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SEMANTIC INTEGRATION IN NORMAL AND LEARNING DISABLED CHILDREN

by

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Abstract

SEMANTIC INTEGRATION IN NORMAL AND LEARNING DISABLED CHILDREN

by

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Psycholinguistic research has suggested that memory for sentences is basically an interpretive, integrative process. The present study was designed to investigate how learning disabled children retain information.

Sixty children classified as learning disabled and sixty normal children were presented with a set of sentences dealing with the same subject matter. Each sentence expressed only partial meaning of one complete idea. Each complete idea was composed of four interrelated propositions (simple sentences) which could be expressed in a single complex sentence as (1) or (2):

(1) "The big bear ate the chocolate candy in the woods," which consists of the four simple sentences:

The bear was big.

The bear ate the candy.

The candy was chocolate.

The bear was in the woods.

(2) "The old farmer milked the brown cow in the barn," which consists of the four simple sentences:

The farmer was old.

The farmer milked the cow.

The cow was brown.

The cow was in the barn.

During an incidental learning phase of the experiment subjects were never presented with those sentences expressing the complete complex ideas. The sentences presented contained from one to three of the related propositions or ELEMENTS (e.g. the bear was big; the old farmer milked the cow; the bear ate the chocolate candy in the woods). Children's ability to integrate information contained in the related sentences was measured by a recognition test which immediately followed the acquisition procedure. Subjects were read a set of sentences and asked to recognize many sentences never actually heard, but which were derivable from integrating the meanings of the sentences which they did hear. Recognition sentence TYPES included sentences actually heard during acquisition (OLD sentences), sentences not actually heard during acquisition but were consonant with the general ideas presented (NEW sentences), and sentences whose meaning was not derivable from one of the ideas presented (NONCASE sentences).

The study also attempted to determine whether semantic integration by these children was related to, or facilitated by, IMAGE factors by presenting two types of sentences. One phase of the experiment consisted of highly imageable (CONCRETE) sentences, as (1) and (2), while another phase consisted of sentences which were not easily imaged (ABSTRACT) as (3) and (4):

(3) "The proud poor people were disappointed by the high taxes."

(4) "The smart children did not understand the important new rules."

The goal of the study was to determine whether the related information contained in several members of a sentence set are integrated into a single representation and stored as such in memory.

Results indicated that the response pattern of learning disabled and normal children was significantly different with respect to sentence TYPE, IMAGE, and ELEMENT classifications. Normal children could not discriminate OLD from NEW sentences which shared consistent meaning; whereas learning disabled children attended to individual sentences and lexical elements.

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Special love to my family.

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CHAPTER I

INTRODUCTION TO THE PROBLEM

For the child, efficient learning depends upon his ability to remember spoken and written passages. There is currently a renewed interest in the role of memory in learning, in the kinds of memory operating within a learning task, and in ways to improve memory. To maximize learning, a child's memory in many areas of performance must become automatic, habitual responses to stimuli. Many factors have an effect on memory: the child's intensity of attention, meaningfulness of the material, interest in the subject, and the amount of drill and overlearning. The "normal" or average learner appears to develop all of the memory skills necessary to enhance all other learning processes. On the other hand, it is frequently observed that children who are unsuccessful learners have poor memories. For these children information retention may be difficult because of inadequate memory processes. Memory of past experiences must be retained and compared in order to organize and interpret experiences. Otherwise each experience is unique, with no connection to previous experience and learning. This study dealt with children with learning problems and the relationship between these problems and memory processes.

It would be helpful at this time to direct this discussion to the hypothetical mechanisms which comprise the memory system. Researchers in the area of human memory refer to three representational levels of the human memory system: (1) a sensory information storage (SIS), (2) "short-term" or "primary store," and (3) "long-term" or "secondary store" (Lindsay & Norman, 1972; Norman, 1969, 1970). Each of these memory levels is involved in the processing and interpretation of information. Each level serves a different function, stores a different form of information and has different capacity limitations. A brief summary of the characteristics of each level will follow.

The sensory information storage (SIS) selectively reduces, or filters, the diversity of incoming sensory stimuli to information that should be attended to by the individual. This information is then transferred from the sensory storage to short-term and/or long-term stores for processing. The decision as to which stimuli are relevant is based on the individual's retention of previous experiences. In general, if a child knows ahead of time what stimuli he should consider as relevant, his ability to select that information would be enhanced.

The short-term store serves as the primary memory in certain types of memory tasks (digits or word repetitions). In addition, the short-term store serves to process information for storage and retrieval in the long-term store

(Norman, 1969). It is in the short-term storage that the processes of rehearsal, coding, and organization determine how efficiently selected information will be remembered. At the same time information in the short-term store is being processed, it is selectively transferred to the long-term storage.

Finally, the long-term store has two basic functions. First, to receive interpreted information and store it for future retrieval, and second, to transfer received information into the short-term store. The information received by the long-term storage has undergone some transformations as compared to the originally perceived information. The long-term store, therefore, does not receive the actual, or original, information, but the individual's interpretation of the information.

This paper was particularly concerned with aspects of long-term memory. Long-term memory requires the ability to assimilate, store, and retrieve information when it is needed. It is dependent upon the learner's skill in seeing the relevancy of the material and relating it to past knowledge.

Constructive Aspects of Memory in Adults

Numerous theoretical questions have arisen concerning how representation of past experiences may be remembered and several alternative hypotheses have been formulated. For example, are there specific "traces" of experiences which remain, or is the representation less specific? In addition, are these "traces" recalled or recognized? Or do we construct or reconstruct past events on the basis of present experiences and the generalized schemata which represents the past?

The contrast between specific traces and the more general theories is not a recent development. It is sometimes discussed in terms of reproductive vs. productive, constructive or generative conceptions of memory. The remainder of this chapter will be concerned with a review of some of the more prominent research in this area.

There have been several theoretical approaches to the study of memory. The "Trace" theory holds that remembering is always a reproduction or recognition of earlier experiences. Errors are not ignored, but are viewed as clues to the processes which hinder correct performance (Cofer, 1873).

The other orientation to the study of memory was illustrated in the book Remembering by F. Bartlett (1932).

