The Role of Introspection in Children's Developing Theory of Mind.

by

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ABSTRACT

Understanding sources of knowledge (e.g., seeing leads to knowing) is an important ability in young children's theory of mind development. The research presented here measured if children were better at reporting their own versus another person's knowledge states, which would indicate the presence of introspection. Children had to report when the person (self or other) had knowledge or ignorance after looking into one box and not looking into another box. In Study 1 ($N = 66$), 3- and 4-year-olds found the other-version of the task harder than the self-version whereas 5-year-olds performed near ceiling on both versions. This effect replicated in Study 2 ($N = 43$), which included familiarization trials to make sure children understood the question format. This finding is in support of the presence of introspection in preschool-aged children. In the same studies, children also showed evidence for theorizing about their own and others knowledge states in a guessing task (Study 1) and in true and false belief tasks (Study 2). These findings together indicate both introspection and theorizing are present during young children's theory of mind development.

DEDICATION

I dedicate this thesis to Josh who put up with me through all this, and to my mother and father who did everything they could to make sure I was here in the first place.

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The role of introspection in children's developing theory of mind.

A hallmark of children's social development is learning how mental states (i.e., beliefs, knowledge, perception, desires, intentions etc.) determine how people view the world and as a result, guide their behavior within it. Specifically, children must develop a theory of mind (ToM). Over the last 30 years, researchers have examined when ToM develops in young children. A main focus has been children's performance on false belief tasks which children begin to pass around the time they turn four years old (Wellman, Cross, & Watson, 2001); however there has also been considerable examination of precursory abilities such as children's understanding of perception, desire, and knowledge (Wellman & Liu, 2004). Despite this large body of research, theorists have disagreed about how children's understanding of these mental states develops.

The development of metacognitive abilities such as introspection, an awareness of one's own mental processes, is one mechanism researchers have explored. The ability to use introspection is generally thought to be relatively late developing, emerging around middle childhood (Flavell, Green, & Flavell, 1995). Researchers have ruled out the presence of introspection in some stages of ToM development like the understanding of false belief. Children are no better at reporting their own false beliefs than they are at reporting other's false beliefs which is evidence against introspection (Gopnik & Astington, 1988; Fabricius & Khalil, 2003). However, evidence has been more inconsistent for earlier stages of ToM development, like the understanding sources of knowledge (i.e., seeing leads to knowing). For example, after having a child or another person look into a box to see what was inside, some researchers found that children were better at reporting their own knowledge than reporting others' knowledge (Ruffman &

Olson, 1989; Wimmer, Hogrefe & Perner, 1989) which is evidence for introspection; although, other investigators have found no difference in performance between self and other (Pillow, 1989; Pratt & Byrant, 1990).

The purpose of the present research is two-fold: to investigate the role of introspection in the development of children's theory of mind, and to resolve the inconsistent findings on children's understanding of seeing leads to knowing. Doing so informs theories of ToM development.

How theory of mind develops

There are two competing theories that describe how ToM develops, simulation-theory and theory-theory. Simulation-theorists propose that children use their own mind as a model to learn about and understand the minds of other people. In this view, children first recognize a mental state in themselves, and when reasoning about another person, children imagine themselves in that person's situation, introspect their own mental state within that situation, and then attribute the mental state back to the other person (Gordon, 1986; Harris, 1992). For example, in order to understand how a person might feel when walking down a dark alley, one could imagine him- or herself as the actual person in the alley, introspect a feeling of fear or anxiety, and then understand how the other person is feeling. For children to understand seeing leads to knowing, they would be able to introspect their own feelings of knowing after looking into a box, and for other people, they can imagine themselves as the person looking in box, introspect a feeling of knowing, and then attribute that back to the person.

Theory-theorists propose that people use naïve theories to understand their own and other people's mental states (Gopnik & Wellman, 1992). In this view, people do not

have direct access to their mental processes, but instead uses the same set of theories to reason about their own and other people's mental states. Using the same example as above, one would not have to go through the process of imagining him- or herself in the dark alley, but could instead just have a naïve theory that people are scared when in dark alleys. For children to connect seeing to knowing, children first must have a theory of seeing (e.g., when a person's lines of sight is directed towards an object, they are able to see that object) and a theory of knowing (e.g., when a person interacts with an object, they know something about it). Children then must connect the two so that seeing causes enduring knowledge (e.g., a person does not always have to see an object in order to know something about it).

There is strong evidence against children using simulation even at older ages. For example, Fabricius and colleagues (Fabricius, Boyer, Weimer, & Carroll, 2010; Fabricius & Imbens-Bailey, 2000; Fabricius & Khalil, 2003) found evidence for theorizing about false beliefs with children as old as six years old. They found preschool-aged children use two behavioral rules: "seeing leads to knowing," and "knowing means getting it right" to pass standard false belief tasks. Fabricius and colleagues called this Perceptual Access Reasoning (PAR). Children's overextension of PAR can be demonstrated when 4- and 5-year-olds pass false belief tasks, but fail a true belief tasks. For example in a false-belief version of an unexpected contents task, when a child is shown a Smarties candy box that contains pencils, 4- and 5-year-olds reason a person will think there are Smarties in the candy box because he does not know there are pencils inside. In the true-belief version, children are shown a candy box with pencils, but instead of putting the pencils back in the box, they are replaced with Smarties. The same 4- and 5-year-olds who pass a false

belief task will reason a person will think there are pencils in the candy box because he does not know there is candy inside. It is not until children are six or seven years old that they start reasoning about beliefs and pass both tasks.

The role of introspection in theory of mind development

Researchers have searched for evidence of introspection in ToM development in many domains of children's social reasoning and behavior. As minimum evidence for children to demonstrate introspection, children must not just act in accord with being in a state of knowing (e.g., searching in the correct place for an object when they know where it is), but they must demonstrate they also know they are in a state of knowing (Perner, 2012). Until recently, there were few instances where consistent evidence for introspection in young children could be found. For example, preschoolers are seemingly unaware of ongoing mental processes like stream of consciousness or thinking (Flavell, Green, & Flavell, 1995), and it is not until middle-childhood that children are able verbally report experiencing these events. The relatively late development of clear introspective abilities has even led some researchers to the counterintuitive claim that one might have to learn about others' minds before one is able to recognize his or her own mind (e.g., Gopnik, 1993), but this topic that is still widely debated (Carruthers, 2009).

There is some recent evidence that children may have more introspective ability than previously thought. With newer behavioral measures, 4- and 5-year-olds can show awareness of some of their mental states (Coughlin, Lyons, & Ghetti, 2014; Ghetti, Hembacher, & Coughlin, 2013; Hembacher & Ghetti, 2014). For example, Hembacher and Ghetti (2014) found that preschool-aged children were able to accurately judge their uncertainty in a memory task and later use this uncertainty to inform their decision

making. Children were able to say they were less certain about items in a memory task they studied only once versus items they studied twice. They were later able to excluded some of their answers to questions they were uncertain about in order to earn better prizes. Young children were able to accurately monitor the quality of their knowledge states which is something that they were previously thought to be incapable of doing.

This recent evidence leads one to suggest that a reevaluation of previous evidence of a lack of introspection in preschool-aged children is needed. The evidence for theorizing in ToM development has resulted in a diminished interest in measuring children's understanding of their own mental states. Some of the most widely used measures of preschoolers' ToM, such as the Scaling Theory of Mind tasks (Wellman & Liu, 2004), do not include a single measure of children's understanding of their own mental states. The previous studies where a self-other difference is found were explained as the result of methodological differences which caused some children to perform worse on the other-version of the tasks than on the self-version; but upon closer examination, there are issues with this claim that are unresolved.

Self and other differences in understanding seeing leads to knowing

The four studies that examined children's understanding of seeing leads to knowing for self and other shared many procedural elements. All the studies required participants to answer multiple questions about a person's knowledge after looking into a one box and ignorance after not looking into another box, and all the studies examined the developmental trends between 3- and 4-year-olds. Where the studies differed was in their scoring procedures, question format and inclusion of warm-up trials to their procedures. As seen in Table 1, the studies by Wimmer, Hogrefe and Perner (1988) and

by Ruffman and Olson (1989) found that 3- and 4-year-olds performed better on the self-version of the task than on the other-version of the task and that 4-year-olds performed better overall. The studies by Pillow (1989) and Pratt and Bryant (1990) found no difference in performance between self and other, and 3- and 4-year-olds performed equally as well.

The reason for the contradicting findings between the studies was initially explained as differences between their question formats (Pratt & Bryant, 1990). The study by Wimmer et. al. (1988) found that 4-year-olds performed better than 3-year-olds, and both groups did better for self than they did for other. The study by Pillow (1989) found no difference in performance for 3- and 4-year-olds, each group did equally well on for self and other. Pratt and Bryant argued that the reason why Wimmer et. al. found a difference between self and other was due to their question format being confusing for some children. In the study by Wimmer et. al., children were asked, "Do you / [other child] know what is in the box, or do you / [other child] not know that?" whereas the study by Pillow asked the simpler test question, "Do you / [other child] know what's in the box?" Pratt and Bryant attempted to replicate the study by Wimmer et. al. but found most participants interrupted the experimenter half way through the question. Pratt and Bryant took this as evidence that children found the question overly complicated, and when they were able to replicate the study by Pillow, finding no difference in performance between self and other using the simpler question format, they concluded that the study by Wimmer et. al. artificially lowered children's performance on the other-version of the task, but not the self-version. A problem with this claim is the study by

Ruffman and Olson (1989) who like Wimmer et al. also found a difference between self and other, but counter to Pratt and Bryant's explanation, did so using the simple test question format.

