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Development of the Understanding of the Polysemous Meanings of the Mental-State Verb Know

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This study investigated children's understanding (3-, 6, 9-, and 12-year-olds) of the different levels of meaning of the cognitive verb know as defined by the Hail, Scholnick, and Hughes (1987) abstractness and conceptual difficulty hierarchy. We found that cognitive verb knowledge increased with development and that certain low levels of meaning were mastered before certain high levels of meaning irrespective of the medium of presentation: video-taped "skits" and audio-taped "stories." However, children developed an understanding of low levels of meaning at a more rapid rate than high levels of meaning. This resulted in a more differentiated and hierarchical cognitive-verb knowledge in older children. Finally, we found that the audio-taped stories were more difficult than the video-taped skits, and that both tasks were significantly correlated with a standardized vocabulary measure for all ages except the 3-year-olds. The implications of this study and others for a model of the cognitive-verb lexicon are discussed.

Most research on lexical development has concentrated on the child's acquisition of words that refer to objects, actions, and events (Clark, 1983). Comparatively little research has been conducted on the child's acquisition of words that refer to states, such as cognitive verbs. Moreover, most research that has been conducted has investigated children's first understanding of these cognitive verbs. Only recently has research been conducted on older children's and adults' understanding of these words (cf. Astington & Olson, 1990; Booth & Hall, 1994a, 1994c; Fabricius, Schwanen-

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flugel, Kyllonen, Barclay, & Denton, 1989; Schwanenflugel, Fabricius, 8z Alexander, 1994; Schwanenflugel, Fabricius, Noyes, Bigler, & Alexander, 1994). Hall and Nagy (1986) defined cognitive verbs as those words for which the internal state component of the meaning is the primary or focal component. Most internal state words are verbs with the experiencer as the subject (e.g., "John knows the answer").

Studies of cognitive verbs are important because theories of lexical acquisition and knowledge representation based on studies of objects may not extend to the acquisition of cognitive verbs (Carey, 1982). Verbs differ from nouns in many ways (Tomasello & Merriman, 1995). For example, verbs have more elaborate, syntactic information associated with them. Verbs represent information about the number of arguments (e.g., subject, object, and oblique) and which roles are carried by these arguments (e.g., agent, patient, and location). Furthermore, the categories for verbs are less coherent partially because the mental or physical sequence labeled by verbs may differ depending on the object or the situation (e.g., ***knowing*** a familiar face vs. ***knowing*** how to juggle). The acquisition of cognitive verbs is also important to study because their acquisition is related to the development of a "theory of mind."

In order for children to be accredited with a theory of mind, they must be able to explain and predict their own mental states as well as the mental states of others (Wellman, 1990). The study of cognitive verbs is very important for our understanding of children's theory of mind because these verbs label all facets of their mental worlds. For example, the experience associated with recalling is very different than the experience associated with recognizing. Because cognitive verbs make fine-grained distinctions between different mental states, this may encourage children to compare and contrast the processes that they designate and the distinctions that they represent (Hall, Scholnick, & Hughes, 1987). Indeed, children may use cognitive verbs to monitor, transform, organize, and interpret their internal mental states (Scholnick & Hall, 1991). Therefore, the acquisition of cognitive verbs may provide the researcher with a window to the inner workings of the developing mind.

The literature contains a growing number of investigations on children's comprehension of the distinction among different cognitive verbs (cf. Abbeduto & Rosenberg, 1985; Beeghly, Bretherton, & Mervis, 1986; Johnson & Maratsos, 1977; MacNamara, Baker & Olson, 1976; Moore, Bryant, & Furrow, 1990; Olson & Astington, 1990; Scholnick, 1987; Shatz, Wellman, & Silber, 1983; Wellman & Estes, 1987). The evidence points to the fact that children begin to distinguish between different aspects of some types of internal state words by 3 years of age. However, this evidence is incomplete because most of the existing data assumes that cognitive verbs have only one meaning. Some cognitive verbs may have only one primary mean-

ing (e.g., ***recognize*** and ***recall)*** but other cognitive verbs have several meanings that characterize distinct mental processes. For example, "I know that face" refers to a recognition, but ***"knowing*** is different from doing" refers to a metacognitive description. Studying the acquisition of polysemous verbs like ***know, think,*** and ***believe*** is important because these are the most frequently used cognitive verbs in the young child's lexicon (Shatz et al., l983). Less frequent words, like ***perceive*** and ***comprehend,*** that label specific levels of meaning are more appropriate in investigations of older children (Booth & Hall, 1994c).

Because cognitive verbs label all aspects of internal mental states, different cognitive verbs or the various meanings of one cognitive verb may have different developmental trajectories (Astington & Gopnik, 1991). Indeed, there is emerging evidence that cognitive verbs may be organized along an informational dimension. One model of the informational dimension is that cognitive verbs are organized hierarchically according to their increasing conceptual difficulty and abstractness. Hall et al. (1987) suggested that internal state words are used to represent a continuum of internal processing (a) registering an experience perceptually, (b) determining its familiarity, (c) embedding it in a factual network, (d) understanding the interconnections among concepts, (e) commenting on how processing is done, and (f) making explicit one's presuppositions about the experience. They referred to these levels as ***perception, recognition, recall, understanding, metacognition,*** and ***evaluation,*** respectively.