> Remembering is not the re-excitation of innumerable fixed, lifeless and fragmentary traces. It is an imaginative reconstruction or construction, built out of the relation of our attitude towards a whole active mass or experience . . . (a schema) . . . and to a little outstanding detail which commonly appears in image or language form. It is thus hardly ever really exact, even in the most rudimentary cases of rote recapitulation. . . . The attitude is literally an effect of the organism's capacity to turn round upon its own "schemata. . . ." The theory brings into line with imagining an expression of the same activities; it has very different implications in regard to forgetting from those of the ordinary trace view. (pp. 213-14)

Bartlett analyzed the ways in which subjects actively organized material presented to them. This he described as "effort after meaning" (i.e., an attempt to match whatever is presented to them by the experimenter to some pre-existing scheme, and which does not necessarily imply conscious effort on the part of the subject). The main implication of Bartlett's research is that remembering cannot be regarded as the mere revival of earlier experience, and thus incompatible with any notion of what has been referred to as "fixed, life-less traces." Consequently, he tried to replace the conven-tional "trace theory" of memory by a theory of "schemata." Bartlett defined the schema as an active organization of past experiences. In his own words, recall is far more decisively an affair of construction than one of mere reproduction.

There is still additional evidence in the literature which suggests that exact memory for what has been studied is not or may not be long lasting. Sachs (1967) has shown that after brief time intervals (27 seconds), subjects were unable to identify structural changes from a stimulus para-graph. The subjects no longer remembered the form of the sentence after the intervals. This finding suggested that meaning is derived from an active, interpretive process. That is, memory for meaning was preserved over time, whereas verbatim memory was not. Retention of only the semantic aspects of linguistic information is compatible with Bartlett's finding that an "impression" is preserved, but that "style" is lost. Thus, in a reconstructive theory of memory, the semantic content of the message is processed for storage.

Research by Bransford and Franks (1972) and Barclay (1973) has indicated that in addition to the meaning of a sentence being stored in memory, the meanings of several sentences may be integrated into one representation. Further, information that is inferable from a sentence, but not explicitly stated in it, is also remembered. The studies which follow present evidence that in memory for sentences, the integrative and inferred meanings may be available to some individuals.

"Integration," in general, is a process of combining independently represented, yet functionally related stimuli into a single organized unit. Integration is a generic term for an operation by which information is succinctly stored. The concept of "semantic integration" originated from research on how adults remember sentences. It has been shown that adults do not remember individual sentences or words, but instead they integrate semantic relationships from a given context (Bransford & Franks, 1971; Franks & Bransford, 1972; Bransford, Barclay, & Franks, 1972; Barclay, 1973). Bransford and Franks (1971) showed that it is the "meaning" of the sentence which is remembered, not the sentence itself. In addition, the meaning of sets of sentences dealing with the same idea were integrated into a single representation and included all the information contained in the several members of the set. It was that single representation which was retained in memory.

Bransford and Franks (1971) constructed four complex sentences, each composed of four interrelated ideas. That is, the complex sentence could be expressed in a single sentence made up of the four simple sentences. For example, "The ants in the kitchen ate the sweet jelly which was on the table," was one of the complete idea sets. The four basic propositions or simple sentences were:

The ants were in the kitchen.

The jelly was on the table.

The jelly was sweet.

The ants ate the jelly.

These sentences expressing one of the basic propositions were called ONES. Correspondingly, the complete ideas containing all four interrelated propositions were termed FOURS. Other sentences related to a complete idea were formed by combining ONES into combinations of two propositions called TWOS (e.g. "The ants in the kitchen ate the jelly."), and three propositions which were called THREES (e.g. "The ants in the kitchen ate the sweet jelly."). The set of all possible THREES, TWOS, and ONES was constructed from the four FOURS.

The basic experimental procedure consisted of an acquisition phase. This was followed by a test to determine if the subjects could recognize the sentences they had heard (Recognition Test). During the acquisition phase, subjects were presented with two each of the ONES, TWOS, and THREES that were derivable from each FOUR. However, subjects were never presented with a FOUR. During the acquisition task, subjects were asked to answer a question about each sentence after it was presented. After the twenty-four sentences had been presented, subjects were given a five-minute break, and then the recognition test was administered. The recognition list was made up of FOURS (which the subjects never actually heard), as well as THREES, TWOS, and ONES.

The sentences were presented one at a time and the subjects were asked to judge whether they had actually heard the sentence before. They gave a confidence rating for each sentence along a five-point scale. Three types of sentences were included in the recognition test: OLDS (sentences that were actually presented during the acquisition phase); NEWS (sentences which were not presented during acquisition but whose semantic structure formed a part of one of the complete ideas, i.e., their meaning was derivable from one of the complete ideas); and NONCASES (sentences whose meaning was not derivable from one of the ideas being communicated--for example, if one of the complete ideas, FOURS, was "The girl who lives next door broke the large window on the porch," the NONCASE could be "The man who lives next door broke the large window on the porch.").

The results of Bransford and Franks studies showed that the order of recognition and confidence rating was FOURS > THREES > TWOS > ONES, even though subjects had never actually heard FOURS at all. OLDS and NEWS received comparable ratings at the level of FOURS, THREES, and TWOS, supporting the hypothesis that the subjects retain information about holistic semantic structures and are much less likely to retain information about the particular sentences used to express the structure. In addition, NONCASES received lower ratings than OLD and NEW sentences, suggesting that subjects were not responding to sentence length, or complexity, or key words found in acquisition sentences.

The sentences used in the Bransford and Franks (1971) study expressed concrete ideas. Begg and Paivio (1969) reported research indicating that "concrete" sentences (e.g. "The spirited leader slapped a mournful hostage.") may be stored differently from more "abstract" sentences (e.g. "The arbitrary regulation provoked a civil complaint."). They matched the concrete and abstract sentences on frequency of their nouns, adjectives, and verbs; the lengths in letters and syllables of the nouns, adjectives, and verbs; and the length of the sentences in syllables. They hypothesized that the concrete sentences are stored as visual images while abstract sentences are stored by using a verbal code. The Begg and Paivio study suggested that an integration effect might not hold for abstract sentences for which images are not readily constructed with these sentences, and the subjects would have greater tendency to remember the particular sentences they had actually heard.

However, Franks and Bransford (1972) duplicated the experimental paradigm of Bransford and Franks (1971) using abstract sentences (an example of an abstract FOUR is: "The arrogant attitude expressed in the speech lead to immediate criticism."). They replicated the results of Bransford and Franks (1971), indicating that the findings were not solely a function of the concreteness of the sentences and that the storage of abstract and concrete sentences have many common properties.

To summarize briefly, the Bransford and Franks experiments supported a view of memory similar to that proposed by Bartlett. That is, people integrated information into a coherent organization or "schema" which directs their pattern of responses as to whether or not sentences have been heard.

One way to characterize these data is to say that elements (sentences) that were distinct at one stage of processing (the immediate processing period when the original sentences were presented) lost their distinctiveness at the memory storage stage (Cairns & Cairns, 1976). The experimental paradigm discussed is an example of nondistinctiveness being produced by integration of information.