Because the self-other difference in children's performance on seeing leads to knowing tasks in these studies cannot be explained by the different question formats, one of the only remaining explanations for the conflicting findings is difference between the studies scoring procedures. All four studies required children to correctly answer a knowledge and an ignorance question to be scored as correct. This method prevented children from erroneously being scored as correct through a yes-bias or a no-bias. The difference between the studies was how performance for self and other were scored from these questions. To be scored as correct for self or other in the studies by Wimmer et. al. (1988) and Ruffman and Olson (1989), children's answers were scored *within-agent* but *across trials* (see Figure 1). For example, children were scored as passing self only if they correctly answered the knowledge question when they looked in the box in the first trial and the ignorance question when they did not look in the box in the second trial. The result of this method was children were only able to answer the questions about the other person through theorizing that seeing leads to knowing. Children were able to able answer questions about themselves through theorizing or introspection. To be scored as correct for self or other in the study by Pillow, children's answers were scored as *within-trial* but *across-agents*. The study was more interested in determining if children could answer a knowledge and ignorance question when the child looked into a box versus answering a knowledge and ignorance questions when someone else looked. For example, children were scored as passing self if they could correctly answer both the

knowledge question about themselves and the ignorance question about the other person when the child looked into a box. Children could answer the first question through introspection or theorizing and the first question through theorizing.

It is likely that children who only had introspection would be scored as doing better overall when using the scoring procedures in the study by Pillow (1989) compared to the procedures used by Wimmer et. al (1988). To be scored as correct for self or other, children could answer the question about themselves through introspection and could guess on the question about the other. This changes the performance that would be expected by chance alone. Children without theorizing who were scored *between-trials* for other would have to guess on two questions. The only way to understand what the other person knew was to make the theoretical connection between seeing and knowing. If these questions are scored *within-trials*, introspection and theorizing cannot be separated.

There is one issue with the argument that the different scoring procedures changed children's performance. The study by Pratt and Bryant (1990) used the correct scoring procedures to separate the use of theorizing ad introspection, but they did not find a difference in performance between self and other. The only remaining procedural difference with the study by Wimmer et. al. (1988) was the study by Pratt and Bryant included a set of warm-up trials in their procedures. Before children received any of the test trials, the experimenter gave the children different colored tokens and asked them a set of Yes/No questions: "Does (other) have the green tokens?" and "Do you have the green tokens?" in order to make sure children were capable of answering the test questions. Whereas there is no immediately apparent reason why these warm-up trials

would change children's performance, there is a possible explanation. A potential problem in all four of the studies is the chance of a carry-over effect between trials. Within each trial, the child and the other person always had opposite mental states. One person always had knowledge and the other person had ignorance. Children with introspection would be able to know when they knew the contents of the box and when they did not. Over repeated trials, they could then learn to default the opposite mental state to the other person. This would allow for correct responses without ever having to theorize about seeing leads to knowing. In the three studies before Pratt and Bryant, there were a limited number of trials, which would minimize the chance of a carry-over effect, but the inclusion of warm-up trials potentially trained children on this procedural-regularity before any of the actual test trials were given. This difference in methodology could explain why children who did not have theorizing performed just as well as children who did.

In summary, the four studies looking at self and other presented conflicting results. The studies by Wimmer et. al. (1988) and Ruffman and Olson (1989) both found that 4-year-olds performed better than 3-year-olds, and that both age groups performed better for self and they did for other. In contrast, the study by Pillow (1989) and the study by Pratt and Bryant (1990) found no difference in performance between self and other, and that 3-year-olds were able to theorize about seeing leads to knowing for other people just as often as 4-year-olds. Pratt and Bryant attempted to explain this discrepancy as a result of the different question formats, but this study did not address the different scoring procedures used in the study by Pillow. The effect of question format did not replicate with Ruffman and Olson, which rules it out as a possible explanation. Additionally, the

lack of a self-other difference in the replication attempt by Pratt and Bryant can be explained by addition of warm-up trials, which inadvertently trained children on how to get the correct answer without theorizing.

The Current Studies

The current studies examined the role of introspection in children's developing theory of mind. Evidence for children's introspective ability during the preschool years has been sparse with only a few recent publications providing evidence that children may have some limited capabilities (Coughlin et al., 2014; Ghetti et al., 2013; Hembacher & Ghetti, 2014). As an improvement over previous studies, children completed tasks that differentiated between their use of theorizing and introspection in their understanding of seeing leads to knowing. Children completed separate tasks to measure their understanding of their own and someone else's knowledge state. It was hypothesized children would show evidence for introspection by performing better on self-version of the task versus the other-version of the task. Second, it was hypothesized that the same children would also show evidence for theorizing and not simulation when asked to reason about the mental states of other people. This was seen by examining overextensions of children's naïve rules for how mental states are related to behavior such as children's understanding of guessing and on children's use of PAR.

Study 1

The purpose of this study was to resolve the conflict from the literature on children's understanding of seeing leads to knowing by testing children's ability to reason about their own and someone else's knowledge using separate tasks. Using separate tasks for self and other removes any chance that children could use introspection to answer

questions about the other person's knowledge, and could only use theorizing. The probability for any carry-over effect is diminished because the child's mental state was independent of the other person's mental state. Any difference in performance between the two versions of the task would be evidence for introspection.

It was also predicted that even with the presence of introspection, children should still show evidence of theorizing and not for simulation. Children who were theorizing about knowledge states should overextend naïve rules about how mental states and behavior are related. This hypothesis was tested using a guessing task which measured children's use of the rule" knowing means getting it right." Using this rule, children should infer that a person who correctly guessed the location of an object knew where it was, and a person who guessed incorrectly did not know where it was even though that the person never actually knew where it was to begin with. Children who simulate a feeling of knowing in each case would say that the person never knew where the object was. It was predicted that even with evidence for introspection in the seeing leads to knowing tasks, children would still show evidence for theorizing in the knowing means getting it right task.

Method

Participants

Sixty-six children ages 3-0 to 6-0 participated in this study. Children were recruited from university-sponsored preschools in a large metropolitan area in the Southwestern United States. There were thirty-two 3-year-olds (14 female, *M* = 3-6, range = 3-0 to 3-11), nineteen 4-year-olds (eight female, *M* = 4-6 range = 4-0 to 4-11), and fifteen 5-year-olds (five female, *M* = 5-5, range = 5-0 to 6-0). No information about

the participants' ethnicity or socioeconomic status was explicitly obtained, however, most participants were from middle-class, European-American families, and all were native speakers of English.

Materials

Twelve small wooden boxes of various colors (red, white, blue and green) were used. Each box could be closed with a lid on a hinge. For the seeing leads to knowing tasks, one of the boxes contained a small bronze key. For the knowing means getting it right tasks, two boxes contained a small pencil, which was glued down inside the box. Two other boxes contained a penny, which was also glued down. All of the remaining boxes were empty. Another penny and pencil were used to show the child what the object looked like during knowing means getting it right tasks. Three plastic dolls were used in the other-versions of all the tasks.

Design and Procedure

Participants were tested individually during the school day in a quiet room away from other children. The participant sat across from the experimenter at a small table, and a video camera recorded the participant's responses. Participants received nine tasks that tested their understanding of several mental state concepts. Only four of those tasks were analyzed for the current study. These tasks were the self- and other-versions of the Seeing Leads to Knowing, and Knowing means Getting it Right tasks. Participants received the tasks in a random order with some constraints. For both the self and other versions of each task, the Seeing Leads to Knowing task was always immediately followed by the corresponding Knowing means Getting it Right task.

Seeing leads to knowing. The Seeing Leads to Knowing task measured participants' understanding of perception as a source of knowledge. The task measured participants' ability to report a person's knowledge after looking in one box and ignorance after not looking into a second box. In two separate tasks, participants' ability to report this for themselves (self) and for another person (other) were tested using new materials for each version of the task. In the self-version, the participant looked into one box and did not look into the second box. In the other-version, the participant watched as a doll looked into one box and did not look into the second box. Participants had to differentiate that the person (either the participant or the doll) knew the contents of the first box but did not know the contents of the second box.

In each version of the task (See Figure 2), the experimenter placed two different colored boxes on the table. In the self-version, one of the boxes contained a key, and the other box was empty. In the other-version, both boxes were empty, but the experimenter acted out having the doll see something in one of them. The experimenter told the participant "I'm going to show [you/doll] what is in the [first] box, but not what is in the [second] box" and then opened the first box. In the self-version of the task, the participant identified the object and held it briefly. In the other-version of the task, the experimenter acted out the doll looking into the box and saying, "Okay I see what's in the box" (the participant was not allowed to see in). In both versions, the experimenter then closed the box and said, "I'm going to ask you if [you/doll] knows what is in each of these boxes. Tell me "yes" if [you/doll] knows or "no" if [you/doll] doesn't know." Before asking each of the test questions in the other-version, the experimenter reminded the participant of the doll's perceptual access by saying "[Doll] looked in the [first] box" or "[Doll] did

not look in the [second] box," This was followed by the knowledge-question, "Do [you/doll] know what is in the [first] box?" and the ignorance-question, "Do [you/doll] know what is in the [second] box?" If the participant did not give a discernibly affirmative or negative response to the test question, the instructions to answer with "yes" or "no" and the question were repeated once. If the participant did not give a discernable response again, his or her response was counted as an incorrect, and the participant was scored as not passing the task.

Knowing means getting it right. The Knowing means Getting it Right task explored children's theorizing about the relationship between knowledge states and behavior. The use of this rule was tested in both the children themselves, and for children's understanding of other people. The experimenter placed two unopened boxes on the table and showed the participant an object, a penny in the self-version or a pencil in the other-version. In the self-version of the task, the participant guessed which of two boxes also contained a penny. In the other-version, the participant watched as a doll guessed which box contained a pencil. For each version, participants received two trials, a right-condition trial and a wrong-condition trial. In the right-condition, both boxes contained the object and the person was always right, and in the wrong-condition, with two new boxes (and a new doll in the other-version), neither box contained the object and the person was always wrong. Participants received the right-condition first, and the wrong-condition second.

In both the self- and other-version of the task (See Figure 3), the experimenter showed the participant the penny or pencil and said, "See this [object]? One of these boxes has a [object] just like this in it." In the self-version, the experimenter asked the

participant to pick a box. In the other-version, the experimenter acted out having the doll pick a box. In both versions, the experimenter then said, "I'm going to ask you if [you/doll] knew where the [object] was when [you/doll] picked this box. Tell me "yes" if [you/doll] knew or "no" if [you/doll] didn't know." After this, the experimenter opened the box and said, "[You/doll] got it right." in the right-condition or "[You/doll] got it wrong." in the wrong-condition. This was followed by the test question, "Did [you/doll] know where the [object] was when [you/doll] picked this box?"

