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Preschoolers' Understanding of Knowing-That and Knowing-How in the United States and Hong Kong

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Two experiments on preschoolers' understanding of the effects of exposure on knowing-that and knowing-how were conducted with 3-, 4-, and 5-year-old children ($N = 388$) in 2 locations: a small midwestern city in the United States and a suburban area of Hong Kong, China. By using both English- and Chinese-speaking samples, the authors examined differences in children's understanding of knowing-that and knowing-how as well as the impact of different types of linguistic markers on the understanding of these concepts. Across both studies, in both locations, and for judging the knowledge of self or of others, children's understanding for knowing-that preceded their understanding for knowing-how. Implications of these findings both for universal patterns of theory-of-mind development and for how culture may impact on that development are discussed.

Keywords: theory of mind, knowing-that, knowing-how, Chinese preschoolers, Cantonese

> It's not what you don't know that gets you, it's what you think you know.
>
> —folk saying, southern United States

In the years from 3 to 6, children's understanding of mental states changes dramatically. This is most frequently documented by their changing understanding of belief—especially their performance on false-belief tasks (Wellman, Cross, & Watson, 2001). However, in spite of the methodological precision achieved by examining false belief, the states of knowledge and ignorance are arguably more general and more central to an everyday, representational understanding of mind. People vary their communications depending on whether someone does or does not know something; they direct their learning and attention on the basis of whether they are already knowledgeable or ignorant. Children in particular are often in the position of not knowing that or how something works, of seeing others who know more and are more accomplished than they are, of having others show and tell them new, as-yet-unknown things. Thus, understanding states of knowing is crucial to social understanding.

However, much is still unexplored about children's understanding of knowledge, and research that has focused on the development of children's understanding of knowing has two important limitations. First, almost all studies of children's understanding of knowing have focused on their knowledge of facts (e.g., O'Neill, 1996; Pratt & Bryant, 1990)—often called *knowing-that*. Knowing that a crayon box actually contains pencils, knowing where your car is parked, and knowing who the president of China is are examples of knowing-that broadly construed. However, knowing-that contrasts with knowing-how, and children's understanding of this latter type of knowledge has been virtually unstudied.

A second limitation of research on knowledge understanding is that such research has been conducted almost exclusively with Anglo-European children—most often with English-speaking children. There are reasons to believe that the cultural communities and language systems in which children are raised influence their insights into mental states (cf. Lillard, 1998; Tardif & Wellman, 2000). Certainly, as we discuss below, different languages carve up the domain of knowing in different ways.

Understanding Knowing-How Versus Knowing-That

In everyday understanding and in cognitive science (e.g., Cohen & Squire, 1980), knowing-how and knowing-that are certainly different (e.g., one can know that a computer boots up without knowing how to boot one up, and vice versa). This distinction has been pervasive in the memory literature—in the distinction between declarative and procedural memory—and in discussions of

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types of knowledge in psychology and philosophy for the past century (see, e.g., Bergson, 1911; Ryle, 1949). However, as is typical for research on theory of mind, our focus is not on children's knowledge per se but on their judgments and awareness of that knowledge. In this article, we focus specifically on children's judgments that they or someone else know(s) how or know(s) that, not on the procedural or declarative knowledge itself. This parallels the everyday understandings of knowing exemplified by saying that someone "knows how to count to three" versus saying that he or she "knows that three is greater than two" and saying that one "knows how to make a call on a cell phone" versus saying that one "knows that a call is currently being made on the cell phone." Researching the everyday distinction between one's awareness and understanding of knowing-how and knowing-that could be important in informing an understanding of children's theory of mind. Specifically, because most studies of children's understanding of knowledge have focused on their awareness and understanding of knowing-that, it is worth asking whether assessment of children's awareness and understanding of knowing would differ if their conceptions of knowing-how were addressed.

On the one hand, an understanding of knowing-how might be early to develop and may constitute an important source of insight for a broadening understanding of knowing in general. In particular, it has been argued that children's first understanding of knowledge is based on an overappreciation of performance. Perner (1991) argued that everyday conversation, especially with children, emphasizes knowledge as successful action more than knowledge as correct representation of accessible information. Given this claim, one might predict that understanding knowing-how could precede and, thus, help engender understanding knowing-that.

On the other hand, in the absence of definitive data, one could argue for the opposite developmental sequence. Children's understanding of mental states often emphasizes those states' distinction from overt behavior (Johnson & Wellman, 1982; Lillard, 1996). Knowing-that, in particular, is characterized by having the correct information, even in the absence of a relevant action. Bartsch and Wellman (1995) found that children's earliest conversational uses of "know" included contrastive utterances in which they carefully distinguished knowledge from success (child at 2 years 7 months: "You have pockets to keep your hands warm. I didn't know that" [p. 53].). If a distinction between knowledge and mere action is central to early understanding, then children might find knowing-how a particularly difficult concept and knowing-that considerably easier. In either case, comparisons between children's developing understanding of knowing-how and knowing-that are needed.

Language-Specific Aspects of Knowing

Both English- and Chinese-speaking toddlers acquire the word for *know* as one of their earliest verbs for talking about cognitive mental states, and they talk about "knowing" more than "thinking" or other belief terms until at least the age of 4 (Moore, Furrow, Chasson, & Patriquin, 1994; Tardif & Wellman, 2000). However, there are differences in how different types of knowing are referred to in these languages. In English, a single verb, *to know*, can be used to refer to a variety of different kinds of knowledge in everyday speech (e.g., to say that one "knows" a particular book exists, that one "knows" the person who wrote it, and that one "knows" how to read it). Chinese languages, in contrast, use different verbs for different types of knowing, with one verb used primarily for *knowing-that* (*zi1* in Cantonese) and another for *knowing-how* (*sik7*). Moreover, Cantonese-speaking children start talking about both types of knowing at roughly the same age, using the verbs appropriately to refer to the different types of knowing, with roughly equal numbers of references to each type (Tardif & Wellman, 2000). English-speaking children also talk about both types of knowing in the preschool years (Bartsch & Wellman, 1995), but they appear to talk about knowing-that more than they talk about knowing-how (Moore et al., 1994; Shatz, Wellman, & Silber, 1983). If the language one uses to talk about knowing matters, then the fact that English uses a single verb may encourage English-speaking children to think about these types of knowing in similar ways. In contrast, the fact that Cantonese uses different verbs may encourage different patterns of developing awareness for these two types of knowing. However, this is an empirical question, and current findings on relationships between linguistic markers and cognitive developments (Gelman & Tardif, 1998; Gopnik & Choi, 1990; Gopnik & Meltzoff, 1992; Lee, Olson, & Torrance, 1999; Shatz, Diesendruck, Martinez-Beck, & Akar, 2003; Tardif, Wellman, & Cheung, 2004) suggest that sometimes language-specific markers have an effect on children's developing understandings of concepts, but sometimes they can be irrelevant.

Alternatively, the differences may not be as great as they seem. English also makes a distinction between the two forms of knowing simply by adding the prepositions *how* and *that*. Quite simply, empirical data are needed to explore the differences between children's understanding of these different types of knowing and to determine whether or not children's emergent understanding of knowing is similar or different across cultures and languages that may differ in their emphases and ways of marking these two forms of knowing.

