WORD-FINDING ABILITIES IN LANGUAGE-IMPAIRED CHILDREN

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Abstract

One symptom reported in the speech of children with specific language impairment is a problem in "word finding," that is, a problem in generating the appropriate word called for in a situation. This problem is usually assumed to reflect a deficit in word-retrieval skills, such as use of inappropriate or inefficient retrieval strategies. The goal of the experiments reported in this monograph was to determine the specific conditions under which retrieval deficits may play a role in language-impaired children's word-finding problems. Four samples of language-impaired and control children participated in a total of seven experiments. Experiments 1-5 dealt with recall, retrieval, and similarity judgments of words presented individually or in lists of words. Experiments 6 and 7 were concerned with naming of pictures and recall of words presented in larger and more meaningful linguistic contexts.

The data provided little support for a retrieval deficit interpretation of the language-impaired children's poorer performance in the experiments. These children recalled fewer words, and both named pictures and judged picture names more slowly than their same-age peers. However, like their peers, these children used item typicality, as well as superordinate category, semantic-syntactic, and textual information to guide retrieval. We interpreted these results in terms of "elaboration" limitations: Words, being less well known by language-impaired children, may be represented in a less elaborate form in semantic memory than is the case for children with normally developing language. According to this view, it is the unelaborate representations of the words that make accessing words difficult for language-impaired children.

In general, the findings suggest the utility of intervention approaches that provide children with a richer base of information about a word's meaning, use, and syntactic privileges of occurrence, and suggest caution in the use of approaches that teach children strategies for retrieval without providing information about the words to be retrieved.

Chapter 1

Introduction

Speech-language pathologists and special educators routinely encounter language-impaired children whose difficulties include problems in "word finding." Such difficulties are often first suspected on the basis of particular behaviors exhibited by these children during conversation. Those behaviors include frequent and pronounced hesitations, circumlocution, the use of fillers (e.g., *uh, let's see*), and overuse of such indefinite terms as *stuff* and *thing*.

Word-finding difficulties are often measured with structured naming tasks, in which language-impaired children typically commit a greater number of errors and show longer naming latencies than their peers with normally developing language. For example, Wiig, Semel, and Nystrom (1982) found that language-impaired 8-year-olds made more errors on naming tasks involving pictured objects and colored shapes than did age-matched controls. The differences occurred even though all children, when given a name, could select the correct picture and could produce the correct names in delayed imitation of the investigator. Similarly, Rubin and Liberman (1983) found that language-impaired 4- to 12-year-olds performed significantly below age level on the Boston Naming Test, in which line drawings of objects ranked in difficulty are named. Children apparently comprehended many of the words they failed to produce on the naming task, because they could point to the correct picture upon hearing the name. Finally, Fried–Oken (1984) presented pictures twice to language-impaired 4- to 9-year-olds. Only those items that the child named correctly on at least one of the two trials were considered. It was reasoned that errors on those items occurred even though the child knew the correct name. With this scoring procedure, the language-impaired children still committed a greater number of errors than a group of age-matched peers showing normal language development.

Even when impaired children name a picture correctly, they typically will take longer to do so than their peers. Perhaps the first study to examine naming latencies in language-impaired children was conducted by Anderson (1965). He found that language-impaired 8-year-olds named line drawings of common objects more slowly than did a group of age-matched normal children. Similarly, Fried–Oken (1984) found that language-impaired children named pictures more slowly than did the age controls, for both correct and incorrect responses.

Using the term "word-finding deficit" to describe these problems implies that the child's difficulty rests with accessing a word that is present in memory. Indeed, the disorder has often been described as a "lexical look-up" problem (Menyuk, 1975, 1978) and as a problem involving "delayed speed of word retrieval" (Schwartz & Solot, 1980). Retrieval problems have been assumed because the words with which the child has difficulty are seemingly understood on comprehension measures and are often produced correctly, albeit not effortlessly, on naming tasks.

There are, however, plausible alternative explanations of word-finding problems. Consider, for example, the extent of language-impaired children's knowledge of words. According to current theories of semantic memory, words that are better known can be viewed as having stronger associations in semantic memory (e.g., Anderson, 1976) or, alternatively, more distinct representations in memory (e.g., Landauer, 1975) than less well known words. In either case, retrieval would be more rapid for the better known words, which seems to explain why children's naming times decrease with increasing age (Denckla & Rudel, 1974) and why less familiar objects are named more slowly (Milianti & Cullinan, 1974). That is, younger children are assumed to have fewer or weaker associations in semantic memory than older children. Similarly, words occurring infrequently in the child's environment would have fewer or weaker associations than words occurring with higher frequency. In like manner, children with word-finding problems may name pictures more slowly because words are stored in a less elaborate manner. Thus, word-finding problems would be byproducts of the fact that impaired children's language develops more slowly and less elaborately than the norm.

Determining the basis of word-finding problems is important for applied reasons as well as theoretical ones. Word-finding problems related to inadequate or inappropriate retrieval strategies would presumably require instruction in the formulation and use of strategies for retrieving words that may be adequately represented in memory. In contrast, word-finding problems stemming from limited lexical knowledge would probably require instruction aimed at providing children with a richer base of information concerning a word's meaning, its semantic relationships with other words, and its syntactic privileges of occurrence. Knowing the source of word-finding problems in language-impaired children would allow us to specify the more appropriate of two general approaches to remediation.

Unfortunately, the methods used in most studies of naming in language-impaired children do not isolate the role of retrieval factors in word-finding problems. The naming errors of the language-impaired children studied by Wiig et al. (1982), Rubin and Liberman (1983), and Fried–Oken (1984) may have been due to the children having less elaborate representations of the words in memory as well as or rather than problems retrieving those words. Similarly, such unelaborate representations may have led to the slower naming times of the language-impaired children in the studies by Anderson (1965) and Fried–Oken (1984).

An additional problem with much of the extant research is that language-impaired children who performed poorly on naming tasks were often heterogeneous, which is reflected in the variety of general clinical or psychoeducational labels used to describe them. Even within the population of children performing at age level on nonverbal measures of intelligence, there are children described as "aphasoid" (Anderson, 1965), "language deficient" (e.g., Fried–Oken, 1984), "dyslexic" (e.g., Denckla & Rudel, 1976), "learning disabled" (e.g., German, 1982), and "language-learning-disabled" (Wiig et al., 1982). These different labels may mask similar problems. Children with oral language deficiencies, including developmentally aphasic children, usually experience significant problems in reading (Stark, Catts, Bernstein, & Condino, 1982). In turn, many children identified initially on the basis of poor reading skills have been found to exhibit subtle problems with oral language as well (Vellutino, 1979). Unfortunately, because investigators rarely provide details concerning psychometric and linguistic test performance of the children, it is impossible to know exactly what types of impaired children have participated in previous research.

In two previous studies we attempted to clarify the nature of word-finding problems in language-impaired children by, first, using well-defined groups of language-impaired children who exhibited word-finding deficits as assessed by standardized tests, and, second, by using tasks in which we could isolate retrieval components of performance.

In the first study (Leonard, Nippold, Kail, & Hale, 1983), we examined children's picture naming. As we described earlier, clinicians and educators often diagnose word-finding problems with some form of a "confrontation naming task" in which individuals name pictures rapidly. On laboratory tasks, the familiarity of an object influences naming time considerably: Naming time decreases linearly as a function of the familiarity (or log familiarity) of the object's name, where familiarity is usually defined as the frequency of the name of the object in printed matter (Oldfield & Wingfield, 1965). One interpretation of this effect is that associations involving frequently used nodes are stronger, and hence retrieval is more rapid than for those less frequently used nodes whose associations are weaker. A second interpretation is that frequently used names are retrieved more rapidly because they have more distinct entries in memory than do less frequently used names (e.g., Landauer, 1975). Thus, frequency of use is an indirect estimate of associative strength in the first case and of the number of distinct representations in the second. In either case, if language-impaired children are less adept at using familiarity to direct retrieval, the slope of the function relating naming time to familiarity should be steeper for language-impaired children than for nonimpaired children.

To test this prediction, we (Leonard et al., 1983) tested 20 language-impaired children and 20 of their age mates on a naming task. Children were shown slides of 64 pictures; we recorded the time from the presentation of the slide until the child initiated naming. Three findings were critical: (a) overall, the impaired children named pictures more slowly than their peers; (b) for both groups, naming time decreased as a function of increases in familiarity; and (c) these decreases occurred at the same rate for both groups of children. Naming time differences found on clinical instruments apparently are not due to the fact that impaired children are less able to use familiarity to guide retrieval of names. Instead, the differences may be due to inefficiencies in other components of retrieval that are independent of the familiarity variable, or they may be due to some ill-defined deficit in the storage and elaboration of object names in memory.

We reasoned that impaired children's word-finding deficits might be more apparent in recall tasks, which are traditionally thought to have more stringent retrieval requirements. Hence, in a second study (Kail, Hale, Leonard, & Nippold, 1984), we tested children on a repeated free recall paradigm devised by Wilkinson (e.g., Wilkinson, DeMarinis, & Riley, 1983). Specifically, 16 words were presented to children. Following presentation of the last word, the experimenter asked the child to perform a brief distraction task. Then the child was asked to free recall the words. After the child had indicated that he or she could recall no additional words, the child was again asked to perform the distraction task. Then the child was told to "tell me again all the words that I just said to you. Tell me again the ones you said before plus any more that you can remember." After the child had concluded recall, this procedure was repeated one more time, yielding one presentation of the list but three recall attempts.

The rationale behind this task is as follows. Suppose one child recalls only half the words on the first attempt, and retrieves exactly those same words on the second and third attempts. Now suppose another child recalls all the words on the first attempt, half on the second, and a quarter on the last. The first child apparently stored fewer items initially, but was quite consistent in retrieving those items thereafter. The second child apparently stored more items initially but was less able to retrieve them consistently on subsequent occasions. Wilkinson et al. (1983) expressed these phenomena formally in a Markov model of memory that will be described in detail later in this monograph. For present purposes, the important point is that the model allows a precise separation of storage and retrieval components in repeated free recall.

When Kail et al. (1984) fitted the recall data to the Wilkinson et al. model, language-impaired and age-control children differed in both the storage and retrieval components of the model. That is, age-control children were more likely to store words presented in the list than were language-impaired children. In addition, given that a word was stored successfully, language-impaired children were less likely than normal children to retrieve it successfully.

Thus, in the Leonard et al. (1983) study, language-impaired children differed from their age mates only in storage processes, but, in the Kail et al. (1984) study, they differed in both storage and retrieval. Our subsequent research was prompted by this unclear picture of the nature of language-impaired children's word-finding problems. The main goal of the experiments reported here was to determine the specific conditions under which retrieval deficits may play a role in language-impaired children's word-finding difficulties.

In this monograph, we describe the results of seven additional experiments conducted with four samples of language-impaired children and matched control children. In chapter 2 we present details concerning the language-impaired children who participated as well as the age- and language-control children. Chapter 3 contains the results of five experiments in which tasks were used that allowed us to examine storage and retrieval processes in settings where linguistic influences were limited to knowledge of individual pictures or words. In chapter 4 we describe two experiments in which word-finding was investigated in contexts that were more complex linguistically. Chapter 5 provides a summary of our findings, a framework in which many of the findings can be interpreted, some general suggestions for future research, and some clinical implications of our work.

Chapter 2

Participants

Four samples of children participated in the experiments. Each sample included children who had been diagnosed as language-impaired and were selected according to criteria adapted from Stark and Tallal (1981b) to reduce the heterogeneity within the group. These children showed a Performance Scale of the Wechsler Intelligence Scale for Children—Revised (WISC-R) (1974) that exceeded 85. In addition, all passed a hearing screening, an examination of oral structure and function adapted from Yoss and Darley (1974), and a neurological screening using age-appropriate items from Touwen and Prechtl (1970).

The standardized language tests administered to the children varied somewhat from sample to sample (see below), due to slight differences in the ages represented in the samples. For those language-impaired children receiving tests that yielded language ages (the younger children), all scored more than 1 year below age level on the expressive language tests and at least 6 months below age level on the receptive language tests; thus the composite language age (receptive and expressive) of each was more than 1 year below age level. For the language-impaired children receiving tests that yielded standard scores, all showed composite scores at least one standard deviation below the mean for their age, with below-average performance on receptive as well as expressive subtests. In fact, the language-impaired children selected scored well below these minimal language criteria. Typically, the younger children's composite language ages were more than two years below chronological age, and all of the remaining children showed receptive as well as expressive standard scores at least one standard deviation below the mean for their age. The language-impaired children's performance on the standardized language tests is summarized in Appendix A. Finally, all of the language-impaired children scored below the criterion established for their grade level in naming time and/or accuracy on the Producing Names on Confrontation subtest of the Clinical Evaluation of Language Functions (CELF) (Semel & Wiig, 1980).

Each sample also included children serving as age controls. Each child in this group was matched with one of the language-impaired children according to chronological age to within ± 6 months. All of these children showed Performance IQs above 85 on the WISC-R, passed the screening tests described earlier, and showed age-level performance on the receptive and expressive standardized language tests as well as on the CELF Producing Names on Confrontation subtest.

Three of the four samples included children acting as language controls. Each of these children was matched with one of the language-impaired children according to composite language age to within ± 6 months in those cases where the tests yielded language ages. Otherwise, the matching was based on estimated language age to within ± 6 months and total raw scores to within ± 10 points in those cases where the language-impaired and language controls could be given the same language test. Estimated language age (in months) was computed as chronological age in Months × Child's Language Quotient converted to a decimal (e.g., 100 = 1.00). The tests involved (TOLD-I, TOAL) are so constructed that the mean quotient is 100. In those cases where the ages of the 2 children in a matched pair prevented the same test from being given, matching was accomplished by estimated language age (to within ± 6 months) alone. The language-control children passed all of the screening tests and showed performance IQs above 85. As the language controls were younger than the children in the other groups, IQs for some of these children were based on the Wechsler Preschool and Primary Scale of Intelligence (1967). All of the language controls showed age-level performance on the receptive and expressive standardized language tests. Some of the children were below the age for which the Producing Names on Confrontation subtest of the CELF was appropriate; the remaining children showed age-appropriate naming times.

CHARACTERISTICS OF SAMPLES OF CHILDREN

Sample 1

The children in this sample, 20 in each of three groups, were those participating in the Leonard et al. (1983) and Kail et al. (1984) experiments. The language-impaired children, 14 boys and 6 girls, ranged in age from 6:1 to 13:1 (years:months). A similar age range—5:8 to 12:10—held for the 4 boys and 16 girls serving as age controls. The language controls, 8 boys and 13 girls, ranged in age from 4:11 to 8:11.

The particular language tests used to select these children varied, necessarily, with the ages of the children.[1] For those children younger than 9:0, two receptive (Picture Vocabulary, Grammatic Understanding) and two expressive (Oral Vocabulary, Sentence Imitation) subtests of the Test of Language Development—Primary (TOLD-P) (Newcomer & Hammill, 1977) were administered. For children between 9:0 and 10:1, the Auditory Reception and Auditory Association subtests of the Illinois Test of Psycholinguistic Abilities (ITPA) (Kirk, McCarthy, & Kirk, 1968) served as the receptive measures, and the Verbal Expression and Grammatic Closure subtests of the ITPA served as the expressive measures. Children age 11:0 and above were administered two receptive (Listening Vocabulary, Listening Grammar) and two expressive (Speaking Vocabulary, Speaking Grammar) subtests of the Test of Adolescent Language (TOAL) (Hammill, Brown, Larsen, & Viederholt, 1980).

Sample 2

The three groups each consisted of 21 children. The language-impaired children, 12 boys and 9 girls, ranged in age from 7:3 to 13:8. Of the 21 language-impaired children, 11 had been in Sample 1. The age-control and language-control groups consisted, respectively, of 6 boys and 15 girls, and 8 boys and 13 girls. The age ranges for the two groups were 7:1 to 14:0 and 4:9 to 9:10, respectively. The language tests used for selecting children were the same as for the first sample, except that a number of the children ages 8:6 to 12:11 were given the Test of Language Development—Intermediate (TOLD-I) (Hammill & Newcomer, 1982) instead of the subtests from the ITPA or TOAL. The TOLD-I contains five subtests, two receptive (Characteristics, Grammatic Comprehension) and three expressive (Sentence Combining, Word Ordering, Generals).

Sample 3

Each of three groups included 18 children. The language-impaired children, 16 boys and 2 girls, ranged from 6:2 to 12:4 years. The age controls, 11 boys and 7 girls, ranged in age from 6:7 to 12:6. The language-control group comprised 12 boys and 6 girls ranging in age from 4:6 to 8:7. The children below age 8:6 received the subtests of the TOLD-P; those older received the TOLD-I.

Sample 4

This sample included 28 language-impaired children (24 boys and 4 girls) and 28 age-matched children (12 boys and 16 girls). The language-impaired children ranged in age from 8:11 to 12:10. The age-controls ranged in age from 9:2 to 12:11. A group of language-matched children was not included in this final sample. All children received the TOLD-I.

GENERAL COMMENTS ON PROCEDURE

Because of the time required to identify both language-impaired children who met the criteria described above and children with normal language who could be matched to the impaired children, we decided it would be inefficient to test children in only a single experiment. In fact, children in the four samples participated in several studies. Children in Sample 1 were tested in 1982 on Experiment 4 as well as the experiments described by Leonard et al. (1983) and Kail et al. (1984). Children in Sample 2 were tested in 1983 on Experiments 2 and 7. Children in Sample 3 were tested in 1983 on Experiments 2, 4, and 5. Children in Sample 4 were tested in 1984 on Experiments 1, 3, and 6. To minimize the possible carryover effect of participation in more than one experiment, the order of presentation of the experiments was counterbalanced across the two sessions usually required for testing. Inspection of the data revealed no systematic effects due to the order of testing.

