

HYPOTHESIS-TESTING AND NONLINGUISTIC SYMBOLIC ABILITIES IN LANGUAGE-IMPAIRED CHILDREN

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This study sought to clarify further the cognitive abilities of language-impaired children by examining their hypothesis-testing and nonlinguistic symbolic abilities. A discrimination learning task and a concept formation task were used to measure hypothesis-testing abilities, and a haptic (touch) recognition task was used to assess nonlinguistic symbolic abilities. Subjects were 10 language-impaired and 10 language-normal children matched for performance Mental Age. Measures of expressive and receptive language were also obtained from each child. The language-impaired children were found to perform significantly poorer than their MA controls on the haptic recognition task and on a portion of the discrimination learning task. No differences were found between the two groups' concept formation abilities. Correlational analyses revealed a particularly strong positive relationship between performance on the Peabody Picture Vocabulary Test and the haptic recognition task. It was speculated that this relationship was motivated by the symbolic demands of these tasks. One implication of this speculation is that a symbolic representational deficit might better explain the receptive language deficit than the expressive one.

The existence of a group of "cognitively intact" language-impaired children has been seriously questioned during the past 10 to 15 years. This particular group of language-disordered children was defined in part by their ability to perform within normal age limits on standardized nonverbal intelligence tests such as the Leiter International Performance Scale (Arthur, 1952) and the Columbia Mental Maturity Scale (Burgemeister, Blum, & Lorge, 1972). Recent research, however, has found deficits in several cognitive areas not evaluated by these tests, including auditory processing skills (cf. Tallal & Piercy, 1978), memory (Menyuk & Looney, 1972), symbolic and conceptual abilities (Camarata, Newhoff, & Rugg, 1981; Johnston & Weismer, 1983; Kamhi, 1981), and hierarchical planning (cf. Cromer, 1981). Performance on nonverbal intelligence tests, thus, is not always indicative of language-impaired children's level of functioning in other cognitive domains. With the ultimate goal to understand better the nature of the developmental language deficit, the current investigation sought to clarify further the nature of the cognitive deficit in language-impaired children.

One area of cognition that has received little attention in this literature involves hypothesis-testing abilities. Current views of language acquisition suggest that children learn language through a process of formulating and testing hypotheses about specific conceptual domains and linguistic rules (e.g., Slobin, 1979). Deficient hypothesis-testing abilities, therefore, might play some role in explaining the developmental language deficit. Two procedures, a multidimensional discrimination learning task and a concept formation task, were used to assess children's hypothesis-testing abilities in this study. In addition,

a measure of nonlinguistic symbolic abilities, a haptic recognition task, was included in order to verify previous reports (e.g., Kamhi, 1981) that these skills are delayed in language-impaired children.

Hypothesis-testing abilities of adults and children have been successfully evaluated using multidimensional discrimination learning tasks (Cantor & Spiker, 1978; Gholson, Levine, & Phillips, 1972; Levine, 1975). In the current investigation, a two-dimensional, verbal-probe, discrimination learning task was adapted from the work of Cantor and Spiker (1978).

Children's performance on a concept formation task was also used to assess hypothesis-testing abilities. To form concepts, children are thought to make hypotheses about the intensional and extensional aspects of concepts (Carey, 1982; Clark & Clark, 1977). In other words, children make decisions about the features that define a particular concept (intensional) and the particular referents with which these features are associated (extensional). In this way, a concept formation task can also be considered to provide a measure of children's hypothesis-testing abilities. Research with nondisordered children (Clark, 1973; Kossan, 1981; Rosch & Mervis, 1975) suggests that children use both a common feature abstraction strategy and an exemplar strategy to formulate concepts. This is another way to say that children make hypotheses about intensional and extensional aspects of a concept. Kossan (1981), for example, found that the most effective concept-learning strategy was a function of age and the structure of the concept to be learned. Second graders learned rule-defined concepts successfully using a common feature abstraction strategy but learned more complex concepts with sufficient but not defining features

most effectively with an exemplar strategy. Fifth graders, however, were able to use both strategies to learn the sufficient-feature concept. In the current study, we examined the ability of language-impaired children to use a common feature abstraction strategy to learn rule-defined concepts.