Results and Discussion

Seeing leads to knowing

There were four response combinations possible between the knowledge- or ignorance-questions. The correct response pattern was an affirmative response when the person knew and a negative response when the person did not know[1]. The three incorrect patterns consisted of two affirmative responses (Yes Bias), two negative responses (No Bias) or the opposite of the correct pattern (Inverse). The proportion of participants who gave each response pattern in the self- and other-versions of the task is shown in Table 2. Participants performed better on the self-version of the task than on the other-version. One participant did not complete the other-version of the task due to experimenter-error which means only 65 participants had complete data.

[1] In the self-version of the task, some participants answered by saying the actual contents of the box in the knowledge-question, (e.g., they answered with "a key"). This was counted as a correct affirmative response as long as they also correctly answered the ignorance-question with a negative response. This same procedure was used in all previous studies.

To examine children's use of introspection, a multilevel logistic regression was conducted using Mplus version 7.1 (Muthén & Muthén, 2007). A multilevel model is analogous to a repeated measures ANOVA but offers several advantages such as potential for increased power and better handling of missing data (Cohen, Cohen, West, & Aiken, 2002). Logistic regression was used for dichotomous data. A logistic transformation turns the probability of being scored as passing the task from a value bounded between zero and one into a "logit score" which is on a continuous scale. This transformation was done by the following equation:

$$logit = \ln\left(\frac{p}{1-p}\right)$$

where *ln* is the natural logarithm and *p* is the probability of being scored as correct. Using this transformation, a logit of zero represents a 50% chance of being scored as passing. This also represents even odds of passing or an odds ratio of one (the natural logarithm of one is zero). Logit scores greater than zero or an odds ratio greater than one represent an increase in probability and logit scores less than zero or an odds ratio less than one represent a decrease in probability (Cohen et al., 2002).

The results of the regression analysis are reported in Table 3. Person (Self vs. Other) was treated as a within-subject predictor, and age and gender were used as between-subject predictors. Overall, the logistic model significantly improved fit over a null model, $\chi^2(3) = 31.71, p < .001, R_L^2 = .20$. There was an effect of age where probability of passing the tasks increased steadily with age. There was also an effect of person; participants' probability of passing the other-version of the task was lower than the probability of passing the self-version. The effect of gender was not significant, and

there were no significant interactions. The predicted probability of passing each version of the task at every age is illustrated in Figure 4. Participants reached a 50% chance of passing the self-version around 39-months-old; however, participants did not reach a 50% chance of passing the other-version until 46-months-old. This suggests there was about a seven month gap when participants only had introspection to their knowledge, but did not understand the source of that knowledge.

Knowing means getting it right

There were four response combinations possible between the right- and wrong-conditions in the knowing means getting it right task. Table 4 shows the proportion of participants who responded with each pattern. Only a small minority of participants responded with the correct pattern by saying the person did not know in both the right- or wrong-condition trials. The majority of participants responded with an affirmative response in the right-condition and a negative response in the wrong-condition which is indicative of theorizing. Several participants did not give a discernibly affirmative or negative response in one or both of the conditions. The most common occurrence of this happened in the wrong-condition in the self-version of the task. When asked if they knew where the object was when picking the box, many participants made the logical inference of the object's location and pointed to that box or said the object was in there. In all these occurrences, participants also responded affirmatively in the right-condition. To be conservative, all participants who gave a non-response were scored as failing the task.

The relation between participants who used theorizing in the seeing leads to knowing and theorizing in the Knowing means Getting it Right task was examined. Because several participants' responses in the self-version of the Knowing means Getting

it Right task were difficult to interpret, only the other-version of each task was analyzed. The impact of participants' performance on the seeing leads to knowing task was significant, $\chi^2(1, N = 65) = 4.90, p = .027$. Of the 36 participants who passed the Seeing Leads to Knowing task for other, 30 of them gave the theorizing response in the knowing means getting it right task, while the 29 participants who failed the seeing leads to knowing task for other were more evenly distributed with only 17 giving a theorizing response.

Study 2

The findings from Study 1 suggest that younger preschoolers are better at reporting their own knowledge than reporting others' knowledge. This is evidence for introspection playing a role in children's theory of mind development. Previous studies (Wimmer et. al., 1988; Pillow, 1989) have found inconsistent evidence for a self-other difference, but these mixed findings can be explained by the study's procedures not controlling for the child's introspective awareness. There still is a remaining possibility that the pretest familiarization trials in the study by Pratt and Bryant (1990) managed to improved participants' performance in some other way besides training participants on procedural regularities. To address this issue, familiarization trials were added to the procedures for the Seeing Leads to Knowing task from Study 1.

The Knowing means Getting it Right task from Study 1 put children's use of theorizing about a person's knowledge directly in conflict with their understanding of seeing leads to knowing. Most participants showed evidence for theorizing about other people's knowledge, using the behavior rule, however there was some considerable noise

in children's responses in the self-version of the task. A more pure measure of children's use of theorizing for both self and other is needed.

It is also unclear how children's understanding of seeing leads to knowing corresponds to performance on false-belief tasks. Some studies have found a delay between acquiring an understanding of seeing leads to knowing and passing a False Belief task (Hogrefe, Wimmer, & Perner, 1986; Wellman & Liu, 2004). This delay means that understanding seeing leads to knowing is a necessary, but not sufficient condition for passing the False Belief task. However, it is unclear if these findings will be replicated with the current procedures for the Seeing Leads to Knowing task. If children's abilities were artificially inflated in the older procedures, it is possible that understanding seeing leads to knowing could be a sufficient condition for passing the False Belief task. A second possibility is that both an understanding of seeing leads to knowing and the knowing means getting it right are needed to pass a false belief task, and additionally a delay could stem from children acquiring each concept individually, and then having to learn to use them together.

Method

Participants

Forty-three children between the ages of 3-1 and 5-11 participated in this study. Participants were recruited from university-sponsored preschools in a large metropolitan area in the Southwestern United States. There were nineteen 3-year-olds (ten female, *M* = 3-6, range = 3-1 to 3-11), twenty-one 4-year-olds (six female, *M* = 4-4, range = 4-0 to 4-10), and three 5-year-olds (one female, *M* = 5-8, range = 5-1 to 5-11). Because there were

so few 5-year-olds in the study, the data for the 4- and 5-year-olds were collapsed together when age was not used as a continuous predictor. Ethnicity for the participants was non-Hispanic or non-Latino (81%) and Hispanic or Latino (16%) or not reported (2%). Participants' race was Caucasian (83%), African American (2%), Asian (2%), Native American (2%) and multi-racial or another race (7%). Most participants were native speakers of English (95%). If English was not reported as their native language, teaching staff reported them to have proficient English skills (5%). Participants came from two-parent households (84%), single parent households (12%), and households with more than two adults (4%). Parents' highest level of education ranged from completion of high school to a PhD or MD. Median education was a college degree for both mothers and fathers. Household income ranged from less than $15,000 a year to over $100,000 a year with a median income of between $75,000 and $100,000 a year.

Materials

The Pre-test used small plastic tokens of different colors (red, blue, yellow). The same kinds of materials for the Seeing Leads to Knowing task from Study 1 were used again here. The Knowing means Getting it Right task used four pairs of wooden boxes painted different colors. The warm-up trials for that task used two plain colored wooden boxes, and one box contained a Lego block. The Belief Understanding Task used separate materials for the True Belief and False Belief tasks. The False Belief task used a typical crayon box and a small toy car was the unexpected item found inside the box. The True Belief task used a movie-theater style box of M&M candies. The M&M candies were kept in a clear plastic cup, and a small bronze key was used as the unexpected item found in the box.

Design and Procedure

Participants were tested individually during the school day in a room away from other children. The participant sat across from the experimenter at a small table, and two video cameras recorded both the participant and the experimenter. Participants received the tasks in one of four fixed orders with the Seeing Leads to Knowing tasks first, followed by the Knowing Means Getting it Right tasks and the True Belief and False Belief tasks. The order of the Self and Other versions of each task, and the order of the true and false belief tasks were counterbalanced.

Pretest. Like Pratt and Bryant (1990), all participants started with a brief pretest. The purpose of this was to familiarize participants with the question format used in the remaining tasks, and to exclude any participants who could not follow this procedure. Participants answered three sets of questions where they were instructed to answer "yes" or "no." Following Pratt and Bryant's (1990) criteria, any participant that could not answer two of the three sets correctly was excluded from the remaining tasks.

The experimenter placed three plastic tokens on the table asked the participant to say the color of each token. The experimenter removed one token and pointed to one of the two remaining tokens. In the first question of the set, the experimenter called the token the wrong color and asked, "Is this the [wrong color] token?" After the participant's response, the experimenter pointed to other token, called it the right color and asked, "Is this the [right color] token?" This made sure the participant could respond to the experimenter with both yes and no. The experimenter swapped one of the tokens with the one removed previously, and the procedure was repeated three times. Only two

participants (one 3-year-old and one 4-year-old) failed to answer two sets of questions correctly. Those participants were excluded from further analysis.

Seeing leads to knowing. Participants' understanding of seeing leads to knowing was measured using the same procedures from Study 1.

Knowing means getting it right. Like Study 1, the Knowing means Getting it Right task explored participants' use of theorizing. This was accomplished by asking participants to predict if a person would act correctly or incorrectly when the person had knowledge or was ignorant of an objects location (see Figure 5). This is in contrast to Study 1 where the participant reported a person's knowledge after the person acted correctly or incorrectly. Participants were tested separately for self and other.