This hierarchical model was based on child (4% years old) and adult production frequencies in natural speech (Hall, Nagy, & Linn, 1984). Hall et al. (1987) found that, for all cognitive verbs, the higher levels were produced more than the lower levels of meaning, except recall and metacognition were produced more than recognition. Later, Frank and Hall (1991) dealt with the discrepancies between the data and theory by restructuring the six levels of meaning for the cognitive verb ***know.*** First, recognition and recall were combined into the one level, ***memory,*** because they both refer to the process of remembering. Second, evaluation was placed lower in the hierarchy than metacognition because evaluation can refer to concrete as well as abstract mental operations, whereas metacognition always involves abstract, internal processing. Third, ***planning*** was added to a highest level in the hierarchy to account for the "assessment of future intention which implies an understanding and integration of past events" (Frank & Hall, 1991, p. 5). This new hierarchy fit the data better: The higher levels were produced more than the lower levels of meaning.

Booth and Hall (1994b, 1994c) then used a multiple-choice comprehension measure of the cognates of ***think*** and ***know*** to test the Frank and Hall (1991) hierarchy with older children (fifth graders to undergraduates). They found that all significant differences between levels of meaning were in the

predicted direction. However, based in part on this study, we altered the hierarchy in three ways. First, we eliminated planning because this level was not reliable in the comprehension study and because this level was never verbally expressed by adults or children in the Frank and Hall (1991) study. Indeed, both planning and evaluation involve an assessment of the truth of a prediction or proposition based on previous or current knowledge. Second, we also considered evaluation to be at a higher level in the hierarchy than metacognition. It is probably more conceptually demanding, for example, to make a truth judgment based on several "facts" than to think about how we remember. Third, we separated the memory level into recognition and recall because the Frank and Hall (1991) analysis was based only on production frequencies (see Clark, 1983). Moreover, the phenomenological experience associated with recognizing something is very different from recalling something. In sum, the six levels of meaning in our present investigation can be restated as follows:

1. Perception: The speaker reports the act of perception (e.g., "I heard your story").
2. Recognition: The speaker acknowledges familiarity with some person or concept (e.g., "I know that face").
3. Recall: The speaker refers to factual information that he or she remembers (e.g., "I know his phone number").
4. Understanding: The speaker refers to a conceptual framework or reasoning (e.g., "I know why he did that").
5. Metacognition: The speaker focuses on discussing the awareness of mental acts (e.g., "Pretending can be fun").
6. Evaluation: The speaker refers to attitudes and beliefs about the truth of statements (e.g., "He guessed the answer, but I know it").

This hierarchy is supported by recent studies that have asked adults and children to judge the degree of relation between many cognitive verbs (Schwanenflugel, Fabricius, & Alexander, 1994; Schwanenflugel, Fabricius, Noyes, et al., 1994). Using multidimensional scaling, these studies found that cognitive verbs vary along a dimension they called "information processing" from input functions ***(e.g., notice*** and see) to processing and memory functions ***(e.g., remember*** and *figure* ***out)*** and to output functions ***(e.g., decide*** and ***explain).*** A comparison of this model and the previously mentioned one reveals that they are in fact very similar even though very different methodologies were employed in order to test them.

Other evidence suggests that cognitive verbs are organized according to an informational or conceptual difficulty metric. Very young children often equate ***knowing*** with ***seeing*** or ***doing. They*** assume, for example, that if someone sees something he or she automatically knows it. When children are asked how they know something, they will often say "I saw it" (Fabricius &

Cavalier, 1989). Another study found that 4- and 5-year-old children could only distinguish accurately between ***know*** and guess when they had access to the outcome of the participant's behavior (i.e.,they successfully or unsuccessfully found a hidden object), whereas the 6- and 7-year-old children could distinguish between ***know*** and guess when they were given only verbal information regarding the location of the hidden objects (Miscione, Marvin, O'Brien, & Greenberg, 1978). Taken together, these results suggest that younger children are having trouble differentiating between mental acts such as ***knowing*** and physical acts such as ***seeing*** and ***doing*** (see also Johnson & Wellman, 1980; Wellman &Johnson, 1979). In contrast, older children realize that in order to know something one may have to mentally manipulate or rehearse the information, When older children are asked how they know something, they will often answer ***"I pictured*** it in my head" (Fabricius & Cavalier, 1989). Finally, children come to realize that the mind is an interpreter, evaluator, and constructor of knowledge and that access to quality information determines whether a person knows something (Montgomery, 1992).

SPECIFIC AIMS

There is converging evidence that cognitive verbs vary along a conceptual or informational dimension and that children first acquire cognitive verbs that are less cognitively demanding (Booth & Hall, 1994c; Schwanenflugel, Fabricius, & Alexander, 1994). The primary goal of this investigation was to provide further empirical support for this hierarchical model using a comprehension measure with a wide age range of children (3-12 years old). We expected that cognitive-verb knowledge would increase significantly with age but that the low levels of meaning of the cognitive verb ***know*** would be acquired earlier than the high levels of meaning. However, because low levels of meaning ***(i.e.,perception, recognition, recall,*** and ***understanding)*** are less abstract and conceptually demanding, we expected their acquisition would be more rapid than the high levels of meaning ***(i.e.,metacognition*** and ***evaluation).*** Similarly, we expected low scores and very few differences between the six levels of meaning for the younger children because 3-year-olds have been shown to understand very few, if any, meanings of ***know*** and other cognitive verbs (Johnson & Wellman, 1980; Miscione et al., 1978). We did expect more differentiation between the six levels of meaning for the older children because they are developing a hierarchical model of the cognitive-verb lexicon.