The justification for evaluating language-impaired children's nonlinguistic symbolic abilities derives from Morehead and Ingram's (1973) claim that these children might have a pervasive symbolic deficit that affects nonlinguistic as well as linguistic symbolic abilities. Language-impaired children's nonlinguistic symbolic abilities have been studied by assessing performance on various sensorimotor and mental imagery tasks, as well as by observing imitative and play behaviors. Studies in these areas (Johnston & Weismer, 1983; Kamhi, 1981; Terrell, Schwartz, Prelock, & Messick, 1981) have generally shown these nonlinguistic symbolic abilities to be delayed in language-impaired children, but seemingly not sufficiently delayed to explain the extent of the language impairment. Kamhi (1981), for example, showed that performance on a haptic (touch) recognition task provided a good indication of nonlinguistic symbolic abilities. It was noteworthy, therefore, that 5-year-old language-impaired children performed significantly poorer than Mental Age (MA) matched control subjects on this task but significantly better than language-matched younger normally developing children. In the current study we questioned whether somewhat older language-impaired children, 6-year-olds, still showed significantly poorer performance than MA-matched control subjects on the haptic recognition task.

Measures of expressive and receptive language were obtained from each child in order to determine whether any clear patterns of cognitive and linguistic performance existed. The study addressed the following three questions.

1. Do language-impaired children demonstrate the same hypothesis-testing and haptic recognition abilities as MA-matched control subjects?
2. Does a relationship exist between children's performance on three cognitive tasks and age, performance MA, or receptive and expressive language measures?
3. What are the implications of the findings from this study for understanding the underlying nature of developmental language deficits?

METHOD

Subjects

Subjects were 20 children, 10 language-impaired (6 male, 4 female) and 10 normally developing children (6 male, 4 female) matched for mental age (MA) according to performance on the Columbia Mental Maturity Scale (Burgemeister et al., 1972). The 10 language-impaired children were all part of the third author's caseload in a middle-class, racially integrated suburban school system. These children were diagnosed by LK as having a pri-

mary language disorder and were all currently enrolled in language therapy during the time of testing. Contributing to these diagnoses were test scores from the Northwestern Syntax Screening Test (NSST; Lee, 1969), Developmental Sentence Scoring Analysis (DSS; Lee, 1974), and the Peabody Picture Vocabulary Test (PPVT; Dunn, 1965). These tests indicated that expressive and/or receptive language abilities were at least 1 year delayed relative to performance MA in these children. Case histories and other formal testing indicated that the language impairment in these children was not the result of globally depressed intellectual functioning, severe emotional disturbance, hearing loss, or physical defects.

The normally developing children were taken from the same school system as the language-impaired children. None of these children had any history of speech, language, or hearing problems, and all performed within normal age limits on the Columbia. The similarities and differences between the language-impaired and nonimpaired groups are exemplified in Table 1. As can be seen in this table, the two groups were essentially the same age and demonstrated equivalent nonverbal intelligence as measured by the Columbia. However, the developmentally normal group obtained significantly higher scores on measures of expressive and receptive language performance, despite the fact that the language-impaired group as a whole generally fell within normal limits on the expressive language measures (e.g., the DSS). The PPVT and NSST-R reflect receptive vocabulary and syntactic abilities, respectively, whereas MLU, DSS (Lee, 1974), and GME (Grammatical Marker Error Index,

TABLE 1. Group means, standard deviations (*SD*), and *t* ratios for age, performance IQ, receptive vocabulary MA, NSST-R, MLU, Developmental Sentence Score (DSS), and Grammatical Marker Error Index (GME).