To start, participants received a brief pretest. The experimenter placed two plain-wood colored boxes on the table and the participant looked into both. One box had a Lego block inside, and the other box was empty. The experimenter then closed the boxes and asked the participant where the right place to look for the block was, and then asked where the wrong place to look for the block was. The purpose of this was to disambiguate what the experimenter meant when asking if a person would look in the "right" box. Two 3-year-olds could not answer both pretest questions correctly and were excluded from analysis in this task.

In both the self- and other-version, the experimenter placed two boxes on the table. In the self-version, the experimenter said, "Here are two boxes. One of these boxes has a pencil inside," and then opened the boxes briefly to show the participant where the object was. In the other-version, the experimenter placed a doll on the table and said "These are two cupboards in [Doll's] kitchen, and one of the cupboards has some

crackers in it." The boxes were never opened. In both versions, the experimenter then told the participant "[You/Doll] know where the [pencil/crackers] is" and then asked the test question, "When [you/doll] first look for the [pencil/crackers], will [you/doll] look in the right box?" After the participant's response, the experimenter asked a justification question, "Why [will/won't] [you/doll] look in the right box?" The experimenter then placed two new boxes on the table. In self-version, the experimenter said, "Here are two more boxes. One of these boxes has a rock inside." In the other-version, the experimenter said, "These are two toy boxes in [Doll's] room. One of the toy boxes has a teddy bear in it" and the boxes were never opened. In both versions of the task, the experimenter then told the participant "[You/Doll] don't know where the [object] is" and asked the same test and justification questions. This required participants to predict a person's behavior in a knowledge- and ignorance-condition.

Belief understanding. Participants' belief understanding was be assessed using the procedures from Fabricius et al (2010). Participants were given a standard False Belief task, and a True Belief task. The combination of these two tasks allowed participants' belief understanding to be categorized into reality reasoning (RR), perceptual access reasoning (PAR), a mixture between RR and PAR, and belief reasoning (BR).

In the false belief task, participants were shown a typical crayon box, and asked what they thought was inside. After the participant correctly guessed "crayons," the experimenter opened the box to show the participant there was really a car inside. The participant held the object for a moment, and the experimenter placed the car back inside the box then closed it. The experimenter asked two control questions: "What kind of box

is this?" and "What is inside the box now?" If the participant answered either question wrong, the participant was corrected and asked the question again. The experimenter set up the test question by first saying, "Let's pretend I have a friend named Suzie waiting right outside. She's never seen inside this box" and then the experimenter asked "When she first looks at this box, before she opens it, will she think there are crayons or a car inside?" The order of saying the belief or reality option first in the test question was counterbalanced. After the participant's response, the experimenter asked the justification question "Why will she think there is [crayons/car] inside?"

In the true belief task, the experimenter showed the participant the M&M's candy box, and asked the participant what they thought was inside. The experimenter opened the box and showed the participant there was really a key inside. Instead of putting the key back in the box, the experimenter took out a clear plastic cup filled with M&M's and poured it into the box. The participant was asked two control questions: "What is inside the box now?" and "What was inside the box when I first showed it you?" If the participant answered either question wrong, the participant was corrected and asked the question again. The experimenter then removed the empty cup and key from the table and asked the test and justification questions in the same format as before only replacing the character Susie with a new character (Sam).

Results and Discussion

Seeing leads to knowing

Performance on the self- and other-versions of the Seeing Leads to Knowing task was analyzed the same way as it was in Study 1. The proportion of participants who gave each combination of affirmative and negative responses within the self- and other-

versions in the task is shown in Table 2. Like in Study 1, participants' performance on both tasks improved with age, but performance was better in the self-version than in the other-version for both age groups.

To see if the effect of person in Study 1 replicated in Study 2, a continuously cumulating meta-analytic (CCMA) approach was taken. The CCMA approach corrects for the increased probability of not replicating small to moderate effect sizes when using similar sample sizes. This is done by pooling the data from both studies together, and using Study as a predictor in the analysis (Braver, Thoemmes, & Rosenthal, 2014; Rosenthal, 1990). If the effect of study and its interactions are not significant, then it can be said the effect of person replicated. If the effect of study or its interactions is significant, then the effect of person can be said to not replicate and the effect was dependent on the study.

The results of the CCMA multi-level logistic regression analysis are reported in Table 3. The effect of Study was non-significant, but the effect of Person and Age remained significant. There were no significant interactions. The logistic model still significantly improved fit over a null model, $\chi^2(4) = 36.33, p < .001, R_L^2 = .14$.

Knowing means getting it right

In both the self- and other-versions of the task, there were four response combinations between the two test questions. Table 4 shows the proportion of participants who responded with each pattern. In contrast to Study 1, only a minority of participants gave the response expected with theorizing. The majority of participants responded in the Yes Bias pattern. Most participants said the person would be right when they knew and also when they did not know.

This pattern of responses was unexpected, because the majority of participants in Study 1 gave the response expected with theorizing. One possibility is that participants misunderstood the test questions as *can* the person (i.e., is the person capable of) looking in the right box instead of *will* the person look in the right box. This is supported by the fact that most participants responded with the Yes Bias pattern here whereas in Study 1, the proportion in each error patterns was more even distributed. Additional evidence comes another study that examined children's use of knowing means getting it right in a No Belief task (Fabricius, Carroll, Weimer, and Boyer, 2009). The No Belief task is analogous to the ignorance question in the Knowing means Getting it Right task. In both tasks, participants had to predict if a person would chose the correct or incorrect option. In the No Belief task, the participant knew which box was right and which box was wrong. In the current task, the participant did not know which was correct and which was incorrect. Fabricius and colleagues (2009) found that around 50% of a sample of 4-year-olds answered a person who had no belief would choose the wrong option. Because there were so few participants who responded this way in the current task, this finding suggests participants misunderstood the test question. Another possibility is making participants think about the right and wrong options more abstractly could have been too challenging for them.

Belief Understanding

Children's performance on the False Belief and True Belief tasks were categorized as Reality Reasoning (RR), mixtures, Perceptual Access Reasoning (PAR), or Belief Reasoning (BR) using the coding scheme suggested by Fabricius and colleagues (2010, see Appendix A). As a brief summary, participants who failed the False Belief

task but passed the true belief task were categorized as RR. Children who failed the True Belief task, but passed the False Belief task were categorized as PAR. Children who passed both the True Belief and False Belief tasks and also provided a correct justification (e.g., "because it's a crayon box") were categorized as BR. Children who passed both tasks but did not provide the correct justifications, or children who failed both tasks were categorized as a mixture between RR and PAR. The proportion of participants in each category is presented in Table 5. The majority of 3- and 4-year-olds were categorized as RR while the proportion of children who were in other categories increased with age. There was significant agreement in categorization between two raters, $\kappa = .899, p < .001$.

Because there were issues with the Knowing means Getting it Right task, only the relation between performance on the Seeing Leads to Knowing task and participants' Belief Understanding was examined. The number of children who passed the other version of the seeing leads to knowing task was compared to the proportion of children who passed the False Belief task. Performance on the Seeing Leads to Knowing to task had a significant effect on the performance on the False Belief task, $\chi^2(1, N = 41) = 5.33, p = .021$. Only two of the 17 participants who failed the Seeing Leads to knowing task passed the False Belief task. Of the 24 participants who passed the other-version of seeing leads to knowing, performance was more evenly distributed with 11 passing and 13 failing the Seeing Leads to Knowing task. This finding is in line with previous studies (e.g., Wellman and Lui, 2004) that suggests understanding seeing leads to knowing is a necessary, but not sufficient condition of the False Belief task.

General Discussion

Until recently (Hembacher & Ghetti, 2014), there was little evidence that preschool children are capable of introspection; most children are not able to verbally report any conscious awareness of their own mental states (Flavell et al., 1995) or do not show any sort of advantage when reporting their own false beliefs over the false beliefs of other people (Gopnik & Astington, 1988; Wellman et al., 2001). One area with conflicting findings in previous studies has been in children's ability to report their own knowledge versus the knowledge of someone else; some researchers found that children had a self-advantage (Ruffman & Olson, 1989; Wimmer, Hogrefe, & Perner, 1988) which is indicative of introspection, whereas other researchers found no difference between self and other (Pillow, 1989; Pratt & Bryant, 1990). This contradiction in the literature was initially explained simply as an artifact caused by differences in the studies methodologies; however, this explanation failed to take into account all the studies available at the time which discounts it as a possible explanation. The methodologies from some of the studies could not separate children's use of introspection from theorizing. This omission resulted in artificially inflating children's performance for other while leaving performance for self unaffected.

The present studies looked to resolve this problem by introducing improved procedures which could more easily separate children's use of introspection and theorizing using separate tasks for self and other. Three- and 4-year-olds found the self-version of the seeing leads to knowing task easier than the other version, and it was not until children were four years old that the majority of children were able to pass both versions of the task. Only 5-year-olds performed equally well in both tasks. These

findings are in support of children being capable of introspecting their own feeling of knowing.

In support of this view, there is additional evidence in previous literature that suggests there are real qualitative differences between 3- and 4-year-olds in their understanding of seeing leads to knowing. Whereas researchers in two of the four studies reviewed above found no difference in 3- and 4-year-olds, there many other studies where 3-year-olds did not do well as well as 4-year-olds (Hogrefe et al., 1986; Marvin, Greenberg, & Mossler, 1976; Wellman & Liu, 2004). In these studies, it was not until children were four years old that a majority of children passed tasks that measured their understanding of seeing leads to knowing in other people. Although some of the differences in these studies could be explained as sampling error, there are other studies that demonstrated 3-year-olds have a limited understanding of seeing leads to knowing compared to 4-year-olds. For example, Perner and Ogden (1988) found that most 4-year-olds could explain why a person had knowledge after looking in a box, but the majority of 3-year-olds could not. This finding was not due to some general problem with justifying internal states since most 3-year-olds could explain other internal states like hunger. Together, findings from studies like these casts doubt on the claim that there is no difference between 3- and 4-year-olds' understanding of seeing leads to knowing.

