertainty were made using a 3-point pictorial confidence scale shown on the touch-screen monitor. Each point on the scale was represented by a picture of a child displaying facial and body expressions of low, moderate, or high confidence (the same image of a child who could be interpreted as being male or female was used for all three confidence levels). On each trial, immediately after identifying a drawing, children reported their subjective un/certainty by touching one of the confidence scale pictures. Low confidence responses were coded as 0, moderate confidence responses as 1, and high confidence responses as 2.

While previous studies with preschoolers have mostly utilized 2-point visual scales depicting low and high confidence only (e.g. Lyons & Ghetti, 2011, 2013), sensitive use of a 3-point scale in 3- and 4-year-olds has recently been shown (Hembacher & Ghetti, 2014), and there is vast evidence of this ability in 5-year-olds (e.g. Ghetti & Alexander, 2004; Ghetti, Qin & Goodman, 2002).

Helper movies

Two helper movies were created to manipulate perceived helper competence. Each movie showed a confederate helper completing six trials of the perceptual identification task. After each trial, the correct answer was revealed and an experimenter provided appropriate verbal feedback (for correct responses, '*Great job. You got it right!*'; for incorrect responses, '*Oh no, you made a mistake and chose the wrong one. Too bad.*'). In the 'good' helper movie, the helper responded correctly to all trials. In the 'bad' helper movie, the helper responded correctly to only half of the trials (trials 1, 3, and 4).

Since several research assistants took turns being the helper during experimental sessions, we created one 'good' and one 'bad' helper movie in which the actress playing the helper was de-identified. The camera angle captured the back of the helper and focused primarily on the computer touch-screen. The helper also wore a costume consisting of a red shirt, red hat, and purple gloves, which was the same costume worn by helpers during actual experimental sessions.

Children's Behavior Questionnaire (CBQ; Rothbart, Ahadi, Hershey & Fisher, 2001)

This was primarily administered to assess inhibitory control using parental report on the *inhibitory control* subscale. The *approach* and *shyness* subscales were also explored to account for individual differences in help-seeking tendencies. Subscales included 13 items, each asking parents to rate how often their child had engaged in specific behaviors within the last 6 months on a scale ranging from 1 (low frequency) to 7 (high frequency).

Theory-of-mind assessment

We used the diverse beliefs, contents false belief, and explicit false belief tasks from Wellman and Liu's (2004) theory-of-mind scale for preschoolers. These tasks were chosen because they measure mental state understanding that may be particularly relevant within a help-seeking context. Each task was presented verbally while corresponding pictures appeared on a computer screen. Responses were scored 0 if incorrect and 1 if correct.

Procedure

Participants were tested individually across three sessions spaced approximately one week apart. Testing was done by one of several trained female research assistants blind to experiment hypotheses. For the first two sessions, participants completed a confidence scale training followed by a main task training and test. Session order was counterbalanced such that half of the participants completed their standard session first and half of the participants completed their help session first. To reduce fatigue, the theory-of-mind assessment was completed during a third session. After each task, participants added a sticker to a sticker chart. They were allowed to pick out a prize once they had completed all session tasks and their sticker chart was full. Parents completed the inhibitory control, approach, and shyness subscales of the CBQ while their child completed the experimental tasks.

Confidence training

Participants were trained on how to use the confidence scale at the beginning of each of the first two sessions using a procedure that has been successfully implemented in studies with 3- to 5-year-olds (e.g. Hembacher & Ghetti, 2014; Lyons & Ghetti, 2013) and appears similarly effective across these age groups (Lyons & Ghetti, 2013). Since this procedure requires that experimenters evaluate participants' behavioral indicators of uncertainty, experimenters were carefully trained to look for specific behaviors (e.g. wavering between the two line drawings).

The training began with the experimenter providing a verbal description of the level of uncertainty depicted by each confidence picture. The low-confidence picture was described as being *'not so sure about your answer'*, the moderate picture with being *'kind of sure about your answer'*, and the high confidence picture with being *'really sure about your answer'*. Participants then completed 10 practice trials during which they attempted to select a target object from two degraded line drawings and then reported their confidence by touching one of the confidence scale pictures. Participants were not given feedback about the accuracy of their perceptual identifications. Instead, the experimenter provided verbal feedback on whether their confidence response for each trial matched their demeanor. If their confidence response matched their demeanor (e.g. they selected the low-confidence picture when their own expression and posture reflected uncertainty), they were given positive feedback (e.g. *'Great job! You were not so sure about that one, so you touched this (point) face.'*). If their confidence response did not match their demeanor (e.g. they selected the high-confidence picture when their own expression and posture reflected uncertainty), they were given negative feedback and prompted to touch the picture that matched their demeanor (e.g. *'Hmm, it seemed like you were not so sure about that one. Remember, if you're not so sure about your answer, this (point) is the face you touch.'*). The training ended with verification of participants' understanding of each confidence picture, and stressing the importance of using all three pictures during the task.