	<i>Language-impaired</i>	<i>Developmentally normal</i>	<i>t ratio</i>
Age (months)			
Mean	70.1	70.6	NS
SD	6.3	2.6	
Performance IQ (Columbia ADS)			
Mean	98.8	101.2	NS
SD	5.8	5.5	
PPVT-MA (months)			
Mean	60.6	89.5	8.08**
SD	7.1	8.8	
NSST-R			
Mean	24.5	34.2	6.54**
SD	4.5	1.3	
MLU			
Mean	8.05	9.83	2.92*
SD	1.56	1.13	
DSS			
Mean	9.54	13.21	3.13*
SD	2.63	2.61	
GME			
Mean	82.9	98.9	4.21**
SD	11.9	1.7	

p* < .01. *p* < .001.

Kamhi & Johnston, 1982) reflect expressive syntactic-semantic abilities.

General Procedures

All children were administered the Columbia Mental Maturity Scale, the Peabody Picture Vocabulary Test, and the receptive portion of the Northwestern Syntax Screening Test. In addition, a spontaneous language sample of at least 50 utterances was obtained from each child. Collecting this information generally took one session. During the second session, the three cognitive tasks were administered: haptic recognition, discrimination learning, and concept formation. Presentation of these three tasks was counterbalanced within each group, such that each matched pair of subjects received the same order of presentation. Testing on each of the tasks included a short training period to ensure that the children understood the task instructions and the response required. Testing took place in LK's therapy room, a setting familiar to, at least, all of the language-impaired children. The three tasks are described in some detail below.

Discrimination learning. As noted earlier, hypothesis-testing abilities of children have been successfully evaluated using multidimensional discrimination learning tasks. In the current investigation, a two-dimensional discrimination learning task was adapted from the work of Cantor and Spiker (1978). In this task, four values of the dimension *color* were arranged to form two artificial dimensions (red-green and blue-yellow). These two dimensions were used to construct two-dimensional discrimination tasks in which the two dimensions were varied orthogonally.

Children were presented two small opaque jars simultaneously. On top of each jar, two colored semicircles were drawn side by side. One of the two jars had a small ball of yarn in it whereas the other did not. Children had to figure out which color jar always contained the ball of yarn. The correct hypothesis was red, in that all jars with red on them had the ball inside. No jar with green ever had the ball inside. The irrelevant colors were thus yellow and blue, for only yellow and blue jars that were paired with red semicircles contained the ball.

Children were introduced to the task in the following manner. Two jars were shown to the child, and the experimenter noted that the jars had different colors on them. The child was asked to name each color; then, the experimenter said:

I'm going to show you two jars at a time. One has a little ball inside and the other doesn't. I want you to try to pick the jar that has the ball inside. There's a trick though. One of the colors, red, blue, yellow, or green, is the *special* color. The jar with the special color always has the ball in it. See if you can figure out which one is the special color. Ready?

Children were allowed to open the jars after each trial to check the accuracy of their hypotheses, and their correctness was confirmed by the experimenter.

Each presentation of two jars constituted one trial. Four

trials constituted one orthogonal set; that is, all the different combinations were presented every four trials. Ten orthogonal sets (40 trials) were presented in blocks of eight trials each. After each block, the child was asked what the special color was. The task continued until the child made eight consecutive correct choices or named the correct color two consecutive times. A maximum of 40 trials were possible.

Children's performance on this task was evaluated in two ways: (a) the number of trials it took to reach criterion, that is, to rule out incorrect hypotheses/solutions and infer the correct one; and (b) whether or not the child was able to verbalize the correct hypothesis. Acceptable solutions included, red, red + green/red + blue, and not green. No child used the negative dimension (green).