It is clear from the findings from this and other recent studies that young children are capable of introspection; however, neither simulation-theory nor theory-theory can explain why children would be capable of both introspection and theorizing. Some theorists have proposed possible hybrid models which allow for an interaction between simulation (i.e., introspection) and theorizing (e.g., Saxe, 2005). A question that arises

with proposing these types of hybrid models is why children would ever need both introspection and theorizing because the two abilities so often overlap in their predictive usefulness.

One possibility is that the two systems are actually redundant and develop independently of each other. Children would use theorizing in some situations and introspection in other situations. What determines which ability is used would just be the specific, situational context. There would be some occasions when children would introspect their knowledge states (e.g., the seeing leads to knowing task), and other occasions when children would theorize about their knowledge states (e.g., the knowing means getting it right task). To argue for this model though, one would have to determine how introspection or theorizing provided an advantage over the other in each situation.

A more compelling possibility is that the introspection and theorizing interact with one another and develop concurrently. Although it is possible that children could learn about the relation between seeing and knowing by only observing the relation between typical behavioral cues (e.g., line of sight, acting correctly), the presence of introspection allows for a more efficient path for children to recognize the relation between seeing and knowing. Children with introspection are aware of when they know and when they don't know and thus would be able to recognize when they change from one state to the other. Children would then be able to search for events that co-occur with this change such as changing from not seeing to seeing. Over repeated exposures to these two events co-occurring, children would be able to recognize the relation between the two states more readily than relying on the behavioral cues alone.

Only theorizing about observed behavioral cues actually presents several challenges to children. There are instances were relying on the behavioral cues to seeing and knowing would actually interfere which children's ability to recognize the relation between the two, such as instances of guessing and forgetting. With guessing children

would witness a person who did not have a line of sight but still managed to act correctly, and with forgetting, they would witness a person having a line of site but acting incorrectly. By only theorizing about the behavioral cues, children would incorrectly conclude that there was no relation or possibly even a negative relation between seeing and knowing in these events. Theorizing about introspective experiences in both cases allows children to correct their wrong assumptions about the behavioral cues. In the case of guessing, children would recognize they did not see and did not know, but still managed to act correctly. In the case of forgetting, they would recognize they did see and did know but some other factor lead them to forget. Theorizing about introspective experiences in these cases leads children to eventually update their assumptions about behavioral cues into more complex indicators of mental states.

Limitations and Future Directions

In order to make stronger claims about the causal influence of introspection in children's ToM development, there is a clear need for longitudinal data that demonstrates that children must first learn about their own knowledge states before they can learn about someone else's knowledge states. The cross-sectional data children are first passing the self-version of the task before the other-version, but without data on the developmental trajectories of individual children, no stronger claims can be made than children simply finding the other-version harder than the self-version.

It is possible that there could be several trajectories for how children learn about other people's mental states. Some children might not use introspection and only use theorizing to understand their own and others mental states. Individual differences in these patterns could be a potentially fruitful endeavor for future research. For example,

children with autism spectrum disorders do not pass false belief tasks until much older ages than typically developing children even when controlling for mental age (Baron-Cohen, Leslie, & Frith, 1985). These children do eventually pass false belief tasks; however, it has always been assumed that they do so in a way that is somehow different than typically developing children (Frith, 2004). It is possible that their delay in theorizing could be in part due to the inability to introspect their own mental states in order to facilitate theory building. Further evidence is needed to support the recent findings for introspection in typically developing preschool children before stronger claims can be made about atypical development.

If children are capable of introspecting their knowledge states, they must also be capable of introspecting other earlier developing mental states as well, such a children's understanding of perception. Most 2 ½ -year olds can demonstrate an understanding of level-1 perception, determining what a person can and cannot see (Flavell, Everett, Croft, & Flavell, 1981), which is about the earliest age in which verbal-based tasks are appropriate for young children. There has so far been no evidence that children are able to report their own level-1 perception any more accurately than other's level-1 perception; however, most of these studies suffer from a similar problem as the seeing leads to knowing tasks. In most cases, the other person's perception is always the opposite on the child's perception. One person always sees the object, and the other person does not. It is possible that these tasks could be inflating children's understanding of level-1 perception in other people in manner similar to the previous versions of the seeing leads to knowing task. If a self-other difference is found, then it would suggest that introspection is an integral part children's early ToM development.

Conclusions

The contradiction in the literature on children's understanding of seeing leads to knowing has been unaddressed for over 25 years. Children performed better on the self-version of the seeing leads to knowing task than on the other-version, which is indicative of introspection. The current findings add to the recent evidence for young children are capable of some introspective abilities.

Evidence for both introspection and theorizing in children's understanding of mental states has the potential to help resolve one of the critical issues in research on ToM, how children construct a concept of other minds. Neither of the leading current theories of children's ToM development can explain why both introspection and theorizing would be present in young children. New models that incorporate introspection and theorizing into children's theory of mind development are needed.

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Table 1

Proportion of children in previous studies who understood seeing leads to knowing for self and other.

Study	Features		Mean Age	Self	Other
Wimmer Hogrefe & Perner (1988)	• Complex question format • Separates introspection and theorizing • Low carry-over effect	Study 1	3-7	.50	.13
			4-6	.94	.56
		Study 2	4-7	.86	.64
		Study 3	4-2	.90	.65
Ruffman & Olson (1989)	• Simple question format • Separates introspection and theorizing. • Low carry-over effect	Study 1	3-6	.87	.39
		Study 2	3-7	.82	.41
Pillow (1989)	• Simple question format • Conflates introspection and theorizing • Low carry-over effect	Study 1	3-5	.69	.56
			4-6	.69	.75
Pratt & Bryant (1990)	• Simple Question format • Separates introspection and theorizing • High carry-over effect	Study 2	3-8	.81	.75

Table 2.

Proportion of Children in each Response Pattern in the Seeing Leads to Knowing task for Self and Other in Study 1 and Study 2.

Study 1

Response Pattern	Condition		Person and Age					
			Self			Other		
	Know	Don't Know	3	4	5	3	4	5
Correct Pattern	Yes	No	.53	.79	.93	.34	.58	.93
Yes Bias	Yes	Yes	.34	.11	.07	.25	.21	-
No Bias	No	No	.03	-	-	.16	.21	-
Inverse	No	Yes	-	.05	-	.13	-	-
	Non-Response [a]		.09	.05	-	.13	-	-

Study 2

Response Pattern	Condition		Person and Age			
			Self		Other	
	Know	Don't Know	3	4	3	4
Correct Pattern	Yes	No	.56	.83	.44	.70
Yes Bias	Yes	Yes	.28	.17	.28	-
No Bias	No	No	.11	-	.11	.17
Inverse	No	Yes	.06	-	.17	.13
	Non-Response [a]		-	-		

[a] Children in this pattern did not give a discernable affirmative or negative response in one or both conditions.

Table 3.

Summary of Multilevel Logistic Regression Analysis for Seeing Leads to Knowing Performance in Study 1 and Study 2

Study 1			
Predictor	*B*	*SE B*	*OR*
Person (Self vs. Other)	-1.241*	.574	.289
Gender	-.775	.735	.461
Age (in months)	.202***	.059	1.224
Constant [a]	.579	.642	1.784
Model χ^2 (3)= 31.71, p < .001			
R_L^2 = .20			
Study 2			
Predictor	*B*	*SE B*	*OR*
Study (CCMA)	.241	.558	1.27
Person (Self vs. Other)	-1.159**	.432	.314
Gender	-.403	.560	.668
Age (in months)	.170***	.042	1.185
Constant [a]	.269	.915	1.308
Model χ^2 (4)= 36.22, p < .001			
R_L^2 = .14			

Note: Person is scored as Self = 0, Gender is scored as Female = 0.
OR (odds ratio) < 1.0 indicates a decrease in odds for passing the task. OR > 1.0 indicates an increase in the odds of passing the task.
[a] The intercept value is for Self (Person = 0) for Females and with Age centered at 42 months.
*p < .05. **p < .01. ***p < .001.

Table 4.

Proportion of Children in each Response Pattern in the Knowing means Getting it Right task for Self and Other in Study 1 and Study 2.

Study 1

Response Pattern	Condition		Person and Age					
			Self			Other		
	Right	Wrong	3	4	5	3	4	5
Correct	No	No	.06	.21	.13	.03	.11	.13
Know = Right	Yes	No	.66	.42	.40	.63	.84	.80
Yes Bias	Yes	Yes	.13	.21	.07	.16	-	.07
Inverse	No	Yes	-	.05	.07	.03	-	-
Inference	Non-response	No	-	-	.07	.03	.05	-
	Yes	Non-responses	.13	.05	.20	.06	-	-
	Non-Response	Non-Response	.03	.05	.07	.06	.-	-

Study 2

Response Pattern	Condition		Person and Age			
			Self		Other	
	Knowledge	Ignorance	3	4	3	4
Know = Right	Yes	No	.33	.14	.11	.13
Yes Bias	Yes	Yes	.44	.86	.67	.57
No Bias	No	No	-	-	.11	.13
Inverse	No	Yes	.06	-	.06	.13
	Non-response	Yes	.17	-	.06	.04

Note: Non-responses could not be categorized as a discernibly affirmative or negative response.

Table 5.