Research by Bransford, Barclay, and Franks (1970) used a similar sentence recognition task to further investigate the nature of sentence representation in memory. Their study also shows a lack of distinctiveness in memory representations as a direct result of the addition of inferred information in memory. During the experiment, subjects were presented with a list of sentences differing only in the underlined prepositions, as examples (1) and (2), and told they would be asked questions about the sentences later:

(1) Three turtles rested beside the floating log and a fish swam beneath it.

(2) Three turtles rested on the floating log and a fish swam beneath it.

Subjects were given a three-minute break and then told that their task would be to recognize the sentences they had been presented with. Subjects were presented with sentences such as (3) and (4):

(3) Three turtles rested beside the floating log and a fish swam beneath them.

(4) Three turtles rested on a floating log and a fish swam beneath them.

The results demonstrated that subjects performed at an essentially chance level in recalling sentences like (2) and (4) correctly and not confusing them. Subjects performed significantly better in recalling sentences like (1) and (3). Sentence (4) can be inferred from (2) because if the turtles are on a log, then a fish swimming under the log is simultaneously swimming under the turtles. However, with sentences (3) and (1), if the turtles are only beside the log, it does not follow that the fish is swimming under the turtles.

The work by Bransford, Barclay, and Franks (1970) demonstrated that the memory representation of sentences (2) and (4) lacked distinctiveness and they argued, therefore, that such inferences were drawn as a normal part of language processing, and that the "knowledge enriched ideas" which resulted comprised the semantic representation stored in memory.

Jenkins (1971) continued research along these lines and investigated whether the representations of such sentences as (2) and (4) in memory are distinct at the moment of comprehension and merge over time, or whether these two sentences are represented in the same way. In other words, he wanted to show that immediate comprehension processes did not involve the addition of inferred information. He did this by asking the following questions of both (2) and (4): Did the fish swim beneath the turtles? The correct answer for both would be "yes." However the difference is that the information necessary for responding is explicit in sentence (4), but must be "inferred" from sentence (2). Both error data and response time of the study indicated that representations of sentences like (2) and (4) are distinct, and that these representations become nondistinct at a later point in time. Thus, there are actually two representations of meaning available for each sentence--the first a basic meaning derived from immediate comprehension processes, and the second an "enriched" meaning resulting from inference and/or integration as a sentence is stored in memory.

In summary, the studies discussed thus far focused on the inferential and integrative aspects of memory. The act of inferring is an information expansion process going beyond the given information and providing elaborative context and relational embellishments. Although the constructive nature of memory expands upon the explicit information, the consequent representation often involves information reduction. Redundant and extraneous information among sentences can be collapsed, resulting in a semantically integrated memory representation of the content of the sentences. Integration is an efficient manner to store information. Integration does not always follow from inferring, just as memory is not always the automatic consequence of understanding, although they are related.

Constructive Aspects of Children's Memory

There has been little research with children's sentence memory. According to Paris (1970), in his research with children, "semantic integration" is taken to be an active strategy of comprehension of sentences which includes expanding of explicit information through inferential operations and combining these constructed relationships. In other words, this constructive elaboration simplifies access to information, while integration provides efficiency of storage. The abilities to elaborate or make inferences and integrate ideas allow children to know the information more completely. Both are contingent upon the child's past experiences and knowledge of the environment.

An unpublished study, as reported by Glick (1975), replicated the integration experiment of Bransford and Franks (1971) with kindergarten, first-, and third-grade children. Results were similar to the original study, suggesting that children also spontaneously integrated information communicated by sets of semantically related sentences.

Paris and Carter (1973) attempted to determine if children constructed inferential relations like adults. The task they used consisted of verbally presenting seven brief paragraphs to second- and fifth-grade children who were instructed to remember the sentences they heard and repeat them. Each story consisted of three simple, contextually related, active, declarative sentences: two premise statements, (1) and (2), and a filler sentence (3).

(1) The bird is in the cage.

(2) The cage is under the table.

(3) The bird is yellow.

The premise sentences permitted the subject to infer an inter-sentence relationship (e.g. "The bird is under the table."). Subjects were then presented with four different sentences pertaining to each story and instructed to indicate which sentences they heard before. These sentences consisted of two semantically true sentences--an old true premise (4), a new true inference (6)--and two new and semantically false sentences--one a premise (5) and one an inference (7)--where the nouns were the same as true premises and inferences, but the prepositions were false relations:

(4) The bird is in the cage. (old true premise)

(5) The cage is over the table. (new false premise)

(6) The bird is under the table. (new true inference)

(7) The bird is on top of the table. (new false inference)

In this study, children, like adults (Bransford, Barclay, & Franks, 1972), could not discriminate OLD (true premise, as (4)), from NEW (true inference, as (6)) sentences which shared consistent meaning. The children readily rejected both false premises (as (5)) and false inferences (as (7)). This does not imply that syntactic and lexical factors cannot be remembered or are unimportant. However, it does suggest that comprehension is an active, constructive process.

Paris, Mahoney, and Buckhalt (1974) used a design similar to that of Paris and Carter (1973) to determine if mildly retarded children also shared the same constructive process of comprehension. In addition to assessing comprehension processes, the study also focused on determining whether the capability of retarded children to construct semantic relationships could be facilitated by imagery instructions of the type "Make a picture of this sentence in your head." Task 1 involved procedures similar to those used by Paris and Carter (1973), however they used only four descriptive passages. Paris et al. argued that retarded children were capable of spontaneous semantic integration in a manner qualitatively similar to nonretarded children and adults. However, subjects had difficulty differentiating between novel true-inference sentences and acquisition sentences, which seemed to contradict their conclusions. On the other hand, the relatively low error rates in the other three categories of recognition sentences (true premise, false premise, and false inference) suggested that subjects had less difficulty differentiating between acquisition sentences and recognition sentences in which the meaning was changed. Paris et al. argue the fact that subjects comprehended and remembered the semantic relationships expressed in the stories and not merely particular acquisition sentences is inconsistent with the nonconstructive characterization of memory. Of course, this does not imply that the retarded children do not rehearse individual words and sentences or do not profit from syntactic cues in sentences.

In a second aspect of the Paris et al. (1974) study, one-half of the subjects were given imagery instructions of the type "Make a picture of this sentence in your head" prior to listening to the paragraphs. The effects of imagery intervention, although not large, appeared to have facilitated the construction of semantic relationships. For True Premises, True Inferences, and False Inferences, the effects of the imagery instruction treatment were significant (i.e., reduction in the percentage of recognition errors). For the False Premises, the results were in the predicted direction, but not significant.