Mode of Exposure and Knowing

An adult conception of knowledge reflects several understandings, but critically, it includes awareness of the relevance and importance of exposure to the appropriate information. If one says "Bill knows his keys are in the drawer," one is saying more than "Bill thinks his keys are in the drawer." Bill knows in this case where he believes his keys are—in the drawer—and he possesses appropriate evidence to support that belief. For example, Bill saw his keys in the drawer, and so he knows they are there. Seeing is only one way in which someone might possess appropriate evidence to justify an attribution of knowledge, but generally, exposure of some appropriate sort to the proper events, objects, facts, or procedures is a requirement for saying that someone "knows," and lack of proper exposure means someone is ignorant or guessing rather than being knowledgeable. This is equally true for knowing-that and knowing-how as it is for *zi1* and *sik7*. For this reason, children's judgments of how knowledge relates to exposure is the primary way in which their understanding has been assessed. Thus, in prior research, children have judged whether they themselves know (or do not know) what is in a box before and after looking into the box (e.g., Gopnik & Graf, 1988) or whether two other people know (or do not know) what is in a box when one has

looked and one has not (e.g., Pillow, 1989; Pratt & Bryant, 1990; Wimmer, Hogrefe, & Perner, 1988).

When young children perform such tasks correctly, it is probably inaccurate to say that they understand how seeing leads to knowing. This is because even when they are accurate in making judgments on the basis of exposure, children at first are incorrect in judging or remembering the exact source of informational exposure—for example, whether it was seeing or being told (Gopnik & Graf, 1988). Children also do not keep close track of the fact that information they have learned may be modality specific (e.g., if you saw what was in the box, you would know what it is and know its color, but if you were told, you might very well not know its color; O'Neill, Astington, & Flavell, 1992). For this reason, we prefer the generic term *exposure* and are interested in young children's understanding of the crucial role of exposure in their judgments of knowing. Exposure plays a critical role for judgments of knowing for both knowing-that and knowing-how, although children's judgments have only heretofore been examined for knowing-that. In the present article, we address children's understanding of knowing in this sense of understanding the influence of exposure, for knowing-how in parallel with knowing-that. Note also that in an attempt to make the tasks as parallel as possible, we consider forms of knowing-how that are learned quickly, in a single exposure, acknowledging that there may still be differences between children's understanding of knowing-how for tasks that are acquired in one or two exposures and those that are acquired gradually over a prolonged learning period.

Study 1

In our first study, we included tasks to assess U.S. and Hong Kong children's understanding of the presence and absence of exposure, in general, as relevant to knowing. We asked children both before and after they were exposed to critical information if they knew a simple fact or knew how to achieve a simple result. If children are sensitive to the presence and absence of exposure, then on our tasks, they should claim to not "know" on preexposure questions but should change their claim to "know" after exposure. Although we were not interested in children's awareness of the mode of exposure, we used two different types of exposure, just in case one was more important for knowing-how but another more important for knowing-that. Thus, half of the time, children were exposed to the critical information by being told (without being shown), and half of the time they were exposed by being shown (without the use of verbal instructions).

Method

Participants

A total of 144 children participated, 72 children in each of two locations: a small midwestern city in the United States and a middle-class suburban area of Hong Kong, China. There were twenty-four 3-, 4-, and 5-year-old children, 12 boys and 12 girls, in each location, with no significant differences between the age of the U.S. and the Hong Kong children, as shown in Table 1.

It was not possible to obtain individual education information for each of the children's parents. Nonetheless, the U.S. samples came from university-affiliated preschools, whereas in Hong Kong, there were no university-affiliated preschools at the time of testing, and thus, the children were selected from preschools in a middle-class suburban neighborhood adjacent to a major Hong Kong university. All children were selected to be native speakers of the dominant language in their respective locations—English in the United States and Cantonese in Hong Kong.

Table 1
Ages (in Years) of Children in Each Sample

	Hong Kong Study 1		U.S. Study 1		Hong Kong Study 2		U.S. Study 2	
Age group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
3-year-olds	3.68	0.25	3.56	0.28	3.81	0.10	3.42	0.35
4-year-olds	4.66	0.24	4.63	0.24	4.59	0.28	4.56	0.25
5-year-olds	5.48	0.34	5.51	0.38	5.30	0.22	5.41	0.29

The protocols for both Study 1 and Study 2 received support from institutional review boards at both locations. Moreover, individual children's participation was contingent on the preschool's approval of the study as well as parental consent and children's verbal-assent procedures.

Materials and Procedure

The general structure of both the knowing-that and knowing-how tasks were similar to many in the literature, requiring children to judge whether they themselves did "know" before and after being exposed to the proper information (e.g., Gopnik & Graf, 1988; Wimmer et al., 1988). The tasks were designed to be as parallel as possible in structure but to vary in the type of knowledge involved—knowing the contents of a set of drawers for the knowing-that tasks and knowing how to do a simple but nonobvious procedure for the knowing-how tasks. Both sorts of tasks involved familiar materials—drawers, a toy car, and a piece of candy for knowing-that; markers, paper, a drinking straw, string, and a pair of scissors for knowing-how—and yet, in each task, these materials were arranged so that something was at first unknown and then, after exposure, known.

For both types of tasks, therefore, we asked the children target questions at two separate phases of the task, which we refer to as *preexposure* and *postexposure*. For the preexposure questions, we were interested in children's abilities to correctly state that they did not know information that they had not been exposed to. Once they were given the critical information (either by showing or telling), they were again asked target questions, which required them to explicitly state whether or not they knew the information at this postexposure juncture. At this point, children should, if they have been able to understand the information given to them, claim to "know." Comparison between these judgments at the two different phases measures children's sensitivity to exposure. A summary of the experimental questions and correct responses to these questions is presented in Table 2.

Each child received two separate trials for each type of knowledge, one trial in which the critical information was shown and another in which it was told to the child. Thus, type of knowledge (knowing-that vs. knowing-how), exposure (preexposure vs. postexposure), and mode of exposure (showing vs. telling) were all within-subject variables, and the order for presenting these tasks was counterbalanced across children, with equal numbers of boys and girls at each age and location assigned to each presentation-order condition.

The English and Cantonese versions of the instructions and test questions were equivalent in every possible way, with the exception of the critical terms *know-that* (*zi1*) and *know-how* (*sik7*). To ensure this equivalence, we went through a multistep process whereby the instructions were developed in one language (English or Cantonese) and then translated into the other language by bilingual speakers of English and Cantonese and checked by other bilinguals. Any phrases that could not be easily translated from one language to the other were rephrased to prevent differences in

Table 2
Correct Response Pattern for Knowing-That and Knowing-How Questions in Studies 1 and 2

Task phase and question	Correct response and reason	
	Knowing-that task	Knowing-how task
Preexposure (−exposure) "Do you know?"	"Don't know" (*m4 zi1*) because container nondescript	"Don't know" (*m4 sik7*) because not obvious
Postexposure (+exposure) "Do you know?"	"Know" (*zi1*) because contents revealed	"Know" (*sik7*) because "trick" revealed

complexity or phrasing in the two languages from confounding the data. This process was repeated until a group of bilinguals, including two of the authors—one a native English-speaking bilingual, the other a native Cantonese-speaking bilingual—could agree on the equivalence of the translations.

