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What Do Young Children Know About Knowing? A Cognitive-Developmental Study of Preschoolers' Understanding of Knowledge Acquisition[1]

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Four experiments were conducted to investigate preschool children's understanding of knowledge acquisition, with 180 male and female children aged 3-, 4-, and 5-years old and enrolled in Quezon City preschools participating. Experiment I showed that children as young as 3 years old can ably differentiate among three knowledge sources, namely Seeing, Feeling, and Telling, and this ability was shown to significantly improve with age. Experiment 2 determined whether young children understand that sensory experiences create personal knowledge. Results indicated that 3-year-olds have grave difficulties causally connecting their knowledge with its source while older children can correctly justify the source of their knowledge. Experiment 3 compared children's ability to identify the direct or non-inferential origins of their knowledge (e.g., Seeing, Feeling, or Telling) with their ability to identify an inferential source. Again, age had a significant effect with older children performing better, but overall, there were no significant differences in performance between non-inferential and inferential tasks, contrary to expectations. Finally, Experiment 4 assessed preschool children's understanding that certain types of knowledge depend on the specific mode of sensory experience involved. In this task, age once more had a significant effect, and children performed better when Feeling was the sensory modality. The results from the four experiments were related to a theory of understanding knowledge acquisition in the preschool years (Wimmer, Hogrefe, & Sodian, 1988). Practical implications for early childhood cognitive development are also discussed.

In James Howe's (1986) popular children's book called *There's a monster under my bed*, a five-year-old boy lies in the dark thinking of monsters lurking under his bed. Mentally, he ticks off the evidence

–he could hear the monsters breathing and sharpening their claws, he feels the room getting hotter as the monsters make a fire to fry him up, and then he feels the mattress jumping as the monsters fight about who gets to eat him first! Finally, the boy musters enough courage to peer under his bed to confirm his fearful suspicions.

Like Howe's brave protagonist, preschool children are avid information-seekers. Through their rapidly expanding representational powers of language and symbolic thinking, preschoolers are acquiring a lot of knowledge about the world. They are eager learners of the names, shapes, sizes, colors and uses of the objects that populate their physical surroundings, as well as keen observers of the rules, relationships, conflicts, and emotions within social units such as their families. They are learning where things come from, how things change over time, what causes something to happen, and why. And they are never reluctant to talk about anything and everything they know nor shy to ask when they want to know more.

But do preschool children know how they know? Are they able to explicitly realize that in order to acquire knowledge, they must have access to this knowledge via perception, communication or inference? Do they know what steps to take to gain such informational access? Can they connect the sources of information with the information itself? Cognitive psychologists who have tried to answer these questions believe that there is a developmental story to children's unfolding understanding that knowledge acquisition and informational access go hand in hand.

Stages in children's inderstanding of knowledge acquisition

According to Wimmer, Hogrefe, and Sodian (1988), there is a fixed sequence consisting of three stages in the development of children's understanding of where knowledge comes from. The stages begin at about age three and culminate at age six when the relationship between knowledge and types of informational access is basically grasped.

Stage 1

The first phase begins at around three years of age when children know what they know but not *how* they know it. In this phase, children are at a loss to explain and justify their knowledge and beliefs. While they can rely on different sources of information (primarily their senses)

to obtain knowledge, they apparently do not associate their knowledge with its sources. For instance, a child may gleefully open a present but will not be able to connect her resulting knowledge (of what is inside the gift box) to her sense of sight. The understanding that knowledge itself has origins is absent at this stage.

Stage 2

The second stage begins between the fourth and fifth years, and is characterized by children's explicit understanding of the association between simple sensory experiences (specifically, seeing, feeling, and touching) and knowledge. The presence of such understanding now allows them to justify how they know something (Wimmer et al., 1988). It also allows them to be more strategic about their own information-gathering activities. For instance, when told that the candy jar is empty, the 4-year-old child may insist on looking inside the jar to ascertain for herself that there is indeed no more candy.

At this stage moreover, preschoolers are able to successfully answer *primary knowledge assessment tasks* wherein they are asked to determine the knowledge state of another person. In order to decide whether some other person knows about an object, they simply observe whether that person has visual and communicative access to the object. However, children still do not completely appreciate the informativeness of an informational source or the possibility of inferential (e.g., non-sensory) access.

Stage 3

The third phase is characterized by success in *modality-specific knowledge assessment* where children are able to determine their own or another person's knowledge state on the basis of the sensory experiences they or the other person must have had. This ability seems to be present at five or six years of age in conditions involving visual and tactile experiences.

Not only are children at this stage aware that their knowledge of a certain fact comes from some piece of evidence, children now understand that information about specific perceptual qualities comes from specific sensory experience (e.g., visual qualities can only be determined through visual access). For instance, if a six-year-old child wants to let his mother

"know" how large a bruise he got when he fell, the child will "show" his mother his knee. The same child will very naturally lift a toy box to find out how heavy it is, or gingerly touch the tip of his tongue to a spoonful of soup to gauge whether it is cool enough to eat.

Related empirical evidence

Children assess their own and others' knowledge

There is rich evidence from everyday life and the psychological literature that children as young as two years of age who are provided with perceptual and verbal information can easily report the knowledge they thus obtain. In Wimmer, Hogrefe, and Perner's (1988) experiment, for instance, children were allowed to look inside a box (e.g., perceptual access) or were told what was inside the box (e.g., communicative access) and then asked whether they knew what object was in the box. Three and 4-year-old children performed equally well on questions pertaining to their knowledge of the object's identity.

But there is also evidence that while visual perception and verbal communication both lead to knowledge among young children, these children do not comprehend the causal, functional relationship of these informational sources to personal knowledge. When children had to assess another person's knowledge (for example, what the experimenter or the child's mother knew) as in Mossler, Marvin and Greenberg's study (1976), 3-year-olds hardly considered the informational access of the other person in judging his or her knowledge state. Hence, they could not correctly attribute or deny knowledge to another person.

Younger children in Wimmer, Hogrefe, and Perner's (1988) experiment also erred frequently when they denied knowledge to another person when in fact, the other person was given the same visual or communicative access that the children had to the object inside the box. The 3- and 4-year-old children had no difficulty assessing whether the other person saw or did not see the object, confirming Flavell's (1988) contention that by age 3, children have accomplished the first level of visual perspective taking. That is, they have arrived at the insight that another person does not always see the same object that they themselves currently see. However, while children are successful in judging another person's visual access, they do not use this information in assessing that

person's knowledge. They continued to neglect perceptual access as a source of the other person's information.