The images may have provided additional cues to organize and decode the verbal information into holistic descriptions of the situations. Perhaps with prolonged training on the use of imagery, the effects on comprehension would have been greater. However, the positive effects of even brief exposure to a mediator such as imagery suggest that retarded children's comprehension and memory for verbal material can be promoted through training procedures utilizing just this type of organizational strategy.

Neither the Paris and Carter (1973) nor the Paris, Mahoney, and Buckhalt (1974) studies revealed age-related improvement in semantic integration as measured by the recognition memory paradigm. Paris and Upton (1974) were concerned with age differences in children's comprehension of different kinds of inferences--such as contextual inferences (requiring integration of information from several sentences) and lexical inferences (where the inferential relationship was dependent upon a single word). They devised six paragraphs ranging from seven to nine sentences in length. They read them aloud to children in kindergarten (about six years old) through fifth grades (about eleven years of age) and asked them questions regarding the inferential relationships described above, in addition to questions requiring verbatim information. The results of the study suggest that children from six through eleven years of age increase the amount of both explicit and implicit information comprehended from paragraphs. In other words, there is an increased proficiency with age of spontaneously performing inferential operations on linguistic material.

In a series of studies by Paris and Lindauer (1976), young children often failed to construct and remember inferred relationships which they were capable of understanding. The paradigm for their three experiments involved the presentation of sentences to children to remember. The sentences were constructed to include an instrument commonly employed to accomplish the action of the verb. For example, one sentence was "The teacher cut into the juicy steak with a knife." The instrument of the sentence (knife) could be stated explicitly or it could be omitted and only implied by the sentence. If a subject ordinarily supplies missing, but implied, information to a sentence in order to understand its meaning, then he should derive the equivalent memory representation for sentences with either explicit or implicit instruments. Subsequently, the subject should be able to employ a retrieval cue such as the instrument to recall sentences with implicit or explicit instruments with equal facility. However, if young children do not spontaneously generate implied relationships such as appropriate instruments, then an instrument cue should be ineffective for retrieval unless it was stated directly in the sentence. This age by implicit-explicit cue factor interaction was the basic prediction in all the studies.

Experiment I consisted of presenting children (grades 1, 3, 5) with eight sentences--four explicit (for example, "His mother baked a birthday cake <u>in the oven</u>.") and four implicit instrument sentences (e.g. "Her friend swept the kitchen floor (with a broom)."). The children were told that the task was a memory game and they should try to remember the sentences. Following list presentation the children were told that they would be given a word which was a clue to one of the sentences they had heard. Each subject received eight instrument prompts (from the four explicit and four implicit sentences previously presented) as retrieval cues. A sentence was considered to be recalled correctly if the subject remembered two out of three words in the subject-verb-object categories. Results indicated that children in successive grades recalled more sentences, and that first and third graders recalled more sentences with explicit instrument prompts, whereas fifth graders recalled implicitly and explicitly cued sentences equally well.

Experiment II was designed to compare the effectiveness of implied instrument prompts with only the explicit subject, verb, and object of the sentence given. The procedure was identical to Experiment I, with the exception that all the instruments of the sentences were implicit (e.g. "The workman dug a hole in the ground"; "Our neighbor unlocked the door."). Again results indicated that older children were able to use implicit relationships to facilitate sentence memory and young children were not.

Paris and Lindauer suggested that young children may not derive semantically complex relations, such as implied instruments, because they only process sentences at a superficial level. The intent of Experiment III was to determine if young children can be made to process sentences at a deeper level and ameliorate their inefficient processing. The procedure was again similar to Experiment I, with the exception that children were permitted to act out the described actions. This forced the child to process the implied instrument.

The results indicated that the simple instructions to act out sentences forced children to generate inferential relationships in order to understand the sentences and allowed them to utilize this information to facilitate recall. This procedure eliminated the previously found differences between implicitly and explicitly cued sentences and aided recall on a longer list of sentences (there were three additional sentences for Experiment III).

These studies can be added to previous experimental evidence that individuals draw inferences (and include this information in memory) from previously given and contextually relevant information. The generated relationships serve as functional retrieval cues for access to information stored directly during decoding. Between the ages of six and twelve, children significantly alter their ability to apply inferential processes to tasks of sentence memory. The functional utility of indirect and implied retrieval cues increases with age accordingly.

Brown (1976) found no significant age effects in an experiment involving the constructive processes of memory utilizing sequence reconstruction tasks. Preschool to fourth-grade subjects (ages 4-10 years) were presented with a series of six pictures depicting a narrative sequence. On test trials each subject was required to reconstruct the story by selecting the events actually seen from another set of pictures containing old items (actually seen) and two types of new items: New-Inconsistent items which depicted events violating the ordered sequence of the story, and New-Consistent items in which the events were consistent with the order of events in the story but were never actually viewed. It was suggested that older children were more efficient at adopting a consistent choice strategy, at rejecting the inconsistent items and at retaining the end-anchor items of the story. However, when the performance on the old anchor items was excluded, all age subjects had difficulty distinguishing the New-Consistent items from the old items actually presented. The experimental results further supported the view that memory for logical narrative sequences (in this case, with the availability of visual cues) involves the retention of the theme in an integrated unified representation of meaning, rather than a series of discrete events. In addition, there were no significant differences in performance across ages.

Collectively, these studies indicated that children (normal and, to some degree, retarded) constructed inferential relationships and integrated these relationships in their effort to comprehend and remember information. To date, however, few known underlying causes of specific learning difficulties have been researched in order to provide functional remedial techniques. Therefore, it seemed worthwhile to examine the possibility that deficient semantic integration contributes to learning problems in some children. A limited amount of empirical evidence concerning the processes involved is available in terms of the learning disabled population. New concepts and constructs are needed to better understand the developmental aspects of information processing in learning disabled children. The research presented in this paper is addressed to this need.

CHAPTER II

LEARNING DISABILITIES IN CHILDREN

Definition

There are several approaches to the problem of operationally defining learning disabilities. Definitions focusing on "neurological dysfunction" or "brain impairment" attempted to identify organic etiology. Johnson and Myklebust (1967) conceptualized learning disabilities as a neurological dysfunction:

> . . . we refer to children as having a psychoneurological learning disability meaning that behavior has been disturbed as a result of a dysfunction of the brain and that the problem is one of altered processes, not of a generalized incapacity to learn. (p. 8)

In addition, another aspect included in their definition was that these children did not fit into any other area of exceptionality; that is, children with learning disabilities are not primarily mentally retarded, emotionally disturbed, culturally deprived, sensorily handicapped, etc. ("definition by exclusion," Lerner, 1976).