Our second expectation was that cognitive-verb knowledge would be highly correlated with standardized vocabulary measures. These findings would confirm other studies that have found a strong correlation between cognitive-verb knowledge and vocabulary and reading comprehension in children (Olson & Torrance, 1986,1987). We have argued earlier that cogni-

tive-verb knowledge may provide a unique content knowledge that facilitates efficient vocabulary acquisition and text comprehension because, for example, to determine what a character ***thinks*** or ***knows*** may be essential for interpreting their pas&present, and future motives (Booth & Hall, 1994c).

METHOD

Participants

Participants were children at four mean ages recruited through day care centers and elementary schools in the metropolitan Washington, DC area. There were 19 three-year-olds (M = 3.96, SD = .30), 21 six-year-olds (M = 6.15, SD = .30), 25 nine-year-olds (M = 8.43, SD = .56), and 17 twelve-year-olds (M = 11.69, SD = .49). All children had English as a first language and all children who volunteered completed all aspects of the study.

Materials

The children were administered 18 video-taped skits and three out of six audio-taped stories. The 18 video-taped skits involved interactions among two hand-held puppets. Three skits represented each of the six levels of meaning of the cognitive verb ***know*** according to the Hall et al. (1987) hierarchy. The skits were balanced so that two skits at each level of meaning were correctly answered in the affirmative, whereas one was correctly answered by a negative response. The order of presentation of the video-taped skits was the same for all children. There were three blocks of six skits, each ascending in level of meaning (fromperception to ***evaluation).*** Each block began with a low level of meaning and ended with a high level of meaning so as to not frustrate the children with continued unsuccessful performance. The six audio-taped stories also characterized the six levels of meaning in. the Hall et al. hierarchy. Each story was accompanied by a 6-page booklet of stick-figure drawings. Half of the children in each age group were administered the same three (out of six) stories in one of two order conditions: Stories 1,2, and 3 or Stories 3,2,1. The questions after each story were presented in ascending levels of meaning (from ***perception*** to ***evaluation)*** so that children were not initially discouraged by unsuccessful performance on the high level of meaning questions and because the information about low levels of meaning tended to occur in the first half of the story, whereas the information pertaining to high levels of meaning tended to occur in the second half of the story. The setting, tester prompts, and "correct" answers for the six levels of meaning for a selected six of the video-taped skits are in Appendix A and for a selected two of the audio-taped stories are in Appendix B.

The 3- and 6-year-olds were administered the Peabody Picture Vocabulary Test-Revised (PPVT-R). A standardized vocabulary measure was obtained from the school records of the 9- and l2 year-olds.

Design and Procedure

Testing was conducted individually with each child on three separate occasions. On the first occasion, there was a brief familiarization procedure that acquainted the child with the experimenter and with the two puppets that were the characters in the video-taped skits. The puppet in the familiarization procedure and in the skits about whom the child was questioned was always matched to the gender of the child. After the presentation of each skit on the television monitor, each child was asked two comprehension questions. The first question required the child to respond "yes" or "no" and the second question required the child to explain why he or she answered yes or no (see Appendix A). All responses were tape-recorded for later scoring.

On the second occasion, the children were administered the audio-taped stories. There was a brief familiarization procedure in which the child and the experimenter talked about their favorite stories. The children then listened to the tape-recorded stories. As with many children's story books, a tone signaled the child that a page in the accompanying book of six pictures should be turned. An experimenter assisted all children to ensure that the pictures and recording were aligned. There were 7-s pauses between the sentences accompanying the six pictures (see Appendix B). Three stories were administered to each child. Immediately after the presentation of each story, the experimenter asked the child five basic plot questions and six questions with two parts corresponding to the six levels of meaning portrayed in the story. The first part required the child to respond yes or no and the second part required the child to explain why he or she answered yes or no. The children did not have access to the pictures when answering questions. All responses were tape-recorded for later scoring. We acknowledge a potential order confound because the video-taped stories were always presented first and the audio-taped stories second. This presentation order was necessary, however, so that the children were not initially discouraged by the "harder" audio-taped stories. Indeed, if the audio-taped stories were more conceptually demanding than the video-taped skits, a difference between them would less likely emerge in this presentation order because initial familiarization with the video-taped skits may enhance performance on the audio-taped stories.

The scoring of responses to the video-taped skits and the audio-taped stories consisted of two parts. The first part entailed scoring the yes or no answer. The scores were given as follows: 0 ***(incorrect response),*** 1 ***(no response; e.g.,*** "I don't know" or a shrug), 2 ***(an inexact response; e.g.,*** "maybe" or "maybe not"), and 3 ***(correct response).*** The second part entailed scoring the explanation of the yes or no response. These scores were given as follows: 0 ***(inappropriate explanation),*** 1 ***(no explanation; e.g.,*** "I don't know" or a shrug), 2 ***(an incomplete explanation;*** e.g., "He just did . . ."

or "He just didn't"), and 3 ***(a complete and an appropriate explanation).*** If a child had a correct response (3) on the explanation part and the child's yes or no answer was an incorrect response (0) or a no response (l), the yes or no part was equated to an inexact response (2). If the child did not have a correct response (3) on the explanation part, the yes or no score was not adjusted.