Concept formation. The concept formation task used in this study was adapted from the one used by Kossan (1981) in her developmental study of children's concept acquisition strategies. There were two parts to this task, one involving a one-feature rule and the other involving a two-feature rule. As Kossan (p. 292) noted, natural concepts often have defining features that indicate concept membership (e.g., the concept "bachelor" can be defined by two features, *unmarried* and *male*). The concepts used in the current study were categories of novel animals that were defined by one-feature and two-feature rules. Table 2 presents the four dimensions on which the two concepts varied and their defining features. *Zonks*, the one-feature concepts, were essentially "horselike," whereas *wugs*, the two-feature concepts, were "fishlike."

For the first concept, a *zonk*, the presence or absence of one feature (curly tail vs. pointed tail) defined the category. The remaining features were equally distributed among members of both categories. A set of 16, 5 × 8 in. (12.7 × 20.32 cm) yellow cards with drawings of the two animal categories was divided into a group of 6 training exemplars (3 from each category) and 10 transfer exemplars.

Children were told that they were going to be shown some pictures of a new animal called a *zonk*, but that not all of the pictures would be of zonks. Some of the pictures would be zonks and some would not be zonks; the child would have to decide which of the pictures were zonks.

TABLE 2. Feature structure of zonks and wugs.

Dimension	Animal	
	Zonk	Nonzonk
Body design	spotted/plain	spotted/plain
Length of legs	short/long	short/long
Number of ears	two/three	two/three
Type of tail	curly	pointed
	Wug	Nonwug
Type of mouth	smiling/frowning	smiling/frowning
Type of tail	large/small	large/small
Body design	striped	striped body or
Type of snout	serrated	serrated snout but not both

Children also were told that there was one thing that made a zonk a zonk. During the training condition, each of the six animal pictures (three from each category) was presented individually in random order until eight consecutive animals were correctly categorized. Children were simply asked to respond to the question, "Is this a zonk?" Correct responses were confirmed by the experimenter. When this criterion was reached, children were shown the six training exemplars and the 10 transfer exemplars in random order and asked again whether the animal was a zonk. At the conclusion of the categorization task, the children were asked to explain how they made their categorization decisions.

For the second concept, a two-feature rule determined whether or not an animal was a wug. Wugs had to have both a serrated nose and a striped body. The procedures for this concept formation task were identical to the one-feature-rule concept task, with the exception that now children were told that two things made a wug a wug. Children's performance on these two tasks was evaluated in two ways: (a) the number of trials it took to reach criterion, and (b) the number of correct responses made on the 16 transfer items.

Haptic recognition. The materials and procedures used in this task were identical to those described in Kamhi (1981). The task consisted of two parts. Part 1 consisted of the presentation of six topological shapes (disk with one hole, disk with two holes, closed ring, open ring, vee, and irregular cross) and six simple Euclidean shapes (square, circle, rectangle, triangle, four-cornered star, and Greek cross). Part 2 stimuli were the simple Euclidean shapes and six complex Euclidean shapes (Maltese cross, ellipse, irregular quadrilateral, trapezoid, rhombus, and six-cornered star). In this task children blindly felt one geometric shape and then had to point to a visual drawing of the corresponding shape from a complex of life-sized drawings of the 12 stimuli plus 3 foils. Correct responses were confirmed by the experimenter.

Because success on this task depends on the child's ability to generate and interpret a symbolic representation of an unseen object, this task is thought to provide a measure of nonlinguistic symbolic representational ability (Kamhi, 1981). Consistent with previous research involving this task (Larendeau & Pinard, 1970), children were assigned a stage score based on the number of correct responses they made. Scores were assigned to three general stages that reflect qualitative differences in

children's performances. The substages reflect quantitative differences. The stage scoring appears below.

- Stage 0: 0-2 Part 1 successes
- Stage 1: 3-5 Part 1 successes
- Stage 2A: 6-8 Part 1 successes and 0-4 Part 2 successes
- Stage 2B: 6-8 Part 1 successes and 5-7 Part 2 successes, or 9-10 Part 1 successes and 0-5 Part 2 successes
- Stage 3A: 9-12 Part 1 successes and 6-9 Part 2 successes
- Stage 3B: 9-12 Part 1 successes and 10-12 Part 2 successes.

