When Seeing Is Not Believing: Children's Understanding of Humans' and Non-Humans' Use of Background Knowledge in Interpreting Visual Displays*

JUSTIN L. BARRETT, ROXANNE MOORE NEWMAN
and REBEKAH A. RICHERT**

ABSTRACT

To explore 3- to 7-year-old children's developing understanding of human and non-human minds, a battery of "background knowledge" tasks was administered to 51 American children. The children were asked to speculate about how three other intentional agents (mother, dog, and God) would understand various visual displays. First, children answered when they themselves did not understand the displays, then they answered after they had been given information necessary to understand the displays. Results revealed that children begin to understand the role of background knowledge around the same age that they pass false-belief tasks; and that before thoroughly understanding the role of background knowledge they already begin to discriminate between different types of minds. By age four, children began to show some understanding that because of having different minds than people, God is more able and dogs are less able to understand some visual displays even with full visual access.

KEYWORDS

Theory-of-mind; cognition; god-concepts; beliefs; dogs; religion

Five-year-old Skylar had a puzzling experience. After drawing a fine replica of a favorite cartoon character, he presented the drawing to his father. Skylar thought his dad would know who this was in the drawing, but his otherwise pretty knowledgeable father did not. Strange. Maybe his father's failure was caused by the quality of the drawing. Or could Skylar understand that his father had never seen the character before and thus could not know its name?

Much research has explored when and how children come to grasp the importance of experiences in forming beliefs (e.g., Pillow & Henrichon 1996; Pratt & Bryant 1990; Wellman & Hickling 1994). While in many cases "seeing is believing," sometimes seeing by itself is little help in forming an appropriate belief. Often, understanding is contingent upon seeing *and* previous experiences or background knowledge of the thing being seen. Adults are typically quite adept at gauging whether someone else has the requisite knowledge for interpreting a visual display. For instance, mothers of preschoolers may leave lists of Christmas presents for their children in plain sight with no fear of ruining the surprise, but gifts for husbands will not appear on the lists. Mothers know their young children can see the list but cannot read it.

Much social interaction is predicated on these sorts of implicit assumptions of others' background knowledge, prompting two questions: (1) When do children understand the role of background knowledge for interpreting visual displays? (2) Do children understand that ability to draw upon background knowledge varies with different cognitive abilities across kinds of minds?

By the time children are three-years-old, they demonstrate some understanding of the role that perception plays in knowledge acquisition. Three-year-old children will attribute knowledge about a hidden object to a person who had looked at it, and not to a person who had not looked at it (Pillow 1989; Pratt & Bryant 1990). This understanding is still fragile, however. For example, three-year-olds will deny that a person who had looked into an opaque container would know what was inside it (Wimmer, Hogrefe & Perner 1988).

In another example, three- and four-year-old children were tested on their ability to take into account perceptual experience in determining an observer's knowledge (Pillow & Weed 1997). More specifically, children

were asked whether an adult or peer, only one of whom had seen a toy hidden in a plastic jar, would know what the toy was. Results revealed that four-year-olds relied on their knowledge of perceptual access to determine who would know what toy was in the jar. In contrast, the three-year-olds most often said their peer would know what was in the jar, even if the adult had seen the toy, and not the peer. In a follow-up experiment using dolls instead of real people, three-year-olds still performed below chance levels, but did not over-attribute knowledge to their peers. In fact, it is not until late preschool or middle childhood that children realize that in order to acquire knowledge through perception, the information must be adequate, as well as present (Flavell 1999).

Research on children's "theory of mind" converges on the claim that sometime around age four, children shift from understanding other people's beliefs as mere reflections of reality (e.g., if there is a car in the bandaid box, then others must believe there is a car in the bandaid box) to an understanding of minds as representational devices (Flavell 1999). Most five-year-olds know that beliefs may deviate from reality and thus differ from person to person depending on such factors as visual access to a display. It is likely then that children may not appreciate the importance of background knowledge or previous experiences until after the shift to understanding minds as representational devices occurs, around age four or five.

