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Children's Representation of Child and Adult Knowledge

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Do children think that adult knowledge subsumes or only partially overlaps child knowledge? Sixty-four 4- and 6-year-old children were asked either whether a child and an adult know the answers to questions tapping adult- and child-specific knowledge (Experiment 1) or to whom each question should be addressed (Experiment 2). Children were also asked directly about the existence of child-specific knowledge. The experiments provided converging evidence that beliefs about child-specific knowledge are relatively limited among 4-year-olds but become well articulated by age 6. The findings contribute to understanding the development of children's beliefs about the relation between knowledge and age.

Children's ability to represent the differences in people's knowledge is critical for their ability to learn from others (e.g., Baldwin & Moses, 1996; Koenig & Harris, 2005). Theory of mind research has made substantial progress in mapping children's understanding of situational determinants of knowledge, such as whether people are in position to see or infer certain information (e.g., Gopnik & Astington, 1988; Gopnik & Graf, 1988; Lyon & Flavell, 1994; Montgomery, 1992; Moore, Bryant, & Furrow, 1989; O'Neill & Chong, 2001; Perner, 1991; Wimmer, Hogrefe, & Perner, 1988). Although fewer studies have addressed children's understanding of more stable knowledge differences, they suggest that children are also sensitive to knowledge differences between social groups (Lutz & Keil, 2002; Miller, 2000; Taylor,

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Cartwright, & Bowden, 1991). For example, 3-year-olds understand that doctors are more likely to know how to fix a broken arm while car mechanics are more likely to know how to fix a flat tire, and 4- and 5-year-olds understand further that doctors generally know more about living things and car mechanics generally know more about machines (Lutz & Keil, 2002). Such beliefs, whether related to individuals' occupation, race, gender, or age, enable effective interactions with individuals whom children know little about and are essential components of their representations of others' minds.

The present research examined children's beliefs about the relation between knowledge and age. The reason for examining children's age-related beliefs is the early and persistent importance of age as a dimension organizing the child's (and adult's) social world (e.g., Kohlberg, 1966; Lewis & Feiring, 1979). This importance is due in part to the fact that age is an attribute of individuals that is easy to apprehend perceptually and in part to its objective role in defining social structure and social institutions (e.g., school). Thus, substantial effort has been expended toward characterizing children's age-related beliefs and how they influence children's behavior and relationships (e.g., Edwards, 1984; Edwards & Lewis, 1979; French, 1984; Taylor et al., 1991; Wintre, Hicks, McVey, & Fox, 1988). Nevertheless, as shown below, children's representation of child and adult knowledge and their relationship are not well understood.

ADULTS KNOW MORE THAN CHILDREN

Taylor et al. (1991) demonstrated that by age 4, children believe that adults know more than children. They asked 4- and 5-year-olds whether a 6-month-old baby, a 4-year-old child, and an adult know a set of words and object labels. The study used items capturing adult-specific knowledge (e.g., "Does she know what the word 'ambiguous' means?") and items capturing knowledge that preschoolers share with adults (e.g., "Does she know what the word 'nice' means?"). Children recognized that an adult knows both types of items, a peer knows only those in the second group, and a baby knows neither. These findings reveal that children identify knowledge that is common to children and adults as well as knowledge that is adult specific. Although Taylor et al.'s (1991) study focused only on knowledge about words and object labels, other research shows that children are more likely to believe information when the source is an adult rather than a peer, suggesting that children perceive adults as generally more authoritative. For example, adult sources of knowledge are more influential in altering children's memories of their own experiences than are peer sources of knowledge (e.g., Ceci, Ross, & Toglia, 1987).

Although by age 4 children acknowledge limitations in the knowledge of individual adults or groups of adults based on situational and social cues (e.g., Lutz & Keil, 2002; Robinson & Whitcombe, 2003), they may nevertheless believe that adults know everything that children know. This would be consistent with the influential thesis that children, especially early in development, regard adults as omniscient (e.g., Freud, 1927; Piaget, 1959; Rosenberg, 1979). It would also be consistent with preschoolers' beliefs that the ability to learn through communication and inference increases from infancy to adulthood (Miller, Hardin, & Montgomery, 2003; Montgomery, 1993) and that cognitive activities such as studying are causally related to older persons' greater knowledge (Furth, 1980). Alternatively, children's belief that adults know more need not imply that children believe adults know everything. Although representing it as greater, they may see adult knowledge as only partially overlapping child knowledge. That is, just as they identify adult-specific knowledge, they may also identify child-specific knowledge (i.e., knowledge that is more characteristic of children than of adults).

CAN A CHILD KNOW MORE THAN AN ADULT?

Research indicates that children concede that a child may know more than an adult. For example, Jaswal and Neely (2006) showed that strong and immediate evidence about the knowledge of informants of object labels can supersede inferences about informant knowledgeability based on age. The children in their study first observed a child and an adult label three familiar objects and then had to decide whom to believe regarding the label of an unfamiliar object. When both informants had labeled the familiar objects correctly (a shoe was called "a shoe" and "a sneaker"), children preferred the adult's label of the unfamiliar object. However, when the adult had been an unreliable labeler (e.g., he/she called the shoe "a glass") and the child a reliable labeler, they preferred the child's label.

In addition, several studies by Laupa (1991; Laupa & Turiel, 1986) show that by middle childhood, children recognize that as a result of differences in training children may know more than adults. The studies examined the influence of a person's age, knowledge (obtained through training), and status (being in an institutionalized position of authority) on 7- to 13-year-olds' obedience. The results revealed significantly greater importance of knowledge and status than age. Children also consider status in relationships, which affects interpersonal knowledge. For example, between third grade and adolescence, children begin to prefer friends (but not unfamiliar children) over adults as informants on topics such as conflict with a peer (Raviv, Bar-Tal, Raviv, & Houminer, 1990; Wintre et al., 1988).

Taken together, these studies suggest that by middle childhood, children become sensitive to performance, training, and familiarity as predictors of the relative knowledge of individuals and that when these factors favor children over adults, they recognize that children know more. Would children, however, endorse that peers know some things better than adults even in the absence of specific information about the involved individuals and of salient justification of how and why a child knows more? The studies say little about the nature and emergence of beliefs associated with age per se.

Recently, VanderBorght and Jaswal (2009) examined whether 3- to 5-year-olds would prefer to ask a child or an adult about the nutritional value of various foods and about where to play with or what some toys do. The child was presented as a "kid, just like you" and the adult as a "grown-up, just like your mom." Regardless of age, children preferentially addressed the toy questions to the child and the food questions to the adult. Although suggestive that preschoolers may see adult knowledge as only partially overlapping child knowledge, this study leaves unanswered whether the reasoning it reveals about toys represents a general, heretofore untapped competence of preschoolers, that challenges the notion of children's early deference to adults or whether it represents a fairly isolated belief. Not only were the topics of the questions constrained, but also the toy questions were about visible facts and the food questions about invisible facts, an important limitation acknowledged by the authors. As the authors state, their interest was in "whether there were *any* [original emphasis] circumstances under which children would seek out information from a child rather than an adult," and their study leaves open the issues of the extent and strength of children's beliefs about child-specific knowledge and how these beliefs develop.