Knowing-that. For the knowing-that task, children were first shown a stacked set of two closed, nondescript drawers and asked (pointing at the upper drawer), "Do you know [*zi1*] what's inside?" If the individual children claimed that they "did not know" (*m4 zi1*) at this preexposure phase, they were then either shown or told the contents of the drawer. However, if they claimed to "know" the contents of the drawer, they were asked to name what was in the drawer; upon their answering incorrectly, they were told, "No, there isn't [*X*] inside," and they were either shown or told the contents of the drawer. In the *show* condition, the experimenter opened the drawer so that the child could see the object, then closed the drawer again for the test questions. In the *tell* condition, the child was told, "There's an [*X*] inside."

The postexposure test questions in both the show and tell conditions were identical. Specifically, individual children were first asked if they did "know" (*zi1*) what was in the drawer they had just been exposed to, and their verbal response was recorded. If children said that they did "know" what was in the drawer, they were then asked to tell the experimenter what it was. (Infrequently—6% of the time—children's answers about the contents were incorrect. In these cases, they were shown or told again what the contents were.)

The second knowing-that task was identical and asked about the contents of the second drawer. One of the drawers contained a wrapped piece of candy, and the other drawer contained a toy car.

Knowing-how. The structure of the knowing-how tasks was identical to that of the knowing-that tasks. The knowing-how tasks consisted of two simple, but initially nonobvious, "tricks" that the children were presumed not to know how to do before being shown or told how by the experimenter but that they were able to do easily once the trick had been demonstrated or explained. One such task (*color-changing* task) involved turning a green line into a purple line using a set of Crayola magic markers with one transparent marker that caused the ink from the colored markers to change color. The other task (*straw* task) involved an ordinary drinking straw with a string running through it. For this task, the child was required to cut the straw in half width-wise without cutting the string. The (nonobvious) way to achieve this was to pull on a loop of string that peeked out of a slit in the back of the straw and to cut the straw at the slit.

For each task, the experimenter showed the individual children the materials, told them the desired result, and then asked them if they knew how to do it (e.g., "Do you know how to make the green line turn purple?"). As with the knowing-that tasks, children's responses to this preexposure question were scored either as "know" (*sik7*) or "do not know" (*m4 sik7*), and then the experimenter would either show or tell the child how to perform the trick. The children were then asked again, at this postexposure juncture, whether they did "know how" to achieve the result, and their verbal responses were recorded (just as in the knowing-that tasks). Children who said they did "know how" to perform the trick were again asked to perform it. (On a minority of trials—23% of the time—children were unable to perform correctly at this point. If they did not perform correctly, they were shown or told again; over 95% of the time, children performed correctly by this second trial.) The Appendix provides more detailed scripts for the show and tell procedures for the color-changing task as an example of how these conditions differed for a single task.

Results

The focal comparison was whether children's judgments of knowing would differ according to the type of knowledge (knowing-that vs. knowing-how) examined. In addition, we were interested in finding out whether the results would be similar or different across two cultures that encode these types of knowing differently in their languages, as outlined in the introduction.

We analyzed children's sensitivity to exposure by looking at their judgments of "know" and "do not know" before and after (i.e., without and then with) exposure. Correct answers for these two judgments differed ("do not know" preexposure and "know" postexposure), so an overall effect of exposure would provide an important initial finding. Given such an effect, our main questions concerned a number of critical interaction effects between exposure and the other variables.[1] For instance, prior research (with English-speaking children) has shown that children better understand the influence of exposure with increasing age. In our data, if children of different ages differed in their sensitivity to exposure as a basis for knowing, we should find an interaction between age and exposure. (Finding only a main effect of age would not indicate increasing accuracy in making knowledge judgments but would, instead, indicate that children of different ages differ in some overall tendency to say "know" vs. "do not know," regardless of whether or not the conditions of exposure support such a judgment.) Similarly, if children differed in their sensitivity for different types of knowing, then we should find an interaction between knowledge type and exposure. If the Hong Kong Chinese children were universally more sensitive than the English-speaking U.S. children, then we should find an interaction between location and exposure. If, however, the Chinese children performed better than

[1] These interaction effects with exposure were crucial to our hypotheses, and using a repeated measures indicator of sensitivity to exposure was a statistically more rigorous method than using a difference score or simply a postexposure score, which would not have accounted for potential response bias differences in the children.

the U.S. children only for knowing-how, we should find a three-way interaction between exposure, location, and task.

The relevant data are presented in Figure 1, which plots "know" and "don't know" responses for each of the questions, pooled across location. As is clear in the figure, children did show differences between their willingness to claim to "know" before they were exposed and their claims of knowledge after exposure. Even the youngest children showed some appropriate differentiation in their responding; indeed, all age groups showed significantly greater claims of "knowing" postexposure than preexposure (all ps $< .0001$). Nonetheless, this sensitivity to exposure seems to increase with age, as shown by the greater bifurcation of responses in the older than in the younger children. Further, the appropriate bifurcation seems greater for knowing-that than for knowing-how.

For our main analyses, we chose to analyze these results using a repeated measures analysis of variance (ANOVA) so that we could examine both main effects and interactions among the variables of interest. Thus, our analyses compared pre- and postexposure judgments on the two types of knowledge and the two modes of exposure, with age, gender, and location as between-subjects variables. The results confirm the impressions generated from an inspection of Figure 1. First, there was a main effect of exposure, $F(1, 123) = 37.35$, $p < .0001$, partial $\eta^2 = 0.23$ (with children mostly answering "do not know" before they were exposed and "know" after). This basic effect of an appropriate differentiation due to differences in exposure also interacted with age and with knowledge type. Specifically, the Age × Exposure interaction, $F(2, 123) = 2.96$, $p < .05$, partial $\eta^2 = 0.05$, confirmed that older children were better judges of the effect of exposure than were younger children. Second, the Knowledge Type × Exposure interaction, $F(1, 123) = 51.60$, $p < .0001$, partial $\eta^2 = 0.30$, confirmed that the appropriate difference in responding (from pre- to postexposure) was stronger for knowing-that than for knowing-how. There were no main effects of age or location, and more important, location failed to interact with exposure, knowledge type, or any other factor. Moreover, mode of exposure (whether children were exposed to the critical events by being told or by being shown) did not interact with exposure or knowledge type, nor was there a three-way interaction between these variables. Thus, children's judgments were not influenced by being shown rather than being told, or vice versa.

Because it is important to confirm that these findings hold for individual children as well as for the overall pattern of means, we also examined individual responses on the pre- and postexposure questions. And, as can be seen from Table 3, the number of children who responded correctly to both the preexposure and