In contrast, other researchers have found that with simple tasks and simple questions, 3-year-old children appear to understand that there is a relationship between seeing and knowing. Pillow (1989) questioned children regarding their own and a puppet's ability to see hidden objects. Preschool children were able to ascribe knowledge and perceptual experience correctly to the puppet that had seen the hidden object but not to the puppet that had not.

Children were also successful in identifying which puppet knew the color of the hidden object, the one that had seen it or the one that had not. Thus, they attributed color knowledge correctly to the puppet that had seen the object and ignorance to the puppet that had not seen it. This significant finding revealed that children comprehend the connection between looking and knowing, and Pillow (1989) concluded that 3- and 4-year-old children understand that perceptual experience is a source of knowledge.

Pratt and Bryant (1990) replicated the results of Pillow's study In their first experiment, children had to assess which of two assistants knew what the hidden object in the box was, the one who looked inside the box or the one who simply lifted the box. Children stated that the one who had looked in the box knew what was in it, again indicating that 3- and 4-year-old children knew that looking inside the box leads to information about its contents. Their ability to answer the simple questions that Pratt and Bryant (1990) employed suggests that children's apparent difficulties in Wimmer et al.'s (1988) experiments may have been due to the complex, double-barreled questions used by the latter.

In sum, in contrast to Mossler et al.'s (1976) and Wimmer et al.'s (1988) studies, both Pillow's (1989) and Pratt and Bryant's (1990) experiments showed that as early as age three, children can distinguish between knowing and not knowing and can understand the link between looking and knowing. They are able to judge another person's knowledge and ignorance on the basis of the sensory experience that provided them the information. This understanding is present whether they are active participants or mere observers of other people involved in looking and not looking.

Children identify sources of information

Gopnik and Graf (1988) wanted to find out at what age children start to identify the sources of their beliefs and at what age they can tell where their beliefs come from. The three types of sources studied were seeing an object, being told about it and making an inference about the object. These researchers also believed that for information to be useful it must be stored in memory so they tested whether the children who could identify the sources of their beliefs maintain their answers even after a short period of time has elapsed.

The researchers discovered that 3-year-olds remembered what the objects were as much as 5-year-olds did. But 3-year-old children had difficulty identifying the sources of their beliefs even when given a training session whereas 5-year olds had no such difficulty. In addition, when 3-year-old children correctly identified the source of information, after a while, they usually forgot the source. On the other hand, 5-year-olds who were able to identify the sources of their beliefs remembered the sources over a period of time. Gopnik and Graf (1988) believe that cognitive limitations in the younger children constrained their capacity to store the information in memory, to comprehend the association between source and knowledge, and to answer open-ended questions.

In a later study by O'Neill and Gopnik (1991), children found out about an object hidden inside a toy tunnel through three different ways – seeing it, being told about it or feeling it. They were then asked to identify the object and to state how they knew what it was. Children were able to identify the hidden object but 3-year-olds struggled to justify their knowledge even when choice alternatives were presented. Since it had been established beforehand that these children could identify and distinguish the three perceptual activities, their failure to identify the source of their knowledge could not have been due to their inability to differentiate among these activities. Instead, the problem seems to be rooted in their inability to link their perceptual experiences to their resulting beliefs or knowledge (O'Neill & Gopnik, 1991). The results of the studies above indicate that developmentally, only children at least 4 years of age can successfully provide evidence for their own and another person's knowledge by identifying which type of perceptual experience led to this knowledge.

Knowledge via inference

Inferential access can be made available to children by showing them the container (for example, an egg carton or a crayon box) from where a hidden object came. Since the container is unique to the object, children can infer the hidden object's identity (e.g., egg or crayon), even without seeing or touching it, by making use of the given clue. Understanding that inference leads to knowledge is much more difficult to achieve and may not be present until six years of age even if the children actually do infer things that contribute to their knowledge. The ability to make a correct inference appears to develop earlier than the ability to explain that knowledge can be created via inference (Sodian & Wimmer, 1987; Wimmer, Hogrefe & Sodian, 1988).

In Sodian and Wimmer's study (1987), the child and another person were involved in a task wherein they could make inferences about an object. It was made known to the child and to a confederate that a container had balls of the same color in it but only the child could see the actual transfer of one of the balls to an opaque bag. The confederate, however, was verbally informed of the transfer of one ball in the presence of the child. If children understand that it is possible for the other person to make inferences using the given information then they should attribute knowledge to the other person regarding the color of the ball in the bag.

Sodian and Wimmer (1987) claimed that children up to six years old assigned knowledge to self but denied it to the other person when visual access was unavailable but the other person was in a position to infer. Only when the other person saw the transfer of objects to the bag did they attribute knowledge to that other person. The children relied on inference in gaining knowledge for themselves but disregarded the idea that the other person might also know through inference, a response that Wimmer, Hogrefe, and Sodian (1988) termed as "inference neglect". They also claim that a clear understanding of inferential access is acquired late, and that younger children's performance is limited to direct access - visual, tactile and communicative - as a source of knowledge.

Modality specific knowledge

Modality specific knowledge is the understanding that some properties of an object can be discovered through one sense only (e.g.,

color through the sense of sight). The modality-specific knowledge assessment task is more complex than the source identification task, and is accomplished later. Additional knowledge is required for children to succeed in such a task - they must grasp that specific sensory experiences create different types of knowledge and they must also be able to identify which sensory experiences lead to which types of knowledge (O'Neill, Astington, & Flavell, 1992). Dretske (1969) termed this as knowledge of *aspectuality*. Children who accomplish this task know that seeing may help them identify an object and furthermore, know that visual access can provide information regarding certain aspects (such as color) of the object. Likewise, they understand that other qualities of an object such as texture can be determined by feeling the object or that some complex intermodal aspects may be discerned by two or more senses.