Reliability

Performance on the three cognitive tasks was initially scored by BL. AK independently calculated all children's scores on these tasks. Agreement was 95%. DSS, MLU, and GME scores for the language samples were calculated by AK. BL independently calculated DSS, MLU, and GME scores for two children from each group. Agreement was 92% for these measures. Disagreements were resolved through discussion.

RESULTS

Group Comparisons

The data were first analyzed to determine whether or not there were differences between the language-impaired and normally developing children on the three cognitive tasks. Performance on the discrimination learning task could be evaluated in two ways: (a) the number of trials needed to meet criterion (maximum 40) and thus to infer the correct hypothesis, and (b) whether or not the child was able to verbalize the correct hypothesis. Table 3 presents these data. As can be seen in this table, there were essentially no differences in the mean number of trials children used on this task. Notably, there was considerable within-group variability in the number of trials children used. All but one normally developing child reached criterion before 40 trials, whereas three language-impaired children did not reach criterion. However, the one nonimpaired child who did not reach criterion accurately named the correct hypothesis, indicating that she just needed a longer time to rule out the possibilities. On the other hand, one language-impaired child who reached criterion was unable to name the correct hypothesis. In other words, all 10 control-group children correctly inferred and named the hypothesis, whereas only 6 language-impaired children correctly inferred and named the hypothesis. This difference proved to be significant at the .05 level using the Fisher Exact Probability Test (Siegel, 1956).

The next comparison involved the two concept formation tasks. These data are presented in Table 4. Somewhat surprisingly, no differences were found in any of the measures derived from either the one-feature concept task or the two-feature concept task. One language-impaired child was unable to do the task, consistently responding "No" to the stimulus question, "Is this a zonk/

TABLE 3. Group performance on the discrimination learning task.

	<i>Language-impaired</i>	<i>Developmentally normal</i>
Hypothesis-testing		
Mean number of trials	23.6	19.5
SD	12.2	11.5
Number of subjects reaching criterion	7	9
Number of subjects naming correct hypotheses	6	10

TABLE 4. Group performance on the two concept formation tasks.

Task	Language-impaired	Developmentally normal
One-feature concept (zork)		
Mean number of trials to criterion	10.4 ^a	14.6
SD	3.0	11.0
Transfer (16 exemplars)	15.6 ^a	16.0
SD	1.3	0
Number of subjects naming correct defining feature	9	10
Two-feature concept (wug)		
Mean number of trials to criterion	10.3 ^a	11.3
SD	3.2	7.3
Transfer (16 exemplars)	14.8 ^a	15.6
SD	1.8	1.3
Number of subjects naming correct defining features	8	10

^aFigures based on data from only 9 of the language-impaired children. One child could not do the task.

wug?" This child's data were not included in the analysis reported in Table 4 so that his aberrant and unrepresentative behavior would not unduly influence the group mean scores. Further, some explanation is warranted regarding the disparate standard deviations between the two groups in the mean number of trials to criterion. One control subject, the same child who did not reach criterion in the discrimination learning task, needed 42 trials to reach criterion on the one-feature concept formation task and 30 trials to reach criterion on the two-feature task. This was 18 and 15 more trials, respectively, than the control subject with the next highest number of trials. Omitting this child from the analysis reduced the group mean number of trials to 11.5 ($SD = 5.6$) in the one-feature task and to 9.2 ($SD = 3.4$) in the two-feature task. These figures were almost identical to those obtained by nine of the language-impaired children.

The final analysis compared performance on the haptic recognition task. The stage-level scores for each group appear in Table 5. The Mann-Whitney U Test (Siegel, 1956) revealed a significant difference in favor of the control group in this task ($U = 16$, $p < .01$). Like their younger counterparts in the earlier study (Kamhi, 1981), 6-year-old language-impaired children continue to exhibit significantly poorer haptic cognitive skills than MA control subjects.