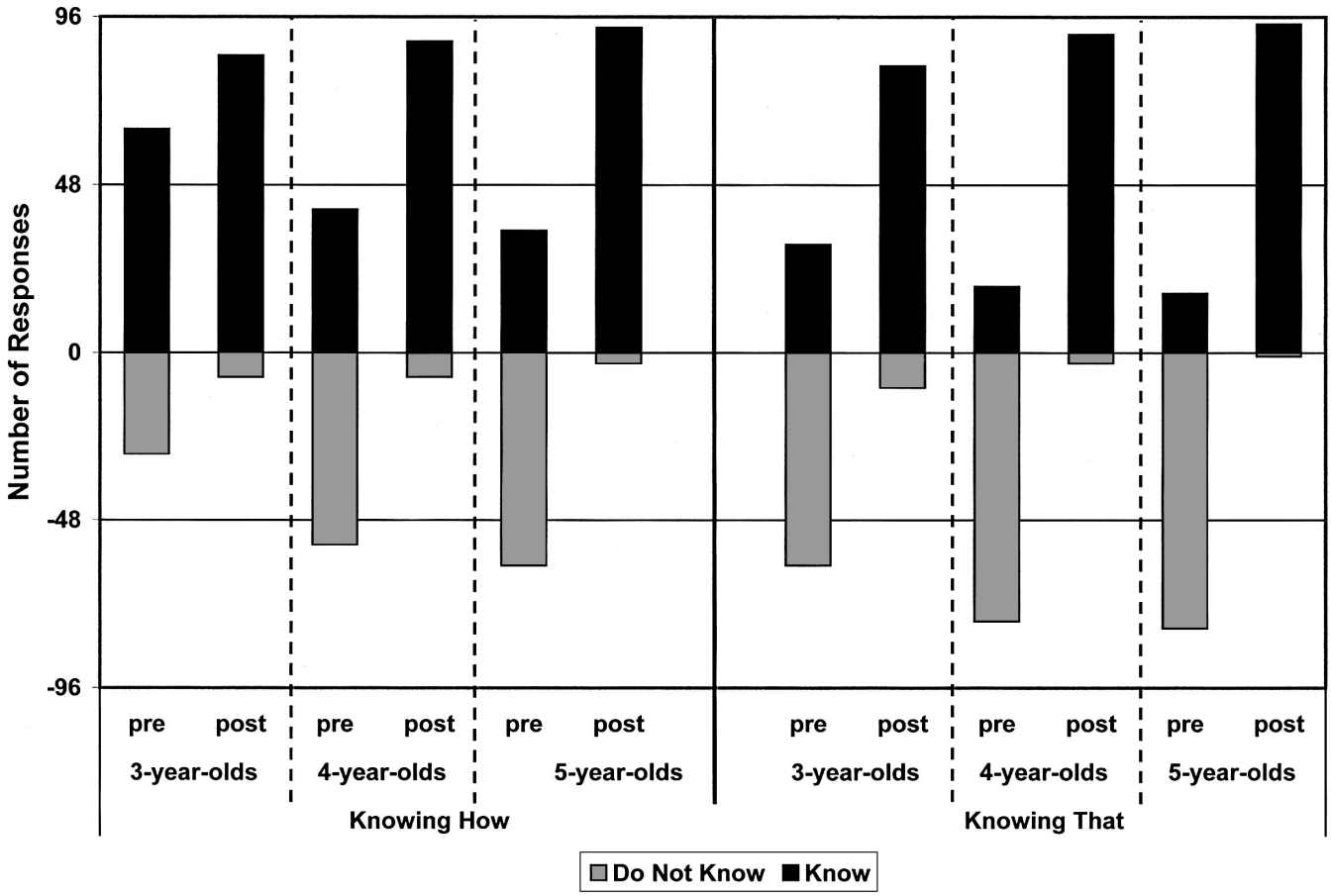

Figure 1. Numbers of "know" and "do not know" responses by age to preexposure (pre) and postexposure (post) questions for knowing-that and knowing-how in Study 1.

Table 3
Numbers of Individual Children's Responses to Pre- and Postexposure Questions by Age and Knowledge Type in Study 1

	Knowing-that		Knowing-how	
Postexposure response	Preexposure response: "Don't know" on both	Preexposure response: "Know" on 1 or more	Preexposure response: "Don't know" on both	Preexposure response: "Know" on 1 or more
		3-year-olds		
"Don't know" on 1 or more	7	1	3	4
"Know" on both	**21**	17	**2**	35
		4-year-olds		
"Don't know" on 1 or more	2	1	2	5
"Know" on both	**30**	13	**14**	27
		5-year-olds		
"Don't know" on 1 or more	1	0	1	2
"Know" on both	**35**	11	**20**	25

Note. "Don't know" was always the correct preexposure response. "Know" was always the correct postexposure response. Bolded values represent numbers of children responding correctly to both preexposure and postexposure questions.

postexposure questions increased with age for both the knowing-that, $\chi^2(2, N = 139) = 8.92$, $p < .05$, and knowing-how tasks, $\chi^2(2, N = 140) = 10.51$, $p < .01$. Moreover, as was the case with the repeated measures ANOVA on mean performance levels across children, the individual children's responses also showed knowing-that to be easier than knowing-how, $\chi^2(2, N = 135) = 5.78$, $p < .05$.

Gender was not a focus in the present study, but because both boys and girls were tested, we included gender as a factor in the overall ANOVA and found a main effect of gender, $F(1, 123) = 4.94$, $p < .05$, with boys more likely to claim "knowing" for both tasks. This suggests that there was a small but significant tendency for boys to say that they did "know," regardless of whether or not they were exposed to information that would allow for true knowing. It is important, however, to note that gender did not interact with exposure (or with any of the other variables), so we do not discuss it further. In addition, no gender effects appeared in the more conservative analysis that we present next.

As mentioned in the *Method* section, a minority of the children in fact failed to name the item in the drawer or to perform the "trick" correctly after the first time they were shown or told (although 97% of the time, children performed correctly given a second exposure). Therefore, we reran the analyses of the data, including only those children who performed the tasks correctly on the first trial. This more conservative set of analyses did not change the general pattern of results. It is important to note that there was a main effect of exposure, $F(1, 70) = 335.49$, $p < .0001$, partial $\eta^2 = 0.83$. This effect again was influenced by age and type of task. Children's knowledge judgments were still more sensitive for knowing-that than for knowing-how, as evidenced by the Exposure × Knowledge Type interaction, $F(1, 70) = 24.82$, $p < .0001$, partial $\eta^2 = 0.26$; and judgments were better for older than for younger preschoolers, as evidenced by the Exposure × Age interaction, $F(2, 70) = 3.12$, $p < .05$, partial $\eta^2 = 0.08$. With this subsample of children, we again found no effects of location nor any interactions between location and exposure or any of the other variables.

Discussion

In the introduction, we claimed that current descriptions of young children's development in understanding knowledge are limited because children's understanding of knowing-how has been almost completely neglected in favor of studying their understanding of knowing-that. Indeed, research could have been seriously underestimating young children's abilities if their early understandings of knowledge are better for knowing-how than knowing-that. Such a misconstrual might be particularly apparent in some cultural contexts (e.g., China) and not in others. However, our data show the opposite pattern. That is, young children's understanding of knowledge is most apparent and most developed for simple cases of factual knowledge. Specifically, we found that children across all age groups were much better at making knowledge judgments for knowing-that than they were at making parallel judgments for knowing-how, and this was true for both cultural groups tested.

Given this result, it is important to consider whether our knowing-how tasks were simply harder and more confusing than our knowing-that tasks, leading to poorer judgments. Although there is no way to definitively equate such tasks, we do want to emphasize that the task formats were extremely similar for both tasks, and the component materials (drawers vs. marking pens) were very familiar in both tasks. In addition, although we have described our knowing-how tasks as "tricks," they were not complicated magical tricks but simple ways to do something that was not apparent from the outset, just as the contents of the closed drawers were not apparent at the outset.