Main task training and test

After the confidence training, participants were told that the next two games would determine the type of prize they would receive. They were shown big and small prizes and told that, in order to win their preferred prize, they had to always choose the correct drawing. This was done to encourage their motivation to achieve high

accuracy. They then completed the main task training and test for either their standard or help session.

Standard session. Participants first completed 10 practice trials during which they were forced to select a target object from two degraded line drawings. After each selection, the correct answer was displayed and they were given feedback on their accuracy. For correct responses, they were told *'Great job! You got it right.'* For incorrect responses, they were told, *'Oh no, you made a mistake and chose the wrong one. Too bad. But it's okay; it's just practice.'* At the end of the practice trials, participants were reminded to do their best to respond accurately and then the test started. Participants completed 20 test trials, during which no feedback was provided, in which they were forced to select a target object from two degraded line drawings. After making their selection for each trial, they reported their uncertainty in their response using the confidence scale.

Help session. Participants were first told that a special helper (wearing a red shirt, red hat, and purple gloves) would be available to help them when it came time for their real test, but that the experimenter would *'pretend'* to be their helper while they practiced how to ask for help. To encourage children's requests for help during practice, the experimenter described herself as very good at the task.

Participants then completed 10 practice trials during which they could either select a target object from two degraded line drawings (as in the standard condition) or press the *'I-want-help'* button. If the *'I-want-help'* button was pressed, the experimenter provided accurate assistance saying, *'I think I see the (target) there (pointing to the target image).'* After receiving help, participants were required to select one of the two degraded images. Immediately after making their selection (either with or without receiving help), the correct answer was displayed and the experimenter provided feedback on their performance. For correct responses without choosing help, she said, *'Great job! You saw that the (target) was hiding here and you chose that one!'* For correct responses after choosing help, she said, *'Great job! You didn't want to make a mistake, so you pressed the help button to get help.'* For incorrect responses without choosing help, she said, *'Oh no! You made a mistake and chose the wrong one! You should have used the "I-want-help" button to get help. But it's okay; it's just practice.'* And for incorrect responses after choosing help, she said, *'Oh no, you made a mistake and chose the wrong one. Too bad. But it's okay; it's just practice.'*

After these practice trials, the procedures relevant to the helper competence manipulation took place. The

experimenter first instructed participants to watch a movie to see how their helper played a game that was similar to theirs. Participants were then shown either the 'good' or 'bad' helper movie. When the helper movie ended, the participant's assigned helper knocked on the testing room door. Upon entering the room, the helper told the participant that she would be sitting next to him/her during the game and that s/he should touch the help button when s/he wanted help. The helper wore the same costume pictured in the helper movie, maintained a mildly positive affect, and was blind to the participant's helper type condition.

Participants then completed 20 test trials during which they were asked to select a target object from two degraded line drawings; they could either answer independently or seek help by pressing the 'I-want-help' button. When the help button was pressed, the helper provided assistance saying, 'I think I see the (target) in there (pointing to the target image).' Importantly, the helper pointed to the correct target image regardless of the participant's helper type condition such that all participants received accurate assistance regardless of whether they were assigned to the good or bad helper condition; participants were not made aware of this fact and never received feedback regarding their performance accuracy. After receiving help, the participant was forced to select one of the two degraded line drawings. After each perceptual identification response, whether or not help was received, participants reported their uncertainty in their response using the confidence scale.

Recording response times

Response times were measured in milliseconds via input to a touch-screen monitor using software that enabled the synchronization of response timing with screen displays. For each test trial, immediately after asking 'Where is the (target)?', the experimenter pressed a key to show the pictorial discrimination screen; the time between this screen's appearance and the participant selecting either the help button (if applicable) or a picture was recorded providing response times for help button or picture selection without receiving help. For trials where the help button was selected, the experimenter followed the helper's feedback by asking, 'So, where is the (target)?', and then keyed in the same screen display only without the help button shown; the time between this screen's appearance and the participant's picture selection was recorded, providing response times for picture selection after receiving help. After a picture was selected (either with or without help), the computer automatically advanced to a screen display of the

confidence scale; the time between this screen's appearance and the participant's confidence scale selection was recorded to provide response times for confidence ratings.