The following criteria were used for determining whether a response was judged correct (see Appendices A and B). For perception, the child had to refer to ***knowing*** as an act of perceiving something (e.g., touching another person, seeing the wall, or feeling the hot day). For recognition, the child had to refer to ***knowing*** as a judgment of familiarity in the presence of a stimuli (e.g., hearing a voice, seeing a tree house, or taking a short cut to the pool). For recall, the child had to refer to ***knowing*** as remembering factual information in the physical absence of that information (e.g., the movie starting time, the tree house wall used to be intact, or a path to the pool). For understanding, the child had to refer to ***knowing*** as reasoning about or comparing facts to general knowledge (e.g., knowing that air can travel through small holes, realizing that the tree house damage is not too bad for their methods to fix it, or comparing the time to travel two different paths). For metacognition, the child had to refer to ***knowing*** as an awareness of mental processing (e.g., long numbers are hard to remember, remembering how you built something will help in fixing it, or imagining a race is different from actually racing). For evaluation, the child had to refer to ***knowing*** as determining the truth of a statement (e.g., whether someone will win a race or whether the fixed tree house will look even better).

Two coders independently scored all the tape-recorded answers. Their independent agreement was over 85% on the yes or no answer and the explanation answer for the six levels of meaning in the video-taped skits and audio-taped stories. The two coders were able to resolve these disagreements in most situations. This resulted in 96% agreement. James R. Booth made a final judgment on the remaining 4% of situations.

On a third occasion, the 3- and 6-year-olds were administered the PPVT-R. The test records of the 9- and l2 year-olds were accessed and their most recent standardized vocabulary measure was recorded.

RESULTS

The results of the data analyses are presented in the following order. First, age and level of meaning differences in the average of the audio-taped stories and video-taped skits are presented using the combined score (yes or no plus explanation) as the dependent variable. We calculated separate analyses for the explanation score because the combined ,score may have

been artifactually inflated due a yes response bias. We also calculated separate analyses for the yes or no score because the combined score may have underestimated the child's knowledge for a variety of reasons: inability to verbalize response, shyness, and so forth. However, we do not provide the specifics of these analyses because they yielded essentially the same results as the combined score analyses. Second, the correlations involving the combined score with the standardized vocabulary measures are presented.

In order to determine the reliability of each of the six levels of meaning, Cronbach's alpha coefficient and item-total correlations were computed for all levels. As a rule, a reliability of alpha about .60 or greater is recommended for basic research (Nunnally, 1978). All levels of meaning, except evaluation (α = .27), were reliable based on this criterion. Evaluation was probably not reliable because of the difficulty of these questions. The percentage of correct answers for this level was very low for all age groups (see Table 1).

Age and Level of Meaning Differences

A 4 (age; 3-, 6-, 9-, 12-year-olds) **X** 6 (level of meaning; perception, recognition, recall, understanding, metacognition, evaluation) **x** 2 (mode of presentation; audio, visual) analysis of variance (ANOVA) was computed to investigate developmental and level of meaning differences. Age was treated as a between-subject variable and level of meaning and mode of presentation were treated as within-subject variables for all analyses presented in this article. It should be noted that the mean age of the 3-year-olds

Table 1. Means and Standard Deviations (in Parentheses) for the Combined Score (Yes or No Plus Explanation) for the Levels of Meaning as a Function of Age

	Age Group			
Level of Meaning	3 Years **Old**[a]	6 **Years Old**[b]	9 **Years Old**[c]	**12 Years Old**[d]
Perception	2.78 (1.2)	3.91 (1.1)	4.86 (1.1)	5.18 (0.9)
Recognition	2.63 (1.4)	4.22 (1.3)	4.99 (O.9)	5.60 (0.6)
Recall	2.49 (1.2)	3.96 (1.2)	4.69 (1.2)	4.83 (1.0)
Understanding	2.60 (1.2)	4.34 (1.20)	5.01 (1.1)	5.46 (0.7)
Metacognition	2.26 (1.0)	3.45 (1.2)	4.15 (1.4)	4.68 (1.4)
Evaluation	1.43 (1.1)	1.71 (1.4)	1.74 (1.6)	1.86 (1.8)
Low	2.63 (1.2)	4.11 (2.6)	4.89 (1.1)	5.30 (0.8)
High	1.84 (1.1)	2.59 (1.5)	2.95 (1.9)	3.27 (2.2)
Total	2.40 (.45)	3.61 (.54)	4.24 (.48)	4.60 (.38)

Note. Scores are means of individual performance means on a 6-point scale. Scores are the mean for the combined mode of presentation: audio plus video. Low levels of meaning equals perception plus recognition plus recall plus understanding. High levels of meaning equals metacognition plus evaluation. Total equals all levels of meaning.