Proportion of children using each type of Belief Understanding in Study 2

Response	3-year-olds	4-year-olds
Reality Reasoning	.89	.52
Mixed Reasoning	.11	.9
Perceptual Access Reasoning	-	.17
Belief Reasoning	-	.22

$\kappa = .899, p < .001$

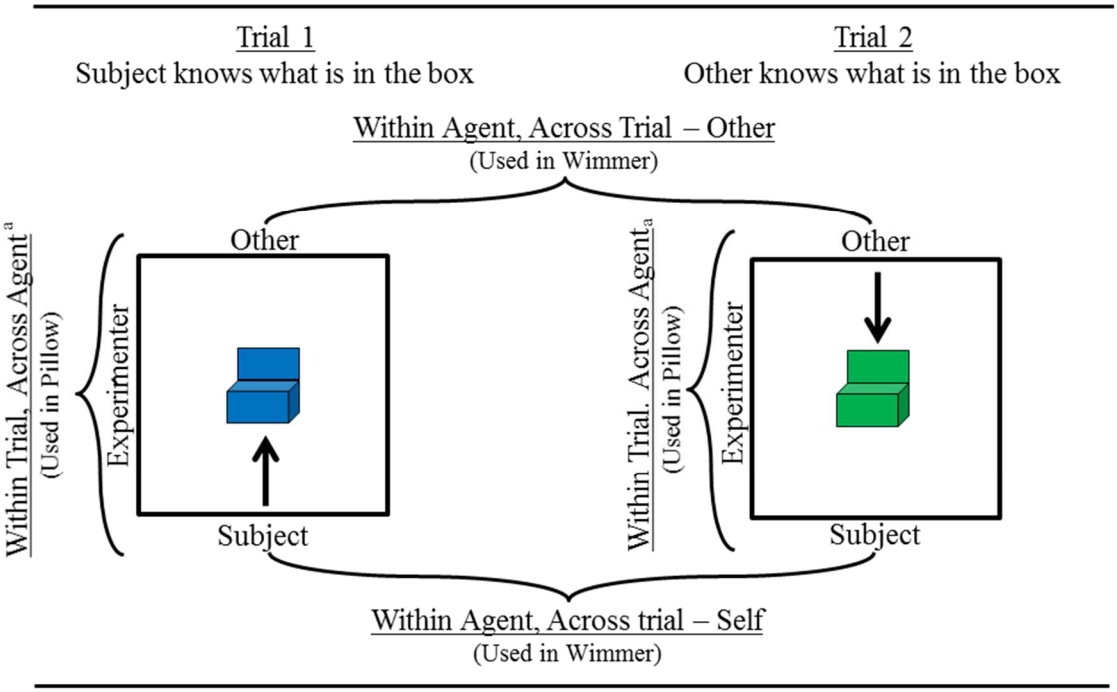

Figure 1. A diagram of scoring procedures from the seeing leads to knowing task in Wimmer, Hogrefe and Perner (1988) and in Pillow (1989). Participants can be can be scored *within-agent* but *across trials* as used in Wimmer et. al. (1988), or *within-trial*, but *across agents* as used in Pillow (1989).

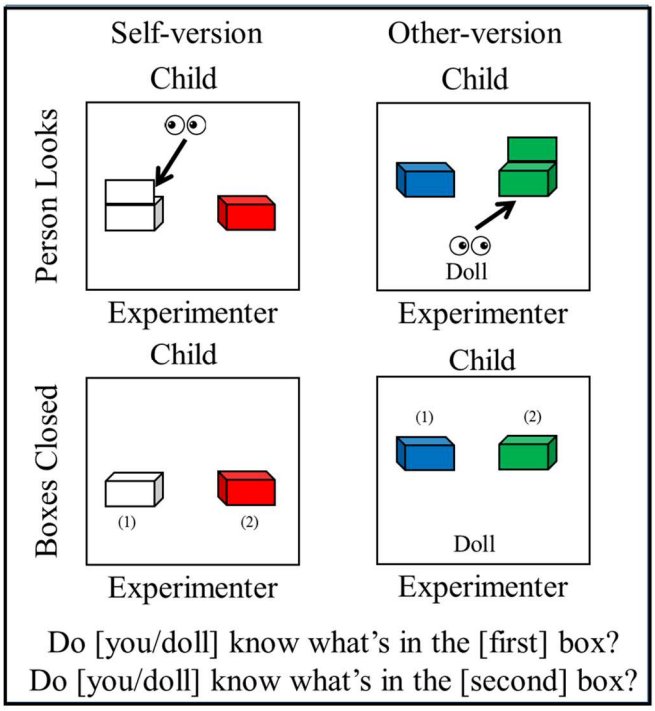

Figure 2. Illustration of the procedures for the self- and other-version of the seeing leads to knowing task in Study 1 and Study 2.

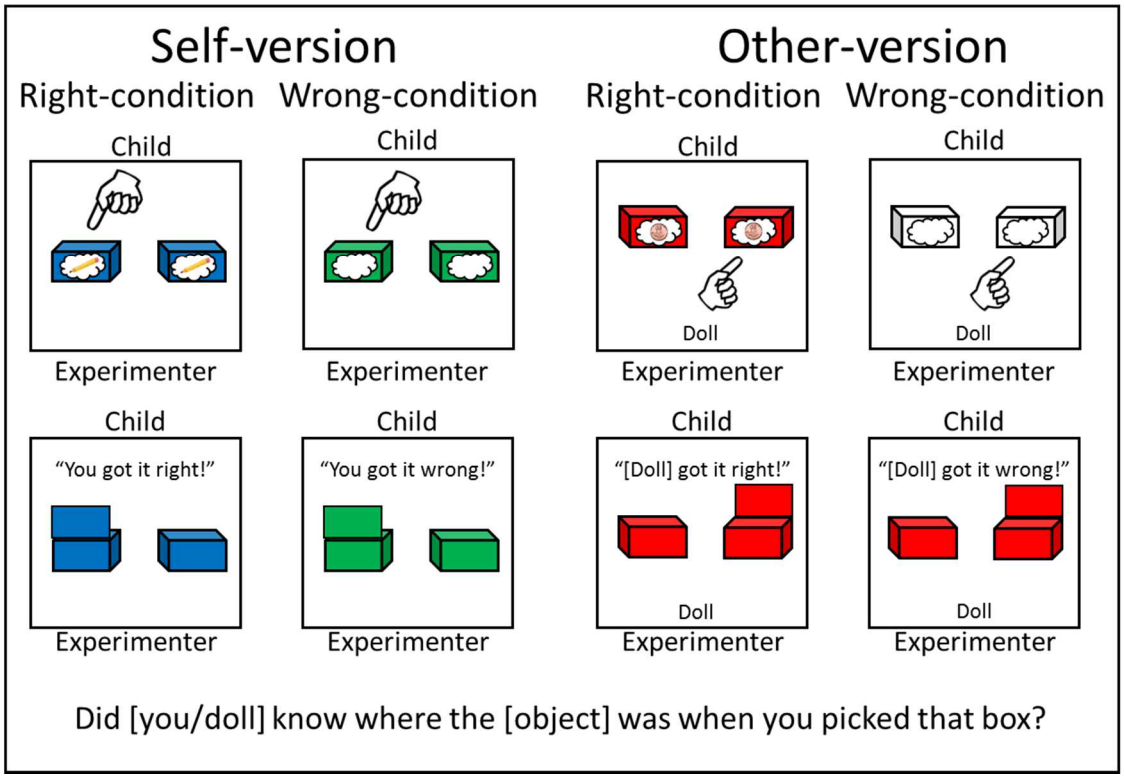

Figure 3. Illustration of the self- and other-versions of the knowing means getting it right task from Study 1.

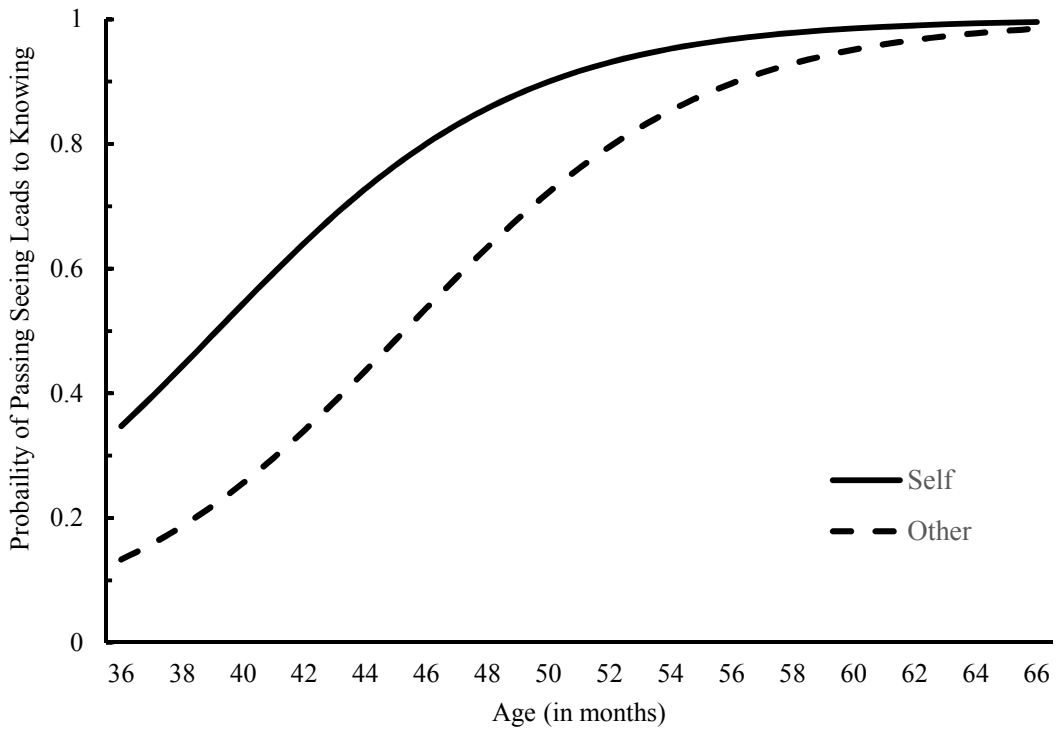

Figure 4. Predicted Probability of passing the Self and Other version of the Seeing Leads to knowing Task by Age (in months) in Study 1.