Study 1 is informative, but it is also limited in several respects. In particular, we may have underestimated children's understanding of knowing, particularly their understanding of knowing-how, by asking them only about their own states of knowing. Children, and young children especially, may have been overly eager to demonstrate their performance, and they might have misconstrued our question about knowing-how as an invitation to try and do the trick (see Perner, 1991). Similarly, they might also have assumed

that our question about knowing-that was an invitation to guess the contents of the drawers. Nonetheless, there could well be a difference in the prepotency of this response such that their answers to the knowing-how questions were more affected than their answers to the knowing-that questions.

To examine children's development of an understanding of knowing-that and knowing-how further, we conducted a second study in which we directly contrasted children's judgments about their own states of knowledge with those of both a knowledgeable other and an ignorant other. If the difference in the difficulty with the two types of knowing in Study 1 stemmed from children's eagerness to correctly demonstrate their own knowledge, especially for knowing-how, then children should have more difficulty in accurately attributing states of knowledge to self than they do to others. Alternatively, it may be easier for children to make judgments about their own states of knowing than it is for them to make judgments about the knowledge states of others (e.g., Wimmer et al., 1988). Regardless, it seems important to examine children's knowledge judgments for self and others and to determine whether these judgments differ depending on the type of knowing that is involved (knowing-that vs. knowing-how).

Study 2

In this study, we further investigated the ability of English-speaking American children living in the United States and Cantonese-speaking Chinese children living in Hong Kong to differentiate knowledge states for knowing-that and knowing-how (a) with and without exposure to the relevant information and (b) in themselves and in others. In case the results of Study 1 were somehow influenced by the fact that our knowing-how tasks involved mild "tricks," our primary knowing-how task in Study 2 was completely nontrick-like: It involved knowing how to turn on some flashing lights.

Method

Participants

A total of 144 children participated, 72 children in each of 2 locations: a small midwestern city in the United States and a middle-class suburban area of Hong Kong. There were twenty-four 3-, 4-, and 5-year-old children, 12 boys and 12 girls, in each location, with no significant differences between the age of the U.S. and the Hong Kong children, as shown in Table 1. As with Study 1, the U.S. samples came from university-affiliated preschools, whereas in Hong Kong, the children were selected from preschools in a middle-class neighborhood in proximity to a major Hong Kong university. All children were selected to be native speakers of the dominant language in their respective locations—English in the United States and Cantonese in Hong Kong—and none of the children in either location had participated in Study 1.

Materials and Procedure

The knowing-that and knowing-how tasks were very similar to those in Study 1, but in this study, children were asked about their own knowledge states as well as those of someone else. For ease of administration, this *other* was one of two dolls, one of whom was exposed to the information (+*exposure* other) at the same time as the child and one of whom came on the scene only after the contents or the trick had been shown to the child (−*exposure* other). The meta-analysis by Wellman et al. (2001) demonstrated that children's judgments of thinking and knowing were identical for others who were real persons, videotaped persons, or representational dolls. Also, because there were no differences in performance whether children were shown or told about the drawer contents and the trick in Study 1, we used only the show condition here so as to simplify the nature of the exposure to information across knowledge types and persons.

For both types of knowledge (knowing-that, knowing-how), we asked the children target questions about knowledge states at two separate phases of the task, preexposure and postexposure, yielding four conditions of exposure (+exposure, −exposure) and person (self, other). Finally, after individual children made knowledge attributions, we asked them a *memory control* question about which of the two dolls had been exposed to the information. A summary of the experimental questions and their correct responses at the different phases of the two types of knowing tasks is presented in Table 2.

As with Study 1, the English and Cantonese versions of the task instructions and test questions were equivalent in every possible way, with the exception of the critical terms "know-that" (*zi1*) and "know-how" (*sik7*). In addition, Study 2 used different dolls in the two locations to ensure that children were familiar with the dolls used in the study (but, for ease of explanation, only the U.S. dolls are listed here).

Knowing-that. As with Study 1, for the knowing-that task, individual children were first shown a set of drawers and asked (pointing at the upper drawer), "Do you know [*zi1*] what's inside?" If the children claimed that they "did not know" (*m4 zi1*) at this preexposure phase, they were shown the contents of the drawer. If they claimed to "know" the contents of the drawer, they were asked to name what was in the drawer; upon their answering incorrectly, they were told, "No, there isn't [*X*] inside. Here's what's inside," and they were shown the contents of the drawer.

During this entire procedure, the +exposure doll was placed next to the child, facing the experimenter and the drawer, with the −exposure doll hidden beneath the table inside a bag. Once the child responded to the preexposure question, the experimenter turned to the +exposure doll and asked, "Tigger, do you know [*zi1*] what's inside the drawer?" The experimenter then answered as Tigger, saying, "No, I don't know [*m4 zi1*] what's inside the drawer." Then the experimenter showed both the child and Tigger what was inside the drawer, addressing each by saying, "Here's what's inside" and "Tigger, here's what's inside," as they were shown the contents of the drawer.

After both the child and Tigger were shown the contents of the drawer, the experimenter asked the child if he or she knew what was inside the drawer (postexposure question). When the child said that he or she now knew the contents of the drawer, the −exposure doll was introduced. At this point, the experimenter brought Pooh out from under the table and placed him near Tigger, also facing the drawer, saying, "Here comes Winnie the Pooh. He's *never* seen inside the drawer. Does Winnie the Pooh know [*zi1*] what's inside the drawer?"

At this point, the child had made knowledge judgments for self (−exposure, +exposure) and for the −exposure other. Next, the experimenter asked about the +exposure doll, "Does Tigger know [*zi1*] what's inside the drawer?" Finally, a control question, "Who saw inside the drawer? Pooh or Tigger?," was asked, with the order of alternatives counterbalanced across participants.

Knowing-how. As with Study 1, the structure of the knowing-how task was identical to that of the knowing-that task. So that the task would have none of the features of an unusual trick, children saw a novel toy bug with eyes that lit up if one moved a lever hidden on the back of the toy (*eyes* task).

For this task, the experimenter showed the individual children the toy and said, "Here's a toy with eyes. Do you know how [*sik7*] to make the toy's eyes light up and flash?" Responses to this preexposure question were scored either as "know" (*sik7*) or "don't know" (*m4 sik7*). Children who said that they did "know how" to perform the task were immediately asked to do so for the experimenter. The few ($n = 3$ across all ages and locations) who performed correctly were praised, and a substitute task was used. However, most performed incorrectly. Upon a child's incorrect perfor-

mance or claim not to "know how," the experimenter turned to the +exposure doll (which had been sitting beside the child, just as in the knowing-that task) and asked, "Minnie, do you know how [*sik7*] to make the toy's eyes light up?" The experimenter then answered as Minnie, saying, "No, I don't know how [*m4 sik7*] to make the toy's eyes light up." Then the experimenter showed both the child and Minnie how to make the eyes light up and said, "Here's how you do it," the same as when the child and Tigger were shown the contents of the drawer.

After both the child and Minnie were shown how to make the eyes light up, the experimenter asked the child, "So, do you know how [*sik7*] to make the toy's eyes light up now?" (+exposure question). When the child said that he or she now knew how to do it and was able to do it correctly (up to a maximum of three trials), the −exposure doll was introduced. At this point, the experimenter brought Mickey out from under the table and placed him near Minnie, also facing the drawer, saying, "Here comes Mickey. He's *never* seen this trick before. Does Mickey know how [*sik7*] to make the toy's eyes light up?" Again, after asking about the −exposure doll, the experimenter then asked about the +exposure doll, "Does Minnie know how [*sik7*] to make the toy's eyes light up?" And, finally, the experimenter asked the control question, "Who saw this trick before? Minnie or Mickey?" with the order of alternatives counterbalanced across participants.