[a] N = 19. [b] N = 21. [c] N = 25. [d] N = 17.

was closer to 4-year-olds (M = 3.96, SD = .30). This ANOVA revealed significant main effects for age, F (3,79) = 150.73, $p < .001$, level of meaning, F (5, 79) = 131.78, $p < .001$, and mode of presentation, F (1, 79) = 62.88. $p < .001$. There was also a significant Age x Level of Meaning interaction, F (15, 79) = 4.49, $p < .001$ (see Figure 1). However, the Age x Mode of Presentation, F (3, 79) = 1.26, $p > .25$, Level of Meaning x Mode of Presentation, F (5, 79) = 2.09, $p > .06$, and Age x Level of Meaning x Mode of Presentation, F (15,79) = 1.65, $p > .05$, interactions were not significant. Table 1 displays the means and standard deviations for the six levels of meaning within each age group. The video and audio mode of presentations are not reported separately because this variable did not interact with age or level of meaning. There was only a main effect involving mode of presentation: Video (M = 3.54) was answered correctly more often than the audio (M = 4.01). This was expected because the audio-taped stories were more conceptually demanding than the video-taped skits (see Appendices A and B).

Student Newman-Keuls comparisons ($\alpha < .05$) were calculated to unpack the significant Age x Level of Meaning interaction This analysis revealed between-age differences on all levels of meaning except evaluation. Specifically, the 3-year-olds scored lower than all of the age groups and the 6-year-olds scored lower than the 9- and 12-year-olds on all levels of meaning except evaluation. In addition, the 9-year-olds scored lower than the l2 year-olds on recognition. This analysis also revealed within-age differences on levels of meaning. For all age groups, evaluation was lower than all other levels of meaning. For the 9-year-olds, metacognition was lower than all lower levels of meaning. For the 6- and 12-year-olds, metacognition was lower than understanding and recognition, and for the 12-year-olds recall was lower than recognition.

Because the post hoc differences reported earlier revealed that evaluation and metacognition were significantly lower than most of the other levels of meaning for most age groups and because the these scores showed the least improvement across age, we combined these levels into a high level of meaning category and combined the remaining levels into a low level of meaning category (see Table 1). We then calculated a 4(age; 3-, 6-, 9-, and 12-year-olds) x 2 (level of meaning; high, low) x 2 (mode of presentation; audio, visual) ANOVA. This analysis revealed a significant main effects for age, $F(3,79) = 115.06, p < .001$, level of meaning, $F(1,79) = 312.90, p < .001$, and mode of presentation, F (1, 79) = 48.03, $p < .01$. The A,ge × Mode of Presentation, F (3, 79) = 1.67, p > .40, Level of Meaning X Mode of Presentation, F (1,79) = 0.01, $p > .90$, and Age x Level of Meaning X Mode of Presentation, F (3,79) = 0.80, $p > .40$, interactions were not significant. However, there was a significant Age X Level of Meaning interaction, F (3, 79) = 8.10, $p < .OOl$. T tests (p < .Ol) revealed that there were significant