Theory-of-mind assessment

This assessment occurred during participants' third session.

Results

Preliminary analyses

Preliminary analyses confirmed that the delay between sessions was similar for all age groups, $F(2, 122) = .93, p = .40, \eta_p^2 = .02$ (3-year-olds: $M = 7.33, SD = 2.19$; 4-year-olds: $M = 8.18, SD = 3.53$; 5-year-olds: $M = 7.81, SD = 2.75$). Additional comparisons revealed no age differences in perceptual identification accuracy during standard session trials, $F(2, 122) = .42, p = .66, \eta_p^2 = .01$, and that each age group's standard session performance was significantly above chance without reaching ceiling (3-year-olds: $M = .71, SD = .10, t(42) = 13.49, p < .001$; 4-year-olds, $M = .69, SD = .09, t(38) = 13.18, p < .001$; 5-year-olds, $M = .72, SD = .10, t(42) = 13.53, p < .001$), confirming comparable task difficulty across age groups. Finally, no main effect of session order was found on accuracy or confidence rating, $ps \geq .54$; this variable was therefore excluded from subsequent analyses.

We verified appropriate use of the confidence scale prior to the main analyses. Research with adults shows that the time it takes to choose an answer tends to be inversely related to participants' confidence in that answer (Koriat, Ma'ayan & Nussinson, 2006). To see whether a similar pattern was observed across our preschool sample, a 3 (age: 3-, 4-, and 5-year-olds) \times 3 (confidence level: low, medium, and high) mixed ANOVA was conducted on response times to pictorial identification during the standard session. Age was entered as a between-subjects variable and confidence level as a within-subjects variable. Results revealed a main effect of confidence level, $F(2, 85) = 6.79, p = .002, \eta_p^2 = .14$, that was not qualified by an interaction with age ($p = .49$). Low confidence ratings were associated with the slowest pictorial identification times ($M = 6.83; SD = 8.24$), high confidence ratings with the quickest pictorial identification times ($M = 4.46; SD = 1.95$), and medium confidence ratings with pictorial identification times in the middle of the two extremes ($M = 5.40; SD = 4.30$). Findings suggest appropriate use of the confidence scale across age groups.

Do preschoolers monitor their uncertainty?

Before testing predictions related to help-seeking, we examined whether incorrect responses were associated with lower confidence ratings than correct responses. We conducted a 3 (age: 3-year-olds vs. 4-year-olds vs. 5-year-olds) \times 2 (response accuracy: correct vs. incorrect) mixed ANOVA on standard session confidence ratings. Response accuracy was entered as a within-subjects variable. Results revealed a main effect of accuracy on standard session confidence ratings, $F(1, 122) = 45.54$, $p < .001$, $\eta_p^2 = .27$, such that all age groups provided significantly higher confidence ratings for correct ($M = 1.49$, $SD = .36$) compared to incorrect ($M = 1.23$, $SD = .51$) responses. The interaction between accuracy and age was not significant, $F(2, 122) = 2.27$, $p = .11$, $\eta_p^2 = .04$. Children in all three age groups were significantly more likely to report higher confidence for accurate compared to inaccurate trials: 3-year-olds, $F(1, 42) = 4.21$, $p = .05$, $\eta_p^2 = .09$, 4-year-olds, $F(1, 38) = 20.17$, $p < .001$, $\eta_p^2 = .35$, 5-year-olds, $F(1, 42) = 30.56$, $p < .001$, $\eta_p^2 = .42$ (Figure 2). Thus, children across age groups exhibited uncertainty monitoring and were more likely to report lower confidence when they were incorrect compared to when they were correct.

Do preschoolers ask for help judiciously?