Results

Knowing-How and Knowing-That

As in Study 1, the primary data concern children's sensitivity to the fact that knowledge changes with and without exposure. Figure 2 shows children's responses for themselves both prior to and after exposure to the relevant information. Because the data concern only responses for self, they parallel the data from Study 1 (shown in Figure 1). As can be seen in Figure 2, the results closely replicate those of Study 1. Descriptively, just as in Study 1, even the youngest children showed an appropriate differentiation of responses, judging they did "know" more often after exposure than before. Yet again, this sensitivity to exposure increased with age (with greater differentiation in the responses of older children) and was greater for knowing-that than for knowing-how. It is important to note that, just as in Study 1, individual children's patterns of responses confirm the overall mean tendencies, as can be seen in Table 4. Overall, collapsed across person, accuracy of responding was higher for the older than for the younger children on knowing-that, $\chi^2(2, N = 141) = 15.86, p < .0001$, and knowing-how, $\chi^2(2, N = 138) = 25.17, p < .0001$, and children's judgments of knowing-that were more accurate than their judgments of knowing-how, $\chi^2(1, N = 135) = 45.79, p < .0001$.

Nonetheless, our concern was that questioning children only about themselves might have masked still greater understanding (especially for knowing-how, as explained earlier). Figure 3 therefore shows the parallel data from Study 2 for children's judgments of others with and without exposure to the relevant information. The patterns in Figures 2 and 3 are similar and, rather than showing worse performance for judgments of self, seem to show

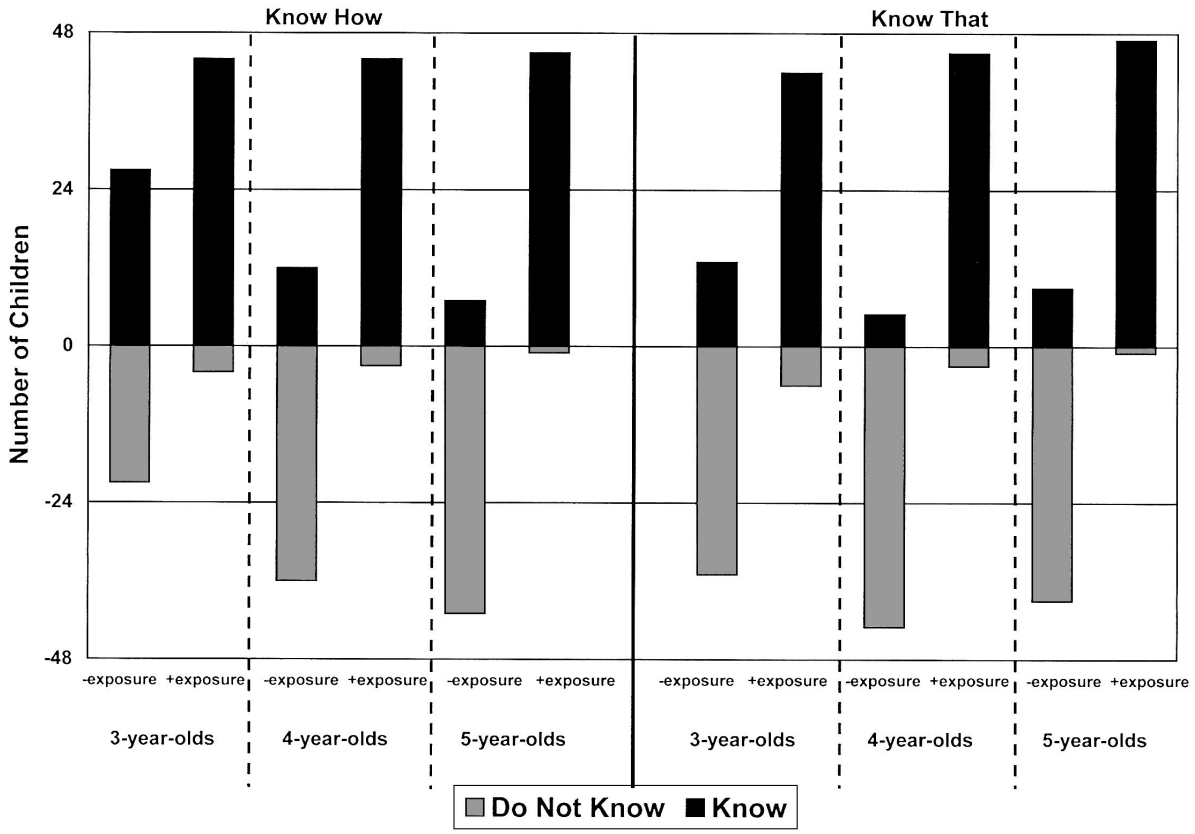

Figure 2. Numbers of children responding "know" and "do not know" by age for self on preexposure (−exposure) and postexposure (+exposure) questions for knowing-that and knowing-how in Study 2.

Table 4
Numbers of Individual Children's Responses to Preexposure and Postexposure Questions by Age and Knowledge Type in Study 2

	Knowing-that		Knowing-how	
Postexposure response	Preexposure response: "Don't know" on both	Preexposure response: "Know" on 1 or more	Preexposure response: "Don't know" on both	Preexposure response: "Know" on 1 or more
		3-year-olds		
"Don't know" on 1 or more	2	1	0	1
"Know" on both	**19**	25	**14**	30
		4-year-olds		
"Don't know" on 1 or more	1	0	0	0
"Know" on both	**33**	12	**34**	13
		5-year-olds		
"Don't know" on 1 or more	0	0	0	0
"Know" on both	**37**	11	**36**	10

Note. "Don't know" was always the correct preexposure response. "Know" was always the correct postexposure response. Bolded values represent numbers of children responding correctly to both preexposure and postexposure questions.

worse performance for judgments of others. A repeated measures ANOVA examining the effects of the within-subject variables of knowledge type (knowing-that, knowing-how), person (self, other), and exposure (−exposure, +exposure) and the between-subjects variables of age and location on children's judgments (claiming "don't know" or "know") confirmed these impressions. To begin with, as in Study 1, there was the crucial main effect of exposure, $F(1, 123) = 484.78$, $p < .0001$, partial $\eta^2 = 0.80$, showing that children were more likely to (appropriately) claim knowledge with exposure than without exposure to the relevant information. With this pattern of appropriate differentiation providing the context, the analysis also yielded several two-way interactions.

Three of these interactions were most focal because they included exposure and, thus, showed how children's sensitivity to the influence of exposure is influenced by other factors. One of these, the Exposure × Age interaction, $F(2, 123) = 26.05$, $p < .0001$, partial $\eta^2 = 0.30$, showed that appropriate differentiation between exposure conditions increased with age, just as expected from Study 1. A second interaction, Exposure × Knowledge Type, $F(1, 123) = 10.68$, $p < .001$, partial $\eta^2 = 0.08$, again replicated the findings of Study 1, with judgments for knowing-that significantly better than judgments of knowing-how. The third interaction provided information novel to Study 2. This Person × Exposure interaction, $F(1, 123) = 14.52$, $p < .0001$, partial $\eta^2 = 0.11$, showed that the appropriate differentiation due to exposure was stronger for self than for others, as is clear from a comparison of Figures 2 and 3.