A number of studies suggest that between the ages of three and five, children begin to recognize that our senses obtain different types of information. Mossler, Marvin, and Greenberg (1976) investigated young children's ability to engage in conceptual perspective taking. Children had both audio and visual access to a story while their mothers were only exposed to the visual channel. There was a tendency in children to overattribute knowledge to their mothers which served as evidence that children still can not discriminate the types of information that are and are not available from just one sensory modality.

In another study, O'Neill et al. (1992) asked preschool children which of two puppets could tell a certain visual or tactile property of the object, the one who looked at it or the one who felt it. Results show that 3- and 4-year-old children perform significantly different from each other and both groups' performance was significantly worse than that of 5-year-old children. Although both puppets had sensory access to the toy, the younger children disregarded the specificity of the source of information involved.

Lastly, O'Neill and Chong (1997) showed children a puppet, Mr. Potatohead, with eyes, ears, nose, mouth and hands. Children were also shown some objects and asked to choose which part Mr. Potatohead should use to determine certain properties of the object. For instance, the experimenters would say, "Here is a ball. What should Mr. Potatohead use to find out if it is red or green?"

Results show that the performance of 4-year-olds was significantly better than that of 3-year-olds who could barely answer the critical test question. Verbally or non-verbally, they were unable to demonstrate how the puppet can ascertain the property in question. It would seem that 3-year-olds do fail to grasp that different information come from different sources, unlike 4-year-olds who were often able to point out the appropriate sensory modality that Mr. Potatohead had to use to acquire the pertinent information.

In summary, the studies reviewed here consistently confirm that perception, communication and inference operate as providers of information even for young preschool children. But developmentally, an awareness of the causal origins of information is achieved only somewhere between the ages of three and five for perception and communication (O'Neill & Gopnik, 1991) and between the ages of four and six for inference (Sodian & Wimmer, 1987). Most studies support the theory of knowledge acquisition proposed by Wimmer, Hogrefe, and Sodian (1988) that an understanding of the links between source and belief starts with an understanding of simple informational source conditions, specifically perception and communication, followed by an understanding of the more complex sources, such as inference.

Research questions

The contemporary child is bombarded with information, as children of earlier times have never been. This information comes with fantastic speed, in massive amounts, and in multiple sensory media and channels that exist in both physical and virtual realities. With the dawn of the new millennium, there are no signs that this information deluge will let up. Undoubtedly, therefore, an essential cognitive task for today's children (and adults) is to discern the origins of the information that forms the basis of their personal knowledge. Without such understanding, children cannot reflect on how they know what they know and consequently, may be unable to sift through information and judge which of their beliefs are trustworthy, reliable, and valid.

In this light, the present study addressed the general question of whether urban Filipino preschool children between the ages of three and 5-years-old understand that sensory experiences as well as their own

thinking processes create knowledge. Specifically, in the experiments reported here, we sought to determine whether preschool children can:

1. understand and differentiate the activities of seeing, feeling and telling;
2. identify the non-inferential sources of their knowledge, namely, visual and tactile perception, and communication;
3. make inferences using available information and identify these inferences as a source of knowledge;
4. understand that specific modes of sensory experiences such as seeing and feeling lead to specific types of knowledge.

Finally, we wanted to ascertain whether 3-, 4- and 5-year-old children differ in their performance of the tasks mentioned above and in their understanding that sensory experience and inferences lead to knowledge.

To answer these questions, we conducted four experiments involving a total of 180 Filipino preschool children. The participating children were 3- (ranging from 2.6-3.5), 4- (ranging from 3.6-4.5) and 5-year-old preschool students (ranging from 4.6-5.5) of nine different preschools in the Quezon City area.

Children were individually tested in a quiet corner provided by the school. Instructions were in Filipino. All the experimental procedures were pretested on preschool children of the same age range to determine the ease with which the instructions could be understood by the participants. Based on the responses of a total of 30 pretest subjects, some questions were simplified and vague items eliminated.

Experiment 1

The goal in the first experiment was to determine if preschool children could understand and differentiate the activities of seeing, feeling and telling. If results here support those of O'Neill and Gopnik (1991), we can assert that the possible difficulties children may experience in Experiment 2 are not due to their inability to distinguish the different sources from one another.

Design

The independent variables in this experiment were Age (3- vs. 4- vs. 5-year-olds) and Informational Condition (See vs. Feel vs. Tell) while the dependent variable was the children's ability to enact the Informational Condition. If children can follow the experimenters' instructions for the puppets' actions then we inferred that they understood what it meant to see, feel and tell. A 3 x 3 mixed factorial design with repeated measures on Informational Condition was used. A majority of the children was expected to do well in this task.

Subjects

Subjects were 30 (21 males and 9 females) randomly selected preschool children at the Montessori Filipino Child Research Center. They were divided into the three age groups of ten subjects each.

Materials

The stimulus objects used were a pair of scissors for the See condition, a ball for the Feel condition, and a lollipop for the Tell condition. They were put in a shoebox wrapped in colorful wrapping paper, henceforth referred to as the Mystery box. A pair of puppets was also used in all three conditions.

Procedure

The child was introduced to the puppet and invited to play a game to help the puppet find out what was inside the Mystery box. The following instructions were given to each child.

> *"Heto si Jenny/Jason, ang ating puppet. Maglalaro tayo ng guessing game kasama niya. Pagtalikod ni Jenny/Jason may itatago tayo sa loob ng box. Tapos, tutulungan mo siyang malaman kung anong bagay ang tinago natin sa box."*

The child was asked to hide the given object inside the Mystery box while the puppet's back was turned. Depending on the condition, the child was told:

See: *Pwede mo bang tulungan si Jenny/Jason tingnan kung anong nasa loob ng kahon?*

Feel: *Pwede mo bang tulungan si Jenny/Jason mahawakan ang bagay na nasa loob ng kahon?*

Tell: *Pwede mo bang sabihin kay Jenny/Jason kung anong nasa loob ng kahon?*

All children went through the three Informational Conditions in counterbalanced sequences. Their behaviors were then observed to see if they corresponded with the experimenter's instructions.