In some experiments we do not have data for all children in a sample; this is usually due to a malfunction in the computer used to run the experiment or to a child's absence on the scheduled day of testing. Whenever we lost data for one child in a matched trio of language-impaired, age-control, and language-control children, we deleted the data for the entire trio.

Finally, the children within each sample varied widely in age. Accordingly, in most experiments we divided the samples into groups of younger and older impaired children and analyzed the data with age as a factor. The customary finding was that older language-impaired children performed better than younger language-impaired children, but that there were no interactions between age, impairment, and experimental variables. For clarity, then, we have not subdivided the groups according to age in the analyses presented here.

[1]The number of different tests required was reduced with the publication of the Test of Language Development—Intermediate (Hammill & Newcomer, 1982) after the data from Sample 1 had been gathered.

Chapter 3

Studies of Word-Finding in Recall, Naming, and Related Paradigms

According to the retrieval hypothesis, the locus of word-finding problems is the strategy used by language-impaired children to retrieve words. Language-impaired children are thought to use strategies less efficiently than their peers or to fail to use them altogether (e.g., Ceci, 1983).

As phrased here, the retrieval hypothesis is not restricted to word-finding in such linguistically rich contexts as listening, speaking, or reading. To the contrary, the hypothesis implies pervasive deficits that should be evident in virtually any memory task. Given this apparent generality, in Experiments 1–5 we attempted to evaluate the retrieval hypothesis in various word recall and naming paradigms, simply because of the ease with which components of retrieval could be identified relative to tasks that were more complex linguistically.

We selected tasks according to three criteria. First, we chose only those paradigms that had been used previously in developmental research, so that we had some expectations of the normal patterns of performance for children of the ages participating in our research. Second, we typically selected tasks that allowed us to separate the retrieval components of performance from the storage and elaborative components. Finally, we chose tasks so that, collectively, they would represent a wide range of storage and retrieval demands.

EXPERIMENT 1: REPEATED FREE RECALL

Experiment 1 concerned the accuracy of performance on a recall task. Specifically, in one of our earlier studies (Kail et al., 1984) we tested language-impaired and age-control children on a repeated free recall task devised by Wilkinson et al. (1983). Using a mathematical model to distinguish storage components of performance from retrieval components, we found that language-impaired children were less likely to complete each of these component processes successfully.

Our interpretation of storage and retrieval in repeated free recall is as follows (derived with some modifications from Anderson, 1976, 1983). When a word is presented, its representation in permanent memory becomes activated and may be tagged as a member of the list to be recalled. Simultaneously, activation spreads to other related entries in memory. When lists consist of unrelated words, this spreading activation has negligible impact, because the words activated in this manner are not list members. However, with the categorized lists used by Kail et al., activation will often spread to other members of the list. If we assume that probability of recall is determined chiefly by the degree of a word's activation, then categorized lists—by virtue of their greater level of activation—should be recalled more accurately than uncategorized lists.

The impact of list categorization is not specific to storage but probably extends to retrieval as well, also due to spreading activation. At the beginning of the interval for recall, the cue "recall the words" activates the list tag, from which activation spreads to traces of words that were presented and tagged successfully. As during the study phase, activation spreads farther to other words; in categorized lists but not in uncategorized lists, these words are likely to have been list members and hence will be retrieved.

Applying this framework to the Kail et al. (1984) study, suppose that language-impaired children have less extensive lexical representations (i.e., fewer and weaker links between nodes), which means that they are less likely to profit from the spreading activation that occurs between category members. Hence, they should be less likely than age-control children to store and retrieve words in a categorized list, and the results obtained by Kail et al. demonstrate this.

This explanation can be evaluated further by comparing children's recall of categorized and uncategorized lists of words. If language-impaired children profit little from spreading activation among category members, the ability of these children to store and retrieve words should be much the same for categorized and uncategorized lists. In contrast, age-control children should be much better able to store and retrieve words from categorized lists than from uncategorized lists. We evaluated these predictions in Experiment 1 by testing language-impaired children and their age mates in the repeated free recall paradigm, once with a list of categorized words, and once with a list of uncategorized words.

Method

Participating were 27 pairs of children from Sample 4. Children were tested individually on repeated free recall of two lists of 16 nouns. Each of the 16 words was read aloud by the experimenter at a rate of one word every 2 s. Following presentation of the last word, the experimenter asked the child to count aloud for 20 s. Then the child was asked to recall the words. After 30 s for recall, he or she was asked to count aloud for 20 s. Then the child was asked to, "Tell me again all the words that I just said to you. Tell me again the ones you said before plus any more that you can remember." After the child had concluded recall, the count-recall procedure was repeated one more time, yielding three recall attempts. These procedures were used with one categorized list and one uncategorized list for each child, with order of presentation counterbalanced across children.

Categorized lists were selected from norms prepared by Posnansky (1978) and Battig and Montague (1969). We constructed 20 sets of four words, one for each of the following categories: insects, weather, clothing, tools, relatives, colors, animals, parts of a house, sports, money, furniture, vehicles, birds, footwear, vegetables, dwellings, kitchen utensils, parts of the body, flowers, and fruits. For each child, the categorized list consisted of all four words from each of four categories, ordered randomly subject to the constraint that members of the same category not appear in succession; the uncategorized list consisted of one word selected randomly from each of the remaining 16 categories. Presentation of individual words in categorized and uncategorized lists was counterbalanced across children.

Results

The mean number of words recalled on each trial is shown in Figure 1, separately for language-impaired and age-control children. A 2 (Group) × 2 (Categorized versus Uncategorized list) × 3 (Trials) ANOVA yielded significant main effects for Group, Categorization, and Trials, $Fs \geqslant 9.72$, $p < .01$: Recall was greater by age-control children, was greater on categorized than on uncategorized lists, and declined over trials. There was also a marginally significant interaction between Group and Categorization, $F(1, 52) = 3.11$, $p < .10$, and a significant interaction between Group and Trials, $F(2, 104) = 5.04$, $p < .01$. As can be seen in Figure 1, the former interaction reflects a difference between the groups of approximately 1.6 words on uncategorized lists and 2.9 words on categorized lists. The latter interaction is due to the fact that language-impaired children's recall declined more rapidly over trials than did that of age-control children.

These findings suggest that language-impaired children are less likely than age-control children to store words, especially on categorized lists, and that language-impaired children are less likely than age controls to retrieve successfully words that are stored. Evidence that converges on these conclusions comes from analyses of the response "histories" of individual words. A word could be either recalled or forgotten on each of three trials, resulting in eight possible recall patterns. As shown in Table 1, in both groups, most words were consistently recalled (i.e., on each attempt) or consistently forgotten. Some words, however, were recalled on some attempts but not others. To account for these various recall patterns, Wilkinson et al. (1983) proposed a strengthen and discard model of repeated free recall that involves three processes. *Naming-storage* refers to the processes whereby a presented word is identified and tagged in memory as a member of the list to be recalled. *Retrieval* of a word on one trial strengthens the association between that word and the list, thereby increasing the likelihood of recalling the word on a subsequent trial. In complementary fashion, *forgetting* of a word on one trial decreases the strength of the association between the word and list, thereby decreasing the probability of its recall subsequently.

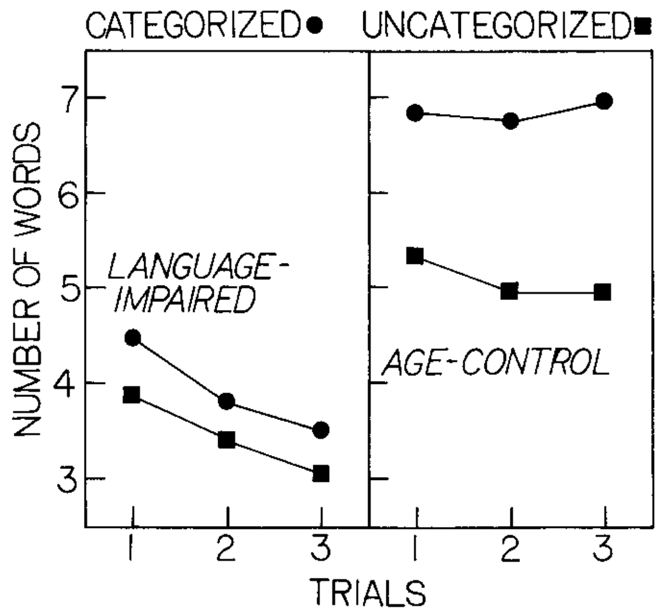

FIGURE 1. Number of words recalled as a function of recall trials, shown separately for categorized and uncategorized lists, and for language-impaired and age-control children.

TABLE 1. Frequency of different patterns of repeated free recall.

	Language-impaired		Age controls	
Pattern	*Categorized*	*Uncategorized*	*Categorized*	*Uncategorized*
RRR	79	79	163	119
RRF	14	10	8	7
RFR	7	1	8	4
RFF	20	14	6	14
FRR	6	4	11	8
FRF	2	1	1	0
FFR	3	0	6	3
FFF	301	323	229	277

Note. R and F indicate recall or forgetting, respectively, of a word during repeated free recall.

According to this model, presentation of a word will result in successful naming-storage with probability s. The probability of successful retrieval on the first attempt is r_0 (the subscript indicates the number of previous retrievals). Such an item will be recalled on the first attempt with probability sr_0. We define r_1 and r_2 as the probabilities of successful retrieval on the second and third attempts, respectively, given successful retrieval on the first and second attempts, respectively. Hence, the likelihood that a word will be recalled on all three attempts is $sr_0r_1r_2$.

Probabilities for the remaining seven recall patterns are depicted in Table 2. For example, there are two ways in which a word would never be recalled (i.e., pattern FFF). First, the word may not be stored successfully, with probability 1 - s. Alternatively, the word may be stored, but the first attempt at retrieval is unsuccessful (1 - r_0). Because the word was forgotten on the first attempt, the associative link is weakened, increasing the likelihood that the word will be forgotten on later attempts. Specifically, f_1 denotes the probability of forgetting given that a word was not retrieved on the immediately preceding trial; f_2 denotes the probability of forgetting given nonretrieval on two immediately preceding trials.

TABLE 2. Probabilities of recall patterns for the strengthen and discard model.

Pattern	*Probability*
RRR	$s\, r_0\, r_1\, r_2$
RRF	$s\, r_0\, r_1\, (1 - r_2)$
RFR	$s\, r_0\, (1 - r_1)\, (1 - f_1)$
RFF	$s\, r_0\, (1 - r_1)\, f_1$
FRR	$s\, (1 - r_0)\, (1 - f_1)\, r_1$
FRF	$s\, (1 - r_0)\, (1 - f_1)\, (1 - r_1)$
FFR	$s\, (1 - r_0)\, f_1\, (1 - f_2)$
FFF	$s\, (1 - r_0)\, f_1\, f_2 + (1 - s)$

Note. R and F indicate recall or forgetting, respectively, of a word during repeated free recall. Parameters are defined in the text.

Thus, the strengthen and discard model includes six parameters—s, r_0, r_1, r_2, f_1, f_2—to account for the patterns generated in three recall attempts. In fitting the model to the present data, we began with a version of the model in which we assumed that values for all six parameters were different for both groups and differed for categorized and uncategorized lists. This version of the model was fit to the data with STEPIT (Chandler, 1969), a subroutine that uses a variation of direct search to yield parameter values that minimize the likelihood ratio, $2\ \Sigma\ O\ ln(O/E)$, which approximates the X^2 distribution with large N. (O denotes the observed frequency of a recall pattern; E, the frequency expected by the model.) This model was consistent with the data, $X^2(4) = 2.48$, $p > .5$. (Throughout df reflects the number of parameters to be estimated—here, 24—subtracted from the df in the data, which are 28 with four sets of response patterns that each have df = 8-1.)

The drawback to this model is that it includes 24 free parameters and hence is hardly a parsimonious description of data that contain 28 degrees of freedom. To generate a more parsimonious account of the repeated free recall data, we created versions of the strengthen and discard model in which some parameters were assumed to be the same for the two groups but other parameters differed. For example, in one version the storage and forgetting parameters (s and f_j) were free to vary across groups and lists, but the retrieval parameters (i.e., r_j) were not. This model was not consistent with the data $X^2(22) = 93.0$, $p <$ .01.

Systematic exploration of possible models indicated that the most parsimonious model consistent with the data, $X^2(11) = 14.8$, $p > .10$, was one with 11 free parameters (see Table 3). In this model, all parameters differed for language-impaired and age-control children. For the age-control children, the storage parameter was larger on categorized lists than on uncategorized lists, but the retrieval parameter did not differ for the two lists. In other words, age-control children were more likely to store a word from a categorized list than one from an uncategorized list, but once stored, retrieval of words was equally likely from either list. The forgetting parameter was larger on uncategorized lists than on categorized lists: Once a word from an uncategorized list was not recalled, it was rarely recalled again; unrecalled words from categorized lists were more likely to be recalled on subsequent trials.

TABLE 3. Estimated values of parameters for strengthen and discard model.

	Language-impaired		*Age controls*	
Parameter	*Categorized*	*Uncategorized*	*Categorized*	*Uncategorized*
s	.33[a]	.33[a]	.48	.41
r_0	.78[b]	.78[b]	.86[c]	.86[c]
r_1	.81[d]	.81[d]	.91[e]	.91[e]
r_2	.87[f]	.87[f]	.95[g]	.95[g]
f_1	.74	.92	.43	.78
f_2	.86	.99	.35	.89

Note. Parameters are defined in the text. Those parameters with a common superscript have been constrained to be equal.

The parameters for language-impaired children differed from those for the age-control children in the expected directions, namely, smaller values for the storage and retrieval parameters and larger values for the forgetting parameters. The *profile* of parameter values was much the same for language-impaired children. For both groups, retrieval was equally likely from categorized and uncategorized lists, but forgetting was more likely with uncategorized lists. One important exception to this pattern of similarity concerned the storage parameter: For language-impaired children, storage was equally likely for words from categorized and uncategorized lists.

Discussion

Of the three parameters in the Wilkinson et al. (1983) model, two yielded results that were consistent with our characterization of differences between language-impaired and age-control children. Specifically, age-control children were more likely to store a word from a categorized list than one from an uncategorized list; language-impaired children were equally likely to store words from the two types of lists.

Values for the forgetting parameters, although not discussed at the outset, were also consistent with our expectations in that the impact of categorization was much larger for age-control children than for language-impaired children. If language-impaired children forgot a word, it was usually forgotten on subsequent trials, regardless of list type. For age-control children, additional forgetting was the prognosis for unrecalled words from uncategorized lists, but unrecalled words from categorized lists were likely to be recalled subsequently.

These differences can be explained with only a slight elaboration of the spreading activation framework described earlier. In a categorized list, activation spreading from words as they were recalled would spread to category members that were (for whatever reason) not recalled, thereby maintaining these words in an active state and making them potentially recallable on the next trial. Unrecalled words in an uncategorized list do not benefit from this spreading activation and consequently are likely to have become inactive by the next trial. However, only for age-control children is spreading activation sufficient to obtain this difference in the forgetting parameter.

One problem with this account of the findings for the forgetting parameter is that much the same logic led us to predict differences for the retrieval parameters, which we did not obtain. That is, we expected that age-control children would show greater retrieval from categorized lists than from uncategorized lists and that language-impaired children would show equal retrieval. In fact, both groups retrieved words from the two lists equally well. Our interpretation of this outcome is that the increase in activation attributable to spreading activation during recall is trivial in comparison to the increase due to the act of recall per se. Consistent with this view, values for the retrieval parameter were consistently large, even for uncategorized lists.

EXPERIMENT 2: MEMORY-SCANNING

Experiment 2 concerned retrieval from memory, but the focus was on the speed rather than the accuracy of retrieval. We used the well-known paradigm devised by Sternberg (1966) in which subjects are asked to remember subspan lists of digits. Immediately thereafter, a probe stimulus is presented, and subjects judge, as rapidly as possible, if the probe was a member of the memory set. The typical result (e.g., Sternberg, 1975) is that response time increases linearly as a function of the number of digits in the memory set. This linearity suggests that the probe stimulus is compared in sequence to each of the digits in the memory set, at which point the individual responds. The slope of this function provides an estimate of the time needed to retrieve each member of the memory set and compare it to the probe.[2] One aim of Experiment 2 was to compare the slopes of these response-time functions—and, thereby, presumably, the speed of retrieval—for language-impaired and control children.

A second aim stemmed from the fact that if the stimuli in the memory set are drawn from two different categories (with $n/2$ items per category), retrieval can be more efficient. Specifically, subjects can determine the category of the probe stimulus, then compare the probe against list items from only that category. The result is that response time increases less rapidly as a function of set size on two-category lists than on one-category lists (e.g., Homa, 1973; Naus, Glucksberg, & Ornstein, 1972). In individuals with normally developing language skills, adults and older children use this strategy but younger children apparently do not (Naus & Ornstein, 1977).

The delayed language skills of language-impaired children led us to predict that language-impaired children would be unlikely to use categorically guided retrieval in the Sternberg (1975) scanning task. To test this prediction, children were tested with memory sets consisting of 2, 4, or 6 pictures in which all items were from a single category (for half the sets) and in which equal numbers of pictures were drawn from two categories (the remaining sets). If children use categories in the second type of memory set to aid retrieval, then response times on these memory sets should increase less rapidly as a function of set size than the times on uncategorized memory sets. Furthermore, if language-impaired children are less likely than normal children to use such categorical retrieval, then response time functions for language-impaired children should not differ for categorized and uncategorized memory sets.

Method

Subjects. Children in Samples 2 and 3 participated. Data were lost from 6 children in Sample 2, resulting in a total of 36 matched trios of children.

Procedure. We used Sternberg's (1975) fixed-set procedure, in which a memory set consisted of 2, 4, or 6 pictures mounted on a 3 × 5 card. Subjects were allowed to study the card for approximately 5 s. Then 12 test trials followed in which individual pictures were presented, and subjects judged whether each picture was a member of the immediately preceding memory set. Of the 12 test trials, 6 were of pictures from the memory set, and 6 were of pictures not included in the memory set.