Another aspect of appreciating the role of knowledge in understanding visual displays is becoming aware that different types of minds – not just different individuals – are more or less likely to possess particular requisite knowledge. For example, do six-year-olds who have begun to read know that a written sign will mean something different to their parents (who can also read) than to a two-year-old? Not only do people have to negotiate the different knowledge states of classes of humans but of non-human agents as well. The promiscuity with which children (and adults) apply human mental states and properties to animals and other non-humans is well-documented (Caporeal 1986; Coley 1995; Inagaki & Hatano 1987). For instance, Inagaki and Hatano (1987) found that kindergartners were prone to over-extend human psychological traits to rabbits and tulips. Forty percent of the children said a tulip can feel happy and 72% said it can feel pretty. More recently, upwards of 80% of the time, kindergartners agreed

that primates, other mammals, birds, reptiles, and fish possess various psychological properties (e.g., thinking, feeling pain, being smart, feeling angry) (Coley 1995).

Given that children attribute minds to animals, are these minds strictly anthropomorphic? Children, might assume that non-humans have the same background knowledge for interpreting visual displays as humans have. If the family dog is present while brother and sister are playing checkers, do the children assume the dog knows they are playing a game? Animal minds are not the only non-human minds about which people reason. Cultural and theological traditions teach that ghosts, spirits, gods, and angels might also be mentalistic beings with different access to knowledge than humans. Can young children represent these differences in knowledge states between these non-natural minds, human minds, and animal minds?

The following three-task experiment explored two major issues: (1) when children understand that seeing is not always enough for believing, but previous knowledge is necessary for interpreting many visual displays, and (2) when children differentially represent the background knowledge of human, animal, and non-natural minds. In this study, three- to seven-year-old children participated in three similarly structured tasks, patterned after "theory of mind" protocols. In all three, the experimenter presented children with a visual display requiring some missing information to understand it, and then asked them whether they or any of three other agents (a parent, a dog, or God) would know what the display was. The experimenter then supplied the missing information only to the children, and asked anew whether the children or each of the other agents would know what the display was *before* being given the missing information.

The three tasks differed in the type of knowledge required to understand the displays. The first task used a mostly-occluded illustration and required children to reason about perspectives on the entire picture. The missing information was visual. In the second task, children speculated about how various agents would understand symbols that represented mundane things. For the second task, the missing information was how symbols mapped on to concepts, but no visual information was withheld. While the first two tasks used static displays, the final task was active. Children observed the experimenter playing a novel game and reasoned whether other

agents not familiar with the game would know what the experimenter was doing. The missing information was the purpose of the behavior. As a battery, the three tasks gauged different sorts of background knowledge necessary to interpret both static and active visual displays much as in natural real-world interactions.

Based on previous theory of mind research, it was hypothesized that three-year-olds and most four-year-olds, many of whom have not yet discovered the representational nature of minds, would assume that if they themselves do not understand the displays, then no one understands the displays. But once they do understand the display (because of being given more information), all four of the other agents would likewise understand the displays – even though the other agents were not supplied with the missing information. That is, three- and four-year-olds would respond as mental realists. A corollary hypothesis is that these youngest children would treat all agents the same. Not until children have a stable and robust representational theory of mind (by age five and six) would they be able to attribute beliefs or understandings to the other agents that are different from their own beliefs and potentially differing across the other agents as well.

Method

For all three tasks children reasoned about the knowledge of a human (the child's own absent mother) and two non-human agents (a dog and God). A dog is an animal with which most or all children in the population sampled have some experience and assume has a mind, whereas only older children might know does not have the same access to knowledge that people have, due to interspecies differences. In contrast, God was included as an agent that children might know as having access to all knowledge. Can children include this theological knowledge in their judgments, or do they, as Piaget and others have suggested, represent God anthropomorphically (Elkind 1970; Goldman 1964, 1965; Piaget 1929)?

Participants

Fifty-one children (29 female) ranging in age from three- to seven-years-old recruited from various Christian schools and churches in the San Francisco Bay area and the greater Grand Rapids area participated: 3-year-olds

(n = 10, 3:3-4:1, M = 3.7 yrs); 4-year-olds (n = 10, 4:3-5:2, M = 4.6 yrs); 5-year-olds (n = 10, 5:4-6:0, M = 5.6 yrs); 6-year-olds (n = 11, 6:1-6:11, M = 6.6 yrs); 7-year-olds (n = 9, 7:1-7:9, M = 7.4 yrs). Since children were asked about God, all were from theistic backgrounds. Three children spoke English as their second language, and demonstrated no difficulty in participating. All children participated individually.