Scoring

Two scoring procedures were applied to the children's responses: Strict scoring and Lax scoring. Subjects were given a score of 1 if they responded correctly, otherwise, they were given a score of 0. In the Strict scoring procedure, a response was considered correct if the child was able to carry out the specific task asked of him or her: to help the puppet see or feel the hidden object or to tell the puppet what the hidden object was. A response was also considered correct when children accidentally did more than what was asked of them but were able to catch themselves and still correctly carry out the specified task (i.e., Feel Condition - *"Ay, nakita!"*, then helps puppet feel also).[3]

A Lax scoring category was created to account for those multiple responses when children responded by enacting a combination of two or three modalities. In this case, multiple responses were considered correct if one of the actions carried out by the child was the one asked of him/her.

Results

Table 1 presents the mean scores obtained by the three age groups using both scoring procedures. On a t-test for repeated measures, the mean difference between Strict and Lax scores was found to be significant among the 3- and 4-year-olds at $p <$ .05. They were also significant for the See and Feel conditions at $p <$ .05 but not for the Tell Condition. When all scores were analyzed collapsing for Age and Informational Condition, the mean difference between Strict and Lax scores was found to be significant, t (89) = 4.05, $p <$ .01. Thus, performance across the board benefited significantly from a more relaxed standard of scoring, especially among the younger children.

A two-way ANOVA with repeated measures on one factor indicated that under Strict scoring, Age had a significant main effect, $F(2, 27) = 8.18, p < .01$. Children's performance significantly increased with age, from a mean of .40 for the 3-year-olds to .97 for the 5-year-olds who scored perfectly on both Feel and Tell conditions. Informational Condition had no significant main effect, and did not significantly interact with Age.

With Lax scoring, Age too had a significant main effect, $F(2, 27) = 18.42, p < .01$. Children's performance improved significantly with age, with 4-year-olds scoring perfectly on two out of three conditions (See and Tell) for an overall mean of .97 and 5-year-olds attaining perfect scores on all three Informational Conditions ($M = 1.00$). On the other hand, the main effect of Informational Condition and its interaction with Age were not statistically significant.

Table 1. Mean Correct Responses for Strict and Lax Scoring by Age and Informational Condition

	Scoring Type	
Age	Strict	Lax
3	.40	.60
4	.73	.97
5	.97	1.00
Informational Condition		
See	.67	.90
Feel	.67	.83
Tell	.77	.83

Thus, the findings in the first experiment support the hypothesis that the ability to differentiate one information-gathering activity from another is present in children as early as 3-years-old but is not yet stable as reflected in the means under Strict scoring. Whether Strict or Lax scoring procedures were applied, findings also show that this ability improves as children get older. Moreover, this ability is not dependent on the informational condition. Children followed the instructions equally well regardless of whether they were asked to help the puppet see, help the puppet feel or to tell the puppet what the hidden object was.

Experiment 2

In the second experiment, our goal was to find out if young children understand that sensory experiences such as seeing, feeling and telling create knowledge.

Design

A 3 x 3 mixed factorial design with Age (3- vs. 4- vs. 5-year-olds) as the between-subjects variable and Informational Condition (See vs. Feel vs. Tell) as the within-subjects variable was used. The dependent variable was the children's ability to identify the source of their own knowledge.

Subjects

The same subjects that went through Experiment 1 participated in this experiment.

Materials

Since there were two trials for each Informational Condition, there were two different objects for each condition. For the See condition, a pencil and a pair of scissors were used; for the Feel condition, a toothbrush and a ball; and for the Tell condition, a toy helicopter and a lollipop. Objects inside the Mystery box were surreptitiously changed depending on the trial.

Procedure

The experimenter gave the following instructions:

"Maglalaro tayo ng isang game. Mayroong mga bagay na nandito sa loob ng box. Aalamin mo kung anong bagay ang nandito sa loob."

The three sources of information were explicitly identified when instructions were given. Depending on the condition, children were told:

See: *"Tingnan mo kung anong nasa loob ng kahon."* (Experimenter opened the Mystery box and made sure the child saw the object inside but couldn't touch it.)

Feel: *"Pwede mong ilagay ang kamay mo sa loob ng box para mahawakan mo yung bagay sa loob. Sige pikit ka muna, tapos ilagay mo ang kamay mo sa loob."* (Experimenter assisted the child to make sure he or she touched the object without looking at it.)

Tell: *"Sasabihin ko sa iyo kung ano ang nasa loob ng kahon. Sa loob ng kahon, mayroong toy helicopter/lollipop."*

Children went through all three conditions in counterbalanced sequences with two trials per condition. After each trial, children were asked to identify the object. The experimenter inquired *"Ano ang nasa loob ng kahon?"* If the children were able to correctly identify the contents of the box, they were questioned about how they knew the contents. An open ended question was used, i.e., *Paano mo nalaman kung ano ang nasa loob ng kahon?"*

If the children failed to answer the target question, they were given forced choice alternatives describing the different informational conditions to which they had to respond with a yes or a no answer. The choices that were stated one by one were as follows: a) *"Nakita mo ba siya?"*; b) *"Sinabi ko ba sa iyo?"*; and c) *"Nahawakan mo ba siya?"*

For the Feel and Tell trials, the children were allowed to see the object inside the Mystery box after they had answered the questions.

Scoring

For this experiment, the two scoring categories - Strict and Lax - were also used and the two trials were scored separately. For both Strict and Lax scoring, subjects were given score of 1 if they responded correctly, otherwise, they were given a score of 0. In the Strict scoring procedure, a response was considered correct if the child correctly stated how he/she knew the identity of the object when given the open-ended question, or if he or she said "yes" to the correct alternative and "no" to the other two choices when given the forced-choice alternatives. In the Lax scoring procedure, multiple responses were considered correct if one of the chosen alternatives was correct.

Results

First, we checked whether performance varied significantly between trials using the paired *t*-test and found that only the scores of the 4-year-olds did ($p < .05$), for both Strict and Lax scoring. The performance of the 3-year-olds and the 5-year-olds did not change significantly between trials. Moreover, only Lax scores in the Tell Condition differed significantly between Trials 1 and 2 ($p < .01$). When all scores were considered across Age and Informational Condition, the difference between Trials 1 and 2 was not significant at $p < .05$ for Strict and Lax scoring. The lack of significant differences led us to average the scores on Trials 1 and 2 on all subsequent analyses.