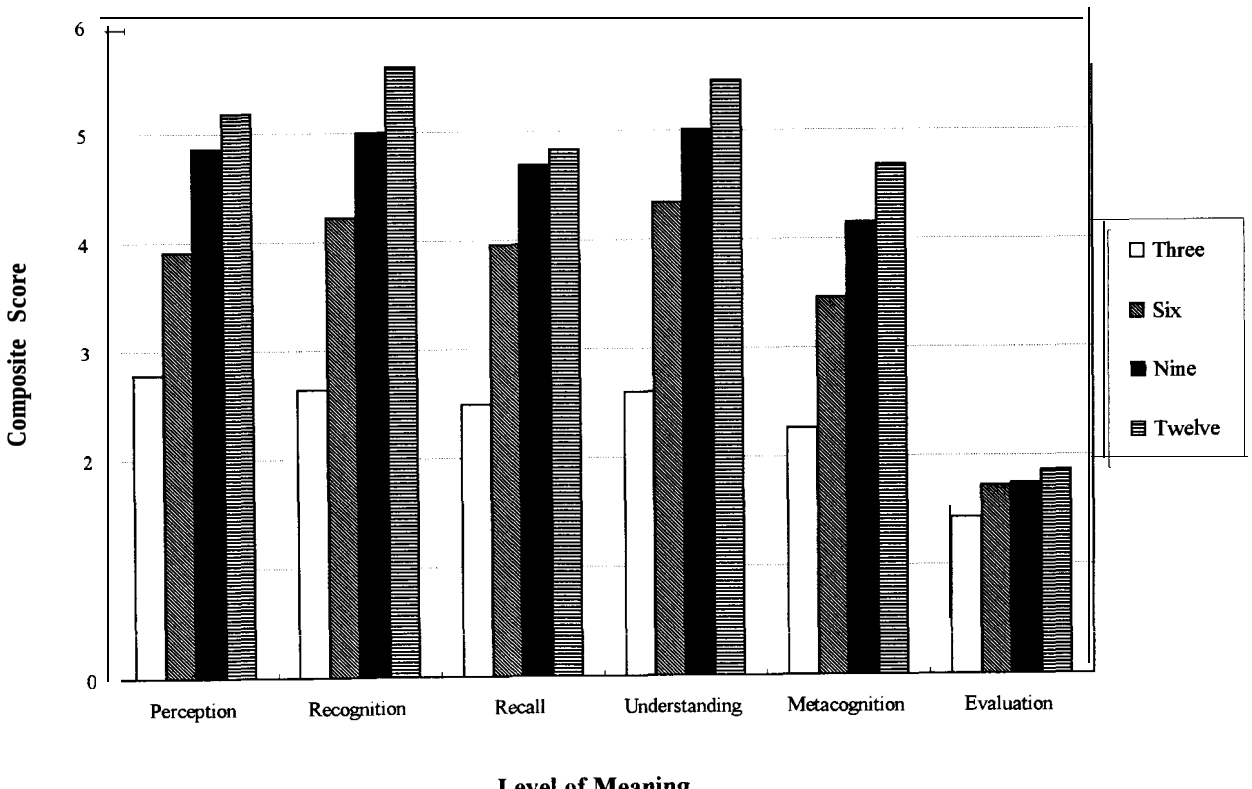

Figure 1. The combined scores (yes or no plus explanation) for the six levels of meaning for the combined mode of presentation (audio plus video) as a function of age.

differences between low and high levels of meaning for all age groups. Student NewmanäKeuls comparisons ($\alpha < .05$) revealed significant differences between all age groups for low levels of meaning. There were less age-group differences for high levels of meaning: 3-year-olds scored significantly lower than all other age groups and 6-year-olds scored significantly lower than the l2 year-olds.

Correlations Between Cognitive-Verb Knowledge and Standardized Vocabulary Measures

The correlations involving the audio-taped stories and the video-taped skits with the vocabulary measures are presented by age group for the combined scores in Table 2. The overall audio- and video-taped correlation was significant for the 6-year-olds (r = .54, $p < .01$), for the 9-year-olds (r = .61, $p <$ .Ol), and for the 12-year-olds (r = ***.64,p*** < .Ol) but not for the 3-year-olds (r = - .07). The correlations were probably not significant for the 3-year-olds due to floor effects on the audio-taped stories. The 3-year-olds scored very low on both low (M = 2.49) and high (M = 1.57) levels of meaning for the combined scores.

DISCUSSION

There are three important findings reported in this article. First, the hierarchical knowledge of the cognitive verb ***know*** became more differentiated with development in that the 3-year-olds scored very low on all levels of meaning and showed the smallest number of levels of meaning differences,

Table 2. Correlations Involving the Levels of Meaning of the Combined Score (Yes or No Plus Explanation) With the Standardized Vocabulary Measures by Age

	Age Group			
Level of Meaning	**3 Years Old[a]**	**6 Years Old[b]**	**9 Years Old[c]**	**12 Years Old[d]**
Audio Taped				
Low	−.26	.42*	.62***	.29
High	−.56*	.36	.37*	.21
Total	−.38	.49**	.62***	.41
Video Taped				
Low	.30	.39*	.33	.33
High	.26	.05	.21	.53**
Total	.34	.44**	.37*	.53*
Overall	−.07	.54**	.61***	.64**

Note. See Table 1 notes.
[a]$N = 19$. [b]$N = 21$. [c]$N = 25$. [d]$N = 17$.
*$p < .10$. **$p < .05$. ***$p < .01$.

whereas l2 year-olds showed the largest number of levels of meaning differences. Second, cognitive-verb knowledge of ***know*** increased with development; however, low levels of meaning scores showed a larger increase over age than high levels of meaning scores. Third, the audio mode of presentation was more difficult than the video mode of presentation, but both measures correlated significantly with standardized vocabulary measures for all ages, except the 3-year-olds. The implications of each of these findings are discussed in turn.

These finding that children's knowledge of low levels of meaning (perception, recognition, recall, understanding) was greater than high levels of meaning (metacognition, evaluation) replicates an earlier pilot study in our laboratory with 3-, 6-, and g-year-old children (Hughes, 1985) and extends previous studies that found that 4½-year-olds and their parents verbally produced certain low levels of meaning significantly more than certain high levels of meaning (Frank & Hall, 1991; Hall et al., 1987). All significant differences we found were in the direction predicted by our hierarchical model (see Introduction), but our study did not statistically differentiate between all the levels of meaning. Future research should address whether all six levels of meaning can be differentiated between in one experiment.

This investigation shows that hierarchical cognitive-verb knowledge tends to become more differentiated with age. We found that the 3-year-olds exhibited the smallest number of levels of meaning differences; they scored reliably lower only on evaluation. This supports other studies that found that 3-year-olds have a very limited understanding of cognitive verbs (cf. Johnson & Wellman, 1980; Miscione et al., 1978). In contrast, older children in our study had more fine-grained distinctions between the hierarchical levels of meaning. For example, the 12-year-olds scored lower on evaluation than all other levels of meaning, lower on metacognition than on understanding and recognition and lower on recall than on recognition. The 6- and 9-year-olds revealed a moderate number of significant levels of meaning differences. In fact, recent studies with older children also show that they distinguish between cognitive verbs that label subtle differences in internal mental states (Schwanenflugel, Fabricius, & Alexander, 1.994; Schwanenflugel, Fabricius, Noyes, et al., 1994).