Our next question was whether the output of preschoolers' uncertainty monitoring would relate to their decisions to seek help. We first verified that all age groups asked for help in the help condition at comparable rates, $F(2, 122) = 0.23$, $p = .80$, $\eta_p^2 = .004$ (3-year-olds: $M = .46$, $SD = .31$; 4-year-olds: $M = .48$, $SD = .31$; 5-year-olds: $M = .43$, $SD = .27$). We then compared confidence ratings in the standard and help sessions as a function of whether or not help was requested in the help session. Recall that

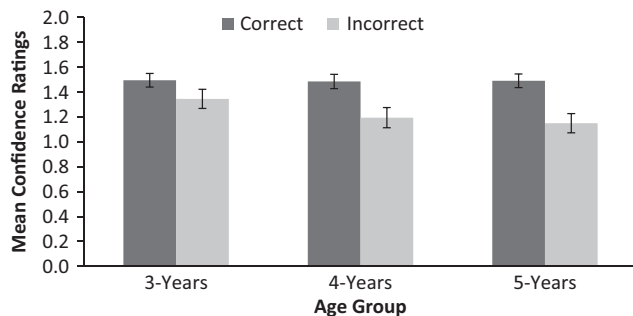


Figure 2 Mean confidence ratings (\pm SE) for correct versus incorrect trials during the standard session across age groups. Results reveal a main effect of accuracy on standard session confidence ratings ($p < .001$) that did not interact with age ($p = .11$).

participants' standard and help session trials were identical except for the opportunity to seek help in the latter. If help was sought judiciously, children should have asked for help on trials for which, when forced to answer independently during their standard session, they felt less certain. For example, regardless of session order, a participant who experienced extreme uncertainty during the fifth trial of their standard session would be expected to have asked for help on the fifth trial of their help session. Therefore, standard session trials yoked to yes-help trials should be associated with lower confidence ratings than standard session trials yoked to no-help trials. Furthermore, if children thought that their helper provided useful information, they should have expressed higher confidence when following their helper's suggestion in the help condition compared to the confidence they expressed on the same trials in the standard condition. One final question pertains to whether children still expressed higher confidence in their independent responses versus responses provided by their helper in the help condition.

Thus, we conducted a 3 (age: 3-year-olds vs. 4-year-olds vs. 5-year-olds) \times 2 (session: standard vs. help) \times 2 (help-seeking decision: yes vs. no) \times 2 (helper type: good vs. bad) mixed ANOVA on confidence ratings. Helper type was entered as a between-subjects variable; session type and help-seeking decision were entered as within-subjects variables. We restricted this analysis to children who asked for help in at least two trials and refrained from asking for help in at least two trials to allow for comparison of confidence levels on both trial types. Results revealed main effects of session type, $F(1, 90) = 6.31$, $p = .01$, $\eta_p^2 = .07$, and help-seeking decision, $F(1, 90) = 36.58$, $p < .001$, $\eta_p^2 = .29$. Overall, participants were more confident during their help session compared to their standard session, and across no-help trials compared to yes-help trials. Of importance, these effects were qualified by a session type \times help-seeking decision interaction, $F(1, 90) = 4.80$, $p = .03$, $\eta_p^2 = .05$ (Figure 3), such that across ages, children were most confident on trials for which no help was requested regardless of session ($M = 1.52$, $SD = .41$ standard session; $M = 1.55$, $SD = .32$ help session), followed by help session trials for which help was requested ($M = 1.41$, $SD = .45$), which were significantly lower than the former ($ps < .03$). Compared to each of the other trial/condition types, children were least confident across trials in the standard session for which help was requested in the help session ($M = 1.24$, $SD = .44$) ($ps < .01$). No main or interactive effect of helper type was found, $F(2, 90) < 2.32$, $p \geq .10$, $\eta_p^2 < .05$.

We then conducted the same analysis with accuracy as the dependent measure since preschoolers were expected

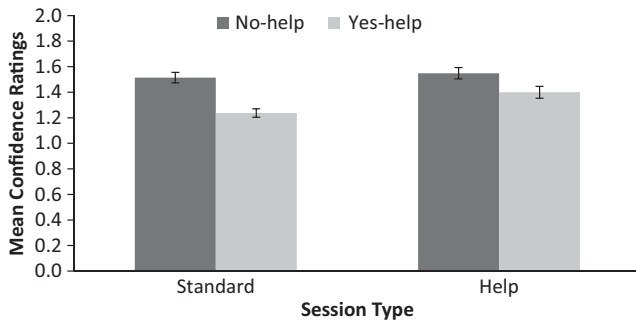


Figure 3 Mean confidence ratings (\pm SE) as a function of session type for trials in which help was or was not sought during the help session (help-seeking decision: no-help vs. yes-help). Results reveal main effects of session type ($p = .01$) and help-seeking decision ($p < .001$) that are qualified by a session type \times help-seeking decision interaction ($p = .03$).