Next, we looked for differences in performance when children were scored using Strict versus Lax criteria (mean scores are presented in Table 2). The differences were significant for the 3-year-olds (whose means improved from $M = .17$ to $M = .74$ when scored less strictly), and the 4-year-olds (from $M = .58$ to $M = .88$), but not for 5-year-olds at $p < .05$. Thus, the level of performance of the oldest children was unaffected by the mode of scoring used.

For all three Informational Conditions, the differences between Strict and Lax scores were also significant at $p < .01$. Thus, on all Informational Conditions, scores benefited from a less stringent scoring procedure. Moreover, for all the children as a whole, the difference between Strict and Lax scores was significant at $p < .01$ for Trial 1, $t\ (29) = 6.34$ and Trial 2, $t\ (29) = 6.50$.

Table 2. Mean Correct Responses on Averaged Trials for Strict and Lax Scoring by Age and Informational Condition

	Scoring Type	
Age	Strict	Lax
3	.17	.74
4	.58	.88
5	.84	.90
Informational Condition		
See	.52	.94
Feel	.52	.86
Tell	.55	.74

Finally, results of the two-way ANOVA on the Strict scores showed that Age had a significant main effect, $F(2, 27) = 17.09, p < .01$, with 3-year-olds scoring only a dismal $M = .17$ while 4-year-olds improved to $M = .58$, and 5-year-olds to $M = .84$. The main effect of Informational Condition was not significant nor was the interaction effect of Age and Informational Condition, both at $p < .05$. Under Lax scoring, Age did not have a significant main effect, but Informational Condition did, $F(2, 54) = 3.98, p < .05$. Children performed best under the See condition ($M = .94$) and worst under the Tell condition ($M = .74$). No other effects were significant.

The findings indicate that children could easily identify the hidden object but had difficulty in identifying the source of their knowledge. We classified their answers to the open-ended question (*"Paano mo nalaman kung anong nasa loob ng kahon?"*) into three categories: no answer, correct answers and wrong answers. According to O'Neill and Gopnik (1991), some 3-year-old children are able to answer the open-ended questions correctly. On the contrary, 3-year-old children in this experiment could hardly answer our open-ended question. They seem not to understand the question since most of them responded by saying, "I don't know" or just keeping quiet. The 3-year-olds attempted to answer the open-ended question only 17% of the time and all their responses were incorrect. In comparison, the 4-year-olds answered the open-ended question 75% of the time; however, only 29% of their answers were correct. The 5-year-olds answered the open-ended question 85% of the time and received credit for 74% of the questions they did answer. Therefore, the trend that was observed was that 3-year-olds scored most often under the "no answer" category, 4-year-olds in the wrong answer category and 5-year-olds in the correct answer category.

We analyzed further the children's wrong answers and found that they fell into the different response types (presented in Table 3). About a third of the children invoked the object's function to explain how they knew what the object was, while another third gave egocentric responses (e.g., "I just know") that circumvented the need to justify their knowledge.

The forced-choice alternatives were given to children who failed to answer the open-ended question but were able to identify the hidden object previously. Even when presented with alternatives, 3-, 4- and 5-year-old children failed to answer during ten, two and four instances,

respectively. The most common error under Strict Scoring was to say "yes" to more than one alternative. The Yes bias (i.e., yes to all three choices) was observed 15 times among 3-year-olds, and four times each among 4- and 5-year-olds. On the other hand, the No bias (i.e., no to all three choices) was observed three times among 3-year-olds, six times among 4-year-olds, but was absent among the 5-year-olds.

Table 3. Incorrect Responses Given by Children to the Open-Ended Question: ***"Paano mo nalaman kung ano ang nasa loob ng kahon?"***

Response category	Example	%
Function of object	*"Kasi, that's for writing..."*	31
Property of object	*"Kasi mahaba, eh..."*	16
Location of object	*"Kasi it's inside..."*	10
Egocentric response	"Cause I know..."	29
Incomplete response	*"Kasi binukas mo yung box..."*	14
Total		100

Some of the 4-year-olds and most of the 5-year-olds who were presented with the forced choices could often choose the correct alternative. They apparently know how they got the information about the object's identity but could not state freely how they obtained this information. They are in a stage wherein they are aware of the source of their knowledge although they still have difficulty spontaneously communicating how they know what they know.

Experiment 3

Children's ability to answer inferential questions (wherein they were required to make inferences regarding a hidden object by making use of a clue given to them) was assessed in this experiment. This was compared with their ability to answer non-inferential questions that related direct sources of information (e.g., seeing, feeling, and telling) to knowledge. We also tested whether it was more difficult for children to identify inference as a source of their knowledge than to identify simple sources such as perception and linguistic communication, as claimed in previous studies (e.g., O'Neill & Gopnik, 1991).

Design

A 3 x 2 mixed factorial design was used with Age (3- vs. 4- vs. 5-years-old) as the between-subject variable and Informational Condition as the within-subject variable. The dependent variable was the children's ability to identify the source of their knowledge.

A series of three experimental comparisons was performed and in each comparison, two Informational Conditions were compared: See versus Infer for the first comparison, Feel versus Infer for the second comparison, Tell versus Infer for the third comparison. Also, the performance in the Non-inferential conditions (seeing, feeling and telling) were combined and compared with the performance in the Inferential conditions.

Subjects

Subjects were 90 preschoolers (56 males and 34 females) randomly selected from two preschools, Family Montessori and Montmichel. There were 30 subjects per experimental comparison with ten subjects in each age group.

Materials

There were two trials per condition and each trial involved one object, except for the Infer condition where we made use of a pair of objects. For the See condition, a pencil and a pair of scissors were used; for the Feel condition, a toothbrush and a ball; for the Tell condition, a toy helicopter and a lollipop; and for the Infer conditions, an egg and an egg carton and a crayon and a crayon box. Objects inside the Mystery box were surreptitiously changed depending on the trial.

Procedure

The experimenter gave the following instructions:

"Maglalaro tayo ng isang game. Mayroong mga bagay na nandito sa loob ng box. Aalamin mo kung anong bagay ang nandito sa loob."

For the Non-Inferential conditions of See, Feel, and Tell, instructions were identical to those in Experiment 2. For the Infer condition, children

were asked, *"Pwede mo bang alamin kung ano ang nasa loob ng box? Ang bagay na nasa loob ng box ay galing dito."* (The experimenter showed the child the egg carton or the crayon box depending on whether an egg or a crayon was inside the Mystery box.)