RESEARCH OUTLINE

The present research was designed to present a broader picture of children's beliefs about child and adult knowledge and their development. The studies used a wider array of items about games and children's television shows to gain insight into the generality and development of children's beliefs about child-specific knowledge. In addition, the studies included procedural, factual, and explanatory items for both child-knowledge and adult-knowledge questions. This "type-of-knowledge" distinction is orthogonal to the visible-invisible dimension in VanderBorght and Jaswal (2009). However, the two can be coarsely aligned in the sense that procedural knowledge can be verified directly through the success or failure of an action (e.g., does one trip on the jump rope or not), while the "truth" of most facts and explanations is either supported by consensus information or fit with other knowledge

(Mills & Keil, 2004). Crucially, the three types of knowledge were fully crossed with whether the knowledge was typical of children or adults, whereas visible-invisible was overlaid with age group in VanderBorght and Jaswal's study.

The present experiments involved multiple tasks to strengthen their conclusions. In Experiment 1, we adopted Taylor et al.'s (1991) procedure and asked for all items both whether an adult and whether a child knew the answers. In Experiment 2, as in VanderBorght and Jaswal (2009) and Lutz and Keil (2002), we used a forced-choice format and asked children whether a child or an adult should be asked for the answer to a question. Each task has particular advantages. The forced-choice format poses fewer memory demands and appears to capture earlier than other task formats children's understanding of who knows what (Miller et al., 2003). Yet, if children perceive adults as always more knowledgeable than children, a strong prediction would be that children perceive adults as equally knowledgeable across domains. This prediction cannot be tested with the forced-choice paradigm because it is unclear to what extent forced-choice data reflect the magnitude of the difference children perceive in the spread of the target knowledge in the groups under consideration. Taylor et al.'s procedure provides a way to map the topography of children's representations of child and adult knowledge independently and thus examine children's perceptions of each group separately.

Both experiments also integrated a metacognitive task in which children directly answered whether children know some things better than adults. There was no reference to particular individuals or topics in this task. Thus, it reveals children's more abstract beliefs regarding the existence of child-specific knowledge.

The present experiments also probed the bases of children's representation of child and adult knowledge. The number of factors that may play a role is too large to be fully explored in any single study, and definitive tests of causality would require specialized experimental designs. However, if children perform better on procedural than factual and particularly explanatory items, this would be indirect evidence for the importance of observational experience in children's generalizations about individuals. As stated earlier, perceptual knowledge has more visible correlates than other kinds of knowledge (Mills & Keil, 2004; Perner, 1991; Taylor, Esbensen, & Bennett, 1994). More directly, the studies examined the role of children's beliefs about their own knowledge. Previous research has demonstrated that children make inferences about others' knowledge based on their own knowledge, a tendency particularly true of younger preschoolers (e.g., Saltmarsh & Mitchell, 1998). Thus, it is possible that if a child does not watch Sesame Street, she is more likely to deny knowledge of Sesame Street to others, and if she believes she knows how to make a cake, she is more likely to attribute baking

skills to others. If so, for this child, child and adult knowledge would largely overlap. It is also possible that children use such reasoning only in attributing knowledge to children. We examined whether there is a relation between children's beliefs about what they know and their attributions of knowledge by asking them whether they knew the answer to each of the questions. The design of Experiment 1 made it possible to test whether such a relation exists both with children's representations of child and adult knowledge or only the former.

The experiments included 4- and 6-year-old children, as Lutz and Keil's (2002) studies revealed substantial development in the representation of group-specific differences in knowledge during the preschool years. Developing broad and stable beliefs about child-specific knowledge may be more challenging than developing such beliefs about adult-specific, or mechanic-specific and doctor-specific, knowledge. Whether or not children realize that adults design their toys, program their video games, build their play structures, or that adults used to be children, they encounter them in every aspect of their lives. Thus, differences in the prevalence of knowledge that favor children may be harder to identify, and are likely smaller relative to differences favoring adults, or differences between doctors and car mechanics.

EXPERIMENT 1

Method

Participants. Fourteen preschoolers ($M = 4;6$, range = 4;1 to 4;11) and 14 first graders ($M = 6;8$, range = 6;6 to 6;11) participated in the study. There were approximately an equal number of boys and girls in each age group. Children came from working- and middle-class backgrounds, and all but three were from European descent.

Materials. In the warm-up phase, four pictures of 4- to 6-year-old children, four pictures of 30- to 40-year-old adults, and a stick figure of a child and an adult were used. In the experimental phase, a poster board showing pictures of 12 children from different non-European ethnicities was used. Flipping a picture revealed a note with a question by the child in the picture.

Table 1 shows the six adult-domain and six child-domain questions used in the study. The questions were selected from a set obtained through asking 15 undergraduates for examples of facts, skills, and explanations that children from preschool to first grade but not adults are likely to know (child-knowledge items) and that adults but not children are likely to know (adult-knowledge items). It should be noted, however, that the elicited

TABLE 1
Stimuli Used in Experiments 1 and 2

Domain/Type	*Item*
Adult/Procedural	...how to make cookies
	...how to cross a street with traffic lights
Adult/Factual	...what the word "haberdashery" means
	...how many video stores there are in [child's town]
Adult/Explanatory	...why balloons fly up and balls fall down
	...why fall comes after summer
Child/Procedural	...how to jump rope
	...how to make a sand castle
Child/Factual	...whether Bert and Ernie are friends
	...which book is funnier: *Green Eggs and Ham* or *The Cat in the Hat*
Child/Explanatory	...why all children want to play with Legos
	...why children prefer bicycles to scooters

child-knowledge items were ones for which children may but ought not believe that there is group-specific knowledge. This reflects the roles adults play in regards to children and the ontogenetic relations between the categories. Two questions of each type were selected for the study. The "procedural" knowledge questions referred to skills (e.g., jumping rope). The "factual" questions sought facts or a consensus opinion,[1] and the "explanatory questions" sought explanation of psychological or physical states.[2]

Procedure. In the warm-up phase, the experimenter explained that children are about the same age as the participant, maybe a bit younger or older, and grown-ups are people who are much older. Pilot testing showed that when prompted to identify children they know, children referred to children their age (e.g., classmates), as well as children of other ages (e.g., siblings, cousins, and friends). Thus, these instructions aimed to encourage children to think of the child category broadly while reflecting the naturally big role peers play in it. To this end, children also sorted the eight child and adult

[1]This variability is seen in particular in the child-domain items. Both items there were labeled "factual" because both have the property of aboutness, which is the classic definition of propositional/declarative knowledge (Cohen & Squire, 1980) and is a characteristic of beliefs in general. As pointed out in the "Results" section, there was no significant difference in children's answers to these two questions.