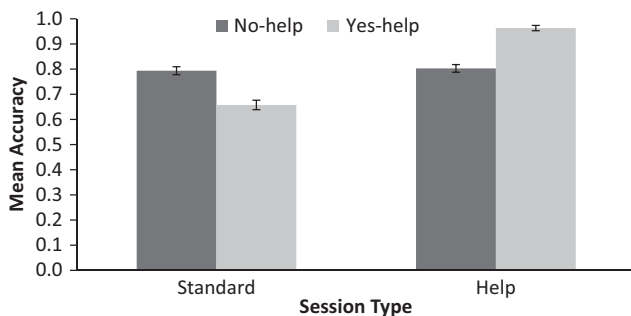


Figure 4 Mean accuracy of perceptual identifications (\pm SE) as a function of session type for trials in which help was or was not sought during the help session (help-seeking decision: no-help vs. yes-help). Results reveal a main effect of session type ($p < .001$) that is qualified by a session type \times help-seeking decision interaction ($p < .001$).

to seek help on help-session trials for which they were least accurate in the standard session. A 3 (age: 3-year-olds vs. 4-year-olds vs. 5-year-olds) \times 2 (session: standard vs. help) \times 2 (help-seeking decision: yes vs. no) \times 2 (helper type: good vs. bad) mixed ANOVA revealed results that largely mirrored confidence results. Specifically, a main effect of session type, $F(1, 90) = 167.09$, $p < .001$, $\eta_p^2 = .65$, was qualified by a session type by help-seeking decision interaction, $F(1, 90) = 103.95$, $p < .001$, $\eta_p^2 = .54$ (Figure 4). Across all age groups, children were less accurate on trials in the standard session yoked to trials for which help was requested during the help session ($M = .66$, $SD = .18$) ($ps < .001$) compared to trials for which help was not requested in both sessions ($M = .79$, $SD = .15$ standard session; $M = .80$, $SD = .15$ help session). The accuracy level for trials in the help session for which help was requested ($M = .96$, $SD = .10$) was

higher than all other conditions ($ps < .001$), indicating that children overwhelmingly followed the helper's recommendation. No main or interactive effect of helper type was found, $F(2, 90) < 2.93$, $p \geq .06$, $\eta_p^2 < .06$.

These results show that participants asked for help on trials for which, when forced to answer independently, they were the least confident and accurate. This suggests that preschoolers used available help judiciously to improve their overall performance.

Examining individual differences in uncertainty monitoring and help-seeking

To provide further evidence of a connection between uncertainty monitoring and help-seeking, we regressed accuracy improvement (accuracy in help condition minus accuracy in standard condition) on uncertainty monitoring (operationalized as the difference in confidence for correct versus incorrect standard session trials) simultaneously with age (in months), frequency of help-seeking (percentage of help session trials for which help was sought), and inhibitory control. We included frequency of help-seeking because this factor may lead to improvements in accuracy for reasons transcending uncertainty monitoring. Finally, we included inhibitory control because it was found to be a significant predictor of accuracy improvement in Lyons and Ghetti (2013). Inhibitory control was assessed by the CBQ; means ranged from 0 (low inhibitory control) to 7 (high inhibitory control). For consistency with previous analyses, the sample included children who asked for help in at least two trials and refrained from asking for help in at least two trials; however, results are virtually unchanged if the whole sample is included. The resulting model was significant, $F(4, 91) = 5.20$, $p < .001$, adjusted $R^2 = .15$. Uncertainty monitoring, frequency of help-seeking, and age emerged as unique predictors of accuracy improvement; inhibitory control did not (Table 1, Model 1). The results of this regression provide further support for a relation between uncertainty monitoring and judicious help-seeking. And, consistent with our prediction, frequency of help-seeking also emerged as a significant predictor of accuracy improvement.

Next, we examined the predictors of frequency of help-seeking. We focused on theory of mind and sex, which we predicted might be related to this variable. A simultaneous multiple regression analysis was conducted including mean performance on theory-of-mind tasks (i.e. diverse beliefs, content false belief, and explicit false belief; information was not available for one participant), sex, age in months, and uncertainty monitoring as predictors. The resulting model was significant, $F(4, 90) = 8.61$, $p < .001$, adjusted $R^2 = .25$. Theory of mind,

Table 1 Summary of multiple regression analyses for variables predicting accuracy improvement