Myers and Hammill (1969) and Gallagher (1966) emphasized the irregular development of mental abilities or psychological processes in relation to educational growth. Bateman (1965) defined children with specific learning disabilities by focusing on the criterion of a significant discrepancy between the child's potential capability for learning (estimated intellectual potential) and actual level of performance.

Focusing on the dimension of actual behavioral manifestations of learning disabled children, Kirk (1962) emphasized the problem that such children encounter:

> A learning disability refers to a retardation, disorder or delayed development in one or more of the processes of speech, language, reading, spelling, writing or arithmetic resulting from a possible cerebral dysfunction and/or emotional or behavioral disturbance and not from mental retardation, sensory deprivation or cultural or instructional factors. (p. 263)

In an attempt to channel these diverse perspectives, a definition was formulated by the National Advisory Committee on Handicapped Children (1967). They determined that:

> A learning disability refers to one or more significant deficits in essential learning processes requiring special educational techniques for its remediation. Children with learning disability generally demonstrate a discrepancy between expected and actual achievement in one or more areas, such as spoken, read or written language, mathematics, and spatial orientation. The learning disability referred to is not primarily the result of sensory, motor, intellectual or emotional handicap, or lack of opportunity to learn. Deficits are to be defined in terms of accepted diagnostic procedures in education and psychology. Essential learning processes and those currently referred to in behavioral science as perception, integration, and expression, either verbal or nonverbal. Special education techniques for remediation require educational planning based on the diagnostic procedures and findings. (p. 283)

Although numerous definitions exist, each having relevance and function for different users, it is suggested that terminology used should accurately describe the child's behavioral symptoms through observation and sampling procedures.

The American Speech and Hearing Association Task Force on Learning Disabilities (1975) has suggested that a definition can and should be interpreted to account for the fact that children who have learning disabilities exhibit a wide variety of behaviors. Such behaviors include various verbal and nonverbal impairments (Johnson & Myklebust, 1967) that may occur as deficits in perception (reception of auditory, visual, tactile, kinesthetic stimuli); conceptualization (cognition, integration); memory and imagery (auditorization, visualization); symbolization (language, reading, writing, mathematics); attentional and impulse control; and motor function. The Task Force further suggested that although much information is available about the nature of, and interferences in, learning-communication processes, additional research is mandatory to meet the practical needs of children with learning problems. Some of the general areas proposed by the Task Force involved:

(a) investigation of the role of sensory integration in the learning process;

(b) investigation of the similarities and differences in the acquisition and development of language by children with normal and impaired communication;

(c) exploration and definition of the processes of perception, conceptualization, memory and imagery, symbolization in relation to communicative competence and performance.

Most recently, the United States Legislature pointed out the problems of defining a specific learning disability very clearly. Pub. L. 94-142, enacted November 29, 1975, contained amendments to the Education of the Handicapped Act which provided for assistance to the states in initiating, expanding, and improving programs for the education of handicapped children. An important part of the program was the definition of "handicapped children," and, in particular, "children with specific learning disabilities." Finally, the United States Congress (Section 5(b)(1) of Pub. L. 94-142, November, 1976) defined "children with specific learning disabilities" as follows:

> Those children who have a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which disorder may manifest itself in imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculation. Such disorders include such conditions as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia. Such term does not include children who have learning problems which are primarily the result of visual, hearing, or motor handicaps, of mental retardation, of emotional disturbance, or environmental, cultural, or economic disadvantage. (p. 52404)

Attempting to comply with Congressional intent, the Office of Education noted general limitations in determining what conditions constitute a specific learning disability. Among the points made by the Office of Education was, "There exists no hard research data collected on a large enough sample in order to state, with certainty, which are the common characteristics of all learning disabled children."

Past research in learning and communicative disabilities has been somewhat contradictory and nondefinitive. Many research findings on effectiveness of intervention cannot be compared because of variations among investigators from different disciplines. These investigations differ in their orientation and use of knowledge, definitions, and conceptual models. The present research attempted to reconcile some of the problems delineated by ASHA and the Government Office of Education, specifically addressing itself to the gap between knowledge acquired from research and its practical application.

Language Processing in Learning Disabled Children

Current research indicates that learning disabled children demonstrate language processing deficits. Among the possible bases for these problems are (1) reductions in auditory memory, temporal, sequencing, and auditory-visual integration, (2) limitations in abstraction and conceptualization, (3) deficits in linguistic processing, and (4) delays in cognitive and logical processing.

Figure 1 (Wiig & Semel, 1976, p. 24) represents a presumed relationship between perceptual, linguistic, and cognitive processing in language comprehension. The complex act of auditory language processing was divided into three levels: (1) perception of sensory data, (2) linguistic

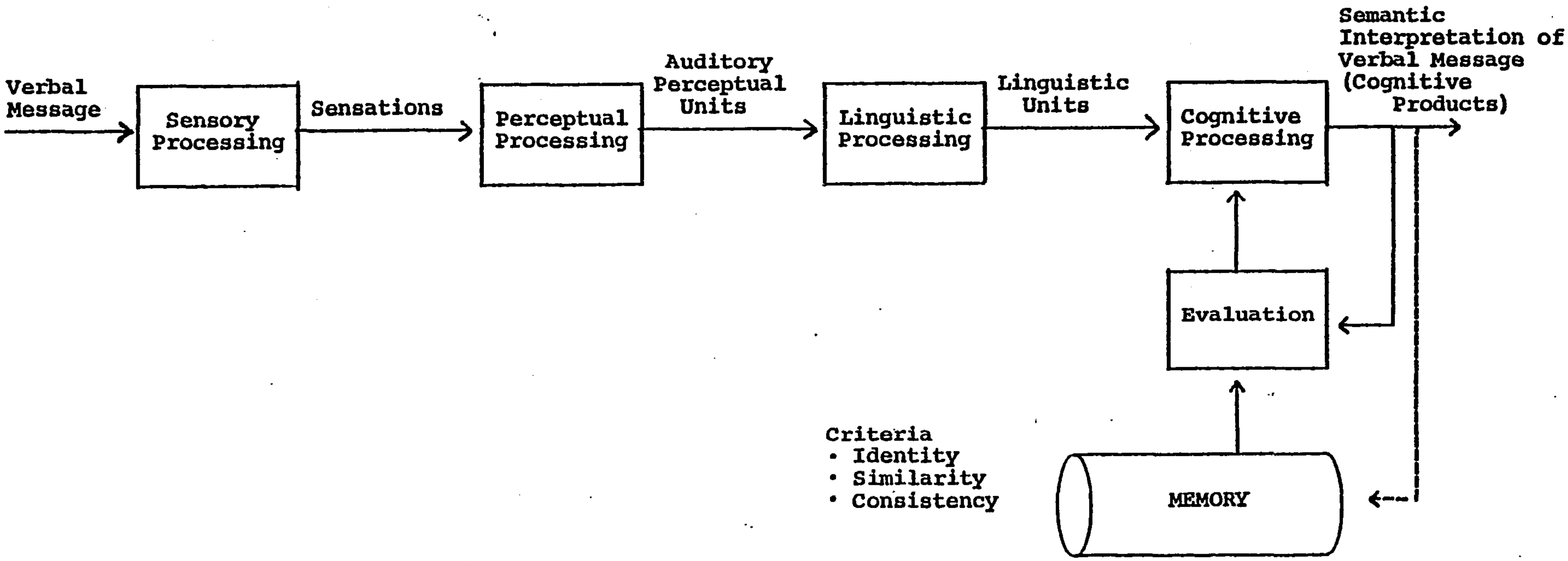

Fig. 1. Illustration of the relationship between perceptual, linguistic, and cognitive processing in language comprehension (Wiig & Semel, 1976).