There was also a Person × Knowledge Type interaction, $F(1, 123) = 4.88$, $p < .05$, partial $\eta^2 = 0.04$, indicating that children were more likely to claim to "know," regardless of exposure, when asked about their own states of knowing-how as compared with knowing-that. This suggests, in line with Perner's (1991) claims, that children may indeed be more likely to claim to "know" when it involves their own knowing-how. There was a complementary Knowledge Type × Age interaction, $F(2, 123) = 5.61$, $p < .005$, partial $\eta^2 = 0.08$, showing that for knowing-how, the tendency to claim to "know" regardless of exposure diminished with age. However, neither of these effects interacted with exposure.

There was also a three-way Exposure × Person × Age interaction, $F(2, 123) = 5.31$, $p < .01$, partial $\eta^2 = 0.08$. This showed that children's uncertainty about ascribing knowledge to others disappears with age such that older children are as able to make the appropriate discrimination between "knowing" and "not knowing" on the basis of exposure for others as they are for themselves.[2]

Memory for Exposure Control Question

Not surprisingly, older children were more accurate at remembering who was exposed to the relevant information than were younger children. A repeated measures ANOVA comparing performance on this question for the two types of knowledge revealed a main effect of age, $F(2, 122) = 7.27$, $p < .001$, partial $\eta^2 = 0.11$, with no effects of knowledge type or location and no interactions between any of the variables. Overall, the means across the two control questions were 1.34 ($SE = 0.12$) for 3-year-olds, 1.70 ($SE = 0.08$) for 4-year-olds, and 1.83 ($SE = 0.07$) for 5-year-olds.

As with the "knowing" questions in Study 1, there was a main effect of gender for this memory control question, with girls more accurate at remembering which doll had had exposure to the information than were boys, $F(1, 122) = 4.97$, $p < .05$, partial $\eta^2 = 0.04$. Because there was no effect of gender on the primary "knowing" judgments in Study 2, however, this is not considered further.

[2] There was also a complex, five-way Exposure × Knowledge Type × Person × Age × Location interaction, $F(2, 123) = 4.13$, $p < .05$, partial $\eta^2 = 0.06$, likely due to ceiling effects for the 5-year-old children who performed at very high rates of accuracy on these tasks (see Figure 2). However, this interaction was rather small and did not appear in the analysis of the subset of children who passed all control questions (discussed next), so we do not discuss it further.

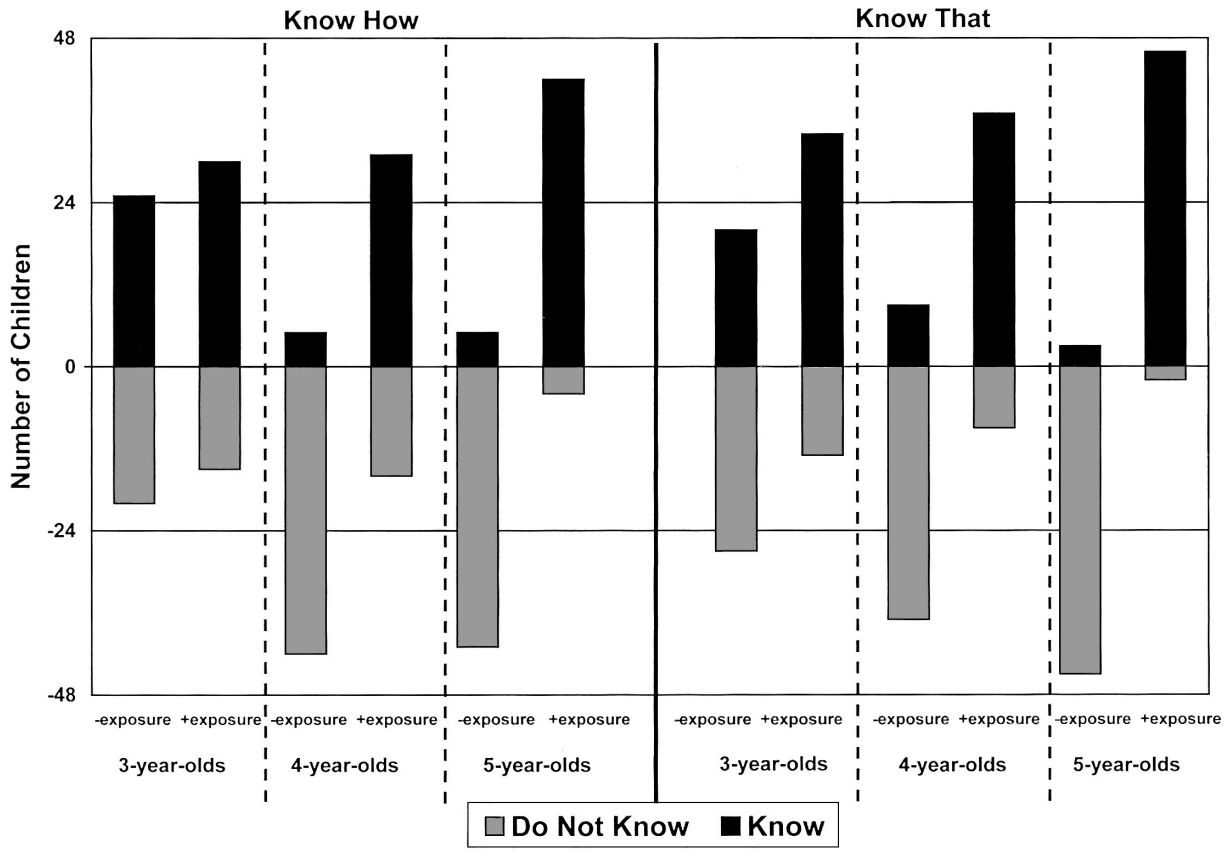

Figure 3. Numbers of children responding "know" and "do not know" by age for others on preexposure (−exposure) and postexposure (+exposure) questions for knowing-that and knowing-how in Study 2.

Because accuracy on this question was lower than might have been expected for a control question (with the 3-year-olds performing particularly poorly), we did a second set of repeated measures ANOVAs on the main comparisons in this study—those examining the effects of exposure, knowledge type, person, age, and location. These analyses excluded all children who failed the control questions. As in the analyses with all of the children included, when we included only those children who passed the control questions, the primary main effect of exposure appeared, followed by an almost identical pattern of interactions. Most crucially, the Exposure × Knowledge Type, $F(1, 84) = 7.97$, $p < .01$, partial $\eta^2 = 0.09$; Exposure × Age, $F(2, 84) = 18.97$, $p < .0001$, partial $\eta^2 = 0.31$; Exposure × Person, $F(1, 84) = 5.80$, $p < .05$, partial $\eta^2 = 0.07$; and Exposure × Person × Age, $F(1, 84) = 9.31$, $p < .0001$, partial $\eta^2 = 0.18$, interactions remained, with no effect of location and no further higher order interactions to modify these main findings. Overall, then, we found clear evidence of an effect of knowledge type in Study 2, as in Study 1, with children performing better on knowing-that tasks than on knowing-how tasks, regardless of location or native language. This major result was observed when children made judgments for themselves (as in Study 1) and when they made judgments for others. Indeed, contra any concerns that asking only about self may have underestimated children's accuracy on knowing-how in Study 1, the data demonstrate that, if anything, children not only more readily claim "knowing" for self than for others, they also do so more accurately, taking better account of exposure conditions for themselves than they do for others, especially at the youngest ages we tested.