A Kodak Carousel projector was used to project slides of the pictures onto a small screen placed approximately .5 m in front of the child. The projected image was approximately 10 cm × 20 cm. Presentation of slides and timing of children's responses were controlled by a Cromemco Z-2D computer. Presentation of a slide initiated a software

[2]There are parallel models of this search process (i.e., those in which the probe is compared simultaneously with each member of the study set) that lead to identical predictions (Sternberg, 1975).

timing loop, which was halted when the child pressed one of two identical buttons marked "same" or "different."

Each child was tested on 12 different memory sets. For approximately half of the children, the first 6 memory sets consisted of two categories of items; the next 6 sets consisted of unrelated items. For the remaining subjects, the order was reversed. The 6 sets of each type consisted of one memory set from each of three sizes (2, 4, or 6 pictures) presented in a random order, followed by presentation of each set size a second time, again in random order. Thus, each child received 144 test trials, representing an orthogonal combination of 2 (Categorized Memory Set vs. Uncategorized Memory Set) × 3 (Set Sizes) × 2 (Presentations of a Given Set Size) × 2 (Responses: "yes, a member of the memory set" vs. "no, not a member of the memory set").

During test trials, each picture was presented twice, once as a member of either a categorized or uncategorized memory set and once as a negative probe (i.e., a test picture that was not a member of the memory set) for the other type of memory set. Categorized pictures were taken from norms prepared by Posnansky (1978).

Results

Response times can be interpreted readily only if subjects generally answer accurately. In fact, this was the case, as the average level of accuracy exceeded 90% for all three groups. Analyses of accuracy data are presented in Appendix B. Each child received 6 experimental trials for every combination of Set Size, Categorization, Replication, and Response. A mean response time was computed for each cell for every child, based only on correct responses. These means were then analyzed with a 3 (Group) × 2 (Categorization) × 2 (Replication) × 3 (Set Size) × 2 (Response) ANOVA. There were significant main effects for Replication, $F(1, 105) = 15.35$, and Set Size, $F(2, 210) = 16.69$, plus a significant interaction between these variables, $F(2, 210) = 7.97$, $ps < .05$. Response times increased as a function of set size in both replications, but less systematically in the first (1213, 1195, and 1277 ms) than in the second (1074, 1192, and 1232 ms). Set size also interacted significantly with Response, $F(2, 210) = 17.0$, $p < .01$. This interaction stems from the fact that response time increased more systematically as a function of set size of "no" responses (1104, 1214, and 1270 ms) than "yes" responses (1183, 1172, and 1237 ms).

The main effect of Categorization was significant, $F(1, 105) = 6.1$, $p < .05$, reflecting the fact that responses were 62 ms faster following categorized sets than following uncategorized sets. Categorization also interacted significantly with Replication and Response, $F(1, 105) = 5.58$, $p < .05$. Responses were faster on categorized sets than on uncategorized sets for "yes" and "no" responses in the first replication (advantages of 95 and 69 ms, respectively); on the second replication, responses for categorized sets were faster on "no" responses (67 ms) but not on "yes" responses (19 ms). Finally, the interaction of Categorization and Set Size was significant, $F(2, 210) = 3.47$, $p < .05$. The impact of set size was larger on uncategorized sets (1148, 1236, and 1302 ms, respectively) than on categorized sets (1149, 1172, and 1237 ms).

Of particular import was the fact that although the main effect for Group was significant, $F(2, 105) = 12.79$, $p < .01$, all interactions involving both Groups and Categorization were nonsignificant, $Fs \leq 1.42$. As shown in Figure 2, responses on categorized sets were faster than those on uncategorized sets for all groups. The language-impaired and language-control children showed the expected pattern, in which the effect of categorization increases as a function of set size. Surprisingly, the age-control children were consistently faster on categorized sets, a finding that is paradoxical because categorization is a pseudovariable for a set size of 2 (i.e., the two pictures came from different categories in both categorized and uncategorized sets). It is also noteworthy that the interaction between Group and Set Size was nonsignificant, $F < 1$, for this indicates that language-impaired children searched memory at the same rate as the age- and language-control children.

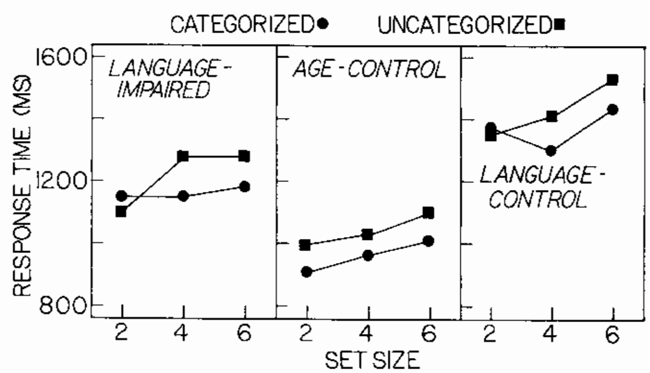

FIGURE 2. Response time as a function of set size, shown separately for categorized and uncategorized study sets, and for language-impaired, age-control, and language-control children.

Finally, there was a significant four-way interaction between Group, Replication, Set Size, and Response, $F(4, 210) = 2.58$, $p < .05$. This interaction was due to responses of the language-control children. On the first replication, their response times increased as a function of set size on "no" responses but not on "yes" responses, where the mean response time for a set size of 2 was actually greater than the means for set sizes 4 and 6. In the second replication, their response times increased linearly as a function of set size on both "yes" and "no" responses.

Discussion

Several outcomes of Experiment 2 are noteworthy, most involving the absence of differences between language-impaired and age-control children. First, the fact that the interaction of Group and Set Size was not significant implies that both groups scanned memory at approximately the same rate, even though the language-impaired children's response times were slower overall. A second important outcome was the nonsignificant interaction among Group, Set Size, and Categorization in conjunction with the significant interaction between the last two variables. Both language-impaired and age-control children searched memory faster when the sets were categorized than when they were uncategorized.

In one respect the data for the age-control children are anomalous. On sets of two pictures, these children responded faster on categorized sets than on uncategorized sets, even though these sets were in fact identical, each consisting of a single picture for each of two categories. There is no obvious explanation for this result. Hence, until the present findings are replicated, our conclusions about similarity of retrieval in language-impaired and age-control children must be accepted with some caution.

One difference between Experiments 1 and 2 concerns the impact of categorization. In Experiment 1, age-control children were more likely to store words from categorized lists than from uncategorized lists; language-impaired children were equally likely to store words from both lists. In Experiment 2, both groups of children were more likely to store categorized lists than uncategorized lists (based on the accuracy data described in Appendix B), and their response times showed comparable benefits from categorized lists. A number of differences in the lists used in the two experiments might be responsible for the diverging outcomes: (a) four separate categories were used in Experiment 1 compared to two categories in Experiment 2; (b) items in Experiment 1 were presented successively, those in Experiment 2 simultaneously; and (c) category items never appeared in succession in Experiment 1 but did appear adjacent to each other on the cards used in Experiment 2. All of these differences would make the categorical structure of lists more apparent in Experiment 2, which may explain why language-impaired children profited from categorization in that experiment but not in Experiment 1.

One other finding bears comment. Recall that in our previous study (Leonard et al., 1983), we found that language-impaired children named pictures less rapidly than their age mates did. We interpreted that finding as related to lexical limitations of the impaired children. Another interpretation of the differences between the language-impaired children and the age controls was that the two groups differed on those aspects of naming time that are unrelated to word retrieval and production, such as the time to detect the presence of a picture on the screen. That is, perceptual-motor components rather than lexical components may have been responsible for the observed differences in naming time between the language-impaired children and their age controls. In the present experiment we again found overall differences in response time between language-impaired and age-control children that could be attributed to the perceptual-motor components of the task. One aim of the next experiment was to verify the presence of these perceptual-motor deficits in task performance.

EXPERIMENT 3: NAME RETRIEVAL

Language-impaired children routinely name pictures less rapidly than age-control children do. Given the clear superiority in language ability shown by the age controls, it is tempting to conclude that lexical factors are implicated in the time differences. Nevertheless, in most of the existing studies—including our own (Leonard et al., 1983, Experiment 2 above)—it is possible that perceptual-motor factors are responsible. To isolate these components of performance, children in Experiment 3 were tested on a task introduced by Posner and Mitchell (1967). Pairs of stimuli are presented. Some consist of stimuli that are identical physically and in name (PSNS), such as AA; others are physically dissimilar but have the same name (PDNS), such as Aa; still others differ physically and in name (PDND), such as AB. Posner and Mitchell (1967) found that adults judged that PSNS pairs were the same approximately 75 ms more rapidly than they judged PDNS pairs to be the same. This difference was interpreted as representing the additional amount of time needed to retrieve letter names from memory (beyond that time required to judge perceptual similarity).

The perceptual-motor components of the task are essentially the same for PSNS pairs as well as PDNS pairs. That is, both pairs involve detection of the onset of the stimulus and the execution of a motor response. Hence, if the findings of the Leonard et al. (1983) study are due solely to perceptual-motor deficits in language-impaired children, then the prediction is that language-impaired children's judgments on the Posner-Mitchell task should be slower than those of their age mates by the same amount on PSNS pairs and PDNS pairs. If our previous findings represent lexical deficits, then language-impaired children should judge PDNS pairs less rapidly than their age mates but should judge PSNS pairs at the same rate. Finally, if both lexical and perceptual-motor factors were implicated in our earlier work, impaired and normal children should differ on both PDNS and PSNS pairs, but to a greater degree on PDNS pairs.

In fact, testing these predictions is somewhat more complicated than we have suggested thus far, because retrieval time for names has been estimated in three different ways on this task (see Table 4). The most common procedure is

TABLE 4. Estimate of name retrieval time.

Procedure	*Language-impaired*	*Age controls*	*t*
(NM:PDNS) − (NM:PSNS)	361	274	1.22
(NM:PDNS) − (PM:PDNS)	231	21	2.39*
(NM:PDND) − (PM:PDNS)	108	42	1.12

Note. NM refers to instructions to match stimuli in name; PM, to match according to physical identity. PDNS denotes pairs of stimuli that differ physically but are alike in name; PSNS denotes stimuli that are identical physically and in name; PDND denotes stimuli that differ physically and in name. Times are in milliseconds.

$^{*}p < .05$.

to ask subjects to determine if letters have the same name; response times on PSNS pairs are subtracted from times on PDNS pairs to determine letter retrieval time. With this procedure, it is assumed that on PSNS pairs subjects make their judgments exclusively on the physical similarity of the items and do not use name information. Another approach is to instruct subjects to use *only* physical identity or name identity as the basis of their responses. When this is done, response times on PDNS pairs under physically identical instructions are subtracted from times on PDNS pairs when the instructions are to judge pairs in terms of identical names. In this method, the former time is based on a "different" response, and the latter is based on a "same" response. Consequently, differences in the speed of these responses would lead to biases in estimates of name retrieval time. Finally, using PDND pairs, one can subtract response times for physical-match instructions from response times obtained under name-match instructions. The drawback to this method is that it must be assumed that subjects use only the instructed criterion as the basis for their judgments. That is, spuriously fast response times on PDND pairs under name-match instructions might reflect judgments based on physical dissimilarity; spuriously slow times under physical-match instructions might reflect judgments based on dissimilar names.

The resolution to this problem is to test subjects on the three types of pairs, once with physical-match instructions and one with name-match instructions. With these procedures, name retrieval time can be estimated in each of the aforementioned ways. The predictions concerning language-impaired children remain unchanged. According to the perceptual-motor explanation, language-impaired children should have greater times (i.e., be slower) than their age mates in both of the response times used to estimate name retrieval time. According to the lexical explanation, language-impaired children should have a greater *difference* between the two response times than should age-control children.

Method

Subjects. We tested 26 language-impaired children and 26 age-control children from Sample 4.

Materials. We used a variation of the Posner-Mitchell task devised by Bisanz, Danner, and Resnick (1979). Children were shown pairs of common objects. Each of four objects (umbrella, banana, jack-in-the-box, book) was shown in two formats (e.g., peeled and unpeeled bananas, open and closed umbrellas). Combining these 8 objects yield 64 possible pairs. Of these, all 8 PSNS pairs (e.g., identical open umbrellas) were used, as were all 8 PDNS pairs (e.g., an open umbrella paired with a closed umbrella). Of the remaining 48 PDND pairs (e.g., an open umbrella paired with a banana), 8 were chosen arbitrarily with the constraint that each object appeared approximately equally often.

Slides were prepared for the 24 pairs and arranged in two sets of 32 slides. One set of slides, used when children judged if pairs were physically identical, consisted of 16 PSNS slides, 8 PDNS slides, and 8 PDND slides. Thus, the correct response was "same" for the 16 PSNS slides and "different" for the remaining 16 slides. The second set of slides, used when children judged if objects were the same in name (regardless of physical similarity), consisted of 8 PSNS, 8 PDNS, and 16 PDND slides. Here the correct response was "different" for the 16 PDND slides and "same" for the remaining 16 slides. In each set of 32 slides, the slides were ordered randomly with the constraint that the three types of pairs were equally represented in the first and second halves of the set.

Procedure. Each child viewed each set of 32 slides twice, using the apparatus described in Experiment 2. Approximately half of the children were tested on 64 name-match trials, followed by the 64 physical-match trials. The order was reversed for the remaining children. Children were told that they would see pairs of pictures, which they were to judge as "same" or "different." Picture pairs mounted on 3 × 5 cards were used to illustrate the appropriate criterion to be used in matching (i.e., identical in name or physically). Test trials followed, with the first 16 in each set considered practice.

Results

The mean percentage of correct responses and the mean response time (for correct responses only) are shown in Table 5, for the six combinations of stimuli and matching criteria. Our initial analyses consisted of a 2 (Group) × 2 (Matching Criteria) × 3 (Stimulus: PSNS, PDNS, PDND) omnibus ANOVA on each dependent variable. Overall, age-control children responded more accurately, $F(1, 50) = 5.17$, $p < .05$, and more rapidly, $F(1, 50) = 21.49$, $p < .01$, than language-impaired children. Physical matches were more accurate, $F(1, 59) = 4.53$, $p < .05$, and marginally more rapid, $F(1, 50) = 3.54$, $p < .10$, than name matches. Finally, children were most accurate, $F(2, 100) = 8.17$, $p < .01$, and most rapid, $F(2, 100) = 57.86$, $p < .01$, on PSNS pairs, followed by PDND and PDNS pairs.

There were no significant interactions in the analysis of the accuracy data, but there were two in the analysis of response times. The Matching × Stimulus interaction, $F(2, 100) = 10.77$, $p < .01$, stemmed from the fact that PSNS

TABLE 5. Mean response times (and percentage correct) for different conditions and groups of children.

Group	*Type of stimuli* PSNS	PDNS	PDND
Language-impaired			
Physical match	1229 (96.5%)	1354 (94.7%)	1402 (95.3%)
Name match	1223 (97.0%)	1584 (90.0%)	1511 (94.3%)
Age controls			
Physical match	971 (98.8%)	1123 (97.7%)	1053 (96.9%)
Name match	871 (98.0%)	1144 (95.6%)	1095 (95.4%)

Note. Response times are in milliseconds.

pairs were judged with equal speed under physical- and name-match instructions, but PDNS and PDND pairs were judged more rapidly under physical match instructions. Notably, the other significant interaction was between group and matching instructions, $F(1, 50) = 5.5$, $p < .01$. Age-control children responded 279 ms more rapidly than language-impaired children under physical-match instructions but 403 ms more rapidly under name-match instructions.

Given the hypothesized difference between language-impaired and age-control children, several specific comparisons are noteworthy. If our previous finding of group differences in naming time (Leonard et al., 1983) included a perceptual-motor component, then the language-impaired children should have responded significantly more slowly on PSNS pairs (where name retrieval is unnecessary), and they did, $t(50) = 21.69$, $p < .01$. Interpreting our previous finding in terms of lexical factors leads to the prediction that name retrieval time should be longer in language-impaired children. As described previously, name retrieval can be estimated in three ways. In each procedure (see Table 4), language-impaired children had longer retrieval times, but the difference was significant only when physical match times on PDNS pairs were subtracted from name match times on PDNS pairs.

Another comparison relevant to the role of lexical deficits in language-impaired children's picture-naming involves PDND and PDNS pairs under physical-match instructions. Both types of pairs differ according to this matching criterion. Nevertheless, older children often respond more slowly on PDNS pairs than on PDND pairs (e.g., Bisanz et al., 1979). The common name in PDNS pairs, though irrelevant to the matching criterion, slows the judgment that the stimuli in a pair differ physically. This difference (PDNS minus PDND under physical matching) was −40 ms for language-impaired children and 70 ms for age-control children. These values differed significantly, $t(50) = 2.26$, $p < .05$, and only the value for age-control children differed significantly from 0, $t(25) = 2.45$, $p < .05$. That is, irrelevant name information interfered with age-control children's judgments of physical similarity but not with language-impaired children's judgments.

Discussion

The results of Experiment 3 indicate that slower picture naming by language-impaired children is due to both perceptual-motor deficits *and* lexical deficits. Concerning the former, identification of a perceptual-motor component in the language-impaired children's performance is not without precedent. In previous studies, language-impaired children have responded more slowly than age controls on such tasks as drawing marks on solid shapes appearing on a page (Stark & Tallal, 1981a), and simple bar-tapping (Hughes & Sussman, 1983). As our main purpose was to examine storage and retrieval aspects of language-impaired children's word-finding problems, we did not attempt to specify further the relative contribution of perceptual versus motor factors to children's performance. Concerning the lexical deficit, we reiterate that the present findings are equivocal concerning the basis of such deficits. Slower naming time could reflect unelaborated lexical representations or could reflect inefficient retrieval algorithms.