[2]The fact that, unlike the adult-knowledge items, child-knowledge explanatory questions required psychological rather than physical explanations reflects the results of the adult survey. It is important to note that children commonly produce and demand explanations of both kinds (e.g., Hickling & Wellman, 2001; Hood & Bloom, 1979).

pictures into two piles marked by the child and adult stick figures. No child showed difficulty with this task. Finally, children answered four questions to ensure that they understand that both "yes" and "no" answers can be correct for both child and adult targets.

In the experimental phase, the experimenter introduced the board and presented the children there as having just arrived in town and having a lot of questions: "See these children? They all were born far, far away. They have just come to live in our town. There are so many new things for them here! There are so many things they want to learn about! So they have a lot of questions, and you have to help them. They want to know who could tell them the answers to their questions. Would a child know the answer? Would a grown-up know the answer? Who would know?" On each trial, the participants were asked two questions (e.g., "This is Desta. Desta wants to know why fall comes after summer. Does a child know that? . . . Does a grown-up know that?" The order of the questions (child vs. adult target first) was counterbalanced both within and between subject to ensure that children did not develop a response set based on question order. The 12 trials were presented in one of two random orders. After each trial, the children flipped the note on which the question was written to see if there was a sticker underneath. During the game, they found four stickers, which they affixed to a picture. Consistent with the findings of Taylor et al. (1991), we found that the sticker search helped maintain children's engagement with the task.

The children were then asked whether they knew the answers to the questions (e.g., "Do you know why fall comes after summer?"). Responses were followed up to prevent the formation of response sets (e.g., "Why does fall come after summer?"). The experimenter made a neutral comment after the response and moved to the next question. Thus, children's actual knowledge was not systematically examined.

Finally, half of the children in each age group were asked, "Do grown-ups always know more than children?" and, "Do children sometimes know more than grown-ups?" The other half of the children were asked, "Do grown-ups sometimes know less than children?" and, "Do children always know less than grown-ups?" These metacognitive questions incorporated generic noun phrases (rather than quantified ones like "most children") to keep them short and minimize demands on children's memory. Hollander, Gelman, and Star (2002) show that by age 4, children interpret generic phrases as referring to a wide scope property of a category. The experimenter asked the questions, emphasizing the adverbs *always* and *sometimes*. Responding "no" and "yes" respectively to the first pair and "yes" and "no" to the second indicates a belief in the existence of child-specific knowledge. The opposite patterns indicate a belief that adults always know more, while the other two ("yes-yes" and "no-no") show inconsistency in beliefs. The two questions

were asked in counterbalanced order across subjects. The board, self-report, and metacognitive tasks were separated with 5-minute filler activities.

Results

Board game: Does an adult know that? Does a child know that?. "Yes" responses in the board game were coded as 1 and "no" responses as 0. There were no significant differences between the two items of each type in each domain, so responses were averaged across item and the scores submitted to a $2 \times 2 \times 3 \times 2$ repeated-measures analysis of variance (ANOVA) with age (4 or 6) as a between-subject variable and question domain (child knowledge or adult knowledge), question type (procedural, factual, explanatory), and question target (child or adult) as within-subject variables. Figures 1a and 1b show the proportion of child- and adult-knowledge questions that 4- and 6-year-olds respectively thought peers and adults could answer. The omnibus analysis revealed significant main effects of domain, $F(1, 26) = 6.683$, $p = .016$, $\eta_p^2 = .2$, question type, $F(2, 26) = 4.371$, $p = .018$, $\eta_p^2 = .14$, and target, $F(1, 26) = 10.261$, $p = .004$, $\eta_p^2 = .28$. There was a significant interaction between domain and target, $F(1, 26) = 63.578$, $p < .001$, $\eta_p^2 = .71$. All other interaction effects involved age. There was a significant age $\times$ question type interaction, $F(2, 52) = 8.322$, $p = .001$, $\eta_p^2 = .24$, an age $\times$ question domain and target interaction, $F(1, 26) = 9.527$, $p = .005$, $\eta_p^2 = .27$, and an age $\times$ question domain, target, and type interaction, $F(2, 52) = 10.789$, $p < .001$, $\eta_p^2 = .29$.

Given the higher-order interaction effects, the results of the omnibus analysis are best understood by examining performance of each age group separately. The analysis of the 4-year-olds' data revealed a significant effect of target, $F(1, 13) = 5.544$, $p = .035$, $\eta_p^2 = .29$. Children were more likely to say that adults than children knew the answers to the questions (71% vs. 41%). The analysis revealed that the interaction of central interest between domain and target was also significant, $F(1, 13) = 16.183$, $p = .001$, $\eta_p^2 = .55$. Four-year-olds were more likely to say that an adult than a child can answer the adult-knowledge questions (80% vs. 26%), $t(13) = 4.56$, $p = .001$, but they were equally likely to say that an adult and a child can answer the child-knowledge questions (63% vs. 55%), $t(13) = 0.5$, $p = .6$. Thus, 4-year-olds distinguished adult-knowledge from child-knowledge items, but they treated the latter as instances of knowledge shared between children and adults rather than instances of child-specific knowledge.

Finally, the ANOVA showed a significant three-way interaction involving knowledge type, $F(1, 13) = 8.311$, $p = .002$, $\eta_p^2 = .39$. As Figure 1a suggests, 4-year-olds were more likely to say that an adult than a child knows the answer for factual and explanatory items regardless of domain.