Materials and Procedure, Task 1 – Droodle

The first task was inspired by Chandler and Helm's "droodle task" (1984). To begin, the experimenter showed the child a partially occluded drawing of two yellow elephants holding a green ball between their trunks. The cover was a manila folder with a window cut in it. When the drawing was covered, the only part that remained visible was the rectangular ends of both trunks and the ball between them, leaving no way of knowing that the picture included elephants. Naturally, none of the children participating were able to correctly identify the picture at this stage. The child then answered whether each of the four agents would know what the picture was, if none of them had ever seen it before, and all they could see was the visible portion. "If [agent] saw this picture for the first time and it was covered up like this, would he/she/it know what the whole picture is?" The child first answered for a parent (usually "mother"), then a dog, and finally God.[1]

Next, the child lifted the occluder, revealing the complete picture. The child reported the content of the illustration and then covered the picture again. The experimenter once again questioned the child about each agent using the same question as before, again emphasizing that the other agents had not seen it before. If hesitant, the child was encouraged to give a yes or no answer.

Materials and Procedure, Task 2 – Secret Code

This task involved a secret code developed for this experiment. First, the experimenter presented the child with three different colored arbitrary

---

[1]At the start of the procedure, all children were asked if they knew who God was. All children answered affirmatively.

symbols, each on a separate sheet of white letter-size paper. The experimenter explained to the child that each symbol was part of a secret code made up by the experimenter and stood for something. The experimenter emphasized that no one other than the experimenter knew the meanings of the symbols. The experimenter then asked, indicating a specific symbol, "If [agent] has never seen this symbol before, and no one explained to [agent] what it means, would [agent] know what it means?" The child was then taught the meaning of each symbol. With no clear connection between each symbol and its meaning, the assigned meanings were "sunshine," "bunny," and "bicycle." The experimenter quizzed the child on the meaning of the symbols until she was satisfied that the child had actually learned the code, and then asked the question about each of the other agents again.

Materials and Procedure, Task 3 – Secret Game

Instead of viewing a static display as in Tasks 1 and 2, in Task 3 the child watched the experimenter engage in an ambiguous action. The experimenter moved coins around on some circles drawn on a piece of paper. The experimenter then asked, "Do you know what I am doing?" After each child's inevitable negative response, the experimenter explained that she was playing a new game that she had invented and not shared with anyone else.[2] The experimenter then explained the rules, and offered the child an opportunity to try the game. Then the experimenter resumed playing the game and, as before, asked the child, "If [agent] saw me doing this for the first time, would [agent] know what I am doing?" If the child responded affirmatively or "you are playing a game," the experimenter followed-up with, "Would [agent] know the rules to the game?" If the child answered negatively, to the second question, the first question was repeated, otherwise the child was scored as answering "yes" to the Secret Game task.

---

[2]The game board was a manila folder with several geometric shapes drawn on it. The experimenter used one coin to push a second coin from one shape to another. The game play was sufficiently different in appearance from popular children's games that no children reported knowing what the experimenter was doing or, after learning that it was a game, what the rules of the game might be.

Results

A repeated-measure ANOVA revealed no significant differences between the three tasks and performance by each child was similar across tasks. Consequently, analyses were performed on scores collapsed across the three tasks, yielding scores ranging from 0 to 3 for each question for each agent. A score of 0 indicated the child did not believe that a given agent would understand the displays, a score of 3 indicated that the child believed that a given agent would understand all three displays. These scores were then divided by 3 to create a percentage representative of the likelihood an agent would understand the displays. Recall that children were asked what each agent would know about the displays both before receiving requisite background knowledge themselves and after. Thus, for each agent, each child had a "before understanding" and an "after understanding" score. A change score from before to after understanding was also calculated for each child concerning each agent. An indication of understanding that one's own new knowledge about a display is independent of another's knowledge of the display would be no change in answering "after understanding" as compared with "before understanding."