processing of phonological, morphological, and syntactic structure and semantic aspects, and (3) cognitive processing. However, it is important to note that it is exceedingly difficult to make a definitive separation between these three levels as presented in this version of the processing model.

Auditory-perceptual deficits associated with learning disabilities sometimes reflect impaired or selective attention to auditory or meaningful linguistic stimuli. The auditory-perceptual deficits may also reflect problems in sound localization, phoneme discrimination, and discrimination of phoneme sequences (Aten & Davis, 1968; Flowers & Costello, 1970).

Within a linguistic-cognitive framework, deficits exhibited by learning disabled children may be manifested at the phonological, morphological, syntactic, and semantic levels. Delays have been noted in the acquisition of morphological and syntactic rules, suggesting deficits in linguistic competence (Rosenthal, 1970; Wiig, Semel, & Crouse, 1973; Vogel, 1974; Semel & Wiig, 1975). A number of authors have postulated that children with learning disabilities frequently exhibit limitations in auditory memory for nonlinguistic (e.g. digits), and linguistic (e.g. sentences) stimuli (Chalfant & Schefflin, 1969; Wiig & Semel, 1976). The limited research reported has resulted in nondefinitive conclusions regarding the relationship between sentence comprehension and specific memory functions.

These investigations found that the linguistic abilities of learning disabled children were characterized by inadequate comprehension of connected speech, grammatic confusions, and errors in language production. They also had problems in processing and producing verbal elements in proper sequence (Rosenthal, 1970; Meier, 1971; Lerner, 1975; Semel & Wiig, 1975; Wiig & Roach, 1975). It has been suggested that limited auditory memory capacities underly the morphological and syntactic deficits of learning disabled children (Rosenthal, 1970; Menyuk & Looney, 1972; Wiig, Semel, & Crouse, 1973; Lerner, 1975; Semel & Wiig, 1975; Wiig & Roach, 1975).

Recent investigations of sentence comprehension and repetition by learning disabled children have shown that they experience significant deficits in linguistic rule using and memory. Rosenthal (1970) observed that for learning disabled children syntactic complexity was a more significant variable in sentence comprehension than length of sentences; thus, comprehension problems increased as a function of syntactic complexity.

Semel and Wiig (1975) found comprehension problems that supported research findings of Menyuk and Looney (1972). Using a sentence comprehension task involving the Northwestern Syntax Screening Test (Lee, 1971) and the Assessment of Children's Language Comprehension (Foster, Giddan, & Stark, 1972), Semel and Wiig indicate that learning disabled children exhibited significant comprehension deficits for syntactic structures and critical verbal elements. In terms of syntactic structures, the greatest comprehension deficits occurred for questions, passive sentences, and sentences which expressed relationships between direct and indirect objects. Learning disabled children also exhibited deficits in the comprehension of sequences with four lexical items (e.g. "happy little girl jumping"). Most of their errors reflected memory problems for the middle elements of the sequence, suggesting that learning disabled children have problems in the comprehension of prepositional relationships as well as in verbal memory.

Wiig and Roach (1975) investigated sentence repetition deficits in learning disabled adolescents by observing the effects of varying the semantic and syntactic constraints on the recall of sentences. When compared to academically achieving adolescents, learning disabled children exhibited significant reductions in sentence recall. The sentences involved those that were syntactically consistent but violated semantic rules (as (1)), or contained correctly or incorrectly sequenced modifier strings (as (2)), or consisted of a random word string (as (3)), or were syntactically complex (as (4)).

(1) The chair roughly painted the fire.

(2) He has sold the long heavy grey shining car.

(3) Not in a tree to the lake ran with.

(4) The politician nearly lost the election.

Responses by the learning disabled adolescents indicated inadequate recall of specific words. In addition, they normalized deviant syntactic structure less frequently than the control group, perhaps because they did not attempt to remember the material in terms of linguistic structure. Wiig and Roach suggested that the significant variables in the recall of sentences by learning disabled adolescents were semantic consistency and syntactic complexity. Their difficulties seemed to reflect limitations in short-term memory. Semantic interpretation represented in long-term store appeared to facilitate auditory processing and recall.

Wiig and Semel (1976) stated that the highest level of comprehension of auditory language involved the ability to discern information that was implied, but not provided. For example, after hearing parts of a story, the learning disabled child may not be able to predict the outcome. He may not be able to generalize the implications of the story to past and future personal interactions. These children exhibit what has been referred to in the literature as impaired "cognition of semantic implications" (Guilford, 1967). However, little, if any, empirical research has been done in this area. Strauss and Kephart (1955) have said:

> We have seen that the brain-injured child has particular difficulty in those aspects of perception which require the organization of elements into wholes, or combination of elements into manageable units. It

would therefore be expected that he would have more than average difficulty in developing language as a symbolism since this type of development rests almost entirely upon combining and organizing various factors of many situations into one unitary concept.

It was the goal of this research to determine if learning disabled children go beyond the given information when trying to understand and remember sentences, i.e., do they spontaneously construct inferential relationships like adults and other children, or do they attend to and rehearse individual sentences or specific sentence constituents. The experimental design used was similar to that of Bransford and Franks (1971) and Franks and Bransford (1972). In addition to assessing memory strategies of learning disabled children, this study presented two types of sentences (highly imageable versus not easily imaged) in order to determine whether or not semantic integration by these children was related to, or facilitated by, image factors. Further, developmental changes in the use of integrative skills were analyzed.