Variable	Model 1 (<i>N</i> = 96)			Model 2 (<i>N</i> = 95)		
	<i>B</i>	<i>SE B</i>	β	<i>B</i>	<i>SE B</i>	β
Uncertainty Monitoring	0.07	0.03	0.23*	0.07	0.03	0.23*
Frequency of Help-Seeking	0.20	0.07	0.27**	0.14	0.08	0.20 [†]
Inhibitory Control	0.00	0.02	0.02	0.00	0.02	-0.02
Age in Months	0.00	0.00	-0.23*	0.00	0.00	-0.26*
Predictors of Frequency of Help-Seeking						
Theory of Mind				0.05	0.06	0.10
Sex				0.04	0.03	0.13

Notes: Uncertainty Monitoring, $M = 0.28$, $SD = 0.46$; Frequency of Help-Seeking, $M = 0.50$, $SD = 0.20$; Inhibitory Control, $M = 4.79$, $SD = 0.90$; Age in Months, $M = 54.97$, $SD = 10.18$; Theory of Mind, $M = 0.56$, $SD = 0.29$. [†] $p = .08$; * $p < .05$; ** $p < .01$

Table 2 Summary of multiple regression analysis for variables predicting frequency of help-seeking (*N* = 95)

Variable	<i>B</i>	<i>SE B</i>	β
Theory of Mind	0.28	0.07	0.41***
Sex	0.13	0.04	0.33***
Age in Months	-0.01	0.00	-0.28**
Uncertainty Monitoring	0.03	0.04	0.08

Notes: Theory of Mind, $M = 0.56$, $SD = 0.29$; Age in Months, $M = 54.97$, $SD = 10.18$; Uncertainty Monitoring, $M = 0.28$, $SD = 0.46$. ** $p < .01$; *** $p < .001$

sex, and age emerged as significant predictors of frequency of help-seeking; more advanced theory of mind and being female related to more help-seeking, while being older predicted reluctance to seek help. Uncertainty monitoring did not predict frequency of help-seeking (Table 2). To ensure that the relation between theory of mind and frequency of help-seeking was not driven by performance on a particular theory-of-mind task, three additional multiple regressions were performed, each substituting the theory of mind composite score with the score from only one theory-of-mind task (i.e. diverse beliefs, content false belief, or explicit false belief), but otherwise unchanged. Results revealed a significant model across each analysis (R^2 s $\geq .12$, p s $\leq .005$); diverse beliefs and explicit false belief scores significantly predicted frequency of help-seeking ($\beta = .34$, $p < .001$ and $\beta = .33$, $p = .001$, respectively); there was a non-significant trend for false belief scores ($\beta = .18$, $p = .09$) to do the same. Thus, the relation between theory of mind and frequency of help-seeking was not driven by performance on one particular task.

Although we predicted that a relation between theory of mind and frequency of help-seeking would be due to a conceptual connection between mental state understanding

and seeing the informational advantage of consulting others, we asked whether the observed relation could be accounted for by experiential factors known to be associated with theory of mind (e.g. number of siblings and temperamental factors; Perner, Ruffman & Leekam, 1994; Suway, Degnan, Sussman & Fox, 2012). To examine this, we conducted an additional simultaneous multiple regression analysis predicting frequency of help-seeking. Predictors included theory of mind, sex, and age, and experiential variables that could influence both theory of mind and help-seeking: number of siblings, approach, and shyness. The resulting model was significant, $F(6, 88) = 6.43$, $p < .001$, adjusted $R^2 = .26$. Theory of mind ($\beta = .42$, $p < .001$), sex ($\beta = .33$, $p < .001$), and age ($\beta = -.27$, $p = .01$) remained significant predictors of help-seeking; number of siblings ($\beta = -.08$, $p = .39$), approach ($\beta = .06$, $p = .57$), and shyness ($\beta = -.14$, $p = .16$) did not emerge as significant predictors.

Given that frequency of help-seeking was a unique predictor of accuracy improvement in our original regression analysis, we conducted a final simultaneous multiple regression analysis predicting accuracy improvement that included the predictors from our original analysis (uncertainty monitoring, age in months, frequency of help-seeking, and inhibitory control) and the two variables that significantly predicted help-seeking (performance on theory-of-mind tasks and sex). The addition of these variables left our original results largely unchanged, $F(6, 88) = 3.75$, $p = .002$, adjusted $R^2 = .15$, and neither theory of mind nor sex significantly predicted accuracy improvement (Table 1, Model 2). We note that age in months was positively correlated with both theory of mind, $r(95) = .27$, $p = .008$, and uncertainty monitoring, $r(95) = .20$, $p = .05$; once they are both accounted for in the regression, the remaining variance in age may involve other factors that prevent children from improving.