EXPERIMENT 4: UNCONSTRAINED FREE RECALL

In Experiments 1-3, we focused on children's retrieval of specific items from memory. That is, the target of retrieval was an explicit lexical item or a small set of lexical items. Such constraints probably characterize much extralaboratory retrieval from memory. Reading comprehension, for example, may depend, in part, on retrieval of specific lexical items. Similarly, the target of retrieval is also explicit when a child sees a friend and retrieves that person's name.

At the same time, there are a number of extralaboratory experiences in which the target of children's recall is specified much less precisely. Consider, for example, the cases of deciding (a) who to invite to a birthday party, (b) what to eat for breakfast, and (c) what to do after school. In each of these cases, the retrieval target refers to a general class of items rather than specifically designated exemplars. Furthermore, the number of potentially appropriate exemplars may be quite large.

To study retrieval of such ill-defined targets, we used the unconstrained free recall paradigm (Bousfield & Sedgewick, 1944) in which an individual simply names, over several minutes, as many members of a large category (e.g., animals) as he or she can. Typically, individuals retrieve several items, pause, then retrieve several more items. The general interpretation of this phenomenon (e.g., Graesser & Mandler, 1978; Gruenewald & Lockhead, 1980) is that information in permanent memory is organized as clusters of related items. Pauses in the retrieval protocol reflect search for such clusters; when a cluster is retrieved, the items are emitted in close succession. The aim of Experiment 4 was to determine if language-impaired and age-control children's retrieval was qualitatively and quantitatively similar in the unconstrained free recall paradigm.

Method

Children from Samples 1 and 3 were tested. Children were informed that they would be told the name of a category and that they should "tell all of the things in that category that you can think of." The category of colors was then presented, and the child was asked to generate color names until the experimenter was sure that the child understood the task. The experimenter then explained that the child would have a long time to think of words and that he or she should continue until told to stop.

For children in Sample 1, the category names were furniture and animals. Order of presentation was counterbalanced so that approximately half of the children retrieved animals first, and the other half first retrieved furniture. Each child was allowed exactly 5 min to respond to each category. For children in Sample 3, the categories were animals and occupations. Each child's retrieval protocols were tape recorded, and a precise time of retrieval for each word was established subsequently from the audiotapes. [Kail and Nippold (1984) provide evidence for the reliability of these procedures for determining retrieval times.]

Results

We analyzed all words that children retrieved, including words recalled twice by the same child. Such repetitions occurred infrequently, and excluding them from the analyses would not modify the findings described here. Some words that were not obvious category members were included, and this characteristic of retrieval was analyzed separately.

Temporal properties of retrieval. The typical pattern of retrieval at all ages was for a few words to be retrieved rapidly, followed by a pause of several seconds, followed by rapid retrieval of several more words. We used the following procedures (adapted by Kail & Nippold, 1984, with minor changes from Graesser & Mandler, 1978) to identify pauses associated with retrieval of new clusters of items. The procedures are based on two assumptions: (1) the distribution of pause times includes pauses associated with retrieval of new clusters and pauses associated with the rapid emission of words, and (2) the mean pause time for retrieval of a new cluster is greater than the mean time associated with emission of successive items from the same cluster. For illustrative purposes, assume the two distributions do not overlap. A cumulative frequency distribution of times derived from the two pause time distributions would have a plateau corresponding to the times between the two distributions that have a frequency of 0. In fact, such a plateau will occur, in some form, whenever two frequency distributions are combined. An example of such a cumulative frequency distribution, derived from one 8-year-old's retrieval of animals, is shown in the left panel of Figure 3. The curve is negatively accelerated between 2 and 5 s and positively accelerated thereafter. The change in the acceleration of the curve corresponds to the transition between the two frequency distributions.

Cumulative frequency of pause times varies considerably across individuals because it equals the total number of words retrieved minus 1. Therefore, we transformed scores in the following way. Let N equal the total number of words retrieved and $cf(t)$ denote the cumulative frequency of pause times to t seconds. If a pause time of t seconds or less is taken to reflect retrieval of items from the same cluster, then there are $N - cf(t)$ clusters in the retrieval protocol. Dividing N by $N - cf(t)$ provides the average size of a cluster in the protocol, assuming that items separated by t or fewer seconds are from the same cluster.

To illustrate this analysis, consider the following hypothetical protocol: *dog* . . . (1 s) . . . *cat* . . . (3 s) . . . *bird*

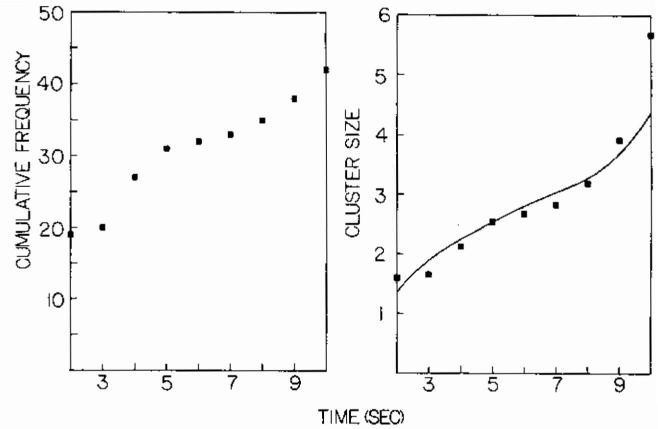

FIGURE 3. Cumulative frequency of pause times (left panel) and cluster size (right panel) as a function of time for an 8-year-old with normally developing language. The function in the right panel is derived from the estimated values of a and b from equation 1. From "Unconstrained Retrieval from Semantic Memory," by R. Kail and M. Nippold, 1984, *Child Development*, 55, pp. 944-951. Copyright 1984 by the Society for Research in Child Development. Reprinted by permission.

. . . (8 s) . . . *lion* . . . (2 s) . . . *tiger*. If a pause time of 1 s or less reflects items retrieved from the same cluster (i.e., $t \leq 1$), then *dog/cat* would be from the same cluster; the remaining words would represent different clusters. In this case, $cf(1) = 1$ and $N = 5$, so the mean cluster size is $5/(5 - 1)$ or 1.25, reflecting 3 one-word clusters and 1 two-word cluster. Continuing the analysis, $cf(2) = 2$, so the mean cluster size is $5/(5 - 2) = 1.67$. Verifying this result, with $t \leq 2$ s as a criterion, clusters consist of *dog/cat*, *bird*, and *lion/tiger*. For t = 3-7, $cf(3) = cf(4) = cf(5) = cf(6) = cf(7) = 3$, so the mean cluster size is $5/(5 - 3) = 2.5$. Finally, $cf(8) = 4$, so the mean cluster size is $5/(5 - 4) = 5$.

Cluster sizes computed in this manner are depicted in the right panel of Figure 3 as a function of t for the cumulative frequency data depicted in the left panel of that figure. The cluster size function, like the cumulative frequency distribution, has a plateau between 5 and 7 s. As before, this plateau corresponds to the break between the two distributions of pause times.

The final step is to identify the point at which the curve begins to accelerate, for this value differentiates the longer pause times associated with retrieval of clusters from the briefer pause times associated with rapid emission of items. Functions like the one depicted in Figure 3 are well described by a third-order polynomial of the type

$$cs(t) = at^3 + bt^2 + ct + d \quad (1)$$

where cs refers to cluster size, and t is time in seconds. Furthermore, the second derivative of this polynomial, $-b/3a$, corresponds to the inflection point at which the function accelerates. Given this inflection point, pauses in the retrieval protocol can be identified unambiguously as reflecting either search for additional clusters or emission of items from within a cluster. Then one can derive the number of clusters as well as the average size of clusters in the retrieval protocol.

Cluster sizes were calculated for each individual's retrieval protocol for t ranging from 2 to 10 s. These cluster values were then fit to Equation 1 with STEPIT (Chandler, 1969). We fitted the data from all children to Equation 1, separately for the two categories. Of the 222 analyses (111 Children × 2 Categories), 29 (13.1%) resulted in negative or extraordinarily large values for the second derivative. Typically, this occurred when children had recalled few words, which meant that there were too few pause times to determine the cumulative frequency distribution. Notably, this problem occurred at approximately the same rate for the three groups of children (language-impaired children—11%; age controls—16%; language controls—12%). The analyses that follow are based on cases for which we had complete data for all members of a matched trio of children. In Sample 1, there were 15 trios for retrieval of animals and 11 for retrieval of furniture. In Sample 3, there were 11 and 10 trios, respectively, for retrieval of animals and occupations.

The number of words recalled by these children during the 5 min of retrieval is shown in Table 6. Although in three of the four categories the age-control children retrieved between 5% and 10% more words than did the language-impaired children, one-way ANOVAs on these data failed to reveal significant differences among groups, $Fs \leq 2.44$.

As shown in Table 6, the fit of the pause-time data to Equation 1 was excellent and, notably, generally comparable for the three groups. One-way ANOVAs on the percentage of variance accounted for by Equation 1 indicated no significant differences in retrieval of furniture, $F(2, 30) = 1.65$, retrieval of occupations, $F(2, 27) < 1$, and retrieval of animals in Sample 1, $F(2, 42) < 1$. In retrieval of animals in Sample 3, there was a marginally significant difference among groups, $F(2, 30) = 2.55$, $p < .10$, reflecting the relatively poorer fit of Equation 1 to the data for children in the age-control group compared to the two other groups. The impact of this difference is negligible on the analyses that follow. The fit of Equation 1 to the data for the age-control children is good in absolute terms. Furthermore, the group difference is chiefly due to the relatively poor fit of Equation 1 to two children in the age-control group. The findings reported here also obtain when the analyses are repeated without the data for those two children. In sum, the absence of group differences in these analyses is noteworthy because it implies that the model of retrieval underlying the analyses holds equally well for all three groups of children.

TABLE 6. Characteristics of unconstrained free recall.

Group	*Number of words*	r^2	*Number of clusters*	*Cluster size*
Sample 1				
Animals				
LI	30.93	.9704	13.38	2.37
CA	32.73	.9700	13.62	2.65
LA	27.13	.9730	12.85	2.18
Furniture				
LI	20.09	.9376	13.74	1.67
CA	22.18	.9604	12.94	1.80
LA	26.64	.9652	13.74	1.80
Sample 3				
Animals				
LI	33.46	.9769	19.4	2.11
CA	31.91	.9220	17.4	2.04
LA	24.82	.9588	14.5	1.81
Occupations				
LI	23.80	.9537	17.6	1.58
CA	26.40	.9595	16.5	1.82
LA	19.80	.9461	17.4	1.19

Note. LI refers to language-impaired children; CA to children matched to the language-impaired children on the basis of chronological age; LA to children matched to the language-impaired children on the basis of language level.

The second derivative of Equation 1 was determined for each retrieval protocol using the values of a and b estimated from STEPIT. One-way ANOVAs on those values revealed no instances of group differences in the value of the second derivative, $Fs \leq 2.45$. Furthermore, the value of the second derivative was stable across categories, with values of 5.76 s and 5.25 s for retrieval of animals in Samples 1 and 3, respectively, 5.43 s for retrieval of furniture, and 5.72 s for retrieval of occupations.

The second derivative was then used to identify clusters in the individual retrieval protocols. As shown in Table 6, language-impaired children and their age mates retrieved comparable numbers of clusters for all categories. One-way ANOVAs revealed no group differences in number of clusters of occupations, furniture, and animals in Sample 1, $Fs < 1$. There was a marginally significant difference in number of clusters of animals retrieved in Sample 3, $F(2, 30) = 3.16$, $p < .10$, which reflected language-control children retrieving fewer clusters than did children in the other two groups.

Analyses of the number of words per cluster (i.e., cluster size) revealed no differences during retrieval of animals in either sample, $Fs \leq 1.28$, and no difference during retrieval of furniture, $F < 1$ (see Table 6). In retrieval of occupations, there was a significant effect for groups, $F(2, 27) = 3.80$, $p < .05$. Mean cluster size for age controls was significantly larger than that for the language controls ($p < .05$). The language-impaired children's clusters were intermediate in size and did not differ significantly from either control group.

Qualitative characteristics of items retrieved. Most children began retrieval with prototypic category members (e.g., *dog*, *cat*), then mentioned familiar but not prototypic instances (e.g., *sheep*, *rat*), and retrieved progressively less common members (e.g., *mongoose, chameleon*). This characteristic of retrieval was analyzed formally by preparing an alphabetized list of all words retrieved. Four judges rated each word on a four-point scale where 4 corresponded to a prototypic category member (i.e., "one of the first that a person would think of"), 3 was "clearly a category member but not a prototypic one," 2 was a "borderline member" (i.e., "perhaps like a category member but not in the strict or usual definition of the category"), and 1 was "not a member." Differences in ratings of more than one scale point were resolved in discussion. These ratings were then averaged to provide a typicality index ranging from 4 to 1. For each child, mean typicality was computed based on all words generated during each minute of retrieval. Means of these means are depicted in Table 7.

TABLE 7. Mean typicality scores for each minute of retrieval.

	Minute of retrieval				
Group	*1*	*2*	*3*	*4*	*5*
Sample 1					
Animals					
LI	3.46	3.24	3.23	3.27	3.27
CA	3.47	3.39	3.28	3.32	3.18
LA	3.39	3.29	3.20	3.18	3.28
Furniture					
LI	3.34	2.93	2.52	2.42	2.40
CA	3.33	2.53	2.51	2.47	2.22
LA	3.07	2.40	2.12	1.81	1.82
Sample 3					
Animals					
LI	3.50	3.31	3.26	3.15	3.18
CA	3.52	3.24	3.20	3.11	3.21
LA	3.48	3.28	3.31	3.13	3.21
Occupations					
LI	2.34	2.55	2.53	2.41	2.70
CA	3.26	3.11	2.75	2.96	3.03
LA	2.37	2.24	2.40	2.21	2.33

Note. LI refers to language-impaired children; CA to children matched to the language-impaired children on the basis of chronological age; LA to children matched to the language-impaired children on the basis of language level. A rating of 4.0 corresponds to a judgment of "prototypic category member," and a rating of 1.0 corresponds to a judgment of "not a category member."

Consider first the results for retrieval of animals. In both samples, the three groups of children performed virtually identically. During the first minute of retrieval, children retrieved approximately equal numbers of prototypic and nonprototypic clearcut category members (mean typicality averaged across groups and samples was 3.47). As retrieval progressed, prototypic category members were retrieved less frequently, but most words retrieved were category members (mean typicality for minutes 2–5, averaged across groups and samples, was 3.24). Much the same pattern was found in retrieval of furniture. Groups performed comparably, with typicality declining systematically over the 5-min interval. However, the results differed for retrieval of occupations. Here the age-control children retrieved more typical words than did the language-impaired or language-control children.

Not all children retrieved words in every minute of the retrieval interval, which meant that these data could not be analyzed with the customary Group × Minutes ANOVA. Instead, we computed a mean typicality score for each minute of retrieval, collapsed across the two samples and two categories. These five means for each group were the raw data for one-way ANOVA contrasting the typicality for the three groups. The analysis revealed significant differences between groups, $F(2, 12) = 32.87$, $p < .01$. Adults judged words retrieved by the age-control children to be more typical (mean across minutes, 3.02) than those of either the language-impaired children (mean, 2.51) or the language controls (mean, 2.31) $p < .01$ by Newman-Keuls, which did not differ from one another, $p > .05$.

Discussion

According to the general model of retrieval used here, the retrieval protocol should consist of long pauses reflecting search for new clusters of items as well as brief pauses between emission of items within a cluster. Three findings suggest that this account of retrieval applies equally well to all groups of children studied. First, the percentage of children whose pause-time data were consistent with the quantitative predictions of the model (i.e., whose data could be fit to Equation 1) was high in all groups (≥ 80%). Second, for children whose pause time data did adhere to the predictions of the model, the fit of the model (i.e., r^2) was excellent in an absolute sense and did not vary across groups. Third, the critical time differentiating search for new clusters from emission of items within a cluster was the same for the three groups. In sum, all groups of children seemed to retrieve lexical items in clusters, where items emitted within approximately 5–6 s of one another defined a cluster.

Not only were the three groups of children alike in the global characteristics of retrieval, but analysis of specific quantitative and qualitative features of retrieval also yielded similarity across groups. The sole exception was in the category of occupations. Language-impaired children retrieved occupations that were judged significantly less typical than those retrieved by age-control children. Even here, the difference between language-impaired and age-control children was only modest. Age-control children tended to retrieve nonprototypic category members; language-impaired children retrieved these members interspersed with equal numbers of words that were borderline category members. In sum, what is striking in Experiment 4 is the degree of similarity in the performances of language-impaired and control children.

EXPERIMENT 5: MULTIDIMENSIONAL SCALING OF CATEGORY MEMBERS

In Experiment 4, the language-control children performed at a level that was comparable to the performance of the age-control children. That is, the linguistic information assessed in that experiment had been adequately acquired and organized even by the youngest children in the study. Consequently, Experiment 4 may not have provided a suitably sensitive measure of potential deficits in the language-impaired children.

The aim of Experiment 5 was to determine if the three groups of children would perform similarly on another task involving unspeeded retrieval from memory. Accordingly, in Experiment 5 we asked children to judge the similarity of pairs of members from the same category. From these similarity judgments, a multidimensional space could be generated (via multidimensional scaling, e.g., Subkoviak, 1975) that expressed the similarity between those points spatially. Howard and Howard (1977), for example, presented all possible pairs of ten animal names to 6-, 8-, and 11-year-olds, who rated their similarity on a 5-point scale. The resulting 10×10 matrix of similarity judgments was then subjected to multidimensional scaling analyses. The outcome was that, at all ages, children's representations of animals' names were best described as a three-dimensional space, with dimensions of size, domesticity, and predativity. In like manner, the objective of Experiment 5 was to determine if the structure of two categories—animals and occupations—was the same for language-impaired children and their controls.