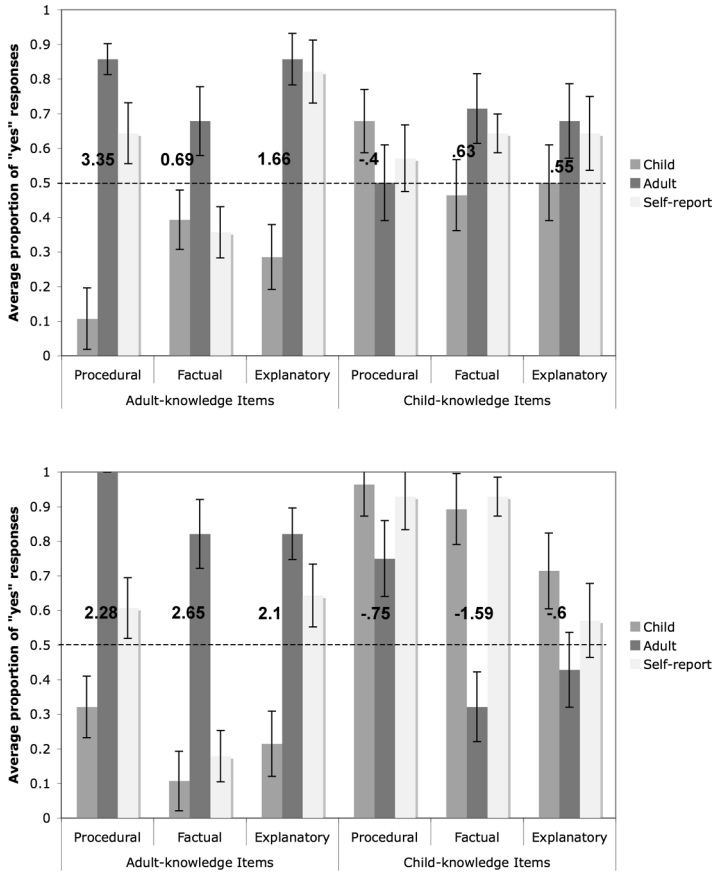

FIGURE 1 Proportion of "yes" responses in Experiment 1 for child and adult and self as a function of the question's domain and type. The top panel shows 4-year-olds' data and the bottom 6-year-olds' data. Error bars represent ± 1 SE. Effect sizes for the difference of "yes" responses to child and adult target questions is also indicated.

This was also true of adult-knowledge procedural items. However, for child-knowledge procedural items, children were more likely to say that a child than an adult knew the answer.

To examine the topography of 4-year-olds' representations of child and adult knowledge, we examined their responses for each target. Four-year-olds were significantly more likely to say that a child knows the answer to child-knowledge than adult-knowledge questions (55% vs. 41%), $t(13) = 4.46$, $p = .001$. In comparison, they were about equally likely to say that an adult

knows the answer to adult-knowledge and child-knowledge questions (71% vs. 63%), $t(13) = 1.9$, $p > .05$.

The analysis of the 6-year-olds' data revealed a significant main effect of domain, $F(1, 13) = 5.658$, $p = .03$, $\eta_p^2 = .3$; target, $F(1, 13) = 6.424$, $p = .025$, $\eta_p^2 = .33$; and question type, $F(2, 26) = 7.852$, $p = .002$, $\eta_p^2 = .37$. Children responded "yes" more often to child- than adult-knowledge questions (68% vs. 55%), to questions about whether an adult knows the answer than to questions about whether a child knows the answer (69% vs. 54%), and to procedural than factual and explanatory questions (76% vs. 54% vs. 54%). Post-hoc pairwise comparisons showed that the effect of question type was due to 6-year-olds more frequently responding that a target knows the answer to a procedural than either factual or explanatory questions (both $p < .01$). Finally, the domain × target interaction was also significant, $F(1, 13) = 48.462$, $p < .001$, $\eta_p^2 = .78$. Six-year-olds were more likely to say that an adult than a child can answer the adult-knowledge questions (88% vs. 21%), $t(13) = 13.49$, $p < .001$. In contrast, they were more likely to say that a child than an adult can answer the child-knowledge questions (86% vs. 50%), $t(13) = 2.84$, $p = .01$. Like 4-year-olds, 6-year-olds were more likely to say that a child knows the answer to child-knowledge than adult-knowledge questions (86% vs. 21%), $t(13) = 3.47$, $p = .004$. They were, however, also more likely to say that an adult knows the answer to adult-knowledge than child-knowledge questions (88% vs. 50%), $t(13) = 9.24$, $p < .001$.

Children's responses to the two questions to each item were also coded in conjunction to more clearly assess the prevalence of beliefs about adult-specific and child-specific knowledge. Figure 2 shows the proportion of times children responded that a child knows but an adult does not know the answer to the questions, that an adult knows but a child does not, that both know, and both do not know. As the figure shows, 4- and 6-year-olds responded more than 60% of the time that adults but not children know the answers to the adult-knowledge questions. A chi-square test showed no difference in the distribution of the four response pairs in the two groups, $\chi^2(3, N = 168) = 4.02$, $p = .25$. The figure also shows that with age, both the proportion of time children thought that only children know the answers to child-knowledge questions and that both children and adults know the answers increased, while the proportion of time children thought that only adults know the answers decreased. The difference in the distribution of response pairs to child-knowledge items in the two groups was significant, $\chi^2(3, N = 168) = 23.61$, $p < .001$.

Metacognitive questions. Children were classified into two categories according to whether their responses to the metacognitive questions

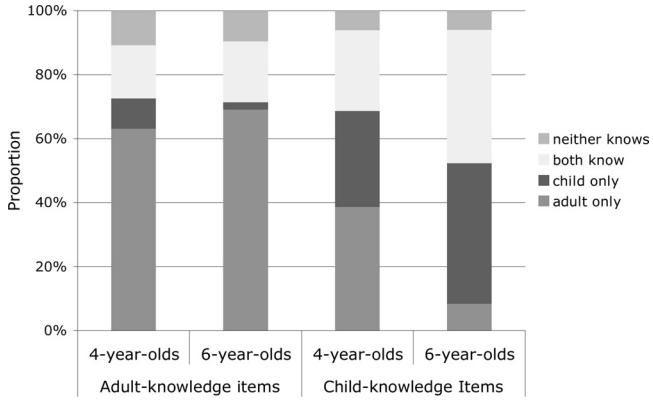

FIGURE 2 Proportion of time the items were seen as adult-only knowledge, child-only knowledge, knowledge common to adults and children, and not known.

indicated a belief in the existence of child-specific knowledge or not. By chance, a response pattern indicative of such a belief would occur 25% the time. Four 4-year-olds and seven 6-year-olds showed it. For 4-year-olds, the result was consistent with chance, $\chi^2(1,\ N=14)=0$, while for 6-year-olds, it was significant, $\chi^2(1,\ N=14)=4.67,\ p=.03$. There was no effect of which pair of metacognitive questions children received and no significant difference between the age groups.

Relation between children's self-reported knowledge and their attributions of knowledge. Figure 1 also displays the proportion of time children reported to know the answers to the questions used in the board game. To explore the role of children's beliefs about their own knowledge in attributing knowledge to adults and children, their self-reports were coded as 1 for "yes" and 0 for "no." Each item was considered separately in this analysis, and thus, the data were binary repeated measures and analyzed using generalized estimating equations (Zeger, Liang, & Albert, 1988). Separate analyses were conducted for the answers to the child-target and adult-target questions. There were no significant effects when age was included as a variable. Because of our a priori hypothesis that the relationship between children's beliefs about their own knowledge and their attributions of knowledge to others would be stronger for younger children, the data from each group were examined separately. In addition to children's self-reported knowledge, question domain was included as a variable in the analyses because both children's self-reports and their choices of addressee were expected to vary with question domain. The effect of own knowledge

was significant only in the analysis of 4-year-olds' responses to questions about adults, Wald $\chi^2(1, N = 14) = 10.524$, $p = .001$. Four-year-olds were significantly more likely to say that an adult knows the answer when they claimed to know it than when they claimed not to know it (79% vs. 61%).