Before understanding the displays

Before the three-year-old children fully understood the nature of the visual displays, that is before the displays were explained to them, they were largely unable to predict whether the other agents would understand the displays. With age, children were increasingly likely to say that their mother and the dog would not understand the displays while maintaining that God would understand the displays. Figure 1 illustrates these results.

Three-year-olds answered not significantly different from 50 percent chance that the three agents would understand the displays, however they did significantly distinguish between the dog and God. When asked about a dog, 23.3 percent of the time ($SD = 38.6$ percent) three-year-olds responded that the dog would understand the display, as compared with 60 percent for God, $SD = 46.6$ percent, $t(9) = 2.538$, $p = .032$, and 40 percent for mother, $SD = 43.9$ percent, *n.s.* All older children significantly distinguished between God and the other agents. Similarly, the older groups answered significantly above chance that the dog would
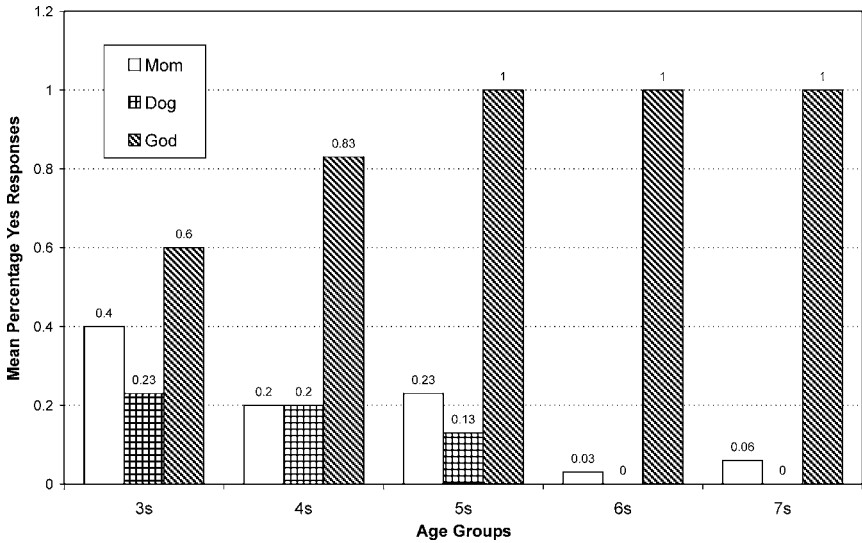
Figure 1.   Percent of children by age group answering that each agent would understand the display before the children themselves understand the display. Three-year-olds significantly disambiguate dog and God; four-year-olds signifi-cantly distinguish between Mom and God as well.

not know the displays, with four-year-olds reporting that the dog would understand the displays only 20 percent of the time, $SD = 32.2$ percent, $t(9) = 2.946$, $p = .016$; five-year-olds answering affirmatively only 13.3 percent of the time, $SD = 32.2$ percent; six- and seven-year-olds never answering affirmatively. The older groups of children also significantly reported that God would know the displays with four-year-olds saying God would understand the displays 83.3 percent of the time, $SD = 32.4$ percent, $t(9) = 3.254$, $p = .01$, and five-, six-, and seven-year-olds always answering that God would know.

Though three-year-olds already significantly distinguished between God and the dog, the children did not reliably understand that their mother would not understand a secret or occluded display until age six. Neither three-, four-, nor five-year-olds answered significantly above chance that their mother would not understand the displays. It was not until six-years-old that the children reliably (97 percent of the time, $SD = 10.1$ percent) reported that their mother would not know about the occluded picture, the secret code, or the secret game, $t(10) = 15.5$,

$p < .0001$. However, five-year-olds' ratings for their mothers did begin to show signs of understanding, with mother being judged as understanding the displays only 23.3 percent of the time, $SD = 41.7$ percent, $t(9) = 2.021$, $p = .074$.

After understanding the displays

A similar pattern of discrimination emerged from children's answers after they were given information for understanding the displays, either full visual access to the droodle, an explanation of the secret code, or an explanation of the secret game. Figure 2 illustrates these results.