Method

All children in Sample 3 participated. Half of the children first judged the similarity of the following eight animals, selected from those used by Howard and Howard (1977): mouse, lion, bear, rabbit, dog, cow, horse, and deer. These children were shown two wooden blocks and four plastic bowls arranged in a row, and read the following:

> I want you to pretend that these bowls are different rooms in a hospital for animals. The person who runs the hospital wants to be sure that animals that are alike stay in rooms next to each other. Animals that are different should stay in rooms far apart. Now we're going to pretend that these two blocks are different animals. [One block is given to the child.] I will tell you what animal I have and put the animal in one of the rooms in the hospital. Then I will tell you the name of your animal, and you decide which room your animal should stay in. Remember, animals that are alike should stay in rooms close together. Animals that are very different should stay in rooms far apart. Animals that are a little bit alike and a bit different should not stay next to each other, but they don't have to be far apart. Do you understand? Do you have any questions?

These instructions were followed by 28 test trials representing all possible pairwise combinations of the eight animals. The experimenter always placed her wooden block in one of the two end bowls, alternating between these two bowls in a predetermined random order.

Following these trials, children were asked to imagine that the bowls were "different rooms in a hotel" and that the blocks were "people with different jobs." They were told, "The person who runs the hotel wants to be sure that people who have jobs that are alike stay in rooms next to each other." An additional 28 trials followed, representing all possible pairwise combinations of these eight occupations taken from Battig and Montague (1969): minister, pilot, baker, policeman, doctor, carpenter, farmer, and teacher.

The remaining children used the same procedures, but judged occupations first, followed by animals.

Results

Children's judgments were use to derive two 8×8 off-diagonal matrices of dissimilarity judgments, one for animals and one for occupations. Multidimensional scaling analyses of these data were accomplished with the Common Space Analysis (COSPA) procedure devised by Schonemann (e.g., Schonemann, James, & Carter, 1979). COSPA, like INDSCAL, ALSCAL, and other computer programs for multidimensional scaling, uses dissimilarity ratings to generate an N-dimensional space depicting relations between stimuli. Unlike some of the other programs, COSPA provides tests of the assumptions underlying the multidimensional scaling procedure. [For details on COSPA and its tests of these assumptions, see Schonemann et al. (1979). Also, Offenbach (1983) provides examples of the use of COSPA in developmental research.]

Preliminary analyses were conducted in which the number of dimensions was varied from one to three. The one- and two-dimensional solutions were interpretable but the three-dimensional solutions were not, so here we present the two-dimensional solutions. The language-control children used the rating procedure less successfully than did the other two groups, frequently judging all 28 pairs to differ maximally, despite repeated encouragement to use "all the rooms in the hospital/hotel." Consequently, the scaling solutions did not meet the constraints of the COSPA procedure. The analyses were then repeated without the data for the language-control children, and the solutions did satisfy the COSPA constraints. It is these analyses that are described here.

The outcome of the analysis of animal names is shown in Figure 4. The first dimension seems to be that of preda-

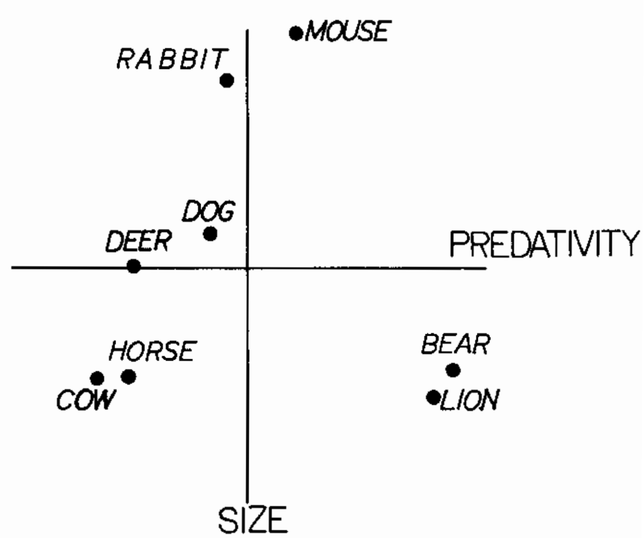

FIGURE 4. Two-dimensional space derived by COSPA from children's judgments of animal names.

tivity, defined by *bear* and *cow* at the two extremes. The second dimension is size and is anchored by *mouse* and *lion*. Analysis of occupations yielded the two-dimensional space depicted in Figure 5. Here the first dimension seems to correspond to a distinction between occupations associated with the production of goods (carpenter, baker, farmer) from those in which services are rendered (policeman, doctor, teacher, minister, pilot). The nature of the second dimension is less clear. Our interpretation is that it represents the excitement or interest that children associate with the occupation. Pilots and policemen are thought to be exciting, teachers and ministers are not.

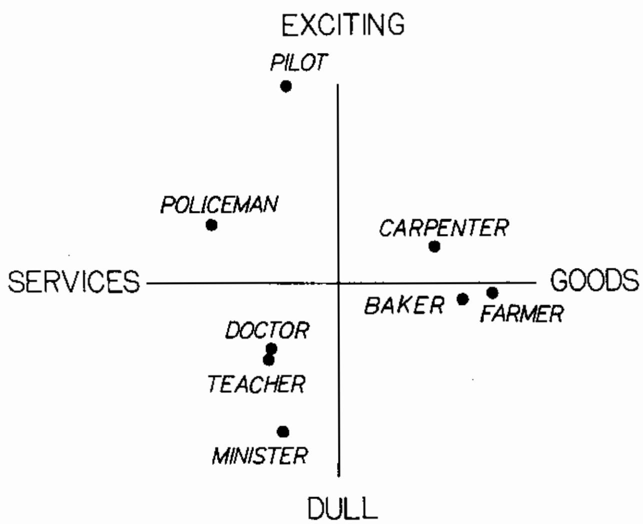

FIGURE 5. Two-dimensional space derived by COSPA from children's judgments of occupations.

Possible differences between the language-impaired and age-control children were explored in two ways. First, COSPA yields measures of the extent to which a child weighed each dimension in judging the similarity of two occupations or two animals (*subjective metrics*, to use Schonemann's term). We compared the mean weights for language-impaired and age-control children on each dimension for both animals and occupations. In none of the four cases did the groups differ, $ts < 1$. Second, the multidimensional scaling analyses were repeated, separately for the two groups. The two-dimensional solutions depicted in Figures 4 and 5 were recognizable in these analyses, though less clearly than in the analyses of combined data. Correlations were computed between the coordinates of the eight stimuli on a dimension for the language-impaired children and the coordinates on the same dimension for age-control children. For animals, correlations were, respectively, .36 and .54 for the predativity and size dimensions. For occupations, correlations were .68 and .52 for the goods-services and excitement dimensions. With $df = 6$, the critical value for $r = .622$, $p < .05$, one-tailed, so these correlations must be treated with caution. Nevertheless, given these four positive correlations and the complete absence of group differences in subjective metrics, it is safe to conclude that language-impaired and age-control children's representations of these eight animals and eight occupations are reasonably similar.

Discussion

Judgments of animals and occupations resulted in comparable multidimensional spaces for language-impaired and age-control children. One way to interpret this outcome is in terms of a model (derived from the work of Smith, Shoben, & Rips, 1974) of the processes underlying the rating process. We assume that when the experimenter presents two stimuli to be rated, the child retrieves from memory those items as well as the properties associated with each. The child then compares the two sets of properties and assigns a rating that represents the similarity of the properties.

With this model, overall similarity of the multidimensional spaces implies that language-impaired and age-control children do not differ concerning: (a) the salient properties associated with the 16 items rated in Experiment 5, (b) the likelihood of retrieving the items and their associated properties, and (c) the rule for assigning a rating based on similarity of properties. In sum, this finding points to much the same conclusion that we reached following Experiment 4: When retrieval requires neither speed nor the generation of particular items, language-impaired children do not differ from their age mates.

Chapter 4

Word-Finding in Linguistic Contexts

In the experiments described thus far, we have examined retrieval of words presented in isolation or in lists with other words or pictures. The purpose of Experiments 6 and 7 was to examine language-impaired children's picture naming and recall in larger linguistic contexts, such as sentences and stories. Such contexts facilitate the performance of normally developing children (e.g., Rudel, Denckla, Broman, & Hirsch, 1980), but this need not be the case for language-impaired children. It is commonplace that such children experience difficulties with sentential information. For example, relative to control children, language-impaired children's knowledge of the semantic arguments required by the presence of particular semantic-syntactic elements in a sentence seems quite limited (Johnston & Kamhi, 1984). Furthermore, processing of textual information is also troublesome for language-impaired children. For example, Graybeal (1981) found that language-impaired children recalled less information from spoken stories than did age controls. That difference persisted when comparisons were based on subgroups of normal and language-impaired children matched according to short-term memory abilities for sentences. Ellis-Weismer and Johnston (1982) reported poorer comprehension of stories by language-impaired than by age-matched children. Deficits were seen on items requiring knowledge of premise information as well as on those requiring an ability to draw inferences. Given such limitations, language-impaired children might have considerable problems using semantic-syntactic and textual cues to direct word retrieval. An additional reason to suspect problems with word retrieval in larger contexts is the symptomatology of word-finding problems reported in the literature, which includes marked hesitations, circumlocution, and overuse of indefinite terms in conversation (e.g., Schwartz & Solot, 1980; Wiig & Semel, 1976).

EXPERIMENT 6: PICTURE-NAMING IN CONTEXT

In one of our earlier studies (Leonard et al., 1983), we found that language-impaired children named pictures more slowly than age controls did but did not differ from age-control children in their use of frequency of occurrence information to guide retrieval. Nevertheless, language-impaired children's naming ability may be hampered when retrieval must be guided by linguistic factors other than word frequency.

The rationale for Experiment 6 was as follows. Normally developing children's generally fluent speech during conversation is probably aided by their ability to use semantic-syntactic and textual information to retrieve necessary words. In the case of the former, Rudel et al. (1980) found that such children showed shorter response latencies when the words to be retrieved completed single, unrelated sentences than when they served as names of pictures presented in isolation. Regarding the latter, Perfetti, Goldman, and Hogaboam (1979) found that children's response latencies were shorter when the stimulus words occurred in a story context than when they appeared in isolation or in a list of unrelated words. However, given the difficulties, noted above, that language-impaired children have in processing semantic-syntactic and textual information, it seemed that these children might show even greater deficiencies than normal peers when naming was required in larger linguistic contexts.

In Experiment 6, children's naming was observed under three conditions designed to reflect three degrees of linguistic redundancy: (a) when the picture to be named appeared at the end of a list of unrelated words, (b) when the picture was the referent for a word that would appropriately complete a presented sentence, (c) when the picture was the referent for a word that would appropriately complete a sentence appearing within a story context. In the list condition, children had no basis for expecting any particular picture. In the sentence condition, children could benefit from syntactic privileges of occurrence and clues from the semantic features of the major constituents of the sentence. The story condition provided the greatest degree of linguistic redundancy. Along with the syntactic and semantic clues provided in the sentence to be completed, additional information was provided in prior portions of the text that narrowed the range of alternative words.

Method

Subjects. We tested 20 language-impaired children and 20 age-control children from Sample 4.

Design and materials. We selected 60 pictures that had been named with at least 90% accuracy by both the language-impaired and the normal children in our earlier study (Leonard et al., 1983). The pictures were divided into three sets of 20, equated for their frequency of written usage by elementary school children (Rinsland, 1946). Frequency ranges for the three sets were 34 to 5,375 (M = 942), 62 to 5,152 (M = 899, and 62 to 4,460 (M = 923). Each set appeared in three conditions. For approximately one-third of the children in each group, the pictures in the set were presented in a list condition; for approximately another one-third, the pictures were used in a sentence condition; and for the remaining one-third of the children in each group, the pictures in the set appeared in a story condition. Each child, in turn, received all three conditions with a different set of pictures for each condition. The particular sets used for the three conditions and the order of presentation of the conditions were counterbalanced across children in each group.

For all conditions, the apparatus from Experiment 2 was used to project slides of the pictures. The presentation of each slide was preceded by the appropriate tape-recorded material (list, sentence, story) at a comfortable listening level via headphones. The appearance of the target slide and onset of the timing interval were triggered by an inaudible tone on the second channel of the recording. This signal followed the last recorded word on the tape by approximately .5 s. Timing was halted when the child's vocal response triggered a Model 320S Hunter Noise Operated Relay.

In the list condition, a variable number of unrelated words (5 to 12) were heard before the presentation of each of the 20 pictures. In the sentence condition, the child heard a sentence ranging from 5 to 12 words that required completion by a noun (e.g., *The dad put all the suitcases in the* ______) before presentation of the picture. Sentences of the same type were also used in the story condition. However, in that case, the 20 sentences were embedded in a story of approximately 2,500 words. Each sentence was preceded by sentences providing additional information concerning the identity of the target word (e.g., *Then they looked out the window. It was raining. "Oh no," said the children. "Don't worry, you won't get wet," said the dad. The mom smiled and looked at the children. "Your dad remembered to bring the* ______."). The sentences to be completed by picture names appeared at unpredictable intervals in the text. However, to provide the child with sufficient story context, none appeared in the first 20 lines of text. The version of the story used for one of the sets of 20 pictures is provided in Appendix C.

Because the interval between picture presentations was longer in the story condition, it was necessary to equate the conditions in terms of children's alertness to the presentation of a slide. To accomplish this, a prerecorded tone was sounded at the beginning of each sentence in the story that was followed by a picture to be named. To offset any difficulties if the tone itself proved distracting, a tone was also recorded at the beginning of each list and sentence in the other conditions.

Two steps were taken to facilitate interpretation of the resulting data. First, it was necessary to ensure that the names of the pictures in the story condition were in fact more predictable than those in the sentence condition, which in turn were more predictable than those in the list condition. To this end, each word set-presentation condition permutation was presented to five adult listeners who were asked to complete the list or sentence by writing the word that seemed most appropriate. Predictions for the story condition proved most accurate and least variable, followed by those for the sentence condition. As expected, predictions for the list condition were highly variable and rarely accurate.

Even though the names of the pictures were more predictable in the story condition than in the sentence condition, it was necessary to ensure that this greater predictability could be attributed to the added information provided by the preceding sentences in the text rather than to features inherent in the sentences to be completed by the picture name. Accordingly, all of the completion sentences selected for the sentence condition were actually those that served as sentences to be completed in the story condition. Because a different word set was used for each condition with each child, no child heard the same completion sentences in two different conditions. However, each sentence had occurred in the sentence condition and in the story condition for an equal number of children in each subject group (e.g., the completion sentence, *She is dressed like a* ______, appeared in the sentence condition for one-third of the children in each subject group and in the story condition for a different one-third of the children in each group).

Procedure. Children were instructed to listen through the headphones and, upon hearing a tone, to prepare to name the picture that appeared on the screen. They were told that the pictures were not always related to what they heard on the tape, but that listening to the tape might help them identify the picture. They were asked to name each picture aloud as quickly as possible. A practice task followed in which nine pictures were presented, three in a brief story context, three in a sentence context, and the remaining in lists of unrelated words. If children made any unnecessary sounds or inserted words (e.g., *a*) before the picture name, they were reminded to say only the name of the depicted object. Following the practice task, children were told that they would "hear more things through the headphones and see more pictures," and to "say just the name of the picture as fast as you can." The child was then presented with the recorded material and corresponding pictures for each of the three conditions. Throughout the task, the experimenter recorded incorrect responses as well as extraneous noises that prematurely stopped the timing loop.

Results

The mean number of pictures named correctly (out of 20) was analyzed with a 2 (Group) × 3 (Context) ANOVA. Although children in both groups named most pictures accurately, children in the age-control group named more pictures accurately (18.57) than did children in the language-impaired group (17.63), $F(1, 38) = 7.06$, $p < .01$.

For each child, a mean naming time was calculated for each condition, based on correct responses only. A 2 (Group) × 3 (Context) ANOVA on naming times indicated a marginally significant main effect for group, $F(1, 38) = 3.27$, $p < .10$, and a significant main effect for context, $F(2, 76) = 12.79$, $p < .01$. The interaction was not significant, $F = 1.68$. As can be seen in Figure 6, for both the language-impaired and the age-control children, naming times were faster in the two context conditions than in the control condition. The sentence condition decreased naming times (relative to the control condition) by approximately 120 ms for the language-impaired children and approximately 50 ms for the age-control children. Corresponding figures for the story context were 150 ms and 80 ms.

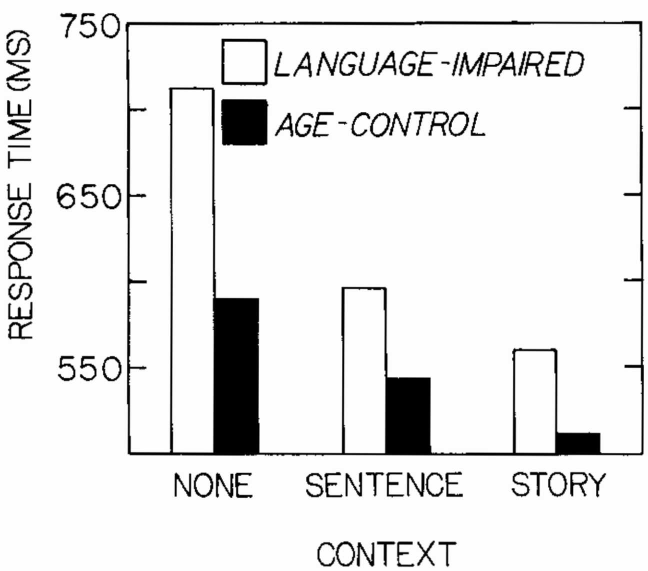

FIGURE 6. Naming time (in ms) by language-impaired and age-control children, for three conditions differing in linguistic context.