Discussion

Both 4- and 6-year-olds appear to consider a broad range of subjects as areas where adults know more than children. To the domains of word meaning, object labels, and nutritional value of foods (Taylor et al., 1991; VanderBorght & Jaswal, 2009), the present study adds street crossing, the physical properties of inflated objects, and the reasons for the change of seasons. The study, however, revealed age differences in children's response to the child-knowledge items. While 6-year-olds indicated that children are more knowledgeable than adults about children's television shows, games, and child preferences, 4-year-olds only showed a (nonsignificant) tendency to favor children over adults in regards to procedural knowledge (how to jump rope and build sand castles). Thus, the study did not replicate VanderBorght and Jaswal's findings that preschoolers recognize child-specific knowledge.

With regards to the topography of child and adult knowledge, both age groups saw children as significantly more knowledgeable about the child-knowledge than the adult-knowledge items. However, only 6-year-olds saw adults as significantly more knowledgeable about the adult-knowledge than the child-knowledge items. Four-year-olds saw adults as uniformly more knowledgeable.

The finding that 4-year-olds, albeit tentatively, saw an advantage of child over adult knowledge only for child procedural items is arguably due to the tangible, visible ways this knowledge is expressed (e.g., Mills & Keil, 2004). It lends support to VanderBorght and Jaswal's (2009) speculation that their results may be affected by the fact that the child questions were about observable information and the adult questions about information that has to be acquired through others' testimony. It is also consistent with Lutz and Keil's (2002) findings that the earliest differentiation children make between experts is on the basis of observable behavior. Taken together, this research suggests that children's earliest beliefs about expertise are observationally grounded.

The study also revealed that in both age groups, children's self-reports about what they knew did not correlate with their attributions of knowledge to children, suggesting that children's beliefs about their own knowledge do not play a detectable role in their mapping of child knowledge. There was also no correlation between 6-year-olds' self-reported knowledge and their attributions of knowledge to adults. In contrast, this correlation was significant

for 4-year-olds, who were more likely to say that an adult knows something if they reported that they themselves knew it than if they did not. Although surprising, this finding is consistent with the expectation that younger children may refer to their own knowledge more often than older children in deciding what others know. Children's perception of a similarity between their own and adults' knowledge may lead to weaker differentiation between adult and child knowledge.

EXPERIMENT 2

Experiment 2 included a forced-choice task, in which the participants had to decide whether a child or an adult would be the better informant on a topic. The study also included metacognitive questions about each type of knowledge.

Method

Participants. Eighteen preschoolers ($M = 4;4$, range = 3;10 to 4;11) and 18 first graders ($M = 6;10$, range = 6;5 to 8;1) were recruited from schools serving middle- and working-class neighborhoods. There were 10 girls in the younger group and 8 in the older group.

Procedure. The warm-up phase was the same as in Experiment 1 except that the last four questions were omitted because this study used a forced-choice task rather than sequential yes/no questions. The experimental phase began by introducing the protagonists again as having just arrived in the participants' town and as having a lot of questions. Children's task was "to tell whether [the protagonists] should ask another child or a grown-up to find out the answer." The questions from Experiment 1 were used. On each trial, children were shown a picture of the protagonist in context (e.g., in front of a television). The protagonist's question was introduced with a brief vignette to highlight his or her need for knowledge (e.g., "Sasha has never seen Sesame Street before. He wonders, 'Are Bert and Ernie friends?' "). The question to the child was, "Whom should Sasha ask, a child or a grown-up? Who would know?" The two addressee options were counterbalanced within and between subjects. The trials were presented in random order.

After the forced-choice task, the children were asked whether they knew the answers to the questions. Three new questions were used in the metacognitive task to elicit children's explicit assessment of the relation between child and adult procedural, factual, and explanatory knowledge: "Can children do things that grown-ups can't do?"; "Do children know about things

that grown-ups don't know about?"; and "Can children explain why some things happen, things that grown-ups can't explain?" These questions were asked in counterbalanced order. Finally, one pair of the metacognitive questions from Experiment 1 was used: "Do grown-ups always know more than children?" and, "Do children sometimes know more than grown-ups?" Their order was also counterbalanced across subjects.

Results

Forced-choice task: Who would know? Figures 3a and 3b show the proportion of questions in the forced-choice task addressed to an adult by

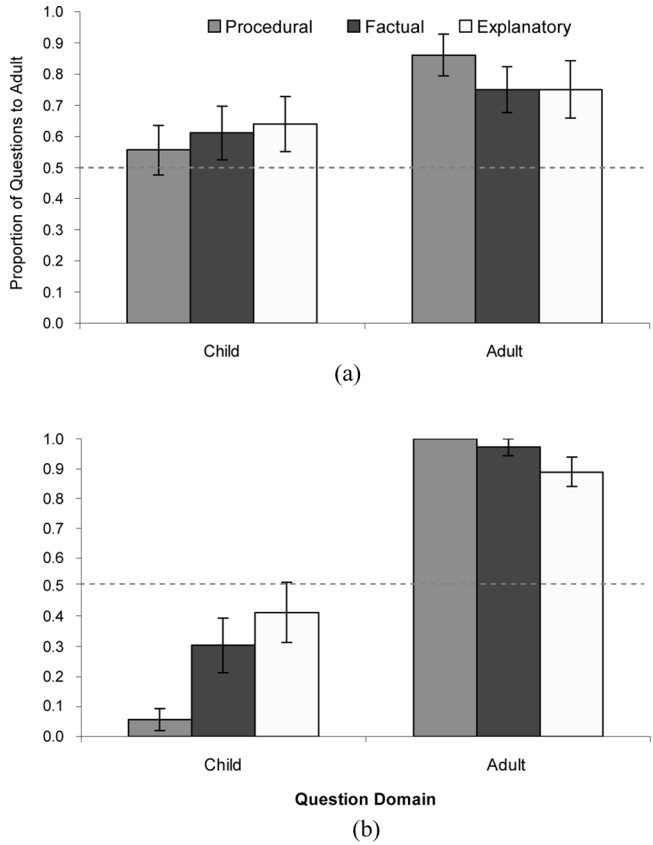

FIGURE 3 Proportion of adult-directed questions in Experiment 2, as a function of knowledge domain and type for (a) 4-year-olds and (b) 6-year-olds. Error bars represent ± 1 SE.

4- and 6-year-olds, respectively, by knowledge domain and type. Preliminary analyses showed no significant differences between the two items of each type in each domain, so children's answers were averaged across items. The data were analyzed using an ANOVA with question domain (adult vs. child) and type (procedural, factual, explanatory) as within-subject variables and age as a between-subject variable. Awareness of adult- and child-specific knowledge was assessed by comparing to chance the rate at which children addressed the child and adult questions to an adult.