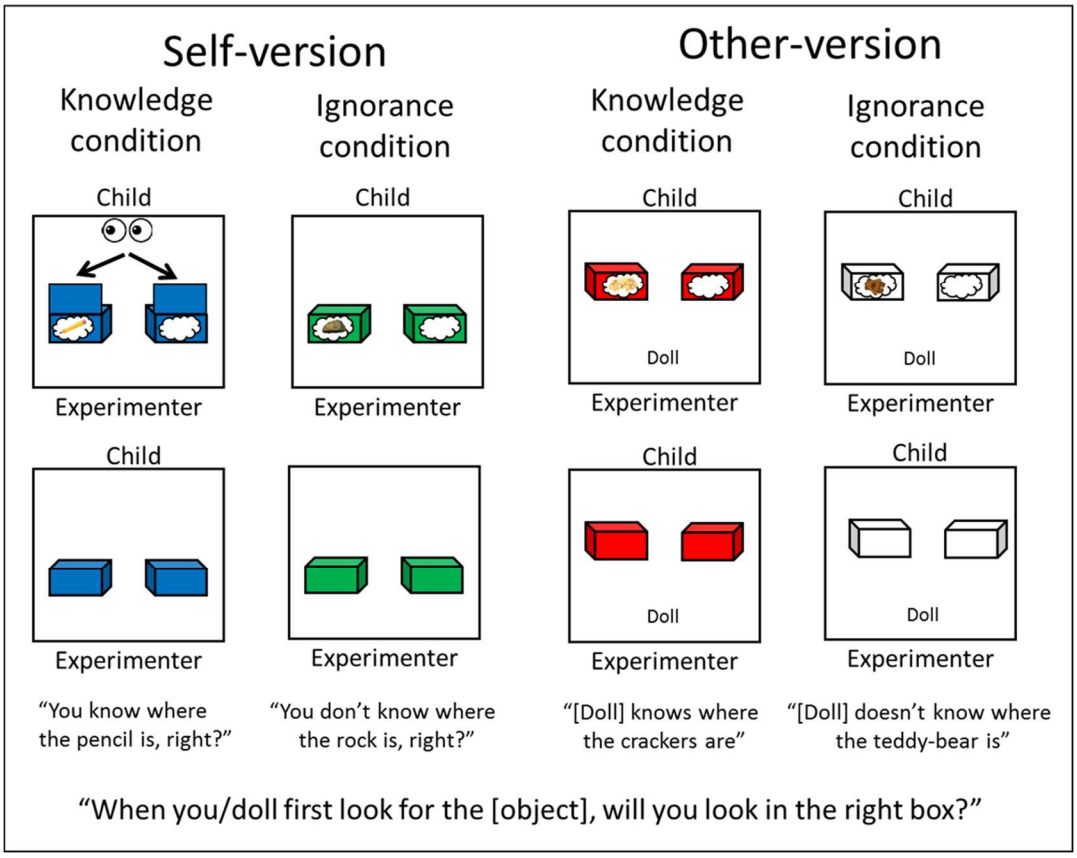

Figure 5. Illustration of the self- and other-versions of the knowing means getting it right task from Study 2.

APPENDIX A

DETAILED STUDY PROCEDURES AND DATA COLLECTION FORMS

Self Knowledge (Language Comprehension)

1 white box and 1 red box with lids

A key in one of the boxes

E: I'm going to show you what is in the while box, but not what is in the red box.

Open white box and show child. Let child take key out, hold it, and replace. Keep box open while you ask Control Q1.

If they don't know, tell them what it is, re-ask and re-record response.

Control Q1: What is in here? Child's 1st response: _____ 2nd: _____

Close the box.

E: I'm going to ask you if you know what is in each of these boxes. Tell me "yes" if you know or "no" if you don't know.

If child doesn't say "yes" or "no" prompt once by repeating the last sentence above and re-asking Test Question

Test Q1: Do you know what is in the white box? *[Record everything said by both people verbatim]*

C:_____ Prompt if necessary: _____ Child's response to prompt:

Test Q2: Do you know what is in the red box?

C:_____ Prompt if necessary: _____ Child's response to prompt:

Other Knowledge (Language Comprehension)

A green box and a blue box with lids

1 new doll (Jane)

E: I'm going to show Jane what is in this green box, but I'm not going to show her what is in the blue box.

Open the green box and have Jane look in. Do not let the child look in.

E: Jane says, "OK, I see what is in the box." *Close the box.*

E: I'm going to ask you if Jane knows what's in each of these boxes. Say "yes" if she knows or "no" if she doesn't know.

If child doesn't say "yes" or "no" prompt once by repeating the last sentence above and re-asking Test Question

Test Q1: Jane looked in the green box. Does Jane know what is in the green box?
[Record everything said verbatim]

C:_____ Prompt if necessary: _____ Child's response to prompt:

Test Q2: Jane did not look in the blue box. Does Jane know what is in the blue box?

C:_____ Prompt if necessary: _____ Child's response to prompt:

ID:_____ Task Order:___ Testing Date:_____ Testing Location:_____ Tester:_____
(Official use only)

Demographic Information Worksheet

Please fill out the following items to the best of your knowledge.

1. **Today's Date:**_____
(MM/DD/YYYY)

2. **Your relationship to your child:** ◯ Mother ◯ Father ◯ Other:_____
(Please Specify)

3. **Child's date of birth:**_____
(MM/DD/YYYY)

4. **Child's gender:** ◯ Male ◯ Female

5. **Child's ethnicity:** ◯ Not Hispanic / Latino ◯ Hispanic / Latino

6. **Child's race:** (check all that apply)
◯ Caucasian ◯ African American ◯ Asian ◯ Native American ◯ Other:_____
(Please Specify)

7. **Is your child a native speaker of English?** ◯ Yes ◯ No

8. **Does your child have any siblings or other children living at home?** ◯ Yes ◯ No
If "Yes," please list their dates of birth below.

_____ _____ _____ _____
(MM/DD/YYYY) (MM/DD/YYYY) (MM/DD/YYYY) (MM/DD/YYYY)

9. **Are there any other adults living at home with the child?** ◯ Yes ◯ No
If "Yes", how many?_____

10. **What is your annual household income?** (check one)

◯ Less than $15,000
◯ $15,000 - $30,000
◯ $30,000 - $45,000
◯ $45,000 - $60,000
◯ $60,000 - $75,000
◯ $75,000 - $100,000
◯ Over $100,000

11. **Mother's highest level of education:**
(check one)
◯ Grade school
◯ Some high school
◯ High school granduate
◯ Some college or 2yr. College
◯ College graduate
◯ Master's Degree
◯ Ph.D or M.D.

12. **Father's highest level of education:**
(check one)
◯ Grade school
◯ Some high school
◯ High school granduate
◯ Some college or 2yr. College
◯ College graduate
◯ Master's Degree
◯ Ph.D or M.D.

ID:_____ Task Order:_____ Testing Date:_____ DOB:_____ Gender:_____

Warm Up Task

Materials: 3 different colored tokens (blue, yellow, red

1. **Look I have these three tokens**
   place tokens on the table

2. **What color is this one? (blue)** 2. _____

3. **What color is this one? (yellow)** 3. _____

4. **What color is this one? (red)** 4. _____

Note: Use the words the child uses to describe the color of each token for the rest of the task.

5. **I'm going to ask you some questions, and I want you to tell me yes or no, okay?**

6. *Place red token aside. Point to the yellow token*
   Is this the [Blue] token? 6. _____

7. *Point to the blue token*
   Is this the [Blue] token? 7. _____

8. *Place blue token aside. Point to the red token*
   Is this the [Yellow] token? 8. _____

9. *Point to the yellow token*
   Is this the [Yellow] token? 9. _____

10. *Place yellow token aside. Point to the blue token*
    Is this the [Red] token? 10. _____

11. *Point to the red token*
    Is this the [Red] token? 11. _____

Note: Child must answer 4 out of 6 test questions correctly in order to continue the session.

ID: _____ Task Order:___ Testing Date:_____ Testing Location:_____ Tester:_____

Rule 2- Self Knowledge Task

Materials: 4 boxes, 1 pencil

Place 2 boxes on table. 1 with a pencil inside.

1. **Here are two boxes** (*Open both boxes and show child*)

2. **One of them has a pencil inside** (*Close both boxes*)

3. **You know where the pencil is.**

4. **When you first look for the pencil, will you look in the right box?** 4. _____

Prompt. *If child does not respond, say "tell me yes or no" and re-ask #4*

Prompt. _____

5. **Why will/won't you will look in the right box?**

_____

_____

Remove boxes. Place 2 new boxes on table

6. **Here are two more boxes** *Do NOT open boxes.*

7. **One of these boxes has a rock inside.**

8. **You do not know where the rock is**

9. **When you first look for the rock, will you look in the right box?** 9. _____

Prompt. *If child does not respond, say "tell me yes or no" and re-ask #9*

Prompt. _____

10. **Why will/won't you will look in the right box?**

_____

_____

ID: _____ Task Order:___ Testing Date:_____ Testing Location:_____ Tester:_____

Rule 2- Other Knowledge Task

Materials: 4 boxes, 1 doll (Anna)

1. **These are cupboards in Anna's kitchen.**
   (*Place two boxes on table*)

2. **One of the cupboards has some crackers**

3. **Here comes Anna.** *Bring Anna out*

4. **Anna knows where the crackers are.**

5. **When Anna first looks for the crackers, will Anna look in the right cupboard?** 5. _____

Prompt. *If child does not respond, say "tell me yes or no" and re-ask #5* Prompt. _____

6. **Why will/won't Anna look in the right cupboard?**

_____

_____

Remove boxes and Anna. Place 2 new boxes on table

7. **These are two toy boxes in Anna's room**

8. **One of the toy boxes has a teddy-bear.**

9. **Here comes Anna.** *Bring out Anna again*

10. **Anna doesn't know where the teddy-bear is.**

11. **When Anna first looks for the teddy bear, will Anna look in the right toy box?** 11. _____

Prompt. *If child does not respond, say "tell me yes or no" and re-ask #11* Prompt. _____

12. **Why will/won't Anna look in the right box?**

_____

_____

ID: _____ Task Order:___ Testing Date:_____ Testing Location:_____ Tester:_____

Rule 2 - Warm Up Task

Materials: 2 boxes, 1 block

Place both boxes on table, 1 with a block inside

1. **Here are two boxes.**
   Open both boxes and show child.

2. **One of the boxes has a block inside.** *Close both boxes*

3. **Where is the right place to look for the block?** 3. _____

4. **Where is the wrong place to look for the block?** 4. _____

ID:_____ Task Order:_____ Testing Date:_____ DOB:_____ Gender:_____

False Belief Task

Materials: Crayon Box, Toy Car

Note: Do not let the child see the car before the test.