Discussion

At the conclusion of Experiments 1 through 5, we thought that word-finding deficits in language-impaired children might be more evident in linguistically richer tasks than those used in our previous experiments. In Experiment 6 we operationalized linguistic complexity by testing picture naming under conditions in which prior linguistic information provided varying amounts of cues as to the picture that was likely to be presented. These cues were effective, as naming times were significantly less with sentence and story contexts than with a context of unrelated words. However, the impact of these differing contexts was comparable for the two groups, and, if anything, was slightly greater for language-impaired children than for age-control children. That is, language-impaired and age-control children were equally skilled in whatever processes are responsible for the facilitative effects of the story and sentence contexts.

EXPERIMENT 7: RECALL OF DISCOURSE

In the repeated free recall task of Experiment 1 (as well as in Kail et al., 1984), the language-impaired children not only stored fewer words than the age-control children, they were also less likely to retrieve stored words successfully on subsequent occasions. This finding was the only one in our research to implicate a specific retrieval factor in language-impaired children's performance. The possibility that retrieval limitations may be more apparent in recall tasks prompted us to examine these children's word recall in larger and linguistically more meaningful contexts.

We used a paradigm devised by Perfetti and Goldman (1976) that is essentially a discourse analog to the running digit span task. Specifically, stories are presented to children; periodically the story is interrupted and a word presented recently is repeated. The child's task is to recall the word that originally followed the repeated word in the text. For example, the child might hear: "The man who owned the bakery stepped forward. He just had to know what was in the chest. *His wife told him to be still when he began to speak.* WHEN?" The correct response would be *he*.

In their experiment, Perfetti and Goldman manipulated two variables that are relevant here. One was the distance between the presentation of a probe word and its appearance in the text. The example provided above represents a *near* test, where the two appearances of "when" are in close temporal proximity. In a *far* test, the probe word occurred much earlier in the sentence, as in: *"His wife told him to be still when he began to speak.* HIS?" The second variable was the structure of the sentence containing the probe. Each sentence contained a main clause and a subordinate clause. Half of the sentences resembled the two previous examples in that the main clause preceded the subordinate clause (i.e., M,S sentences); in the remaining sentences, the order was reversed (i.e., S,M). An example of the S,M construction is *"When he began to speak his wife told him to be still"* where the probes "HIS?" and "WHEN?" represent *near* and *far* probes, respectively.

The key finding of Perfetti and Goldman's experiment for our purposes is that recall of *near* probes was substantially more accurate than recall of *far* probes for S,M sentences but not on M,S sentences. Our interpretation of this finding is that word strings are first parsed to reveal their syntactic structure and held in short-term memory. Not until all necessary arguments have been identified does comprehension begin. According to this line of reasoning, comprehension of M,S sentences begins at the clause boundary (for all necessary arguments have been identified), thus freeing the limited capacity of short-term memory to store the subordinate clause. In S,M sentences, comprehension does not proceed at the clause boundary because obligatory elements of the sentence (e.g., subject noun and verb) have yet to be identified. Presentation of the main clause displaces the subordinate clause from short-term memory, limiting recall of the word following the far probe.

This analysis suggests several hypotheses regarding performance differences between language-impaired and unimpaired children. First, suppose that the capacity of short-term memory for discourse is less for impaired children than for unimpaired children. We would then predict that the distance effect on S,M sentences should be larger for impaired than for unimpaired children. Second, suppose that impaired children are less likely than unimpaired children to recode sentences at clause and sentence boundaries. The result here would be that distance effects would be seen in impaired children's recall of S,M *and* M,S sentences. Third, assume that language-impaired children's difficulties with particular grammatical categories (in this case, adverbials that initiate subordinate clauses) prevent them from making use of probe words from these categories to guide retrieval. In this case, the difference between S,M *far* and M,S *far* (favoring the latter), and between M,S *near* and S,M *near* (also favoring the latter) should be greater for the language-impaired children than for the normal children. Finally, suppose that the language-impaired children simply know words and syntactic frames less well than normal children. We would predict that for the language-impaired children, elements within clauses would undergo a less than complete analysis and that words in short-term memory, because they are less well known, would be more likely to be forgotten. Therefore these children's recall would be poorer than that of normal children on all four types of probes. However, the recall profile for language-impaired children should not differ from that of the normal children.

To evaluate these predictions, children listened to two stories, each containing 12 probes, three for each combination of probe (*near*, *far*) and syntax (S, M; M, S). After each story, children were asked five true-false questions to assess their story recall. These questions were included to encourage children to understand the meaning of the stories and not simply track sequences of words.

Method

Subjects. We tested 18 matched trios of children in Sample 2.

Materials. Two stories were adapted from a second grade reader (Rasmussen & Goldberg, 1968), for which we constructed four alternate forms each. In addition, certain vocabulary items and syntactic constructions were simplified to insure that the stories were easily comprehended by all of the children in the study. All stories were approximately 125 sentences and 950 words in length. Each story included 12 target sentences that contained a main clause (M) and a subordinate clause (S); six were M,S sentences, six were S,M sentences. Target sentences were separated by 3 to 12 intervening sentences in all stories. Following each target sentence, a probe word was presented. For half of the sentences (3 M,S and 3 S,M) the probe was a word that had appeared as the first word (or second if the first word was an article) in the second clause of the sentence. Hence, it appeared in the clause that was in closer temporal proximity to the probe presentation *(near)*. For the remaining sentences, the probe word had appeared as the first word (or second in the case of a preceding article) in the first clause of the sentence *(far)*. For *near* sentences, approximately six words intervened between the appearance of the word in the sentence and its appearance as a probe word. For *far* sentences, this distance was approximately 10 words. The four alternate forms of each story were constructed to ensure that each target sentence appeared once in each of the Clause Order × Distance permutations (M,S *near*; S,M *near*; M,S *far*; S,M *far*). An example of the four alternate forms for one of the target sentences (with surrounding story context) is provided in Table 8. One of the versions of each of the two stories appears in Appendix D.

TABLE 8. Example of alternate forms of a target sentence.

Example	*Probe*	*Sentence type*
The man who owned the bakery stepped forward. He just had to know what was in the chest. *His wife told him to be still when he began to speak.*	WHEN	M,S near
The man who owned the bakery stepped forward. He just had to know what was in the chest. *His wife told him to be still when he began to speak.*	HIS	M,S far
The man who owned the bakery stepped forward. He just had to know what was in the chest. *When he began to speak his wife told him to be still.*	HIS	S,M near
The man who owned the bakery stepped forward. He just had to know what was in the chest. *When he began to speak his wife told him to be still.*	WHEN	S,M far

Note. In each example, the italicized sentence is the target sentence.

Each form of both stories was audio-recorded by a male speaker at a normal rate of oral reading. The probe words, also prerecorded, occurred one second after the target sentence. To facilitate children's detection of the probe words, these words were recorded by a female speaker.

Procedure. Children were told that they were to listen to two stories and that the experimenter would ask them certain questions about each story after it had been presented. They were also informed that "every once in a while" they would hear a woman say a word from the story and that they were to tell the experimenter "the word in the story that came right after this word." Several practice sentences and probe words were read by the experimenter, to ensure that children understood the task.

The recorded stories were presented to the children at a comfortable listening level. Following each probe, the experimenter stopped the tape to allow the children to respond. Presentation of the recording continued immediately after children responded. After each story, the experimenter asked five true-false questions concerning the content of the story. The presentation order of the two stories and the particular version of each story presented were counterbalanced.

Results

Memory task. In each story, children were presented 12 probes, 3 for each of the 4 combinations of distance and syntax. These data were analyzed with a 3 (Group) × 2 (Story) × 2 (Syntax) × 2 (Distance) ANOVA in which all but the first factor were within-subjects. The groups differed in accuracy of responses to the probe, $F(2, 51) = 4.76$, $p < .01$, with the age controls (69.9%) surpassing the language controls (58.56%), who were, in turn, more accurate than the language-impaired children (45.83%). The two stories differed in difficulty, $F(1, 51) = 16.72$, $p < .01$. Children were more accurate on *near* tests than on *far* tests, $F(1, 51) = 22.18$, $p < .01$, but this effect interacted with syntax, $F(1, 51) = 6.54$, $p < .01$. As was the case in Perfetti and Goldman (1976), distance effects were substantial on S,M sentences (48.15% and 65.12% for *far* and *near* probes, respectively) and negligible on M,S sentences (57.41% and 61.73%).

Also noteworthy is the fact that the interaction of Group, Syntax, and Distance was not significant, $F(2, 51) = 2.43$, $p > .10$. As shown in Figure 7, the language-impaired children and their age mates have virtually identical profiles across the four types of probes. Attesting to this fact, when the ANOVA was repeated deleting the data

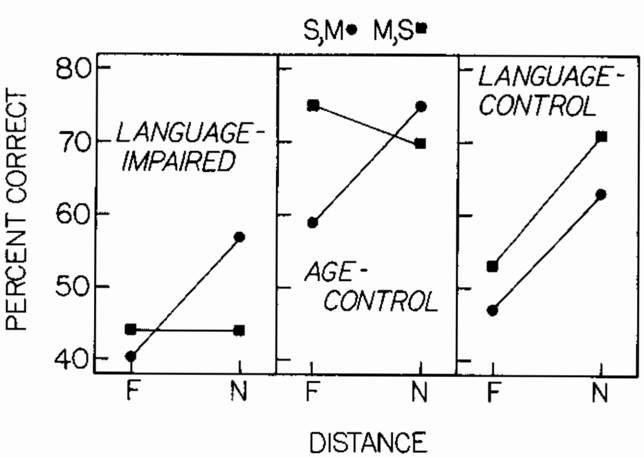

FIGURE 7. Recall as a function of the distance of the probe, shown separately for M,S and S,M sentences, and for language-impaired, age-control, and language-control children.

for the language controls, the F ratio for the Group × Syntax × Distance interaction was less than 1. The language-control children appear to have a distinct profile in which the distance effect occurs for both constructions.

Comprehension data. Each child was asked five true-false questions at the end of each story. Overall accuracy on those questions was quite high (86.67%), indicating that performing the probe task did not preclude comprehension of the stories. Nevertheless, a 3 (Group) × 2 (Story) ANOVA yielded a significant main effect for Group, $F(2, 51) = 5.72$, $p < .01$. The age-control children answered the comprehension questions with near-perfect accuracy (97.22%), significantly greater than either the language-impaired children (82.78%) or the language-control children (80%).

Discussion

Considering these results, we can eliminate three of the four hypotheses proposed initially regarding discourse processing deficits in language-impaired children. Because distance effects were qualitatively and quantitatively similar for language-impaired children and their age mates, impaired children do not appear to have more limited short-term memory capacity than their peers, nor are they less likely to begin recoding at clause and sentence boundaries. In addition, these children seemed no different in their relative ability to use words from particular grammatical categories to guide retrieval. That is, in general, the probe word from a main clause (i.e., a noun, pronoun, or verb) was associated with greater recall than the probe word from a subordinate clause (i.e., an adverbial), but this was no more true for the language-impaired children than for their age mates. Instead, based on a difference in recall that was remarkably consistent across conditions, our conclusion is that the chief problem of the language-impaired children was one of encoding individual words and their syntactic roles.

Surprisingly, the profile for the language-control children differed from those of the language-impaired and age-control children in showing a distance effect for both constructions. That is, language-control children recalled *near* probes more accurately than *far* probes on both S,M *and* M,S constructions. As we described earlier, this pattern indicates that children apparently were not recoding sentences at clause boundaries. Because the language-control children were younger than the other two groups, this suggests that sentence recoding begins to develop in the early elementary school years. The fact that Bolesta (1985) recently replicated our findings of a distance effect on S,M and M,S sentences in a sample of first graders with normal language skill is consistent with this view.

Chapter 5

General Discussion

OVERVIEW OF FINDINGS

We begin with a summary of the results of the seven experiments described in this monograph. In Experiment 1, a mathematical model of performance on repeated free recall revealed that language-impaired children were less likely than age-control children to store and retrieve words, and they were more likely to forget them. Moreover, category relationships in the list influenced storage and forgetting only for age-control children. In Experiment 2, the language-impaired children showed slower overall response times than did the age-control children, but both groups scanned memory at the same rate. Furthermore, both benefited from the presence of categories in the sets to be remembered. In Experiment 3, children judged whether pairs of pictures were identical physically or in name. Language-impaired and age-control children differed in the perceptual-motor components of the task, and, less reliably, in the lexical aspects of the task. Also, age-control children's judgments were slowed by the presence of irrelevant name information, but language-impaired children's judgments were not.

In Experiment 4, in which children generated the names of animals, articles of furniture, and occupations, language-impaired and age-control children were generally alike in both global and fine-grained measures of retrieval. Similarly, in Experiment 5, the multidimensional spaces derived from children's similarity judgments were much the same for language-impaired and age-control children.

In Experiment 6, language-impaired children named pictures more slowly than age-control children, but both groups' naming was improved, by comparable amounts, when pictures were preceded by story and sentence contexts. In Experiment 7, children listened to stories that included periodic probes, for which children were to recall the word that had followed the probe in the story. Overall, language-impaired children were less accurate than age-control and language-control children. However, language-impaired children and their same-age peers showed the same pattern of effects involving the syntax of the sentence and the recency of the probe word.

In the remainder of this chapter, we (a) provide a general theoretical framework for these findings, (b) discuss the contribution of language-control groups to interpretation of the results, (c) consider alternative approaches for selecting subjects, and (d) mention some clinical implications of our work.

A STORAGE-ELABORATION INTERPRETATION

Most of the experiments described were designed so that retrieval deficits would be revealed in significant interactions between groups and an experimental variable. In fact, the typical outcome in our research was a significant main effect for Group but nonsignificant interactions between Group and experimental variables. This was true in Experiments 2, 4, 5, 6, and 7. In each of those experiments, then, the findings indicate no group differences in retrieval skills per se. Where language-impaired children's performance is less accurate or less rapid than that of age-control children, we believe this can be due to the language-impaired children's less extensive lexical knowledge. Specifically, we assume that semantic memory is qualitatively similar for language-impaired and age-control children, consisting of many of the same entries organized in fundamentally the same way. That is, we assume that language-impaired children and age-control children are qualitatively similar in knowledge concerning the properties and features of lexical entries, the conceptual domain to which a lexical item belongs, and the linguistic contexts and privileges of occurrence for a lexical item. However, because language-impaired children learn words later than children with normal language do, we assume that their knowledge is less extensive than that of their peers. For example, the entries corresponding to words are weaker in language-impaired children than in age-control children. Furthermore, we assume that language-impaired children's semantic memories contain generally weaker links between entries as well as fewer connecting links.

The qualitative similarity of entries and links is necessary if we are to account for the results of Experiments 4 and 5. However, differences in the strength of nodes as well as differences in the strength and number of links provide a mechanism for explaining those differences that did occur. We discussed earlier how these variables could account for the differences in the mathematical model of repeated free recall (Experiment 1). Similarly, differences in lexical elaborateness would explain why language-impaired children name pictures less rapidly (e.g., Experiments 3 and 6) and are less likely to recall words (e.g., Experiment 7) but otherwise perform comparably to age-control children. In each case, the language-impaired child's less elaborate representation means that accessing a particular entry in memory is more time-consuming and more prone to error.

Our emphasis on lexical elaboration is also consistent with the findings of earlier work. Specifically, when language-impaired children's word-finding problems present evidence of a particular type of difficulty, the semantic domain is usually implicated. For example, in Fried–Oken's (1984) sample of language-impaired children, semantic naming errors (e.g., *blouse* for skirt) were twice as frequent as both perceptual errors (*pillows* for crackers) and phonological errors ([*trembelin*] for tambourine). Similarly, Rubin and Liberman (1983) found that in their language-impaired subjects, nonphonetically related semantic substitutions were much more frequent than phonetically related errors (e.g., *acorn* for unicorn) or phonetically related semantic errors (e.g., *elevator* for escalator). This is not to say that other factors, such as poorly integrated phonological representations, were not sometimes involved in the word-finding problems of our language-impaired subjects.[3] However, we believe that the notion of unembellished lexical representations is better able to account for the entire pattern of results in Experiments 1-7 as well as previous findings (Fried–Oken, 1984; Kail et al., 1984; Leonard et al., 1983; Rubin & Liberman, 1983).

In sum, we see little evidence to suggest that language-impaired children's word-finding problems must be attributable to some specific retrieval deficit. Instead, these problems are simply one more manifestation of the fact that language-impaired children learn words more slowly than their peers with normal language, which makes many words less accessible to normally functioning retrieval algorithms.

Of course, language-impaired children may not always use retrieval strategies flawlessly. Some retrieval strategies depend upon knowledge of words and their paradigmatic (e.g., subordinate category membership) and syntagmatic (e.g., semantic-syntactic privileges of occurrence) relations. Others are metalinguistic in nature in that they require an ability to consider the form of words independent of their meanings. These components of word knowledge are usually restricted in language-impaired children (e.g., Kamhi, Lee, Nelson, & Dershem, 1984), which may preclude the ability of such children to use certain retrieval strategies.

A good example of strategic deficits that may be related to general language limitations is found in a study by Ceci (1983). Language-impaired 10-year-olds, age-matched controls, and 4-year-old controls participated in a picture-naming task in which all pictures were preceded by a prime that was semantically related to the pictures (e.g., "Here's an animal"—HORSE), misleading ("Here's a fruit"—HORSE), or unrelated to it ("Here's something you know"—HORSE). When misleading primes outnumbered related primes by a 4:1 ratio, the misleading and unrelated primes resulted in similar naming times for all children, and, for all groups, related primes showed slightly faster naming times. When the ratio was reversed, so that related primes outnumbered misleading primes, 10-year-olds' naming was slowed by misleading primes (relative to unrelated primes) but language-impaired and 4-year-old children's naming was unaffected. Also, the 10-year-olds' naming times for related primes were much faster relative to the times for unrelated primes than was seen for the other subject groups.