After each trial, the child was asked the following questions.

1) *Ano ang nasa loob ng kahon*?
2) *Nalaman mo ba kung ano ang nasa loob ng kahon dahil*
   See versus Infer: a) *naisip mo siya* o b) *nakita mo siya*
   Feel versus Infer: a) *naisip mo siya* o b) *nahawakan mo siya*
   Tell versus Infer: a) *naisip mo siya* o b) *sinabi ko sa iyo*

The children received two trials for each of the three experimental comparisons. The order of conditions was counterbalanced and so was the order of alternatives in the second question. In this experiment, the justification question was presented with forced-choice alternatives instead of the initial open-ended question.

Scoring

It was not necessary to use Lax and Strict scoring in this experiment. A response was considered correct if the child chose the correct alternative and rejected the other. A response was considered wrong if the child said "yes" or "no" to both alternatives.

Results

To test for significant differences between trials, *t*-values across paired scores were computed. No significant differences between Trials 1 and 2 were found for all Age groups and all Informational Conditions, thus scores on these two trials were collapsed and averaged on all subsequent analyses.

A series of two-way ANOVAs with repeated measures on one factor was performed to uncover significant effects in the three Non-inference (e.g., See, Feel, Tell) versus Inference comparisons. No significant main effects for Age and Informational Condition nor interaction effects were found in the first two experimental comparisons, namely See versus Infer and Feel versus Infer.

Table 4 shows the descriptive results for the third experimental comparison (Tell versus Infer) where main effects for Age, F (2, 27) = 8.80, $p < .01$ and Informational Condition, F (1, 27) = 5.73, $p < .01$ were found. Thus, children's performance in both Tell and Infer conditions improved significantly with age. In total, 5-year-olds (M = .82) did better than the 4-year-olds (M = .75) and the 3-year-olds (M = .42). Also, children performed better in the Infer Condition (M = .76) than in the Tell Condition (M = .56). The interaction effect was not statistically significant.

Table 4. Mean Correct Responses on Averaged Trials by Age on Non-inferential and Inferential Tasks

	Informational Condition		
Age	Tell	Infer	Total
3	.30	.55	.42
4	.75	.75	.75
5	.65	1.00	.82
Total	.56	.76	
Age	Non-inferential	Inferential	Total
3	.46	.45	.46
4	.58	.66	.62
5	.65	.82	.74
Total	.56	.64	

To compare children's overall performance on Non-inferential versus Inferential tasks, scores on the See, Feel and Tell Conditions were collapsed under the Non-inferential Condition while scores on the three Infer Conditions were summed under the Inferential Condition. Mean correct responses on these conditions are also presented in Table 4. The ANOVA showed a significant Age effect in this analysis, F (2, 87) = 6.94, $p < .01$, with children's performance improving with age. On the other hand, although 4- and 5-year-old children did better in the Inferential condition, the overall difference between Non-inferential (M = .56) and Inferential (M = .64) tasks was not significant. There was no significant interaction effect as well.

Experiment 4

Our goal in this fourth experiment was to determine whether preschool children understand that having certain types of information depends on the mode of sensory experience involved. Children were exposed to pairs of objects that looked the same but felt different or felt the same but looked different. They were then asked whether they had to see or feel the objects to differentiate one from the other according to a certain characteristic (i.e., color).

Design

A 2 x 3 mixed factorial design was used with repeated measures on Modality Condition (See versus Feel). Age (3- vs. 4- vs. 5-year-olds) served as the between-subjects variable. The children's ability to determine the mode of sensory experience necessary to find out about a property of one of a pair of objects was the dependent variable.

Subjects

Sixty children from six different preschools (Right Start, Seed Montessori, Piaget Learning Center, Basic 2's and 4's, Metro Learning Center and Live and Learn) participated in this experiment. There were 20 children per age group, all of whom went through both Modality Conditions.

Materials

The same Mystery box as in the previous experiments was used. For the See condition, a pair of balls (one yellow and the other green) and two pieces of paper (one with circles and the other one with lines) were used. For the Feel condition, two piggy banks (one empty and one full of coins) and two plastic cups of water (one filled with cold water and the other filled with warm water) were used.

Procedure

The experimenter began with the following instructions:

"Maglalaro tayo ng isang game. Tatanungin kita tungkol sa mga bagay na alam natin dahil nakita natin at mga bagay na alam natin dahil nahawakan natin."

The children were told that the pair of objects had a certain quality wherein they were similar and a certain quality in which they differed. For example, when the stimulus pair consisted of balls, children were told that the balls felt the same but looked different. The experimenter then allowed the child to look at and touch the balls so that they can see or feel the similarities and differences themselves.

For the See Trials, further instructions were given thus:

Trial 1: *"Heto ang dalawang bola. Pareho ang bigat. Pero tingnan mo. Yung isa yellow, yung isa green."*

Trial 2: *"Heto ang dalawang pirasong papel. Pareho ang bigat. Pero tingnan mo. Yung isa may circles, yung isa may lines."*

For the Feel Trials, the instructions were:

Trial 1: *"Heto ang dalawang piggy bank. Pareho ang kulay. Pero buhatin mo. Yung isa mabigat kasi may laman at yung isa magaan.*

Trial 2: *"Heto ang dalawang basong tubig. Pareho ang kulay ng baso ng tubig. Pero hawakan mo. Yung isa malamig kasi galing sa refrigerator at yung isa mainit.*

After children looked at and felt the objects, the experimenter informed them that one of the objects was going to be placed inside the Mystery box while their backs were turned. They were then given questions to test their understanding. The first question simply asked what the child had to do to find out which object was placed inside the box. Depending on the condition, children were asked:

See: *Anong dapat mong gawin kung gusto mong malaman aling bola/papel ang nasa loob ng kahon?*

Feel: *Anong dapat mong gawin kung gusto mong malaman kung aling piggy bank/baso ng tubig ang nasa loob ng kahon?*

The second question mentioned the specific sensory attribute (i.e., yellow or green) involved and offered forced choice alternatives in case the first question could not be answered. The alternatives specified the action that had to be carried out in order to determine which specific object was in the box.