The omnibus ANOVA revealed an effect of item domain. Overall, more adult-knowledge than child-knowledge questions were addressed to an adult, $F(1, 34) = 94.42$, $p < .001$, $\eta_p^2 = .76$. This effect was qualified by a significant interaction between domain and age, $F(1, 34) = 31.65$, $p < .001$, $\eta_p^2 = .48$, and between domain and type of question, $F(2, 68) = 8.92$, $p < .001$, $\eta_p^2 = .2$.

Examining the two age groups separately showed that 4-year-olds chose the adult as addressee more often for adult-knowledge than child-knowledge questions (79% vs. 60%), $F(1, 17) = 8.25$, $p = .01$, $\eta_p^2 = .33$. The choice of adult was above chance only for the adult-knowledge questions, $t(17) = 5.2$, $p < .001$. This suggests that 4-year-olds distinguished the two sets of questions in terms of questions that only adults can answer and questions that both children and adults can answer. First graders chose the adult as the addressee on average for 95% of the adult-knowledge questions and for 26% of the child-knowledge questions, $F(1, 17) = 119.38$, $p < .001$, $\eta_p^2 = .87$. Their performance was different from chance for adult-knowledge questions, $t(17) = 20.1$, $p < .001$, and for child-knowledge questions, $t(17) = 4.08$, $p = .001$.

Examining Figure 3 suggests that the interaction between item domain and type reflects that, regardless of item domain, children performed more accurately (i.e., addressing child-knowledge items to a child and adult-knowledge items to an adult) with procedural rather than factual and explanatory questions. Recoding the responses as the proportion of child-related items addressed to a child and adult-related items addressed to an adult and submitting them to a 2 (age) $\times$ 2 (domain) $\times$ 3 (type) repeated-measures ANOVA revealed a main effect of type of knowledge and no interaction between type and domain of knowledge. Overall, children performed significantly better with procedural (81% correct) than with either factual or explanatory questions (70% and 64% correct, respectively). Factual and explanatory questions did not differ from each other. (Bonferonni adjustment was applied to all pairwise comparisons, alpha at .05.) As the comparison of Figures 3a and 3b suggests, the effect of type of knowledge did not depend on age. There was a decrease in accuracy from procedural to factual to explanatory knowledge for both 4-year-olds, $F(1, 17) = 4.503$, $p = .049$, $\eta_p^2 = .2$, and 6-year-olds, $F(1, 17) = 24.939$, $p < .001$, $\eta_p^2 = .59$.

Metacognitive task. Figure 4 shows the proportion of children endorsing child-specific knowledge on the three questions addressing the three types of knowledge. As the forced-choice task, these data showed an effect of type of knowledge independent of age. The proportion of children endorsing child-specific knowledge varied significantly by question, Cochran $Q(2) = 8.714$, $p = .01$. Children were most likely to explicitly recognize the existence of child-specific procedural knowledge. Seventy-eight percent of all participants agreed that children have privileged procedural knowledge, 67% agreed that they have privileged factual knowledge, and only 53% agreed that they have privileged explanatory knowledge. Children's endorsement of child-specific procedural knowledge was significantly higher than that of child-specific explanatory knowledge ($p = .01$, McNemar test). Because the anticipated answer was "yes" for all three questions, it is important to note that a yes-bias may be affecting responding, but this bias should be the same across questions. In addition, the tendency to respond "yes" to yes/no questions decreases with age (Fritzley & Lee, 2003) and therefore works against finding differences between the groups. (This tendency would presumably exaggerate the proportion of "yes" responses for younger children more than for older ones.) Hence, it is important to note that collapsing across the three questions, first graders were significantly more likely than preschoolers to affirm the existence of child-specific knowledge, $t(34) = 1.99$, $p = .05$.

Children were classified into two groups according to whether they indicated a belief in the existence of child-specific knowledge or not in their

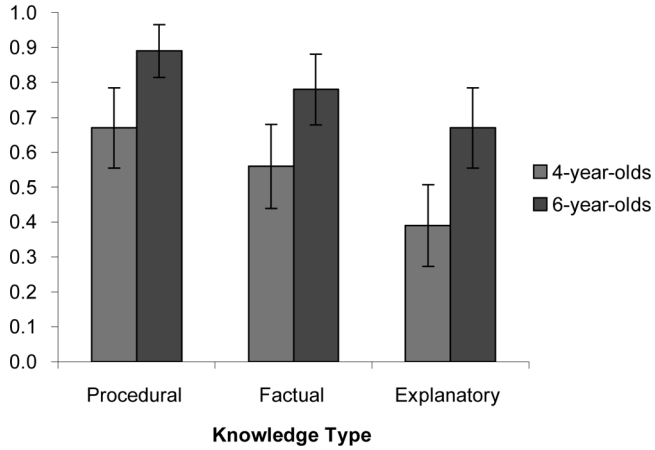

FIGURE 4 Proportion of "yes" answers to explicit questions about whether children have knowledge that adults do not have by age and knowledge type in Experiment 1. Error bars represent ± 1 SE.

answers to the other two metacognitive questions. Five 4-year-olds and eleven 6-year-olds showed the response pattern consistent with such a belief. For 4-year-olds, the result was again consistent with chance, $\chi^2(1, N = 18) = 0.07$, $p = .7$, but for 6-year-olds, it was significant, $\chi^2(1, N = 18) = 12.519$, $p = .001$.

Relation between children's self-reported knowledge and their attributions of knowledge. As in Experiment 1, children's responses to the self-report questions were scored as 1 if children asserted the possession of knowledge and 0 if they asserted lack of knowledge. Figure 5 displays the proportion of time they reported to know the answers. The scores were entered as a predictor of children's choice of addressee in a general estimating equations model. Knowledge domain was also entered as a predictor because both children's self-reports and their choices of addressee were expected to vary with item domain. Analyses conducted in each group showed no effect of own knowledge for first graders, Wald $\chi^2(1, N = 18) = 1.311$, p = .25, but a significant effect for 4-year-olds, Wald $\chi^2(1, N = 18) = 4.47$, p = .03.