Ceci explained the impact of primes in terms of two distinct processes. Primes could operate automatically: Presentation of the prime activates a portion of semantic memory that is relevant to the picture to be presented. Primes may also have impact via deliberate strategic actions by the child: Upon presentation of the prime, the child may spontaneously think of various exemplars from the category, thereby activating them.

Ceci argued that only the 10-year-old control children engaged in active processing of the stimuli when the conditions indicated that this would be a useful approach. Such processing resulted in particularly fast naming times for related items. However, when the picture was other than that anticipated (misleading pairs), naming time suffered. Language-impaired children, like the younger controls, apparently failed to engage in this type of processing and therefore seemed to exhibit a strategic deficit. Given that the language-impaired children exhibited deficits in receptive language and performed poorly on auditory reception subtests of the ITPA, they may not have been equipped to use this linguistically based strategy on the experimental task.

THE LOGIC AND UTILITY OF LANGUAGE-CONTROL GROUPS

We hoped that inclusion of language-control groups in our study would significantly facilitate interpretation of the data. We reasoned that if elaboration limitations were responsible for word-finding problems, language-impaired children would show performance levels and profiles consistent with those of younger normal children. If deficits specific to retrieval were contributing, the profiles of the two groups would differ.

In practice, the contributions of the language controls were not so clear-cut. These children participated in four of seven experiments. In two of them, their participation clearly aided interpretation of the data. In Experiment 2, the language-impaired children were slower than the age controls but approximated the language controls in speed and in profile. Thus, the language-impaired children seemed to exhibit limitations that seemed to represent developmentally delayed language skills. In Experiment 4, the language-impaired children performed much like the age controls. However, the language controls, too, resembled the age controls in performance, suggesting that

[3]Even if poorly integrated phonological representations were involved, they would seem better characterized as a storage limitation than as a retrieval limitation.

the linguistic knowledge tapped in this experiment was rather basic. Hence, real differences between language-impaired and age-control children in the quantity and pattern of unconstrained free recall may have been missed.

In Experiment 7, the language-control children's recall showed a different pattern than seen for the language-impaired and age-control children. Unlike the latter two groups, the language controls performed considerably better on *near* items, in contrast to *far* items, on M,S as well as S,M sentences. It can be concluded, then, that in Experiment 7 the language-impaired children were not performing like younger normal children of comparable composite language age. Possibly the findings are attributable to the fact that the language-control children's language comprehension levels were somewhat lower than those of the language-impaired children (whose language production limitations lowered their composite language ages), and that at these levels comprehension strategies of the sort described by Chapman (1978) may be at work.

The remaining experiment involving language controls illustrates one of the pitfalls in using such children in experiments involving formal tasks. In this case, Experiment 5, the language-control children had difficulty with the rating procedure. Although 6-year-old children have performed adequately on such a task (Howard & Howard, 1977), a number of language controls in the present study were below this age, the youngest being 4:6. Given the above-noted comprehension differences between the language-impaired and language-control children, the clear differences between the two groups in cognitive ability, and the likelihood that the task required some degree of metalinguistic and/or metacognitive skill, the results may not be surprising; although we were certainly hoping for a better outcome. Importantly, this suggests that the strategy (first introduced by Morehead & Ingram, 1973) of matching language-impaired children with younger normal children on the basis of some general measure of language development may be useful primarily at the early stages of language development when language-impaired and language-control children differ in chronological age by only one or two years, and measures of naturally occurring language serve as the focus of comparison. At higher language levels, when language controls may be several years younger than the language-impaired children, and performance on structured tasks constitutes the basis of comparison, this matching strategy should be adopted with considerable care.

ALTERNATIVE APPROACHES

The approach taken in the present investigation was to select children for inclusion who showed limitations on language production, language comprehension, and confrontation naming tests. This appeared reasonable, given that children included in earlier studies of word-finding problems were often described as experiencing limitations in other aspects of language as well, though precise levels of linguistic functioning were typically not provided. The result of our approach to subject selection was a group of language-impaired children whose limitations included below-age-level functioning on a confrontation naming task, but whose most serious problem may not have been word-finding difficulty. It might be argued that marked symptoms of word-finding problems should have been the chief selection criterion.

This alternative approach would have been problematic. Of the children referred to us with the primary clinician or parent complaint of word-finding problems, a number fell considerably below the nonverbal IQ level of 85, and several of these also failed the neurological screening. Language comprehension abilities showed an even greater range (grossly deficient to age-appropriate) in these children than in the group actually selected. In short, our investigation might be aptly described as a study of lexical storage and retrieval in language-impaired children. However, an investigation that attempted to single out children primarily on the basis of symptoms of word-finding difficulties would result in such a heterogeneous group of children as regards their other abilities that task selection and data interpretation would be enormous problems.

Although our subject selection criteria permitted us to reduce heterogeneity while including children with suspect word-finding ability, there may have been a benefit to using the remaining differences among the children as the basis for forming distinct subgroups. For example, children might have been selected whose language comprehension abilities clearly exceeded their production abilities, while others selected might have shown comprehension levels that approached the level of deficit seen for production. One might hypothesize, for example, that if retrieval problems were seen they would be seen only in the former group; or that storage-elaboration factors would be sufficient to explain the word-finding limitations of the latter group. Post-hoc inspection of our data provided no clear indications of distinct profiles for different subgroups, but the number of children who clearly fit into one or another of these subgroups was small.

IMPLICATIONS FOR CLINICAL WORK AND INSTRUCTION

Applied concerns were at the heart of much of our research effort. In fact, the elaboration view of word-finding limitations adopted here has implications for both assessing and teaching language-impaired children. An important assumption behind this view is that even when a language-impaired child has "acquired" a word, in the sense that it is occasionally comprehended and produced, the representation of the word in memory is less elaborate than is the case for children with normal language. Thus, the *degree* to which the child knows the word is an important consideration. A language-impaired child's appropriate production of a word does not seem to constitute a sufficiently stringent criterion for assuming adequate lexical knowledge. More detailed assessment is required.

Activities designed to assist the child with word-finding limitations should emphasize strengthening and elaborating the child's representations of words in memory. A word's paradigmatic characteristics can be emphasized by teaching the child the primary and secondary functions of the word's referent (e.g., the fastening and decorative functions of *cufflinks*), a range of nonidentical exemplars for the word (e.g., army, football, and hockey *helmets*), referents from similar categories for purposes of comparison and contrast (e.g., similarities and differences among snakes and lizards), and, where necessary, the superordinate category to which the word belongs. With regard to syntagmatic characteristics, information such as the attribute, agent, and locative terms commonly used with the word might be provided, as well as the word's general syntactic privileges of occurrence. Information making explicit the physical characteristics of the word (e.g., its syllable structure and consonant composition, the presence of prefixes) might also be given.

Instructional activities that point out and allow the child to practice using such information as aids to retrieval could also be appropriate. However, it appears critical that one determine that the child possesses knowledge of the information to be used in a strategy for retrieval. Activities that instruct the child to guide retrieval by using an object's function or a word prefix will have little value unless information of this sort is part of the particular word's representation in memory.

Appendix A

Standardized Language Test Performance of the Language-Impaired Children Participating as Subjects

SAMPLE 1

CHILDREN ADMINISTERED TOLD-P

Subtest Language Ages

Child	*CA*	*PV*	*GU*	*OV*	*SI*
1	6-1	4-8	4-1	3-5	3-1
2	6-4	4-3	6-3	3-5	5-1
3	6-6	6-8	4-4	3-11	4-1
4	8-1	6-3	8-4	7-4	3-5
5	8-1	8-4	5-6	4-6	3-1
6	8-7	7-10	6-11	7-4	5-5

CHILDREN ADMINISTERED ITPA

Subtest Language Ages

Child	*CA*	*AR*	*AA*	*VE*	*GC*
7	9-3	5-0	7-8	6-10	7-11
8	9-6	7-3	7-11	6-2	7-7
9	10-1	6-5	8-6	6-4	7-0
10	10-1	7-3	7-8	7-0	9-2

CHILDREN ADMINISTERED TOAL

Subtest Scaled Scores[a]

Child	*CA*	*LV*	*LG*	*SV*	*SG*
11	11-0	5	5	6	1
12	11-2	7	1	4	5
13	11-2	5	2	5	5
14	11-5	2	1	3	3
15	11-6	1	2	3	2
16	11-9	5	1	5	1
17	11-11	3	6	4	6
18	12-5	3	3	5	5
19	12-9	5	2	6	5
20	13-1	1	1	5	2

SAMPLE 2

CHILDREN ADMINISTERED TOLD-P

Subtest Language Ages

Child	*CA*	*PV*	*GU*	*OV*	*SI*
1	7-3	4-8	6-3	4-6	4-7
2	7-5	6-8	4-10	4-6	4-4
3	7-6	7-0	6-3	6-9	4-1
4	8-1	4-8	7-9	6-9	7-1
5	8-10	8-4	6-3	5-5	4-1

CHILDREN ADMINISTERED TOLD-I

Subtest Standard Scores[b]

Child	*CA*	*SC*	*CH*	*WO*	*GL*	*GC*
6	8-7	6	4	4	4	5
7	9-5	5	7	3	5	5
8	9-7	3	1	7	5	6
9	10-0	2	6	6	5	6
10	10-0	6	4	5	4	2
11	10-1	6	7	6	5	6
12	10-4	5	2	5	5	4
13	10-4	7	3	5	4	7
14	11-0	5	5	6	4	6
15	12-6	6	7	1	5	6

CHILDREN ADMINISTERED TOAL

Subtest Scaled Scores[a]

Child	*CA*	*LV*	*LG*	*SV*	*SG*
16[c]	11-0	5	5	6	1
17[c]	11-2	7	1	4	5
18[c]	11-9	5	1	5	1
19[c]	11-11	3	6	4	6
20[c]	12-5	3	3	5	5
21	13-8	4	4	5	4

SAMPLE 3

Children Administered TOLD-P

Subtest Language Ages

Child	*CA*	*PV*	*GU*	*OV*	*SI*
1	6-2	7-0	4-1	5-2	3-1
2	6-9	5-8	4-10	4-9	4-1
3	8-4	7-10	6-11	4-9	4-1

Children Administered TOLD-I

Subtest Standard Scores[b]

Child	*CA*	*SC*	*CH*	*WO*	*GL*	*GC*
4	8-11	6	8	3	5	5
5	8-11	5	5	1	3	7
6	9-0	7	6	4	7	6
7	9-0	5	6	3	3	6
8	9-7	4	6	3	3	4
9	9-9	5	7	7	6	6
10	9-10	3	8	1	3	5
11	9-10	6	3	3	8	4
12	9-10	5	6	5	8	6
13	10-3	4	6	5	4	5
14	10-5	3	6	3	4	2
15	11-2	3	3	5	4	4
16	12-2	6	8	3	7	2
17	12-3	7	7	1	7	6
18	12-4	4	8	5	9	4

SAMPLE 4

Subtest Standard Scores[b, d]

Child	*CA*	*SC*	*CH*	*WO*	*GL*	*GC*
1	8-11	3	6	2	2	5
2	9-3	4	6	1	5	7
3	9-4	2	5	3	5	4
4	9-5	3	3	1	4	4
5	9-8	2	5	4	3	8
6	9-9	5	5	5	7	7
7	9-9	9	7	5	5	6
8	9-9	4	6	2	5	6
9	10-0	2	3	1	5	5
10	10-5	1	8	5	6	2
11	10-6	3	7	8	6	6
12	10-7	3	6	3	4	7
13	10-7	2	3	3	4	5
14	10-8	4	3	2	4	2
15	10-9	6	6	6	5	7
16	10-11	6	8	3	5	5
17	11-0	4	2	2	5	2
18	11-0	4	6	2	3	2
19	11-4	3	5	2	5	4
20	11-5	4	8	6	8	5
21	11-9	6	6	1	3	4
22	11-10	6	5	1	3	7
23	12-0	4	6	1	3	4
24	12-1	2	3	1	2	5
25	12-2	6	6	1	9	7
26	12-3	5	7	6	8	6
27	12-5	2	3	1	2	5
28	12-10	2	5	7	4	6

Note. TOLD-P refers to Test of Language Development—Primary; CA to Chronological Age; PV to Picture Vocabulary; GU to Grammatic Understanding; OV to Oral Vocabulary; SI to Sentence Imitation; ITPA to Illinois Test of Psycholinguistic Abilities; AR to Auditory Reception; AA to Auditory Association; VE to Verbal Expression; GC to Grammatic Closure; TOAL to Test of Adolescent Language; LV to Listening Vocabulary; LG to Listening Grammar; SV to Speaking Vocabulary; SG to Speaking Grammar; TOLD-I to Test of Language Development—Intermediate; SC to Sentence Combining; CH to Characteristics; WO to Word Ordering; GL to Generals; GC to Grammatic Comprehension.

[a]Possible Scaled Scores range from 1 to 20 with 10 representing the mean and 3 the standard deviation. [b]Possible Standard Scores range from 1 to 20 with 10 representing the mean and 3 the standard deviation. [c]These children's participation in Sample 2 closely followed their participation in Sample 1. Therefore, the standardized language tests were not readministered. The chronological ages reported for these children are their ages during standardized test administration. [d]All children in Sample 4 received the Test of Language Development—Intermediate.

Appendix B

Analysis of Accuracy in Experiment 2

The number of correct responses was analyzed with a 3 (Group) × 2 (Categorized vs. Uncategorized sets) × 2 (Replications: first vs. second presentation) × 3 (Set Size: 2, 4, or 6 pictures) × 2 (Responses: Yes, No) ANOVA. (All factors but the first are within subjects.) This analysis revealed differences between groups, $F(2, 105) = 6.54$, $p < .01$, which reflected the fact that the language controls (93.15%) were less accurate than either the language-impaired children (95.52%) or the age controls (96.32%). There were also significant main effects for Categorization, $F(1, 105) = 11.06$, Set size, $F(2, 210) = 9.89$, and Response, $F(1, 105) = 85.37$, $ps < .01$, as well as significant interactions between Response and Categorization, $F(1, 105) = 17.29$, $p < .01$, and between Replication and Categorization, $F(1, 105) = 5.38$, $p < .05$.

Each of these effects was qualified by additional significant interactions. First, the interaction between Response, Replication, and Categorization was significant, $F(1, 105) = 13.03$, $p < .01$. On the first replication, the subjects were more accurate in verifying that a probe had appeared in a categorized set (94.86%) than when the probe appeared in an uncategorized set (89.71%), but categorization had no impact on their accuracy in deciding that a probe was *not* a member of the set (categorized sets, 97.58%; uncategorized sets, 97.74%). These differences were much smaller on the second replication, with corresponding *M* of 93.42%, 92.23%, 97.33%, and 97.12%. Second, there was a significant interaction between Set Size and Response, $F(2, 210) = 7.39$, $p < .01$: Accuracy decreased systematically as a function of set size on "yes" responses (95.22%, 91.74%, and 90.70%, respectively for set sizes 2, 4, and 6) but not on "no" responses (corresponding *M* of 97.26%, 97.76% and 97.30%). Finally, the interaction of Replication, Set Size, and Response was also significant, $F(2, 210) = 6.16$, $p < .01$: The interaction between Set Size and Response was more pronounced on the first presentation than on the second.

Appendix C

One Version of the Story Used in Experiment 6[a]

This story is about a boy named Jim and his sister Carol. Jim and Carol lived in California, near the ocean. Everyday when the two children came home from school they would go to the beach. They loved to swim and dive into the water. They did not return home until it was almost nighttime. Their mom always asked, "Why do you stay at the beach for such a long time?" "Because it's so much fun!" the children would say. To tell the truth, the mother was happy that Jim and Carol played so hard at the beach. When they played at the beach they got real hungry. And when they were hungry, they would eat all their dinner, even their vegetables.

One day, when the two children came home from the beach their mom said, "Your dad has some good news!" "What is it?" Jim and Carol asked. "Your Uncle Bob called today. He invited us to come visit him on his farm." "When can we go?" asked the children. "Next Saturday," said the mom. "Let's go pack!" said Jim. The dad said, "You can pack later. But remember, Uncle Bob lives up north, and it's wintertime."

Well, when Saturday came the children were ready. All their suitcases were packed. Jim's suitcase was full of clothes, and Carol had to help him close it. "Do you have everything?" Carol asked. Then Jim looked down at the floor and saw his *hat*. "Oh no! We have to open the suitcase again!" said Jim. "No, you can put it in my suitcase," said Carol. "I have plenty of room." And this was true. She had only packed a few clothes and two of her favorite books. Also, she had put in a doll and some *crayons*. "You do have lots of room," Jim said. "Can you take a few more of my things? Uncle Bob will want to play with my football!" "No, it won't fit. My suitcase is not that big," said Carol.

Soon, the children's mom came into the room. "I hope you packed the right things," she said. "Remember, you can't go swimming, so don't bring your bathing suits." "There's no water?" Carol asked. "Yes, there is a lake, but it will be wintertime up there." Somehow this did not mean anything to the children. They lived in a place where people went swimming in the winter and the summer. But they didn't say anything to their mom because they didn't want to get her angry.

Later that morning, it was time to leave on the trip. The dad put all the suitcases in the car. Then he told everyone to climb in. "How long will it take to get to Uncle Bob's?" Jim asked. "Three days," said the mom. "Three days!" said Carol. "Where will we sleep at night?" The mom laughed. "We'll stay in a motel." Then the dad got in the car, but he didn't start it. He couldn't find the *key*.

Finally, the dad found the key and started the car and away they went. After a while, the children got tired of looking out the car window. "Let's talk about all the things we will do at Uncle Bob's," said Carol. "Ok," the mom said. "First, you can play with your cousins." "How old are they?" asked Jim. "Well, the boy is a bit older than you are, Jim. But the girl is about Carol's age." "What do they look like?" Carol asked. "Well, I have a picture of the boy that Uncle Bob sent me. But it is hard to see what he really looks like. The picture was taken at a Halloween party. He is dressed like a *ghost*." "Let me see it," said Carol. After Carol saw the picture, she tried to show it to Jim. But he didn't want to see it. In fact, he didn't want to do anything. He did not seem very happy. His mom said, "Jim, I brought along some food. Do you want to eat some *bread*?" "No, I'm not hungry," Jim said.