After understanding the displays, three-year-olds characteristically overestimated what their mothers and the dog would know, 66.7 percent of the time ($SD = 41.6$ percent) answering that their mothers, and 50 percent of the time ($SD = 47.8$ percent) that the dog, would understand the displays. However, only God was judged as likely to understand
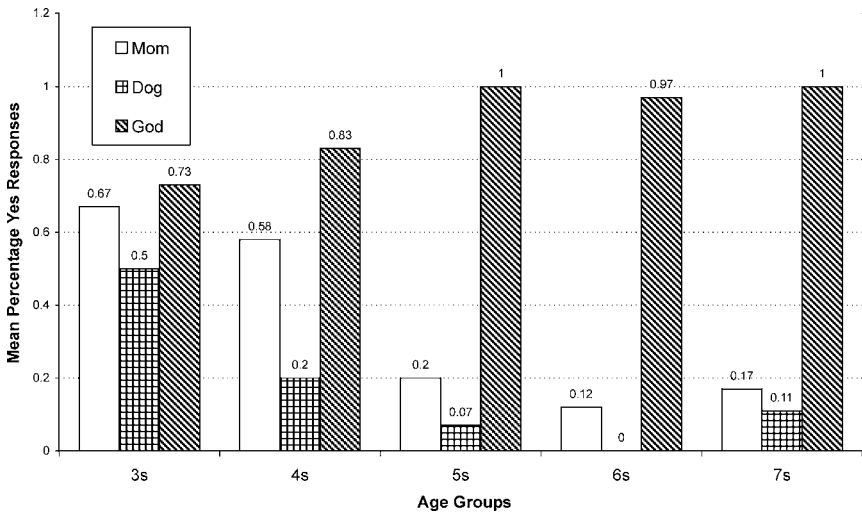

Figure 2.   Percent of children by age group answering that each agent would understand the display after the children have been provided relevant background information for understanding the displays themselves. Four-year-olds significantly differ when reasoning about dog versus God, whereas older children distinguish God from both other agents.

the displays significantly above chance, 73.3 percent, $SD = 30.6$ percent, $t(9) = 2.409$, $p = .039$.

Four-year-olds began to show evidence of understanding the limitations on a dog's knowledge but not their mothers'. The four-year-olds significantly rejected that the dog would understand the displays, only answering affirmatively 20 percent of the time, $SD = 35.8$ percent, $t(9) = 2.648$, $p = .027$. By contrast, four-year-olds answered significantly more often (58.3 percent, $SD = 41$ percent) that their mothers would understand the displays, $t(9) = 3.146$, $p = .012$. As with the three-year-olds, above chance, four-year-olds judged God as likely to understand the displays, 83.3 percent, $SD = 32.4$ percent, $t(9) = 3.254$, $p = .01$. Unlike the threes, God was rated as significantly more likely to understand the displays than the dog, $t(9) = 4.67$, $p = .001$, providing additional evidence that the four-year-olds discriminated between the dog and the other agents.

Children age five and older consistently and reliably discriminated between God and the other agents, judging significantly above chance that God was likely to understand the displays and the dog and mother to not understand the displays. That children did not rate their mothers as unlikely to understand the displays until age five suggests that it was at this age children began to fully appreciate the role of background knowledge for forming beliefs about the displays.

Changes in answering

Examining the difference between "before understanding" and "after understanding" judgments is a third way of investigating whether and when children understood the role of background knowledge in forming complete beliefs about a display. Being given the secret information about a display should not change judgments about whether another would understand the display. The information given to the children in the task was irrelevant for evaluating whether mother, the dog, or God would understand the displays. Thus, "passing the task" would be indicated by a change score (before – after) of zero, indicating that children can disentangle their own knowledge from that of others. A negative change score would indicate that children increased their estimation of another agents' knowledge based on secret information given to the children.

Not surprisingly, three-year-olds averaged significant negative change scores for both the dog (-26.7 percent, $SD = 34.4$ percent, $t(9) = 2.449$, $p = .037$) and their mother (-26.7 percent, $SD = 34.4$ percent, $t(9) = 2.449$, $p = .037$), but not for God.[3] More surprisingly, four-year-olds only showed a significant change score for mother but not for the dog or God. The average change score for God was 0, $SD = 15.7$ percent; and for the dog was 0, $SD = 31.4$ percent. However, for mother the mean change score was -38.3 percent, $SD = 33.8$ percent, $t(9) = 3.632$, $p = .005$. No change scores from the five-, six-, and seven-year-olds were significantly different from zero.