Failure to respond to helper's competence: are there more subtle effects?

The between-subject manipulation of helper competence failed to affect performance. The absolute competence judgment required in this task may have reduced participants' sensitivity to helper type. However, the presence of the helper in the room may have also added an element of social compliance such that participants may have felt obliged to use their helper regardless of their perceived competence. This led us to consider whether children with a bad helper may have expressed greater hesitancy than those with a good helper despite their similar overt behavior, suggesting more subtle or implicit effects of helper type. Such hesitancy and resulting slower responding could reflect children's need to resolve the conflict resulting from a perceived social obligation to request help despite knowledge that one's helper is not very competent.

To explore this possibility, we conducted a Multivariate Analysis of Variance (MANOVA) on variables that might capture this hesitancy, namely, the response times to press the help button, to make a picture selection, and to make a confidence rating when help was requested. Given the exploratory nature of this analysis and our prediction that participants with a bad helper might be overall more hesitant across yes-help trials, we deemed it important to include all three variables. Results of a 3 (age: 3-year-olds vs. 4-year-olds vs. 5-year-olds) \times 2 (helper type: good vs. bad) MANOVA revealed multivariate effects of age, $F(6, 198) = 3.12, p = .01, \eta_p^2 = .09$, and helper type, $F(3, 99) = 2.63, p = .05, \eta_p^2 = .07$. Children were slower and thus appeared to be more hesitant in their responses in the bad helper condition (response time in seconds for help button: $M = 5.76, SD = 3.03$, picture selection: $M = 2.76, SD = 1.58$, and confidence rating: $M = 6.20, SD = 3.34$) compared to the good helper condition (response time in seconds for help button: $M = 5.83, SD = 3.49$, picture selection: $M = 2.35, SD = 0.91$, and confidence rating: $M = 5.09, SD = 1.28$). Of importance, children assigned a bad helper were not more hesitant in general. A MANOVA conducted on response times for responses during the standard session, and for responses during the help session for which help was not requested, revealed no significant multivariate differences as a function of helper type, $F(4, 110) = 1.23, p = .30, \eta_p^2 = .04$.

Discussion

Help-seeking supports strategic learning and is a driving force of cognitive development across childhood (Ames,

1983; Nelson-Le Gall, 1985; Newman, 1991, 1994, 1998). Results from the present study support the view that uncertainty monitoring may be one of the mechanisms underlying this important behavior in preschoolers. Across all age groups, participants reported lower confidence when they were inaccurate compared to accurate, confirming previous evidence that children as young as 3 years can monitor their uncertainty in a perceptual identification task (Lyons & Ghetti, 2011, 2013). Furthermore, all age groups were most likely to seek help on trials for which, during their standard session, they reported being less confident. Consistent with the purported role of metacognition to allow for the on-line assessment of knowledge states which guide action and decision-making (Ghetti *et al.*, 2013), preschoolers may have used their uncertainty monitoring to strategically seek help when they could benefit from it the most. Moreover, individual differences in uncertainty monitoring predicted improvements in accuracy, bolstering the claim that the two constructs are related.

Of interest, no age differences were found in the extent to which confidence ratings related to judicious help-seeking. This is in contrast to the age-related improvement reported by Lyons and Ghetti (2013) in a task that required response withholding. It is possible that this behavior imposed greater demands on inhibitory control. Indeed, inhibitory control, which predicted accuracy improvement in Lyons and Ghetti (2013), did not emerge as a significant predictor in the current study. Therefore, the lack of age-related improvement in the current study may be due to the fact that help-seeking places lower demands on inhibitory control and is a more natural and frequent activity than withholding responses. Together, these results confirm that uncertainty monitoring may play a critical role in multiple forms of early strategic behavior while suggesting that reliance on uncertainty monitoring may be moderated by the type of regulatory behavior. An important direction for future research will be to examine the relation between uncertainty monitoring and multiple forms of strategic behavior within the same sample.

Preschoolers exhibited remarkable skill in their uncertainty monitoring. They reported highest confidence across standard and help session trials for which help was not requested indicating consistency across situations for items thought (rightfully) to be identified at high accuracy levels. In contrast, confidence ratings increased from the standard to the help condition on trials for which help was requested, indicating that preschoolers could update their confidence evaluation upon receiving the helper's suggestions. Intriguingly, even after receiving help, participants were still less confident than when they produced the answer

themselves. This may be due to a tendency for children's self-evaluations to be positively skewed (Harter & Pike, 1984; Lipko, Dunlosky & Merriman, 2009). On the other hand, although the helper provides suggestions, the participant does not know that her suggestions are always accurate since the correct answers are never revealed; it may therefore make sense to retain some uncertainty compared to when one believes an answer is known.