The mom could see that Jim was sad about something. "What's wrong?" she said. At first, Jim said nothing. Then he looked up and said, "I won't have anyone to play with at Uncle Bob's. One of my cousins is too old and the other one is too young." The mom and dad looked at each other and smiled. "Oh, I think you will have a lot of fun," the dad said. "The older one, Matt, likes to do a lot of things that you will like, too." "Like what?" Jim asked. "Well, Matt likes to ride his *bicycle*. And he may have an extra one for you to use." "Mm, that does sound like fun," Jim said.

Then Jim's mom said, "But remember, it may be too cold to ride on the bicycles." "If it is cold there may be snow," said the dad. "That's right. And the driveway may be blocked because of the snow. The boys may have to help with a *shovel*."

As the family drove on, they passed through a thunderstorm. The rain came down so hard they had to stop until the storm passed. After a few minutes the rain stopped, and the sun came out. Just as they started the car, Carol pointed and said, "Oh, look." Up in the sky there was a *rainbow*.

That night, the family stayed in a motel. Jim and Carol

[a]Words in italics indicate instances in which a picture, whose name is the italicized word, was presented for the child to name.

had never been in a motel before. Of course, they were pretty far from home, and they didn't have their friends to play with. But they could watch T.V. The T.V. in the motel was different from the T.V. at home. None of the T.V. shows were on the right channel! But the children had fun anyway.

The next day, the family got up real early. They ate breakfast, and then continued on their trip. It was still dark when they left the motel. By the time the sun came up, they had been driving for an hour. But Jim and Carol didn't notice. They went back to sleep as soon as they got in the car. Finally, the mom woke them up. When the children woke up they looked out the window. "Wow," said Carol. "Everything looks different. Look at the trees!" Well, the trees were different. For one thing, they were yellow and orange and red—not green like the children were used to. Also, there were a lot of them. There weren't very many trees where the children lived.

The children had another surprise when the family stopped for lunch. When they got out of the car it was cold! Carol did not care. She ran toward one of the trees. "Where are you going?" Jim asked. "I'm going over to that tree to get some leaves." Soon, she walked back to the car. She had an armful of colorful leaves. "These are so beautiful. I want to keep them all. Can we put them in a *basket*?" "I'm afraid we don't have a basket," the dad said. "But pick out two or three to keep in your books. They'll be safe there." While the family ate their lunch, the mom told the children how the leaves change colors and fall off the trees when it gets cold.

Well, the family got back in the car after lunch. They drove for four or five hours and finally stopped at another motel. By the time they stopped, it was even colder, and most of the trees had no leaves. The children watched T.V. that night and found out that the T.V. channels were all mixed up again.

The next day was not much fun for the children. They were tired of sitting and they had already played all the games that they had brought with them. The mom reminded the children that it was almost Valentine's day. Then Carol wanted to make a Valentine's card. She got out some paper and her crayons. Then she drew a red *heart*. Finally, they arrived at Uncle Bob's farm. It was dark, and the children could not see the farm very well. Uncle Bob came out of the farmhouse when the family drove up. His leg was hurting him, and he moved pretty slowly. He walked with a *cane*. He said everyone else in his family was already asleep. But he fixed some soup for the children to eat. Carol was very sleepy, though. She could barely lift her *spoon*. Jim and Carol finished eating. Then the children went to *bed*.

Jim and Carol slept late the next morning. Even when they finally woke up they were still sleepy. In fact, Jim forgot he was at Uncle Bob's. He remembered when he heard people talking downstairs. He heard some voices that he had never heard before. After getting dressed, the children went downstairs. There they saw their cousin Matt and Uncle Bob. Their other cousin, Susan, was sick and had to stay in bed.

After everyone ate breakfast, it was time to play. Jim asked his cousin Matt if they could go riding on the bicycles. "No," said Matt. "We won't be able to do that today." "How come?" Jim asked. Matt said, "Follow me." The two boys walked toward one of the windows. Then Matt opened the drapes so that Jim could see outside. Jim had never seen anything like this before. "It's snowing," Matt said, "and there's already too much snow on the road to go on the bicycles." "But," he said, "we can play in the snow." "Ok," said Jim. Jim had never seen snow until today, and he really didn't know what games they would play. But he thought it might be fun. "Can I play too?" asked Carol. "Sure," said Matt. Then Uncle Bob said, "Matt, Jim and Carol haven't played in the snow before. Make sure they wear the right things on their hands and feet. They can wear some of your extra clothes." As the children were putting on warm clothes, Matt noticed that Jim was wearing sneakers. Matt held up a *boot*. "Jim, this is what you need to wear out in the snow," he said. After the children got bundled up they went outside to play.

Matt showed Jim and Carol how to make snowballs. The children had a good time throwing snowballs at telephone poles. Then they started throwing snowballs at each other. Carol stopped the game because she was young and couldn't throw the snowballs very well. So then Matt showed Jim and Carol how to make a snowman. They rolled a ball of snow in the ground until the ball got real big. This was the snowman's body. Then they were ready to make another large ball of snow. As Jim reached down he noticed his bare hand. He had lost a glove. "Where's my glove?" he asked. Just then Carol saw something brown sticking out of the snowman's body. Everybody laughed. "The snowman must have been hungry," Matt said. "He ate your glove."

After Jim put his glove back on, the children continued to make the snowman. They made another big ball of snow to make the snowman's head. By now the snowman was so tall, Matt had difficulty putting the head on. After the snowman's head was on, Jim said, "We still have to put two eyes, a nose, and a mouth on the snowman." "Oh, let me do it," Carol said. "Ok," said Jim, "but what are we going to use?" The children looked around the yard but the snow covered everything that was on the ground. Then the children looked in the *barn*. "My dad has some things in here that may be good," said Matt. Jim and Carol noticed that there were no cows or chickens in the barn. "This is where my dad keeps his *truck*," Matt said. He then pointed to an old truck that was painted black. Then Matt held up three large buttons that he found on a shelf. "We can use two of these as eyes for the snowman and the other as a nose," he said. "Now what will we put in the snowman's mouth?" "How about this?" said Carol. She pointed to an old *pipe*. "Great," said Matt. "That will do." The children then went back to the snowman.

Carol was too short to reach the snowman's head. But she really wanted to make the snowman's face. "You need something to stand on," said Jim. "I know, come with me," Matt said. Matt went into the barn, and Jim and Carol followed. After a minute, the children came out again.

They were carrying a wooden *chair.* Carol stood on the chair and was able to put the eyes, nose, and pipe on the snowman.

Just then Jim and Carol's mom called to them. "Time to come in the house. It's starting to get dark." So Jim brought the chair back to the barn while Matt and Carol waited for him. A minute later Jim came running out. "There's something in the barn!" he yelled. "I heard it!" "What was it?" asked Matt. "I don't know," Jim replied. "There was a scratching noise. When I looked around it was too dark to see. But the noise started again, so I ran." Matt thought for a minute. "That's funny," he said. "We don't have any animals that stay in the barn." So they all went into the house to tell Uncle Bob. "Well, let's take a look," Uncle Bob said. "It's pretty dark," Jim said. "We will see better with a flashlight." Uncle Bob got a flashlight and everyone went out to the barn. Sure enough, they heard something scratchng. But even with the light from the flashlight, they couldn't see anything.

Then Matt thought the noise was coming from a corner of the barn where some old tables, lamps, and other furniture items were kept. Everyone walked toward the corner and then stopped to listen. The scratching noise started again. "Something is in this *vase,*" said Uncle Bob. He then turned on his flashlight and looked inside a large vase. "Well, I'll be," he said. "It's a pigeon. He must have flown into the barn through the open doorway. Somehow he fell into this vase and got caught."

Uncle Bob then tipped the large vase over and reached in to take the pigeon out. The neck of the vase was not very wide, so it was difficult to get the pigeon out. Finally he got it. But instead of flying away, the pigeon just sat on the ground. "He must be sick or hurt," said Matt. "We should get him to a veterinarian." "How will we get him there?" asked Jim. "The driveway has too much snow to use the car." Uncle Bob looked at his watch. "Well, we can walk to the main road. Then we can wait for the *bus.* It will come by in about ten minutes." "Oh, let me take the pigeon," Matt asked. "I'll bring Jim and Carol with me and the rest of you can stay here." "Ok," said Uncle Bob. "But I'll call the veterinarian to let him know you are coming." Matt took the pigeon, and the three children walked to the main road.

When the veterinarian saw the pigeon he thought it was just weak from not having much food. "Let me keep the pigeon here for a day or two," he said. "I'll feed it and see if that's the only problem it has." So the children returned to Uncle Bob's. Jim and Carol couldn't wait to get back to read about how to take care of pigeons. They thought it would be fun to keep the pigeon as a pet. Even during dinner they talked about taking care of the pigeon. But later, as the children slept, it was clear that they would not have their chance. After eating, the pigeon had become stronger and began flying around in the veterinarian's office. So the veterinarian opened the window and let the pigeon fly away.

The children were disappointed when they learned that the pigeon had flown away. And even though Uncle Bob said that the pigeon was probably healthy and safe, they weren't sure. They thought about it for a long time. But they were never sure what really happened to the pigeon. And later, back in California they thought about it. Especially at the beach, whenever a seagull flew overhead.

Appendix D

Versions of the Two Stories Used in Experiment 7[a]

THE KINGDOM WHERE NOTHING WAS DONE

In a land far beyond the tallest mountains and the deepest seas, there lived a king. His name was King Trueblue, and clearly all the people loved him.

The streets of the kingdom were always filled with men, women, and children shouting, "Hurrah for King Trueblue!" It happened wherever he went. People shouted "Hurrah" when he went to the park or to the store. WHEN Even in the restaurants, people shouted, "Hurrah for the King!"

Now you would think that such a well-loved king would be a happy king. But he was really very sad. Here's the reason: His people were so busy hurrahing that they never got down to business.

Whenever the king gave an order, the people would smile and say, "In a minute!" PEOPLE

King Trueblue would ask his men to build something.

"In a minute," they'd say.

He would go to the chief woodcutter and ask, "When will you start to cut the wood?"

The chief woodcutter would smile and say, "In a minute!"

Well, every time someone said, "In a minute," the king waited. And he waited a long time. The minutes grew into days. The days grew into weeks. The weeks grew into months. And the months grew into years. And nothing ever got done.

King Trueblue went to the wisest man in the kingdom because this was a real problem. KING TRUEBLUE The man was very old but very wise.

"Something must be done," said the king. "This kingdom is in trouble. People say they will do things in a minute, but they don't. Nothing ever gets done. If no one works, the kingdom will fall apart." IF

The old man blinked in a wise old way. Then he threw his hat up in the air and spun around three times. He winked at the king and then whispered something into the king's ear.

The king thanked the wise old man, saying, "It shall be done. It shall be done."

The next day the king had a big clock put on top of the town hall. The clock was so big that it could be seen from one end of the land to the other. Then he sent out a bulletin asking all the people in the kingdom to come to the town hall. As King Trueblue began to speak, the people grew quiet. PEOPLE

"As you all know," the king said, "nothing ever gets done in our kingdom. No one ever builds anything. No one ever finishes his job. The shoemaker never makes a pair of shoes. The woodcutter never cuts wood. You always say, 'In a minute,' when I give an order." YOU

King Trueblue took a sip of water and went on.

"From now on, there is a new rule. The job will have to be done in just one minute by this clock if anyone says that work will be done in a minute." IF

And he pointed to the big clock on top of the town hall.

"It is easy to say, 'In a minute.' Now you will indeed find out what 'In a minute' really means."

The next day King Trueblue went to the woodcutter. He said, "We need some wood for the town hall."

"In a minute," said the woodcutter.

"So be it," said the king.

The woodcutter began to cut the wood when he remembered the new order. WOODCUTTER Tick, tick, tick, went the seconds. Chop, chop, chop, went the woodcutter's ax. He worked hard until the minute was up, and he was out of breath.

All day long it was the same wherever the king went with an order. The shoemaker made a pair of shoes in a minute.

The players in the playhouse put on a play in a minute.

Even the king's own cat was able to catch a mouse in a minute.

So it went until all the people in the kingdom were out of breath.

Because the town hall needed more wood, the king went back to the woodcutter the next day. BECAUSE "Can you cut some more wood for the town hall?" he asked.

The woodcutter was about to say, "In a minute," but he stopped short. He smiled at the king. He smiled at the clock. He smiled at the wood. And this is what he said:

"Yes, I'll be glad to. If I start cutting this minute, it will take about thirty minutes." IT With that, he picked up his ax and began to chop the wood.

[a]Words in capital letters indicate the presentation of probe words.

Next the king visited the shoemaker again. "When can you repair my shoes?" he asked.

When the shoemaker remembered the king's order, he said, "I'll start on them now." WHEN

And so it went all day long. People did not say, "In a minute." Instead they got down to work.

All the people in the kingdom were busy.

Woodcutters cut wood.

Shoemakers made and repaired shoes.

Many houses were built. Everyone began to work if the king asked for something. IF But they did not say, "In a minute."

Now that King Trueblue's kingdom was a busy one, the king was not only well loved but also happy.

The king left the big clock on top of the town hall so that the people could see it every day. That way they would always remember the true meaning of "In a minute!"

THE BRASS CHEST

There is a faraway town in a faraway land that lies under the North Star. Only one road leads to the town.

As the sun went down one evening, a strangely dressed old man appeared on that road. AS

He had a lantern in one hand and a cane in the other. And strapped to his back was a brass chest.

Tap. Tap. Tap. Down the road he came.

He was dressed in rags, like a scarecrow. He had white hair and a yellow beard. Around his neck he wore a purple scarf that flapped in the wind.

Tap. Tap. Tap. Tap. Out of the darkness he came.

Just then, a storekeeper looked out the window. He ran out of his store when the old man appeared. WHEN He then yelled, "Someone has come down the road! Someone has come down the road!"

The old man was the first person to come down the road in nearly a year.

The old man passed the church and the market and came to the town square. A crowd soon gathered, for everyone could hear the storekeeper yelling.

Soon many lamps lit the square, and the North Star shone clearly in the black sky.

It was an evening the town would remember forever afterward.

The old man got up onto the back of a farmer's wagon, because the crowd could not see him. OLD He unstrapped the brass chest and put it down beside him. The crowd moved forward.

"Who are you, old man?"

"Where have you come from?"

"What do you have in your chest?"

He held up one hand.

"Hear my words," he said. "I am an old man. Because of my old age, I don't remember my own name." I "I have come from far away. And I have come with something very fine. It is in this chest."

"What is it?"

"Yes, what?"

"Tell us, old man."

He lifted his hand a second time, and he said:

"Pardon me. I can't tell you what it is. It is not possible for me to describe it. It is something fine, I can tell you that. It is the finest thing in the world."

"Show it to us, if you can't describe it." SHOW

"Let us see it."

"Open the chest."

But the old man said, "No, I won't show it to you." Then a tear rolled down his cheek.

"But I can do even better," he said. "I have kept this prize to myself for many years, and it is most dear to me. It has cheered me and filled my life with joy. It has made me by far the happiest man in the world. I will be very sad when someone else has it." WHEN

He wiped away the tear.

"But I am old," he said. "And my time is short. The time has come to share this thing with others. And I will sell it now to any man who wants it."

"Sell it?"

"To any one of us?"

"For how much?"

The old man lifted both hands. "Just one gold coin," he said. "Or two silver ones. For the finest thing in the world."

That wasn't much, to tell the truth. But the men of the town were careful with their coins. And they weren't prepared to pay for something they hadn't seen.

"How do we know it's worth it?"

"How do we know it isn't a trick?"

"How do we know the chest isn't empty?"

"Fear not," the old man told them. "I am one, and you are many. I would not dare to trick you."

The crowd could see that there was something to that. But even so. . . .

"I ask only one coin," said the old man. "And it is worth far more than that. It is worth more coins than a king could pay. Or ten kings, for that matter. When the chest is opened, you will be very happy." YOU

But nobody came forward.

"I don't care about the coin," said the old man. "One coin will not make me rich. But this is a gift for the man who deserves it. And the man who deserves it will part with a coin."

"We work hard for our coins," said the storekeeper.

"We do indeed," said a clerk. "And how do we know this thing is as fine as you say? Maybe *you* think it is. But we don't know you, sir."

"What do you fear?" he asked. "At worst, you will have spent only a coin. And I warn you. I shall go soon, and not return. Come forward now if you want to know what I have in my chest." COME

But no one came forward.

The truth was, there were many who wanted to. They wanted to know what was in the chest. They did not even care if they were tricked out of one coin.

But they didn't want it to happen there where the town would know about it. If no one else was there, every man would pay a coin. IF

Each one feared what the others would say or think. No one wanted the others to make fun of him.

"Just one coin," the old man repeated. "You pay that much for a sack of flour or a bag of turnips."

The man who owned the bakery stepped forward. He just *had* to know what was in the chest. When he started to speak, his wife told him to be still. HIS

"Don't you dare," she whispered. "Do you want the town to think that you're foolish?"

The old man prepared to go when the people turned away. WHEN He lifted his chest and strapped it onto his back. He picked up his lantern and waved his cane at the crowd.

"Is it possible?" he asked. "Is it possible there is not one man here who will dare a coin for the finest thing in the world?"

It was possible.

Without another word, the old man left the town. He disappeared up the dark road, and he never returned.

To this day, the town remembers him. To this day, the men of the town speak of the chest.

"What was in it?" they ask.

"What in the world was in it?"

Some say that they wish now that they had spent a coin to find out. "If one of us had paid the coin, we would have the prize," they say. IF

Others say it was a trick. And they are glad they weren't taken in by it.

And yet . . . and yet. . . .

What about you? Would you have paid the coin?

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