Discussion

The present experiment was motivated by two primary questions: (1) When do children understand that previous knowledge is necessary for interpreting many visual displays, and (2) when do children differentially represent the background knowledge of human, animal, and non-natural minds?

Children's understanding that seeing is insufficient for knowing

It appears that children showed appreciation that background knowledge is necessary to interpret visual displays around age five. After being given full knowledge of the displays, threes and fours (but not the older children) significantly changed their responses regarding their mothers' understanding of the displays, apparently confusing their own knowledge with their mothers'. Only children five-years and older reported above chance that their mothers would not understand the displays after the children themselves did understand the displays.

This difficulty for preschoolers but not older children to divorce others' beliefs from their own parallels and extends results from many theory of mind tasks. For example, in surprising contents false-belief tasks children are shown a container suggesting its contents (e.g., a candy box), and then

---

[3]The lack of change in four-year-olds' judgments when reasoning about God after being supplied background information was unlikely to be the consequence of a ceiling effect since their mean score was only 73.3 percent. A more likely explanation is that children found their own change in epistemic state less relevant to speculating about God's mental state than about their mothers'.

shown that the actual contents are very different (e.g., pencils). In these conditions preschoolers regularly mistakenly report that another person who does not have accurate information about the contents (i.e., has not seen inside the box) will know the correct contents. By age five most children do not make this mistake (Wellman et al. 2001). Similar demonstrations have been made with appearance-reality tasks (Flavell, Green & Flavell 1986) and unexpected transfer false-belief tasks (Wimmer & Perner 1983), and other tasks manipulating access to a visual information (e.g., Moses & Flavell 1990; Chandler & Helm 1984; Perner & Davies 1991).

In previous studies the information that is withheld from the child at first, and the other agents throughout, is simple and perceptual in character. In appearance-reality tasks, the potentially ignorant other has not felt the rock-like sponge (Flavell et al. 1986). In false-belief tasks, the other agents have not seen inside the container or seen the target object be moved. The present study adds the observation that by five-years-old children can attend to others' access to information that is not simply perceptual. The other agents were granted full visual access to the displays in the secret code and secret game tasks but what was withheld was information about the nature of the displays. The missing information was not knowledge of the object but knowledge *about* the object. Still, children within the examined age range performed quite similarly to children in previous theory of mind studies.

Children's understanding humans and non-humans differ in their knowledge

Though children in the present study did not appear to consistently appreciate the importance of background knowledge until around age five, children showed signs of discriminating between different types of minds already in the three-year-old group. Before being granted any background knowledge themselves, threes regarded God as significantly more likely to understand the displays than the dog, and fours regarded God as significantly more likely to understand the displays than the dog or their mothers. Further, four-year-olds judged their mothers as more likely to understand the displays than the dog, but this was due to children overestimating their mothers' knowledge relative to the dog. That is, they

"figured out" that the dog would not understand the displays before they "figured out" that their mothers would not.

A provocative finding in regards to differentiating kinds of minds was the pattern of children extending their own insights to others. A standard finding in theory of mind tasks is that three-year-olds and many four-year-olds extend their own knowledge indiscriminately to others. If the child knows the location of the Smarties, so does everyone else. In the present study, the younger children were not so indiscriminate. Three-year-olds did not significantly revise their estimations of God's knowledge after learning about the displays, though they did revise their estimations of the dog's and their mothers' knowledge. Note that this was not simply a ceiling effect for these children still only judged God to know 73.3 percent of the time as compared with 83.3 percent by age four and 100% by age five. Further, among the four-year-olds, only estimations of mothers' knowledge was significantly revised, whereas neither God's nor the dog's knowledge was changed at all on average. These results suggest the intriguing possibility that through development, children pare-back the range of minds for which their own minds serve as legitimate simulations or bases of comparison. For the three-year-olds, both the dog and mothers seemed appropriate targets. For the fours, only mother seemed a good target. Thus, children did not uniformly extend their own knowledge to other minds.