See: *"Para mo malaman kung yellow or green yung bola (lines or circles ang nasa papel)"*: a) *"dapat mo bang tingnan yung bola/papel?"*; b) *"dapat mo bang hawakan yung bola/ papel?"*

Feel: *"Para mo malaman kung mabigat or magaan yung piggy bank/malamig or mainit yung tubig": a) "dapat mo bang tingnan yung piggy bank/baso ng tubig?" b) " dapat mo bang hawakan yung piggy bank/ baso ng tubig?"*

The order of conditions and the presentation of forced-choice alternatives were counterbalanced across trials and subjects.

Scoring

A score of 1 was given to the children if they correctly answered the open-ended question or chose the correct alternative. When children answered the open-ended question correctly, the forced-choice alternatives were not given anymore.

Results

Paired *t*-tests revealed that the difference between the two trials in this experiment was only significant for 5-year-olds in the See Modality at $p < .05$ ($t = 2.18$). Thus, scores across trials were collapsed and averaged on all subsequent analyses.

Table 5 contains the mean correct responses on averaged trials of the three age groups on the two Modality Conditions. There is a significant effect of Age, F (2, 57) = 7.88, $p < .01$, with performance improving across the three age groups from a mean of .38 for the 3-year-olds to a mean of .72 for the 5-year-olds. There is also a significant effect of Modality Condition, F (1, 57) = 6.81, $p < .01$, with children performing better in the Feel Condition ($M = .66$) than in the See Condition ($M = .48$). There was no significant Age by Modality interaction.

Three, 4- and 5-year-olds attempted to answer the open-ended question (e.g., *"Anong dapat mong gawin kung gusto mong malaman kung (ano) ... ang nasa loob ng kahon?"*) 30%, 60% and 79% of the time, respectively. The rest of the time, children remained silent or

shrugged their shoulders. Out of those attempts, the correct responses were 4%, 10% and 13% for 3-, 4-, and 5-year-olds, respectively.

Table 5. Mean Correct Responses on Averaged Trials by Age and Modality Condition

Age	Modality Condition		Total
	See	Feel	
3	.30	.45	.38
4	.48	.72	.60
5	.65	.80	.72
Total	.48	.66	

A few responses to the open-ended questions were not the expected answers (i.e., *"iinumin"* instead of *"hahawakan"*; *"babasahin"* instead of *"titingnan"*) but were considered correct since these actions can indeed enable one to find out about the quality in question (i.e., the water's temperature and the paper's design, respectively). The results of the content analysis of children's wrong responses to the open-ended question are shown in Table 6. More than two-thirds of the children who erred in their responses merely repeated the property of the object in question. In effect, majority of the incorrect responses to the target question (e.g., *"Anong dapat mong gawin..."*) revealed the children's insufficient strategic understanding of how to acquire the information about the relevant property.

Table 6. Incorrect Responses Given by Children to the Open-Ended Question: ***"Anong dapat mong gawin kung gusto mong malaman kung ano ... ang nasa loob ng kahon?"***

Response category	Example	%
Property of object	"Yellow *siya*..."	69
Object in question	"Ball *siya*..."	10
Location of object	"It's inside..."	5
Function of object	"*Na-shu-shoot siya sa ring*..."	4
Miscellaneous	"One..."	5
	"Don't know"	8
Total		100

General discussion

Children can manifest their understanding of knowledge acquisition in several ways (Wimmer et al., 1988). In this research, preschoolers' understanding of how knowledge is obtained was assessed through their ability to justify how they arrived at some piece of information (Experiments 2 and 3) and to identify the appropriate sensory experience necessary to find out about a perceptual property of an object (Experiment 4).

Like the preschool children in previous researches (Gopnik & Graf, 1988; Wimmer et al., 1988; Pillow, 1989; Pratt & Bryant, 1990; O'Neill & Gopnik, 1991), most of the 3- and some 4-year-old children in this study did not appear to fully understand the causal chain between informational access and knowledge acquisition. Even when presented with alternatives, the 3-year-olds could not make the correct choices. The results from Experiment 1 suggest that the children's failures are not simply due to an inability to distinguish among the different sources of knowledge. It was also evident that even the youngest children could rely on their different sensory modalities to acquire information as they were almost perfect in identifying the hidden object after seeing or feeling the object or being told about it.

Instead, the findings tend to confirm Wimmer et al.'s (1988) proposed developmental sequence where simple and direct forms of informational access, such as visual and tactile perception and verbal transmission of information are said to function as early as age three but are understood as such only at age four. The late acquisition of such understanding may be due to the fact that although different sources of knowledge operate as information providers, these sources function silently and are not represented explicitly in the child's mind as such. Moreover, younger children may be pragmatic information gatherers who are more concerned with the knowledge they need and how useful it is than in monitoring where it came from.

On the other hand, the 5-year-olds in this study were already secure in the understanding that knowledge and its source go hand in hand. They were able to assert not only what they knew, but also where this knowledge originated. Many of them were even perplexed that the experimenter had to query them about such a clearly logical sequence of

events – *"Alam ko, kasi di ba sinabi mo sa akin!"* Their facial expressions indicated that they thought the experimenter was the one being dense!

Realizing that certain qualities of an object may be perceived only through a specific sense (i.e., color through seeing) is another vital component of understanding knowledge acquisition. This study supported the hypothesis that Age is significantly associated with success in the modality-specific knowledge task. Results further showed that 5%, 15% and 35% of the 3-, 4- and 5-year-olds, respectively, obtained perfect scores across all trials in this task. The increasing number of children performing at ceiling in the various age groups indicate that modality specific knowledge develops between the ages of three and five as suggested by O'Neill et al. (1992). Modality Condition had a significant effect also with children performing better in the Feel Condition. In other words, children knew that one should touch the glass of water to know whether it is hot or cold (or that one should lift the piggy bank to find out whether it is heavy or light) better than they knew that one should look at the ball or paper to find out its color or design, respectively.

Nevertheless, as in previous studies (O'Neill et al., 1992; O'Neill & Chong, 1997; Wimmer et al., 1988), many of our 3- and 4-year-old children were unable to grasp the idea that only a specific type of sensory experience will bring about a specific type of information. This cognitive limitation was evident when these children could not specify which action they had to take to determine the quality of the object in question. The most common error was to respond by merely restating the quality itself (e.g., "yellow").