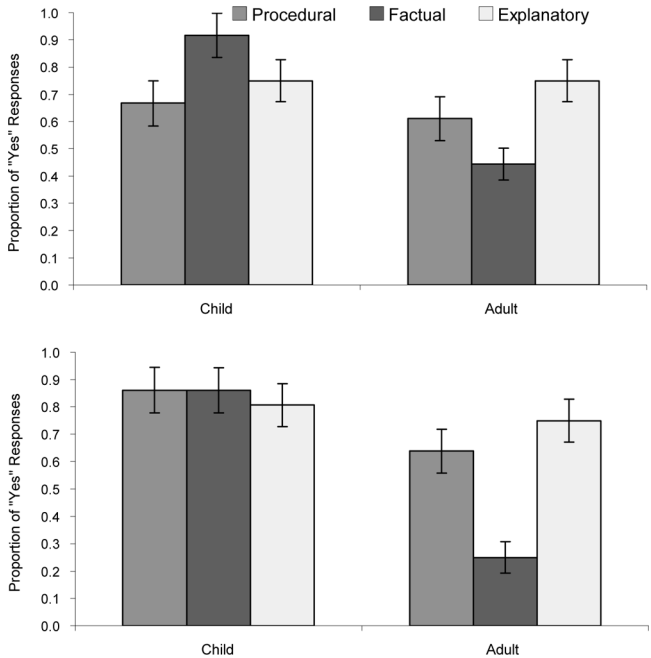

FIGURE 5 Proportion of "yes" responses to the self-report questions in Experiment 2 as a function of the question's domain and type. The top panel shows 4-year-olds' data and the bottom 6-year-olds' data. Error bars represent ± 1 SE.

Four-year-olds were more likely to ask a child if they knew the answer to a question than if they did not (34% vs. 23%).

Discussion

The results from this experiment confirm and extend the conclusions suggested by Experiment 1. Although forced-choice tasks are easier for younger children and may be more sensitive to small differences in children's perception of the distribution of knowledge, in this study, 6-year-olds were again the only group that attributed greater knowledge to children and endorsed the existence of child-specific knowledge.

This study also provides converging evidence that the type of knowledge being sought matters for children's knowledge representations. Of the child-knowledge items, both 4- and 6-year-olds were most likely to direct the procedural ones to children. The same was true of adult-knowledge items: Children were most likely to direct the procedural ones to adults. The type of knowledge effect was also replicated in the metacognitive questions.

Consistent with Experiment 1, Experiment 2 revealed an effect of own knowledge on informant selection in the younger group. Preschoolers were more likely to select a child informant if they reported that they knew the answer to the question than if they reported that they did not. Conversely, they were more likely to select an adult informant if they reported that they did not know the answer to the question than if they reported that they did. Thus, extending the findings from Experiment 1, this study demonstrates a relationship between what preschoolers say they know and whether they believe a child or an adult is a better informant.

GENERAL DISCUSSION

The aim of this research was to understand the development of children's representations of child and adult knowledge. The findings reveal significant changes in children's beliefs about the existence of child-specific knowledge between the ages of 4 and 6. In Experiment 1, 6-year-olds were more likely to assert that children know the answers to the child-domain questions than adults, while 4-year-olds were not. In Experiment 2, while 6-year-olds directed the child-knowledge questions to children, 4-year-olds were at chance in selecting an addressee.

With respect to 4-year-olds' performance, it is important to consider that two different methodologies—sequential yes/no questions and forced-choice questions—provided limited evidence for beliefs in child-specific knowledge. Most of our child-domain items, like VanderBorght and

Jaswal's (2009) items, made reference to toys (e.g., rope, Legos, Bert and Ernie), but our 4-year-old participants were equally likely to credit knowledge of these items to adults and children. Furthermore, it is important to consider the metacognitive findings which reflect children's explicit commitment to the existence of child-specific knowledge. Four-year-olds' responses were consistent with chance in both studies. Finally, even though 4-year-olds answer "yes" to yes/no questions more often than older children (Fritzley & Lee, 2003), in Experiment 2, 4-year-olds were more reluctant than 6-year-olds to say "yes" when this response indicated that a child knows something better than an adult. Together, these findings provide converging evidence from three different tasks that even though 4-year-olds, and even younger children, may choose a child rather than an adult informant in some circumstances, such behaviors are not integrated into a coherent belief about child-specific knowledge.

Experiment 1 also provided information on children's presentation of the topography of child and adult knowledge. Consistent with the other findings, unlike 6-year-olds, 4-year-olds did not identify significant weaknesses in adult knowledge. Although they identify knowledge differences among adults (e.g., Lutz & Keil, 2002), their responses indicated that they see adults as knowledgeable across domains. This finding suggests that 4-year-olds' performance on the child-knowledge items results not only from weaker representations of strengths in child knowledge but also from weaker representations of weaknesses in adult knowledge.

Differences between the items used in the present research and those used by VanderBorght and Jaswal (2009) could be relevant to explaining the differences in the findings. The items in the present studies were diverse and concrete, while VanderBorght and Jaswal's items were similar and abstract. The experimenter in their study held a card in front of her (that children never saw), and all items were introduced by the experimenter saying, "I have a picture of a new toy/food here that you have never seen before . . . " It is possible that when items are highly similar, children converge on a successful strategy that does not truly represent their underlying understanding. The children were told that the child knew about some of the items and the grown-up knew about others, and as there were two types of cards—toys and foods—and two informants—child and adult—they could have arrived at the target mappings based on superficial associations of toys with children and food with adults. It is also possible that the use of abstract information (toys and food vs. Lego and baking cookies) is better for revealing children's knowledge. In several domains, children have shown deeper levels of understanding when working with abstract rather than concrete representations (Carlson, Davis, & Leach, 2005; Kaminski & Sloutsky, 2009). Future research should address these possibilities.

Our findings are, however, consistent with the existence of individual topics where very young children perceive peers as more knowledgeable than adults. Both the information-seeking and metacognitive tasks in Experiment 2 revealed that beliefs about child-specific knowledge develop gradually. Independent of age, children were most likely to represent procedural knowledge as child specific, followed by factual and explanatory. Type of knowledge was not counterbalanced across the specific topics of the questions used in the board and forced-choice tasks, because we were concerned that children might perceive the items as repetitive, which could affect their response strategies; further studies implementing such counterbalancing would be useful. However, type of knowledge was counterbalanced across child- and adult-knowledge items, and the type of knowledge effect held also for adult items, suggesting that procedural knowledge may be easier for children to apprehend across targets. Moreover, the metacognitive questions did not refer to any specific knowledge and replicated the type-of-knowledge effect.

How Do Representations of Child and Adult Knowledge Develop?

The present research provides two insights into the development of children's representations of child and adult knowledge. The type-of-knowledge effect is consistent with research showing a continuum in how easy it is to infer knowledge (e.g., Mills & Keil, 2004; Taylor et al., 1994). Researchers, including Perner (1991), Taylor et al. (1994), and Mills and Keil (2004), conclude that differences in children's attributions of different kinds of knowledge reflect differences in the availability and the assessment of evidence that licenses knowledge inferences. For instance, they argue that as procedural knowledge is typically demonstrated through actions, its existence can be quickly inferred from the success or failure in attaining the action's goal. In contrast, it is difficult to determine what constitutes evidence for factual and especially explanatory knowledge, and it is difficult to independently verify factual and explanatory statements because they often fall outside the realm of the present and the observable. Children's graded performance on the three types of knowledge then is consistent with an observation-driven development of their representations of child and adult knowledge.