Implications for the anthropomorphism hypothesis

Following Piaget (1929), scholars often refer to the process of children reasoning about non-human intentional beings, and especially God, as anthropomorphism. That is, children form a representation of human minds and then map this representation on to all other minds. In the study of God concepts in particular, it has been argued that young children (before about age seven or eight) simply lack the cognitive resources to represent God's non-human properties, and so they are guilty of anthropomorphism of a "crudely physical kind" (Goldman 1964). Together with several other recent studies examining children's God concepts, the present study severely weakens the anthropomorphism hypothesis.

Previous research has shown that concurrent with understanding a given property of human minds, children already discriminately apply the property to human and some other minds but not to God's mind.

Considering visual perspective-taking (Barrett, Richert & Driesenga 2001, Experiment 3), or visual, olfactory, and auditory perspective-taking (Richert & Barrett, forthcoming), when children understood the conditions for another human to perceive what they perceived at around age five, children did not extend these restrictions to God or animals specified as having special sense organs. Similarly, when considering a surprising-contents false belief scenario, children shown a cracker box containing rocks continued to suppose God would know there were rocks in the box even after they realized that their mother would suppose there were crackers in the box (around age 5) (Barrett, Richert & Driesenga 2001, Experiment 2).

The present study shows that even *before* children fully recognize the dynamics of background knowledge in illuminating displays for humans, they begin discriminating among various minds. Three-year-olds significantly disambiguated what God might know and what a dog might know, even though children did not typically "pass" the task until age five.

Such results cast doubt on the assumption that children *first* develop a distinctively human theory of mind and *then* later begin forming representations of non-human minds. Not only do the data show evidence of discrimination before a human theory of mind is well-developed, but the default assumptions children make do not necessarily fit human minds better than other minds. Actually, children appeared to recognize the limitations of a dogs mind prior to recognizing the limits of their mothers' minds. Further, the tendency in this and other theory of mind tasks is to over-estimate what others know or perceive. That is, children assume minds to be more "God-like" than human-like. Perhaps, then, children first possess a general theory of mind that gets refined into various theories of minds including a dog theory of mind, a God theory of mind, and human theory of mind.

Certainly it is the case that children frequently over-attribute human properties to non-humans (e.g., Coley 1995; Inagaki & Hatano 1987), and, theologically speaking, God is no exception (e.g., Heller 1986; Tamminen 1991). Indeed, under conceptually demanding conditions, adults are prone to treat gods more anthropomorphically than they would claim their theologies support (Barrett 1998, 1999; Barrett & Keil 1996). However, this tendency to anthropomorphize may not be because children only have

a human theory of mind from which to reason. Rather, children (and adults) possess many specific theories of minds that vary not only in the particular properties of mind but also in the number of properties and in salience. For example, based on visits to the zoo and television programs, a child might have a theory of wolf-minds, but lacking much exercise and breadth in using this skeletal theory, in many circumstances the wolf theory of mind is unlikely to rapidly produce needed inferences. Consequently, a more developed and more salient theory or mind, such as a human theory of mind or a domestic dog theory of mind, might fill in the inferential gaps. Given that a human theory of mind will be the most complete and salient of all theories of mind, it will be drawn upon most frequently when other theories of minds fail, accounting for observed anthropomorphisms.

Clearly, such an interpretation is in need of further support. Of particular help would be identifying the contextual or environmental factors that help children to acquire non-human theories of minds. For example, given the suggested model, one would expect that children who have prolonged interaction with animals that brings out the animals' distinctive mental and perceptual properties would have richer theories of these animals minds than other children, and be less prone to anthropomorphize. Perhaps children in hunter-gatherer societies or in traditional agrarian cultures would be examples. Cross-cultural studies that contrast hunter-gatherer and urban children might be particularly revealing. Another possibility could be to experimentally "train-up" children on various animal concepts or manipulate the salience of particular theories of mind and then measure consequences for tendency to anthropomorphize.

Conclusion

On one hand, the results of this study affirm conventional wisdom in the theory of mind field. It is not until around age five that children have a stable and robust understanding of minds as representational devices capable of different understandings of the same object (Flavell 1999), and this generalization applies to understanding that different individuals have different access to requisite knowledge for interpreting displays. On the other hand, the results of this study challenge an important, pervasive assumption. Typically, when cognitive developmentalists speak of a child's "theory of mind" it is a single understanding of all human minds that is

being implicitly considered. However, results of this study suggest young children might be able to understand different classes of agents – animal, human, and non-natural – as possessing minds with importantly different potential for knowledge.