CHAPTER III

PROCEDURE

Subjects

Experimental subjects included sixty children (thirty girls and thirty boys) classified as learning disabled by a psychoeducational diagnostic team consisting of a speech and language evaluator, an educational evaluator, and a psychologist. Each subject received an educational evaluation, lasting approximately two hours. During the evaluation, the subject's academic, perceptual, and motor performance skills were tested. Each subject also received a complete speech, hearing, and language evaluation (lasting approximately one hour). The subjects were also seen by a certified psychologist, a qualified pediatric neurologist, and a licensed psychiatrist for full evaluations or supplementary testing to update previous reports. In addition to individual testing sessions, each subject was required to spend two other days in a special group setting with a teacher who evaluated peer interactions as well as academic functioning in a small class situation. A complete social history, including pertinent pregnancy, birth, and neo-natal history, developmental milestones, and family background was obtained from the subject's parents or guardians. These evaluation procedures were done routinely by the New York City school system for children exhibiting learning problems.

Criteria for subject selection as learning disabled were:

(1) educational test scores in two or more academic areas two years below grade level

(2) language test results within one standard deviation from the mean for the various tests administered (it should be noted that on the current language measures available, learning disabled children do not exhibit gross linguistic deficiencies, and despite their more subtle learning and language problems, tend to fall within normal limits)

(3) auditory acuity within normal limits

(4) psychometric evaluation WISC Verbal Scale IQ score above 85

(5) evidence of organicity

Following the abovementioned criteria, the actual characteristics of the subjects included:

(1) reading and math abilities at least two years below chronological grade levels, as measured by the following tests: Wide Range Achievement Test (Word Recognition, Math, Spelling), Gray Oral Reading Test, Key Math Diagnostic Test, Durrell Test of Reading Analysis, Peabody Individual Achievement Test (Reading, Math, Spelling, General Information)

(2) language test results: results of the Peabody Picture Vocabulary Test (a controlled vocabulary test) indicated a mean IQ score of 99 (test mean 100, standard deviation 15). Selected auditory vocal subtests of the Illinois Test of Psycholinguistic Abilities were administered. The I.T.P.A. is a widely used test of language related abilities. Results of both the Auditory Association and Auditory Reception subtests indicated a mean scaled score of 32 (test mean 36, standard deviation 6).

(3) psychometric evaluation yielded a WISC Verbal Scale IQ mean of 93 (test mean 100, standard deviation 15).

The experimental subjects ranged in age from 7 years 0 months to 10 years 11 months. There were fifteen subjects in each of the following age groups:

(1) 7 years 0 months-7 years 11 months

(2) 8 years 0 months-8 years 11 months

(3) 9 years 0 months-9 years 11 months

(4) 10 years 0 months-10 years 11 months

These subjects were either attending or awaiting placement in coed special education classes in New York City public schools. They were predominantly from middle-class socioeconomic backgrounds.

Control subjects consisted of sixty normal children (thirty girls and thirty boys). They were chosen by their respective classroom teachers. Criteria for selection was appropriate grade level performance in all academic areas.

Consultation with teachers and principal ruled out potential subjects with any history of special education or related learning problems.

Control subjects ranged in age from 7 years 0 months to 10 years 11 months, with fifteen subjects per age range corresponding to experimental groups. These subjects attended grades two through five of a predominantly middle-class regular day elementary New York City public school.

Method

Subjects in both the experimental and control groups were tested individually. For the experimental subjects, testing was done in a room approximately 150 square feet, containing a large desk (2' x 3'), two chairs, a metal file cabinet, and a clothes closet. Subjects were seated at the side of the desk, facing the examiner. Control subjects were tested in a similarly arranged room at their school. All subjects were seen early in the school day between the hours of nine and eleven a.m.

The experimental design consisted of three sections. A separate set of sentences was constructed for each section. Sections I, II, and III each had two parts. Part 1 was an incidental learning procedure in which subjects were presented with a list of sentences, one by one. A question followed each sentence. Subjects were required to answer the question about the sentence before the next sentence was presented. This procedure continued for all sentences of

Part 1. Subjects were not told that they were later going to be tested on the sentences, nor that they would be integrating the meanings of the sentences presented. During Part 2 of each section subjects were presented with another list of sentences and asked whether they had heard those sentences before. Section III was a control task to determine the general ability of the subjects to answer questions about sentences and to recognize a list of eight sentences.

Selection of Sentences

Twenty-five four-proposition sentences were constructed. The psycho-educational diagnostic team, involved in the subject selection and evaluation of experiment subjects, were asked to separate the sentences into groups ranging from "easily imaged" to "not easily imaged." Two sentences unanimously judged to be at the extreme ends of the scale were chosen for Section I (CONCRETE) and Section II (ABSTRACT). Further screening consisted of matching the two sets of sentences for word frequency (Carroll, Davis, & Richman, 1971). All words chosen fell within the 0.2% of the 5,088,721 most frequently used words.

Apparatus and Instructions

All sentences for Parts 1 and 2 were prerecorded on a portable Channel Master audio tape recorder (model 6394) using TDK SD-C60 tape cassettes. Specific instructions presented by the examiner prior to administering Part 1 sentences were:

> You are going to hear a list of sentences. After each sentence you are going to hear a question about that sentence, and I want you to tell me the answer.

The recorder was stopped long enough for the subject to respond to the question.

After Part 1 was completed, Part 2 instructions were given by the examiner as follows:

> You are going to hear another list of sentences. Some of the sentences are the same and some are different from the sentences you just heard. I want you to tell me if you heard the sentences before, or if you did not hear them. Tell me "yes" if you heard it before, "no" if you did not. Listen carefully because the sentences will not be repeated.

Testing Procedure

Specifically, Section I consisted of two complete idea sets in sentences which were imageable (i.e., CONCRETE). For each of these complete sentences, the meaning could be summarized into one organized unit. For example, the two complete sentences were:

"The big bear ate the chocolate candy in the woods."

"The old farmer milked the brown cow in the barn."

Each complete sentence was composed of four basic propositional units. Sentences, each expressing only part of the meaning of one of the complete ideas, were formed. Those expressing one of the basic propositions were called ONES, as the following sentences:

The bear was big.

The bear ate the candy.

The candy was chocolate.

The bear was in the woods.

And:

The farmer was old.

The farmer milked the cow.

The cow was brown.

The cow was in the barn.

Correspondingly, the complete sentences containing all four interrelated basic propositional units were called FOURS. Additional sentences such as the above were constructed by combining ONES into combinations of two propositional units called TWOS, as the following sentences:

The big bear ate the candy (which consists of "The bear was big" and "The bear ate the candy").

The old farmer milked the cow (which consists of "The farmer was old" and "The farmer milked the cow").

Three propositional units called THREES were constructed, as the following sentences:

The big bear ate the chocolate candy.

The old farmer milked the cow in the barn.

Appendix A presents each FOUR of Section I and the complete set of ONES, TWOS, and THREES related to it.