The second insight relates to children's beliefs about what they know. The expectation was that younger children may show weaker differentiation between child and adult knowledge in part because of a tendency to attribute their knowledge to others. Six-year-olds indeed did not rely in any significant way on their own knowledge in attributing knowledge to either children or adults or in their choice of an informant. In contrast, in Experiment 2, 4-year-olds' self-reports were positively correlated with their choice

of a child informant. In Experiment 1, there was also a correlation between their self-reports and their attributions of knowledge to adults.

In sum, the present studies implicate two factors in the development of children's representations of child and adult knowledge: observational experience and their beliefs about their own knowledge. These factors are not inconsistent with each other. A person's knowledge is relevant data for representing what the groups the person belongs to know. This may in fact be pertinent to the somewhat surprising trends observed in Experiment 1. The interactions between 4-year-olds and adults foster high identification of the child with the adult because the latter anticipates the child's needs and directs, supervises, or participates in practically all child activities (Rosenberg, 1979). In contrast, adults expect and demand greater independence from older children, and there is greater separation between child and adult activities. Compared with child-adult interactions, peer interactions may foreground differences more so than similarities between actors, not only because children may be less able or less willing to routinely take the other's perspective but also because children are more willing to disagree and assert a different opinion with peers (e.g., Hartup, 1989; Piaget, 1959). Thus, the findings in Experiment 1 may be due to the dynamics of child-peer and child-adult interactions and the role of observational experience in children's representations of child and adult knowledge.

Clearly, much further research is needed to clarify the role of beliefs about one's own knowledge and observational experience. For example, while both experiments suggested that 4- but not 6-year-olds tend to rely on what they know, the results were inconsistent in that there was a positive correlation between children's self-reports and their answers about what adults know in Experiment 1 and a negative correlation between children's self-reports and their choice of an adult informant in Experiment 2 (equivalent to a positive correlation with choice of child informant). It is possible that this discrepancy is related to the different dependent measures used in the studies. In Experiment 1, we had direct measures of children's beliefs about child and adult knowledge, and the choice measure in Experiment 2 was a comparative one.

More generally, correlational data can play but a limited role in assessing developmental mechanisms. In future studies, it will be useful to experimentally manipulate children's knowledge and the information other children and adults provide to better understand the relative influence of these information sources on children's knowledge representations.

Representing Others' Knowledge and Theory of Mind Development

The present findings have several implications for understanding the development of children's theory of mind. Unlike much earlier research (e.g.,

Laupa, 1991; Wintre et al., 1988), the present studies captured children's beliefs about child-specific knowledge when they were not provided with information that could immediately justify the superior knowledge of children (e.g., through past reliability, training, or familiarity with relevant people). Thus, the findings contribute to clarifying children's beliefs about child-specific knowledge and age (Taylor et al., 1991).

Furthermore, along with studies suggesting that children's representation of others' minds are substantially enriched between early and middle childhood (Banerjee, Larson, Easton, Robinson, & Rowley, 2007; Burton & Mitchell, 2003; Carpendale & Chandler, 1996; Danovitch & Keil, 2004, 2007; Lutz & Keil, 2002), the present findings indicate that their commitment to epistemic diversity—that some people know things that others do not—develops gradually during this period. The development of secure beliefs about age-related or other social category-related knowledge may be slower than other aspects of children's theory of mind (e.g., false belief understanding) for a number of reasons. First, children's generalizations about the knowledge of doctors, car mechanics, children, and adults require some critical amount of experience with representatives of the relevant social group. In contrast, other aspects of normally developing children's theory of mind may be hardwired (e.g., Leslie, 1992; Onishi & Baillargeon, 2005) or may not require generalization across individuals. Second, establishing an area of expertise for a social group may be more computationally complex. The task may, for example, require that children ignore other roles individuals take, tease apart relevant from irrelevant but correlated characteristics of individuals (e.g., occupation from gender), and assess the representativeness of the sample they have.

Finally, a key motivation for theory of mind research is understanding children's interpersonal behavior. Beliefs about others' knowledge in particular provide an epistemic basis of learning from the actions and testimony of social agents (Hanna & Meltzoff, 1993; Koenig & Harris, 2005; Jaswal & Neely, 2006; Nurmsoo & Robinson, 2009). Future studies may usefully extend the present findings by examining not only whether children prefer to seek information from children but also whether they learn better from child testimony about what they consider child-domain knowledge. Importantly, the combination of yes/no questions about what a child and an adult know and forced-choice questions provides preliminary insights into the relationship between children's behavior in a forced-choice context, such as information or help seeking, and their knowledge representations. Comparing Figure 1, which shows the effect sizes associated with the differences in children's endorsements of knowledge for each target, and Figure 3, it is clear that the direction and the magnitude of the difference in the spread of a piece of knowledge in the two groups matter for the direction and magnitude of children's choices

in a forced-choice task. Overall, children reported greater differences between child and adult knowledge for adult-knowledge than child-knowledge items in Experiment 1 and showed stronger informant preferences for adult-knowledge than child-knowledge items in Experiment 2. However, the direction and the magnitude of the difference in the spread of a piece of knowledge are not sufficient to account for the type-of-knowledge effect observed in Experiment 2. For example, in Experiment 1, 6-year-olds differentiated child and adult knowledge more clearly for child factual rather than procedural items. Yet, in Experiment 2, they were more likely to select child addressees for the procedural items. The effect appears to most closely reflect children's representation of the prevalence of the knowledge being sought in the target group. For instance, children's responses to the procedural, factual, and explanatory child-knowledge items for child targets in Experiment 1 show the step-like pattern of the data from these items in Experiment 2.

These observations suggest that children's responses in forced-choice tasks may be the result of a two-step process where they first rely on the magnitude and direction of the difference to decide who knows better and then focus on their representation of the knowledge landscape of the target group in refining their decision. If so, combining methodologies and sampling a wide range of items in studies of children's representation of cognitive expertise is critical for better understanding how children's beliefs about the minds of others influence behaviors involving choice.

Conclusion

The present research confirmed previous findings that by age 4 children believe that adults know things that children do not and further demonstrated that by age 6 children have well-formed ideas about the existence of child-specific knowledge. These results contribute to the growing literature on children's mapping of cognitive expertise and understanding of the determinants of knowledge. Developmental psychologists have often referred to children as "little scientists" (e.g., Gopnik, Meltzoff, & Kuhl, 1999), yet few have viewed them as "little developmental psychologists" and examined their ideas about cognitive growth. This metaphor could be useful in framing further research on children's thinking about knowledge in relation to age.

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