TABLE 5. Distribution of subjects by group and by stage in the haptic recognition task.

Group	Stage					
	0	1	2A	2B	3A	3B
Language-impaired	0	1	0	4	3	2
Developmentally normal	0	0	0	0	6	4

In summary at this point, language-impaired children performed significantly poorer than MA-matched normally developing children on the haptic recognition task and in their ability to accurately infer and name the correct hypothesis in the discrimination learning task. In contrast, their ability to formulate one- and two-feature concepts on the concept formation tasks was comparable to the control group subjects.

Correlational Analyses

Our second series of analyses attempted to determine whether there was a relationship between children's performance on the three cognitive tasks and age, performance MA (as measured by the Columbia), expressive language (DSS scores and MLU), and receptive language (PPVT and NSST-R scores). Performances on the one- and two-feature concept formation tasks were combined so that one measure could be correlated with the other variables. Kendall rank correlation coefficients were first calculated for all 20 children and then for each group. For the first analysis the only significant coefficients involved the receptive language measures and performance on the discrimination learning and haptic recognition tasks. A significant ($p < .001$), moderate correlation obtained between both PPVT and NSST-R scores and performance on the haptic task ($\tau = .58$ and $.53$, respectively). A significant ($p < .01$), moderate correlation also obtained between PPVT scores and performance on the discrimination learning task ($\tau = .46$). The correlation between NSST-R and performance on this task was low and nonsignificant ($\tau = .17$).

A similar pattern emerged for the within-group coefficients (see Tables 6 and 7). However, in this case, the only measure that was moderately correlated to cognitive performance was performance on the PPVT. For the language-impaired group, a high, significant correlation obtained between performance on the PPVT and the haptic task, whereas the correlation between performance on the discrimination learning and the PPVT was moderate and significant. For the developmentally normal group, a moderate, significant correlation was found between performance on the discrimination learning task

TABLE 6. Kendall rank correlation coefficients between cognitive task performance and age, MA, and language performance for the language-impaired group.

	Haptic recognition	Discrimination learning	Concept formation
Age	.26	.24	.20
Columbia MA	.32	.37	.26
Columbia ADS (IQ)	.24	.22	.22
PPVT-MA	.74**	.56*	.20
NSST-R	.12	-.02	.02
MLU	-.33	-.24	.02
DSS	-.26	-.18	-.27
GME	-.21	-.11	-.11

* $p < .05$. ** $p < .01$.

TABLE 7. Kendall rank correlation coefficients between cognitive task performance and age, MA, and language abilities for the developmentally normal group.^a

	<i>Discrimination learning</i>	<i>Concept formation</i>
Age	.09	.11
Columbia MA	.16	-.12
Columbia ADS (IQ)	-.27	-.19
PPVT-MA	.52*	.30
NSST-R	.07	.05
MLU	.07	.07
DSS	.18	0

^aHaptic recognition and GME scores were omitted from this analysis because of the lack of variability in these children's scores.

* $p < .05$.

and the PPVT. No coefficients were calculated for the haptic task or the grammatical marker error index because there was very little variability in the normally developing children's scores.

To confirm the apparent relationship between performance on the haptic and discrimination learning tasks, coefficients were calculated between the three cognitive tasks. As expected, significant coefficients obtained between performance on the haptic and discrimination learning tasks for all 20 children ($\tau = .37, p < .05$) and for the language-impaired group ($\tau = .55, p < .05$). Coefficients involving the concept formation task were low and nonsignificant.

DISCUSSION

This study sought to clarify further the nature of the cognitive deficit in language-impaired children by examining their hypothesis-testing abilities and nonlinguistic symbolic abilities. A discrimination learning task and one- and two-feature concept formation tasks were used to measure hypothesis-testing abilities, whereas a haptic recognition task was used to assess nonlinguistic symbolic skills. The language-impaired children were found to perform the same as MA-matched control subjects on the concept formation tasks but somewhat poorer than the control children on the discrimination learning and haptic recognition tasks.