In contrast to reports in the Western literature, children as young as three years of age in this study were able to make use of inference to guess the identity of the Mystery object when shown its container as a clue. Moreover, children were able to indicate that their knowledge came from these clues rather than from a direct sensory experience of the object. There was an Age effect however, with 3-year-olds scoring correctly less than half of the time in the inference conditions while 4- and 5-year-olds scored correctly 66% and 82% of the time, respectively.

Our results do not support the hypothesis that only 5-year-old children are able to justify knowledge through inference (Sodian &

Wimmer, 1987; Wimmer et al., 1988; O'Neill & Gopnik, 1991). To the contrary, our sample did not seem to experience significantly greater difficulty in identifying inference (vis-a-vis perception and communication) as a source of knowledge. We can only begin to speculate whether the surprisingly impressive performance of our children in the inference conditions has anything to do with the Filipino communicative context that is often indirect, half-veiled, non-verbal, and incomplete, and where children have to rely on *pakiramdam* and guesswork to infer the information they need or want.

Implications for early childhood cognitive development

The results of the study are consistent with a cognitive developmental outline of understanding knowledge acquisition (Wimmer et al., 1988) which strongly suggests that there are developmental constraints in children's ability to link what they know with how they know. There could be manifold cognitive-maturational explanations for these constraints: early childhood memory deficits (Gopnik & Graf, 1988); the immaturity of preschoolers' metacognitive skills (Siegler, 1986); their inability to construct second-order mental representations, e.g., "I know that you know that..." (Perner & Wimmer, 1985); the lack, before the age of four, of a "theory of mind" or the ability to infer unobservable mental states in one's self and others and to use these attributions to explain and predict behaviors (Leslie, 1988); or a general failure of causal cognition in preoperational children (Sperber, Premack, & Premack, 1995).

Nevertheless, the social and cultural environment may contribute in critical ways to scaffolding children's understanding of the links between knowledge and its sources. The first is in terms of how much encouragement children are given to explicitly talk about and discuss the origins of their knowledge. For instance, are there adults who constantly inquire and gently challenge children with questions like, *"Paano mo nalaman 'yan?"* (e.g., "How did you know that?"); *"Bakit mo 'yan naisip?"* (e.g., "Why do you think that?"); and *"Bakit mo nasabi 'yan?"* (e.g., "What made you say that?"). The epistemic talk of parents and teachers could encourage children to think for themselves but even further, to reflect on the basis of their thinking. On the other hand, persistent questioning on the part of children, especially when the children

themselves ask for evidence or justification of adult beliefs, pronouncements, and assertions, need not be frowned upon as *"kakulitan"* or disrespect. It is not an unfamiliar scenario that parents themselves often respond in an egocentric fashion to their children's challenges, exasperatedly answering *"Basta, alam ko!"* (e.g., "I just know!"), or even more simply, "*Basta*!"

The kinds of games that children play may also provide countless scaffolding opportunities. Even simple games such as Hide-and-Seek create enjoyable instances for understanding the causal connection between informational access and knowledge (we hide to prevent other persons from having informational access to our location). These games can generate insight into the relation between absence of information and knowledge or ignorance, and facilitate what Shultz and Cloghesy's (1981) called the "recursive awareness of intention" (e.g., I'll hide so you won't know where I am). Simpler versions of charades and pantomimes can help children develop their ability to infer, and discussions after can elicit understanding of the connection between knowledge and its origins. Also, open-ended stories that encourage children to think about "what will happen next" or "what will happen if..." can be beneficial as these questions require them to infer using the given situations.

The ability to infer and to be aware that inference is a rich knowledge source may be developed further by honing the children's sensitivity to cues in their environment. Children can be encouraged to be more observant and to watch out for cues that can be used to infer things that are left unexplained to them. This may also help them become even more attuned to the non-verbal languages of facial expression and gesture as indirect sources of information.

In addition, through the learning environment they provide, parents as well as curriculum designers and preschool teachers can enrich curriculum by helping children experience the links between knowledge and evidence. For instance, in a "Learning about our Senses" curriculum, children should be able to experience that indeed, the eyes are for seeing and the nose is for smelling, and so forth, instead of just learning these by rote or by picture-book. In other words, the children could be given "data-gathering" exercises and opportunities to reflect on the nature of "data" and its relation to the manner in which it had been obtained. The

experiments in this study, for instance, can be easily modified as classroom activities.

Lastly, teachers need not just rely on one method of teaching (i.e., "telling" children information) but on a variety of methods that can support children's understanding of the different sources of knowledge (like allowing children to "see" things for themselves). The different sensory experiences could also be given equal importance instead of limiting information processing to the usual verbal and visual modes. More importantly, children should be allowed, through these experiential activities, to explicitly construct and represent the links between their experiences, their thinking, and their knowledge.

Recommendations for further research

This study was limited to children who are already enrolled in preschools in the Quezon City area. They were also homogeneous with respect to socioeconomic status (middle and upper middle class, e.g., had parents who could afford to send their child to preschool). We therefore recommend that in future studies, children from different socioeconomic groups and geographical regions should participate so as to increase the likelihood of generalizing the results and going beyond developmental differences. It is also important to raise the question of whether these cognitive understandings (though closely bound to intellectual maturation) are better or less developed in preschool aged children who do not go to school, to explore the possible "environmental effects" of the different types of early cognitive training or stimulation that preschool education presumably provides.

Moreover, children's general understanding of the functioning of informational channels as sources of knowledge can be exhibited in other ways such as awareness of another person's knowledge, children's false beliefs, and the appearance-reality task (Wimmer et al., 1988). We recommend that future studies assess these other indicators. We need to study further how well children store the sources of their information in memory. Source information cannot otherwise be epistemically useful if its memory representation is fragile (see Johnson, 1988 for a discussion of some consequences of source monitoring failures in memory).

Knowledge acquisition is of the essence to the mental life of children as well as adults. Equally important is the consideration of where personal knowledge comes from for it helps people appraise the validity and reliability of the information they have, making them less vulnerable to false impressions, misinterpretations, and erroneous beliefs (Nisbett & Ross, 1980). For children and adults alike, this achievement is the foundation of critical thinking.

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[3]For more detailed descriptions of the scoring criteria used in all four experiments reported here, please refer to Tiangco (1998).

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