Most importantly, this study provides further support for recent models of the cognitive-verb lexicon that suggest that internal state words are organized according to a continuum of internal processing or information manipulation (Booth & Hall, 1994; Fabricius & Cavalier, 1989; Hall et al., 1987; Hughes, 1985; Wellman & Johnson, 1979; Miscione et al., 1978; Schwanenflugel, Fabricius, & Alexander, 1994; Schwanenflugel, Fabricius, Noyes, et al., 1994). We suggest that the cognitive-verb lexicon may be organized according to six levels of abstractness or conceptual difficulty. Perception, the most concrete level, describes sensory input that is immedi-

ately available to the observer, whereas recognition is a step removed from immediately available sensory input in that it relates this sensory input to past information but merely to assess familiarity. Recall describes actual retrieval of past input, independent of immediate sensory input, whereas understanding represents a higher level of abstractness because it describes the semantic network to which knowledge is referred, thereby bringing to bear general knowledge rather than specific, factual information, as is the case in the preceding levels. These are the lower levels of meaning in this hierarchy. At the most abstract levels in this model, the child steps away from the act to report awareness of the process, not the product of thinking (metacognition), and he or she evaluates mental acts according to whether they imply true observations, contrary to fact propositions or uncertain states (evaluation).

Our investigation revealed a significant Age x Level of Meaning interaction. Specifically, there were a greater number of Age differences on the low levels of meaning than on the high levels of meaning. In other words, children's knowledge of the low levels of meaning tended to increase at a faster rate than their knowledge of high levels of meaning (see Figure 1). Interestingly, Booth and Hall (1994b) found a significant Level of Meaning (low or high) x Age (fifth grade, seventh grade, 10th grade, and college students) x Word Frequency (low or high, based on Carroll, Davies, and Richman, 1971) interaction, and a significant Level of Meaning x Age x Cognate ***(think*** or ***know)*** interaction. Their results suggested that levels of meaning differences for all cognitive verbs decreased with age. Indeed, the mean difference in percent correct for low versus high levels of meaning was 17% for the fifth and seventh graders, but only 8% for the 10th graders and college students. Taken together, the Booth and Hall study and our investigation suggest that knowledge of low levels of meaning develops more rapidly than high levels of meaning from the preschool years until about the fifth grade, whereas knowledge of high levels of meaning develops more rapidly than low levels of meaning from the fifth grade through high school. This pattern probably results from the less abstract nature of and the less conceptual difficulty associated with the low as compared to the high levels of meaning. For example, it is less conceptually demanding to determine that a person is perceptually encoding or remembering something than it is to determine how a person is reflecting on their cognitive operations or how they are evaluating whether something is true or not.

Our observed Age x Level of Meaning interaction was statistically the same for the audio and video modes of presentation. Because different methodologies revealed the same interaction, this suggests that this finding is robust and not a methodological artifact. The methodologies were in fact very different; the audio-taped stories were more difficult to comprehend

than the video-taped skits. This difficulty difference is probably due to several factors. First, the video-taped skits were more motivating and appealing because they were viewed on television, whereas the audio-taped stories were only accompanied by static schematic drawings. Second, the video-taped skits were much shorter than the audio-taped stories (i.e., the former were no more than three short sentences, whereas the latter were always at least six sentences). The longer audio-taped stories put greater demands on short-term and long-term memory. Third, each audio-taped story represented all six levels of meaning, whereas each video-taped skit represented only one level of meaning. Fourth, 11 questions were asked after the audio-taped stories, whereas only one question with two parts was asked after the video-taped skits. The reason we employed both audio-taped stories and video-taped skits was to replicate any age or levels of meaning differences with two very different tasks and to ensure that we could test knowledge of cognitive verbs over a large age range.

This difference in difficulty between the audio-taped stories and video-taped skits explains the low percentage of correct explanations even by the 12-year-olds. The l2 year-olds had over 80% correct explanations for the video-tapes skits but only over 45% for the audio-taped stories for all levels of meaning except evaluation, Again, the greater cognitive demands of the audio-taped stories may have caused this discrepancy. The relatively flat success rate for evaluation is more puzzling. It appears as though most children have not realized that the future cannot be predicted with certainty (e.g., who will win a race or if a repair job will improve the appearance of a tree house).

Finally, we found that knowledge of cognitive verbs correlated significantly with standardized vocabulary measures for all age groups, except the 3-year-olds. Indeed, research has revealed that knowledge of mental states and cognitive verbs is correlated with many other cognitive abilities, such as perspective-taking skills (Flavell, 1992) and metacognitive strategies (Booth & Hall, 1994a). The ability to distinguish between cognitive verbs, such as ***think*** and ***know,*** also seems to be correlated with many theory-of-mind tasks that require the ability to represent things in contradictory ways (cf. Flavell, Flavell, & Green, 1983; Gopnik & Astington, 1988; Wimmer & Perner, 1983). However, the investigation of children's developing understanding of mental-state verbs provides additional insights into a child's theory of mind because it allows an assessment of a child's understanding of the mental distinctions that these verbs represent. Many theory-of-mind tasks do not explicitly tap into children's conscious knowledge about how their minds operate. For this reason, the investigation of the cognitive-verb lexicon seems to be particularly well suited to test theories about the development and organization of mental concepts in children as well as adults.