Hypothesis-Testing Abilities

Quite frankly, we were surprised by the similar performance of the language-impaired and control children on the concept formation task. Recall, however, that one language-impaired child could not do the task. Based on pilot testing with adult subjects, we did not anticipate either group performing as well as it did. Though differences did exist in the number of trials children needed, children in both groups performed at or near ceiling levels in the transfer task. Perhaps a more difficult con-

cept formation task would have uncovered differences between the two groups. Despite this possibility, we view the findings from this task as providing strong evidence that most language-impaired children have generally intact hypothesis-testing abilities. To support this interpretation, it is necessary to find an alternative explanation for the inability of four language-impaired subjects to infer or name the correct hypothesis in the discrimination learning task. Recall that all 10 normally developing children inferred and named the correct hypothesis in comparison to only 6 language-impaired children.

One of the four children who could not solve the discrimination learning problem was the same child who was unable to do the concept formation task. In addition, this child obtained the lowest score of all the children on the haptic task, performing only at Stage 1. This child's comparatively poor performance on these cognitive tasks suggests that he suffers from a more broad-based cognitive deficit than the other language-impaired children.

Of the three remaining language-impaired children who did not solve the discrimination learning problem, one child reached criterion in 17 trials, which was one over the minimum possible. After getting the first trial wrong, she got the next 16 correct. However, this child could not verbalize the correct solution, both times saying it was "blue and red." She was the only child in the study who inferred the correct hypothesis, but could not verbalize her solution. She also reached criterion on the concept formation task relatively quickly and got all the transfer items correct. It seems clear that this child's hypothesis-testing abilities are intact, whereas her ability to express her problem solutions may be questionable.

The remaining two language-impaired children could not infer or name the correct hypothesis. These children also were generally successful with the concept formation task, missing only 4 of the 32 possible transfer items for the one- and two-feature problems. Their ability to form concepts based on subtle feature differences on the concept formation task and inability to solve the discrimination learning problem is puzzling. Assuming that the concept formation task provided a valid measure of their hypothesis-testing abilities, then something specific to the discrimination learning task must have caused them difficulty. One possibility is that they were confused by the presentation of two colors side by side. A study that examines language-impaired children's performance on a different discrimination learning task is needed to determine whether these performance difficulties are peculiar to this particular discrimination learning task or typical of others as well.

Nonlinguistic Symbolic Skills

The significantly poorer performance of the language-impaired children on the haptic task confirms the findings from a previous study involving this task (Kamhi, 1981). Consistent with this previous study and others (e.g., Johnston & Weismer, 1983), there does appear to be some relationship between linguistic and nonlinguistic

symbolic abilities. As Kamhi (1981, p. 451) suggested, "The extent of the conceptual delays manifested by language-impaired children appears related to the involvement of the symbol in developing a particular concept." The haptic recognition task clearly had a stronger symbolic component than the other two tasks because the solutions to the two hypothesis-testing tasks were aided by visual representations of the concepts. To succeed on the haptic task, however, children had to generate, maintain, and interpret symbolic representations of the geometric shapes.

The Relationship Between Cognitive and Linguistic Performance

The correlational analyses suggest that there was some relationship between the nature of children's language disorder and their performance on the two cognitive tasks that differentiated between the language-impaired and language-normal children. Language-impaired children with low receptive vocabulary skills generally performed poorer on the haptic recognition and discrimination learning task than language-impaired children with relatively high receptive vocabulary skills. Performance on the NSST-R was also significantly related to haptic performance when all the children were considered in the analysis. However, the strongest relationship involved performance on the haptic task and the PPVT. Somewhat surprisingly, none of the expressive language measures were significantly correlated to performance on the cognitive tasks, nor was there a significant correlation involving the concept formation task.