1. **Take a look at this box.** (*show closed box*)

2. **What do you think is in here?** (Crayons) 2. _____

Prompt. Ask the following questions if child is incorrect on **#2** until they give the correct answer.
"What does the bag look like it will have inside?"
"Can you guess what will be inside?"
"What kinds of things come in a box like this?" Prompt. _____

3. **I am going to show you what is in here.** (*open box, remove car*)
Look, it's a car! (*Let child touch the car*)

4. **Now I am going to put the car back inside the box** (*replace car in box*)

5. **What kind of box is this?** 5. _____

Prompt. If the child is incorrect on **#5**, correct the child, and re-ask the question.
Prompt. _____

6. **What was inside the box now?** 6. _____

Prompt. If the child is incorrect on **#6**, correct the child, and re-ask the question.
Prompt. _____

Remove cup and key from table now

7. **Let's pretend I have a friend named Suzie waiting right outside. She's never seen inside this box. When she first looks at the box, before she opens it, Will she think there is . . .**
Crayons or a Car inside? Car or Crayons inside? 7. _____

8. **Why will she think there are/is Crayons/Car inside?**

_____

_____

ID:_____ Task Order:____ Testing Date:_____ DOB:_____ Gender:____

True Belief Task

Materials: Candy Box, Key, Clear cup with candy,

Note: Do not let the child see the candy before the test.

1. **Take a look at this box.** (*show closed box*)

2. **What do you think is in here?** (Candy/M&M's) 2. _____

Prompt. Ask the following questions if child is incorrect on **#2** until they give the correct answer.
"What does the bag look like it will have inside?"
"Can you guess what will be inside?"
"What kinds of things come in a bag like this?" Prompt. _____

3. **I am going to show you what is in here.** (*open box, remove key*)
It's a key! Here, look. (*Let child touch the key. Put key down at the side of the box*)

4. **Here, let's put some candy inside.** (*Add Candy to box*)

5. **What is inside the box now?** 5. _____

Prompt. If the child is incorrect on **#5**, correct the child, and re-ask the question.
Prompt. _____

6. **What was inside the box when I first showed it to you?** 6. _____

Prompt. If the child is incorrect on **#6**, correct the child, and re-ask the question.
Prompt. _____

Remove cup and key from table now

7. **Let's pretend I have a friend named Sam waiting right outside the door. He's never seen inside this box. When he first looks at the box, before he opens it,Will he think there is ...**

candy or a key inside? key or candy inside? 7. _____

8. **Why will he think there is Candy / Key inside?**

_____

_____

APPENDIX B

JUSTIFICATION CODES FOR TRUE BELIEF CONTENTS TASK

3 = Belief

Belief Question: Pass ("M&M's")

Justification Question: explicitly or implicitly say that the type of box causes character to think there are M&M's inside.

- *Explicit:* "he sees M&M's on the box so he knows what's inside"
- *Implicit [implies the box makes him think it's M&M's]:* "it's a M&M's box" "M&M's are always in these boxes" "that's what the box is for"

2 = Perceptual Access

A. Belief Question: Fail ("Key" or "both key & M&M's")

Justification Question: explicitly or implicitly describe one or more of the 3 parts of PAR (not see => not know => be wrong)

- *Not see:* "he hasn't looked inside" "he didn't see us take key out / put M&M's in"
- *Not know:* "he doesn't know what's inside" "he doesn't know what we put inside" or *Uncertainty:* "he'll guess" "he'll think both" "he'll think maybe it's a key" "it could be M&M's or a key"
- *Explicit be wrong:* "he'll be wrong" *Implicit be wrong:* "key is not in there" "M&M's are in there" "key was in there first" "key used to be there" "we took out the key" "when he looks he'll find M&M's"

B. Belief Question: Pass ("M&Ms")

Justification Question: explicitly or implicitly describe one or both of the first 2 parts of PAR (not see => not know)

- *Not see:* "he hasn't looked inside" "he didn't see us take key out / put M&M's in"
- *Not know:* "he doesn't know what's inside" "he doesn't know what we put inside" or *Uncertainty:* "he'll guess" "he'll think both" "he'll think maybe it's M&M's" "it could be M&M's or a key"

1 = Reality

A. Belief Question: Pass ("M&M's")

Justification Question: explicitly or implicitly say that there are M&M's inside

- *Explicit:* "M&M's are in there"
- *Implicit:* "he wants them" "he likes M&M's"

B. Belief Question: Pass ("M&M's")

Justification Question: explicitly say the character will get perceptual information about the M&M's inside, which will then cause him to know there are M&M's inside.

- "he will look inside" "he'll see the M&M's" "he won't see any key" "he'll shake the box" "it sounds like it" "there will be M&M's in there"

0 = Other

Belief Question: Pass ("M&M's") or Fail ("key" or "both M&M's and key")

Justification Question: including but not limited to the following:

- "I don't know"
- *Making up additional information:* "he heard me" "he saw someone put a key in there" "he put the key in"
- *Reiteration of answer to the Belief Question:* (M&M's) "because he thinks it's M&M's"; (key) "because he thinks it's a key."
- *Contradiction of answer to the Belief Question*: (M&M's) "because he thinks it's a key"; (key) "because he thinks it's M&M's" "because it's a M&M's box"
- *Misrepresentation of the contents:* (key) "because there's a key in there"
- *Irrelevant responses*

Justification Codes for False Belief Contents Task

3 = Belief

Belief Question: Pass ("crayons")

Justification Question: either explicitly or implicitly say that the type of box causes character to think there are crayons inside.

- *Explicit:* "he sees crayons on the box so he knows what's inside"
- *Implicit [implies box makes him think it's crayons]:* "it's a crayon box" "crayons are always in these boxes" "that's what the box is for"

2 = Perceptual Access

A. Belief Question: Pass ("crayons") or Fail ("both crayons and car")

Justification Question: explicitly or implicitly describing one or more of the 3 parts of PA reasoning (not see => not know => be wrong)

- *Not see:* “he hasn’t looked inside” “he didn’t see us put the car in”
- *Not know:* “he doesn’t know what’s inside” “he doesn’t know what we put inside” or *Uncertainty:* “he’ll guess” “he’ll think both” “he’ll think maybe it’s crayons” “it could be crayons or a car”
- *Explicit be wrong:* “he’ll be wrong” *Implicit be wrong:* “crayons are not in there” “a car is in there” “crayons were in there first” ”crayons used to be there” “you took out the crayons” “when he looks he’ll find the car”

B. Belief Question: Fail (“car”)

Justification Question: explicitly or implicitly describing one or both of the first 2 parts of PA reasoning (not see => not know)

- *Not see:* “he hasn’t looked inside” “he didn’t see us put the car in”
- *Not know:* “he doesn’t know what’s inside” “he doesn’t know what we put inside” or *Uncertainty:* “he’ll guess” “he’ll think both” “he’ll think maybe it’s a car” “it could be crayons or a car”

1 = Reality

A. Belief Question: Fail (“car”)

Justification Question: either explicitly or implicitly saying that there is a car inside

- *Explicit:* “the car is in there”
- *Implicit:* “he wants the car” “he likes to play with it”

B. Belief Question: Fail (“car”)

Justification Question: explicitly saying the character will get perceptual information about the car inside, which will then cause him to know there is a car inside.

- “he will look inside” “he’ll see the car” “he won’t see any crayons” “he’ll shake the box” “it sounds like it” “there will be a car in there”

0 = Other

Belief Question: Pass (“key”) or Fail (“car” or “both crayons and car”)

Justification Question: including but not limited to the following:

- "I don't know"
- *Making up Additional information:* “he heard me” “he saw someone put a car in there” “he put the car in”
- *Reiteration of answer to the Belief Question: (crayons)* “Because he thinks it’s crayons” *(car)* “Because he thinks it’s a car.”

- *Contradiction of answer to the Belief Question: (crayons)* "Because he thinks it's a car" *(car)* "Because he thinks it's crayons" "Because it's a crayons box"
- *Misrepresents the contents: (crayons)* "Because there are crayons in there."
- *Irrelevant responses*

APPENDIX C

IRB APPROVAL MATERIALS

ASU Knowledge Enterprise Development

APPROVAL: EXPEDITED REVIEW

William Fabricius
Psychology
480/965-9372
WILLIAM.FABRICIUS@asu.edu

Dear William Fabricius:

On 6/5/2014 the ASU IRB reviewed the following protocol:

Type of Review:	Initial Study
Title:	Children's Developing Theory of Mind
Investigator:	William Fabricius
IRB ID:	STUDY00001170
Category of review:	(6) Voice, video, digital, or image recordings, (7)(b) Social science methods, (7)(a) Behavioral research
Funding:	None
Grant Title:	None
Grant ID:	None
Documents Reviewed:	• Parent Consent Letter, Category: Consent Form; • Video Release Form, Category: Consent Form; • Child Assent Script, Category: Consent Form; • Data Collection Forms, Category: IRB Protocol; • Demographic Information Worksheet, Category: IRB Protocol; • HRP-503a - TEMPLATE PROTOCOLSOCIAL BEHAVIORAL (1).docx, Category: IRB Protocol; • FB study Standard Operating Procedures.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • Data forms.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • Demographics Sheet.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);

	• Sample Script introducing data release form.docx, Category: Recruitment Materials; • Sample Recruitment Email to Parents, Category: Recruitment Materials;

The IRB approved the protocol from 6/5/2014 to 6/4/2015 inclusive. Three weeks before 6/4/2015 you are to submit a completed "FORM: Continuing Review (HRP-212)" and required attachments to request continuing approval or closure.

If continuing review approval is not granted before the expiration date of 6/4/2015 approval of this protocol expires on that date. When consent is appropriate, you must use final, watermarked versions available under the "Documents" tab in ERA-IRB.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

IRB Administrator

cc: Christopher Gonzales
William Fabricius
Anne Kupfer
Annelise Pesch
Vivien Poterack
Christopher Gonzales
Lindsay Leiferman
Alissa Brennan