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APPENDIX A

The setting, tester prompts, and correct answers for the six levels of meaning for a selected six video-taped stories.

Perception Level

(Setting: Jane on stage. John comes on stage and hugs Jane.)

Tester: Does John know Jane is there?
Answer: Yes.
Tester: Why do you say that John knows (or doesn't know)?
Answer: John is touching Jane.

Recognition Level
(Setting: John on stage, Jane off stage.)

Jane: Today its sunny.
John: I hear a voice. That's Jane.
Tester: Does John know the voice?
Answer: Yes.
Tester: Why do you say that John knows (or doesn't know)?
Answer: John has heard Jane's voice before.

Recall Level
(Setting: John and Jane on stage.)

Jane: Let's go to the movies.
John: Ok, it starts at 3.
Tester: Does John know when the movie starts?
Answer: Yes.
Tester: Why do you say that John knows (or doesn't know)?
Answer: John remembers it starts at 3.

Understanding Level
(Setting: Jane, John, and a cardboard box with holes in it on stage.)

John: My gerbil breathes air. The air comes in these holes.
Tester: Does John know how the air gets in?
Answer: Yes.
Tester: Why do you say that John knows (or doesn't know)?
Answer: John understands that air can travel through small holes.

Metacognition Level
(Setting: John and Jane on stage.)

Jane: I will teach you your phone number. Say 936-1212.
John: 9...3...6... it is too much to remember.
Tester: Is there a lot for John to know?
Answer: Yes.
Tester: Why do you say that there is (not) a lot for John to know?
Answer: John cannot remember the phone number because its too long.

Evaluation Level
(Setting: Jane and John are on stage.)

Jane: I am going to be in the race tomorrow.
John: You'll win!
Tester: Does John know Jane will win?
Answer: No.

Tester: Why do you say that John knows (or doesn't know)?
Answer: John can not be sure that Jane will win.

APPENDIX B

The setting, tester prompts, and correct answers for the six levels of meaning for a selected two audio-taped stories.

The Tree House

1. Kate and Chuck are playing in the woods behind their house. 2. They walk along the path that leads to the tree house they have built. 3. Kate says, "Oh no! Someone has been here and one of the tree house walls is broken." 4. Kate and Chuck are angry. Chuck says, "It really doesn't look too bad. Maybe we can put it back together again." 5. Kate agrees with Chuck and says, "I think we will need a hammer, some nails, and a piece of wood to fix the wall." 6. Kate and Chuck agree that, when they are done fixing the wall, it will look even better than it did before.

Perception Level

Tester: Do the children know that the tree house wall is broken?
Answer: Yes.
Tester: How do they know?
Answer: They see it.

Recognition Level

Tester: Do the children know the tree house when they see it?
Answer: Yes.
Tester: How do they know?
Answer: They built it together behind their house.

Recall Level

Tester: Do the children know what the tree house used to look like?
Answer: Yes.
Tester: How do they know?
Answer: They know that the wall is now broken.

Understanding Level

Tester: Do the children know how to fix the tree house?
Answer: Yes.
Tester: How do they know?
Answer: They know that hammer, some nails, and a piece of wood will be enough to fix it.

Metacognition Level

Tester: Does Kate know that a hammer, nails, and wood will help them fix the tree house?
Answer: Yes.
Tester: How does she know?
Answer: She can use the things she used to build the tree house.

Evaluation Level

Tester: Do the children know that the tree house will look even better than before?
Answer: No.
Tester: How come they do not know?
Answer: Something may go wrong or the damage may be irreversible.

A Trip to the Swimming Pool

1. It is a beautiful, hot day. So Marla and Jackie are going to go swimming at the pool. 2. Marla meets Jackie and says, “Hi! Are you ready to go swimming?” Jackie says, “Marla, follow me, I know a shortcut to the pool.” 3. Marla tries to remember if she has ever gone this way to the pool before. She tells Jackie that she doesn’t know where they are. 4. Jackie says to Marla, “Look, the pool is right over there. Now you can see how fast my shortcut is.” 5. Marla pretends that she and Jackie race to the pool and jump right into the cool water. 6. Marla says, “Let’s race to see who gets to the pool first.” Jackie says, “Okay, but I know who will win the race.”

Perception Level

Tester: Do the children know it is a good day to go swimming?
Answer: Yes.
Tester: How do they know?
Answer: They feel it is a hot day.

Recognition Level

Tester: Does Marla know the shortcut Jackie takes her on?
Answer: No.
Tester: How come she does not know?
Answer: Marla does not remember going that way, and she does not know where they are.

Recall Level

Tester: Does Marla know how to get to the pool?
Answer: Yes.
Tester: How does she know?
Answer: She has gotten there before, she is just not familiar with the shortcut.

Understanding Level

Tester: Do the girls know that taking a shortcut got them to the pool quicker?
Answer: Yes.
Tester: How do they know?
Answer: They compare the times after they arrive at the pool.

Metacognition Level

Tester: Does Marla know that she must ask Jackie in order to actually race her?
Answer: Yes.
Tester: How does she know?
Answer: First she pretends, then she asks to race.

Evaluation Level

Tester: Does Jackie know who will win the race to the pool?
Answer: No.
Tester: How come she does not know?
Answer: She may have a good idea, but she doesn't know for sure.