General Discussion

When beginning these studies, we fully expected that children's understanding of knowledge might be better for knowing-how than for knowing-that and that this might be especially pronounced for Chinese-speaking children. Indeed, the results for knowing-that were not the same as those for knowing-how. However, counter to our initial thoughts on this, children's judgments of themselves (Studies 1 and 2) or others (Study 2) were less accurate when the information and judgment concerned knowing-how. Moreover, we found no evidence in either Study 1 or Study 2 that the development of these understandings begins at different times in the two cultures that we examined. This is despite the fact that English-speaking children use the same word ("know") to refer to both knowing-that and knowing-how early on in their everyday conversations (Bartsch & Wellman, 1995), whereas Cantonese-speaking children use distinct terms for "knowing-that" (*zi1*) and "knowing-how" (*sik7*; Tardif & Wellman, 2000). In particular, in Hong Kong just as in the United States, children were less able to judge whether a person knows how (*sik7*) to do a simple task than

they were to judge whether a person knows (*zi1*) the contents of an unmarked container. More important, the primary differences between understanding knowing-that and knowing-how were maintained even when only the children who performed the control tasks correctly were included in the analyses.

Of course, this conclusion—that it is easier for young children to judge knowledge for knowing-that than for knowing-how—is limited to the case of know-how acquired quickly on the basis of a single demonstration. Our knowing-how tasks were of this nature to make them comparable with the knowing-that tasks, which involved exposure to a single revealing fact. These cases were not only as comparable as we could make them, they were also, arguably, simple in the sense that they made the contrast between not-knowing and knowing as immediate as possible. It would certainly be interesting, in further research, to examine children's awareness of knowing and learning in cases in which the change from not knowing to knowing is more prolonged and effortful, punctuated by intermediate steps of partial knowing (both for knowing-that in the case of knowing more complex facts and information and for knowing-how in the case of knowing more complex skills and procedures).

In sum, we found three general results in this research. First, children get better at understanding the nature of knowledge over the preschool years, and this is true for both of the types of knowledge tested in the present study. Second, judgments of knowing-how are more difficult for very young children than judgments of knowing-that. Finally, the effect of person—whether one asks about one's self or another—does seem to matter (at least to 3-year-olds, who are better when asked about themselves than about others), but it does not change the basic finding that judgments about knowing-that are easier to make than judgments about knowing-how.

These data demonstrate that a full understanding of children's developing theory of mind, and their understanding of knowing in particular, will be complex and nuanced. Children's developing awareness of mental states proceeds through a progression of insights. For example, a recent study validating a theory-of-mind scale showed that children normally develop understandings first about desire, then about true beliefs, then about knowledge and ignorance, and then about false beliefs, in strict sequence (Wellman & Liu, 2004). However, not only is an understanding of different states (e.g., desire vs. knowledge) acquired gradually, our data confirm that an understanding of knowledge itself is acquired gradually, with several progressive insights. Intriguingly, our data suggest that a consistent sequence in this unfolding is that children's understandings about knowing-that begin to emerge before their understandings about knowing-how.

Why might understanding knowing-that appear so uniformly in advance of knowing-how? Perhaps children's early and frequent experiences with word learning (e.g., knowing that the word *house* corresponds to the appropriate object) play a role. Studies of early word learning have also shown the gradual nature of coming to understand who knows and what is known (as opposed to what is novel and, therefore, to be learned), suggesting that word learning may in fact be a source of early understandings of knowing-that. From these studies, it is clear that by 10–14 months, infants are able to discriminate when novel objects are and are not being named, based on infants' appreciation for how adults have exposed them to the relevant information (Baldwin & Markman, 1989). By 24 months, children are able to appropriately infer that a novel name uttered excitedly by an adult refers to an object that is unfamiliar to the adult, even though the children themselves were familiar with that same object (Akhtar, Carpenter, & Tomasello, 1996). Thus, to the extent that knowing words for things counts as a form of knowing-that, young children have extensive experience with knowing-that and show an early appreciation of some of the features, such as exposure, that affect knowing-that in word learning. This is speculation, but these word-learning findings suggest that relations between children's developing language and their understandings of knowing and other aspects of a theory of mind continue to be an important area to explore in future research (see also Astington, 2001).

Regardless, by showing that children's understanding of knowing-that precedes their understanding of knowing-how, our data underscore how little conceptions of knowing-how have been investigated in prior research. Knowing-how—and an understanding of how exposure influences knowing-how—is also important in everyday life, especially for young children, who must acquire an enormous variety of skills, not just facts and vocabulary items. Further research on how children come to understand knowing-how would surely be informative, and it might also help in an appreciation of how children learn skills more generally. Moreover, addressing knowing-how along with knowing-that highlights ways in which an understanding of knowing is arguably a broader, more frequently used concept than is false belief. In natural-language conversations, English- and Chinese-speaking children use terms for *know* more often than they use terms for *think*, and when they do use "think," they do not generally use it to refer to falsely thinking—even in Chinese, in which a specific term exists that could facilitate such reference (Lee et al., 1999; Moore et al., 1994; Tardif & Wellman, 2000; Tardif et al., 2004).

Finally, the issue of how children acquire understandings of knowledge in different cultures is fascinating and, as our data show, yields conclusions that are not immediately obvious. On the one hand, our data demonstrate that despite linguistic and cultural factors that might result in a difference in the rate or order of acquisition of an understanding of knowing-that and knowing-how in U.S. and Chinese children, there are likely to be some aspects of knowledge and theory-of-mind development that are fundamental and culturally invariant (see also Shatz et al., 2003; Tardif et al., 2004; Wellman et al., 2001). On the other hand, we investigated children from urban, and relatively affluent, homes in two cultures, both of which have strong emphases on schooling (which typically emphasizes knowing-that) and knowledge acquisition in preparation for schooling that begins in early childhood. It is possible that if we varied the types of populations that we looked at (cf. Sharp, Cole, & Lave, 1978), we would find that children from different social and cultural groups differ in how they come to understand knowing-that versus knowing-how. Further, we believe it is likely that the two groups we investigated differ in their acquisition patterns for aspects of knowing that we did not investigate in these two studies. For instance, we know from Li (2001) that the full folk understandings of *knowing* and *learning* differ in these two cultures and that children and adults have very different understandings of concepts for *know*, *study*, and *learn* that may have important consequences for how children and parents attribute knowing once children begin school. In any case, it is clear that investigations of children's understandings of knowing are neces-

sary and revealing and that these investigations should further examine children's understandings of knowing-how as well as their understandings of knowing-that.

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Appendix

Knowing-How Instructions to Child

Show Procedure

"Here's how you do it." (Experimenter's instructions: Use the green pen to draw another line. Pick up the clear pen. Hold it out to make it salient to the child that the clear pen has been picked up. *Scribble* over the green line, turning it purple.)

Tell Procedure

"Here's how you do it." (Experimenter is not allowed to gesture but can point to the appropriate pens.) "First, you pick up the green pen and draw a line on the paper. Then you use the white pen . . . and draw right over the green line. Keep drawing over the green line. That makes the green line change into purple."

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