REFERENCES

BARRETT, J.L.

1998 Cognitive constraints on Hindu concepts of the divine. *Journal for the Scientific Study of Religion* 37, 608-619.

1999 Theological correctness: Cognitive constraint and the study of religion. *Method and Theory in the Study of Religion* 11, 325-339.

BARRETT, J.L. & KEIL, F.C.

1996 Conceptualizing a non-natural entity: Anthropomorphism in God concepts. *Cognitive Psychology* 31, 219-247.

BARRETT, J.L., RICHERT, R.A. & DRIESENGA, A.

2001 God's beliefs versus mother's: The development of nonhuman agent concepts. *Child Development* 72, 50-65.

CAPORAEL, L.A.

1986 Anthropomorphism and mechanomorphism: Two faces of the human machine. *Computers in Human Behavior* 2(3), 215-234.

CHANDLER, M.J. & HELM, D.

1984 Developmental changes in the contribution of shared experience to social role-taking competence. *International Journal of Behavioral Development* 7, 145-156.

COLEY, J.D.

1995 Emerging differentiation of folkbiology and folkpsychology: Attributions of biological and psychological properties to living things. *Child Development* 66, 1856-1874.

ELKIND, D.

1970 The origins of religion in the child. *Review of Religious Research* 12, 35-42.

FLAVELL, J.H.

1999 Cognitive development: Children's knowledge about the mind. *Annual Reviews of Psychology* 50, 21-45.

FLAVELL, J.H., GREEN, F.L. & FLAVELL, E.R.

1986 Development of knowledge about the appearance-reality distinction. *Monographs of the Society for Research in Child Development* 51, 1-68.

GOLDMAN, R.G.

1964 *Religious Thinking From Childhood to Adolescence*. London: Routledge and Kegan Paul.

1965 *Readiness for religion*. London: Routledge and Kegan Paul.

INAGAKI, K. & HATANO, G.

1987 Young children's spontaneous personification as analogy. *Child Development* 58, 1013-1020.

HELLER, D.
    1986 *The Children's God.* Chicago: University of Chicago Press.
MOSES, L.J. & FLAVELL, J.H.
    1990 Inferring false beliefs from actions and reactions. *Child Development* 61, 929-945.
PERNER, J. & DAVIES, G.
    1991 Understanding the mind as an active information processor: Do young children have a "copy theory of mind?" *Cognition* 29, 51-69.
PIAGET, J.
    1929 *The Child's Conception of the World.* New York: Harcourt Brace.
PILLOW, B.H. & HENRICHON, A.J.
    1996 There's more to the picture than meets the eye: Young children's difficulty understanding biased interpretation. *Child Development* 67, 803-819.
PILLOW, B.H.
    1989 Early understanding of perception as a source of knowledge. *Journal of Experimental Psychology* 47, 116-129.
PILLOW, B.H. & WEED, S.T.
    1997 Preschool children's use of information about age and perceptual access to infer another person's knowledge. *Journal of Genetic Psychology* 158, 365-377.
PRATT, C. & BRYANT, P.E.
    1990 Young children understand that looking leads to knowing. *Child Development* 61, 973-982.
TAMMINEN, K.
    1991 *Religious Development in Childhood and Youth: An Empirical Study.* Helsinki: Suomen Tiedeakatemia. (Finnish Academy of Science and Letters, Tiedekirja, Kirkkokatu 14, 00170, Helsinki, Finland.)
WELLMAN, H.M., CROSS, D. & WATSON, J.
    2001 Meta-analysis of theory-of-mind development: The truth about false belief. *Child Development* 72, 655-684.
WELLMAN, H.M. & HICKLING, A.K.
    1994 The mind's "I": Children's conception of the mind as an active agent. *Child Development* 65, 1564-1580.
WIMMER, H. & PERNER, J.
    1983 Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition* 13, 103-128.
WIMMER, H., HOGREFE, J. & PERNER, J.
    1988 Children's understanding of informational access as a source of knowledge. *Children Development* 59, 386-396.