Helper's competence: caveats and hypotheses

Based on research demonstrating that preschoolers prefer to learn from reliable compared to ignorant sources (Jaswal & Malone, 2007; Koenig & Harris, 2005; Pasquini *et al.*, 2007), we predicted that the helper's competence would influence preschoolers' performance, but considered that the absolute competence judgment required by our manipulation may yield a reduced effect. The fact that there was no effect of helper type on preschoolers' behaviors suggests that competence is not factored in successfully when seeking help from the only adult available. However, the slower response times associated with decisions to respond after asking for help from the bad helper compared to the good helper additionally suggest that children noticed competence even though it did not alter their overt decisions.

The element of social compliance built into our experimental procedure may partly account for this result. Across helper conditions, participants received help from an adult with a mildly positive affect. In addition, asking her for help was not necessarily unwise given that participants were not forced to accept the helper's feedback (although the majority of participants did). Future studies should provide children with a non-social source of help to address this social-compliance issue, and also examine when children's perceptual identification decisions and confidence ratings become sensitive to more subtle manipulations of helper competence.

Theory of mind and propensity to seek help

Although the main hypothesis motivating the present study was that uncertainty monitoring would underlie preschoolers' selection of trials for which to seek help, we reasoned that additional factors would support overall propensity to seek help. We had hypothesized that theory of mind (particularly an understanding of diverse desires and false beliefs) would predict help-seeking because preschoolers who recognize that others may have beliefs or knowledge states that differ from their own may be more likely to appreciate the potential

to gain knowledge from others. Results were consistent with this possibility. However, it is still possible that experiential factors may have contributed to this relation (although number of siblings, approach, and shyness did not). Interestingly, performance on theory-of-mind tasks did not predict accuracy improvement directly, suggesting that theory of mind was not critical for identifying which trials on which to select help. Indeed, accuracy improvement continued to be predicted by uncertainty monitoring even when theory-of-mind performance was included in the last regression analysis.

To further probe the contribution of theory of mind, future research could present children with the choice to request help among potential helpers who vary in their level of competence *and* content expertise. Choices that more closely consider the potential helper's beliefs and knowledge should be particularly associated with young children's understanding of others' beliefs. Research examining this possibility could provide valuable insight on the connection between an understanding of others' knowledge and requests for help.

Results also indicated that being female predicted higher rates of help-seeking. This adds to a body of literature demonstrating that females ask for help more often than males even during early childhood (Thompson *et al.*, 2012; Thompson & Moore, 2000). Meanwhile, older preschoolers appeared to be more reluctant to seek help when the other relevant variables were accounted for, suggesting that the beneficial effects of help-seeking should be considered in the context of normative changes in the tendency to seek help. Critically, there were no age differences in accuracy, so older preschoolers could not have simply responded to the task being easier overall.

Therefore, although uncertainty monitoring predicted judicious help-seeking, other variables exerted an effect as well, and these variables had to do with promoting children's propensity to ask for help. This suggests that multiple factors may contribute uniquely to different forms of early strategic behavior and reinforces the importance of considering the contextual demands of the regulatory behavior being examined.

Conclusion

Overall, the results of the present study demonstrate that uncertainty monitoring is related to judicious help-seeking during early childhood. Not only can preschoolers monitor their uncertainty, but they may use their monitoring output to strategically seek help when it is most needed. These findings add to a growing body of evidence supporting metacognitive ability during early

childhood (Balcomb & Gerken, 2008; Call & Carpenter, 2001; Cherney, 2003; Ghetti *et al.*, 2013; Lyons & Ghetti, 2011, 2013). To date, uncertainty monitoring has emerged as an independent predictor of the strategic regulation of at least two forms of behavior in preschoolers: asking for help and withholding a response (Lyons & Ghetti, 2013). Although both studies looked at other predictors of strategic regulation, uncertainty monitoring was the only variable to emerge as a significant predictor in both, suggesting a central role in early strategic behavior. These results have the potential to inform parenting and educational practices with preschoolers, as fostering early efforts to introspect on one's mental state may promote advantageous help-seeking in early childhood and beyond.

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