The individual subject data supported the pattern suggested by these analyses. For example, the language-impaired child with the lowest PPVT score also obtained the lowest scores on the haptic and discrimination learning tasks. This was also the same child who could not do the concept formation task. Despite this child's relatively poor performance on these tasks, his expressive language abilities were within normal age limits. At the other end of the continuum, the child who obtained the highest scores on the haptic and discrimination learning tasks also obtained the second highest PPVT score. Moreover, this child suffered only from an expressive language delay. These findings suggest that different factors might underlie receptive and expressive language deficits.

It is intriguing to consider the possibility that the strong correlation between the haptic and PPVT scores was motivated by the symbolic demands of these tasks. As suggested earlier, the haptic task places considerable demands on children's symbolic representational abilities because success on this task requires the ability to generate, maintain, and interpret symbolic representations of the geometric shapes. Though symbolic abilities clearly play an important role in all language tasks, perhaps a receptive vocabulary test such as the PPVT places more demands on children's symbolic abilities than other measures of receptive and expressive language. There is some indirect evidence in support of this

hypothesis from recent studies on children's comprehension and production of grammatical structures (e.g., Chapman, 1978; Chapman & Miller, 1975). This evidence indicates that production of a form is sometimes easier than comprehension of the same form and that certain comprehension tasks are easier than others. The key variable in determining the relative difficulty of these tasks is thought to be the presence or absence of contextual cues. As Rice (1980) noted, young children use contextual cues and knowledge of probable meanings to comprehend language before they understand all the structural components of a sentence. The importance of contextual support for comprehension and production led Chapman to hypothesize that the developmental order for a given grammatical structure was comprehension in context followed by production in context, production out of context, and comprehension out of context. One reason for this particular developmental order might be that the presence of contextual cues reduces the processing demands required to produce or comprehend a particular form, in particular, the symbolic processing demands. This interpretation suggests that an out-of-context comprehension task is the most difficult language task because it involves more symbolic processing demands than production tasks and contextually supported comprehension tasks. It might be no coincidence, then, that performance on the PPVT, an out-of-context comprehension task, and performance on the haptic recognition task were strongly related. Both of these tasks placed considerable demands on children's symbolic representational abilities. Note that although performance on the PPVT is aided by picture cues, there are no communicative or contextual redundancies available to facilitate comprehension. One might wonder why performance on the NSST-R, also an out-of-context comprehension task, was not as strongly correlated to performance on the haptic task. Perhaps the symbolic demands on the NSST were lessened by pictures of the situational contexts, the two-choice option (the PPVT has four choices), or processing differences inherent in lexical versus grammatical comprehension tasks. Further research is clearly needed to investigate these speculations.

If our interpretation of the strong correlation between performance on the PPVT and haptic recognition tasks is correct, then it follows that a symbolic representational deficit would explain better the receptive language deficit than the expressive one. This hypothesis implies that a language-impaired child might have a relatively severe symbolic deficit without an associated expressive language impairment or, conversely, have intact symbolic skills but still suffer from an expressive language deficit. The findings from this study are consistent with this hypothesis as are findings from some other studies. Curtiss and Yamada (1981), for example, have documented an instance of a child with severe cognitive delays in conceptual as well as nonlinguistic symbolic areas who showed intact expressive language abilities. The only exception to this child's cognitive deficit was above-normal performance in verbal short-term memory tasks. These data imply that short-term auditory memory skills

might be more closely linked to expressive language abilities than to receptive ones.

Attributing receptive and expressive language deficits to different causal bases is consistent with recent psycholinguistic models of comprehension and production (e.g., Foss & Hakes, 1978). These models depict the interdependence of these processes as well as their distinctiveness. The findings from the current investigation led to the speculation that a symbolic representational deficit might explain better the receptive language deficit than the expressive one. Subsequent research efforts in this area need to systematically investigate the symbolic demands of various receptive and expressive language tests as well as attempt to specify those cognitive deficits more likely to underlie receptive language delays and those more likely to underlie expressive language delays.

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