In addition, NONCASE sentences were constructed. A NONCASE sentence is a sentence whose meaning is not derivable from one of the complete ideas being presented. Two types of NONCASES were formed: (1) TYPE I--a false inference, in which the combination of propositions of complete ideas is incorrect (e.g. "The farmer ate the chocolate candy in the barn"); and (2) TYPE II--a sentence whose idea is not related to either of the complete ideas, however contains a similar lexical item as one of the complete ideas (for example, "The cow ate the grass"). NONCASES were one (ONE), two (TWO), three (THREE), and four (FOUR) proposition sentences. Appendices A and B include all examples of NONCASE sentences presented.

Part 1 of Section I contained eight sentences--two ONES, one TWO, and one THREE related to each of the two complete sentences. Sentences were chosen so that, as a group, they included all the information contained in each complete idea. The sentences, which were taped, were presented individually to each subject (experimenter controlled stopping and starting of the audio tape recorder as previously discussed). Each sentence was followed by a question, read by the experimenter, about that sentence. For example, for the sentence, "The cow was brown," the question, "What color was the cow?" followed. The response from the subject would be, "brown." Questions were selected so that each constituent of each complete sentence was questioned for all eight sentences in Part 1. Subjects were not told that there would be a second part to the experiment.

Subjects were given a one- to two-minute break after Part 1 was completed. They were then told that they would now hear another set of sentences, all of which were related to the sentences they just heard during Part 1. Their task was to indicate by saying "yes" or "no" which of the sentences they heard before and which ones they had not.

Part 2 contained three general types of sentences: eight old sentences (OLDS); eight new sentences (NEWS); and eight NONCASES (four each for TYPE I and TYPE II). OLDS were sentences actually presented during Part 1, including two ONES, one TWO, and one THREE related to each of the two ideas. NEWS were sentences whose meanings were derivable from one of the complete ideas (by combining the meaning of the set of sentences dealing with the same idea), however they were not actually presented during Part 1. NEWS consisted of one ONE, one TWO, one THREE, and one FOUR (the complete sentence). Finally, eight NONCASES were included--one ONE, one TWO, one THREE, and one FOUR for each of the two types of NONCASES previously described. Thus, Part 2 consisted of twenty-four sentences.

The order of presentation was similar to that of Part 1. The sentences were randomized with the constraint that no two sentences related to a given idea appear consecutively in the lists. Appendix C (Section I) represents sentences and questions given during Parts 1 and 2.

The general sentence TYPES (OLDS, NEWS, and NONCASES), as well as the number of sentences used, were similar for Section II of the experiment. However, Section II consisted of two complete sentences in which the verbal units could not easily be summarized or transformed into a nonverbal unit, i.e., they were not easily imaged (ABSTRACT). For example, the two complete (FOURS) ideas for Section II were:

"The smart children did not understand the important new rules."

"The proud poor people were disappointed by the high taxes."

Other sentences related to each complete idea, as well as NONCASES, were constructed as for Section I. Appendix B presents each FOUR and a complete set of ONES, TWOS, and THREES related to it. Appendix D presents the additional sentences and questions given during Parts 1 and 2 of Section II.

Section III was used as a control to determine the ability of children to answer questions about sentences and to recognize a list of eight sentences. Section III also consisted of two parts. During Part 1, the examiner presented each sentence to each subject followed by a question about that sentence. Subjects were also required to respond to each question. The eight sentences were totally unrelated to each other. The list consisted of sentences composed of one (ONE), two (TWO), three (THREE), and four (FOUR) propositions (two of each for a total of eight sentences).

Part 2 consisted of presenting another list of sentences to each subject. After each sentence subjects were instructed to respond "yes" or "no" as to whether it was heard before. The list of sentences for Part 2 was composed of five OLDS, i.e., sentences presented during Part 1 (one ONE, one TWO, two THREES, and one FOUR), and three NONCASES--one FOUR which was completely novel and unrelated to Part 1 sentences, and one ONE and one TWO which were related to Part 1 sentences only in terms of a repeated lexical item. Appendix E contains all the sentences and questions used for Section III, Parts 1 and 2. The presentation of Sections I, II, and III was randomized.

Summary

It is important to initially discuss the type of performance pattern that constitutes semantic integration. Within the limitations of the present study, semantic integration occurs when subjects respond in the following way: (1) NEW sentences should receive positive or "yes" ratings because they are derivable from the complete idea (i.e., all the information given) which has been stored. Subjects should think they heard NEW sentences even though they did not actually hear them before. Such responses are called "false positives"; (2) both types of NONCASES should receive negative or "no" responses because they are not derivable from the complete idea. NONCASE data are very important for interpreting results. TYPE I NONCASES would show that subjects were not just responding to sentence length or complexity, inasmuch as they are just as long and complex as any of the clear cases. TYPE II NONCASE results would also suggest that subjects were not merely responding on the basis of key words heard in the Part 1 sentences given. This ability to distinguish subtle differences in sentences suggests precise discrimination of semantic information remembered; (3) OLDS and NEWS should receive similar "yes" responses since responses are based on combined information of a sentence set, not just individual sentences actually heard.

CHAPTER IV

RESULTS

All data reported were in terms of the mean number of "yes" responses to sentences presented. The raw data used was the actual number of "yes" responses to each sentence presented.

The following between and within subject variables and levels of the variables were referred to by these labels:

Between subject variables:

CATEGORY - (2 levels) LD/NORMAL

AGE - (4 levels) 7/8/9/10 years

Within subject repeated measures:

IMAGE - (2 levels) CONCRETE/ABSTRACT

TYPE - (3 levels) OLD/NEW/NONCASE

NONCASES - (2 levels) TYPE I NON/TYPE II NON

ELEMENTS - (4 levels) ONE/TWO/THREE/FOUR

An analysis of variance was computed for the following variables across the repeated measures (Tables 1 and 2): CATEGORY X AGE X IMAGE X TYPE (OLD/NEW/NON). As there was a total of eight sentences per sentence IMAGE/TYPE, the maximum number of "yes" responses was eight. There was no main effect for AGE across variables. Results indicate a significant difference between the mean number of "yes" responses

TABLE 1

MEAN NUMBER OF "YES" RESPONSES BY LEARNING DISABLED CHILDREN AS A FUNCTION OF SENTENCE IMAGE AND TYPE

Age	CONCRETE				ABSTRACT				Total Row Mean
	OLD	NEW	NON		OLD	NEW	NON		
7	7.13	6.00	1.67	4.93	6.33	5.20	2.13	4.54	4.74
8	7.07	6.07	1.13	4.76	6.93	5.20	2.13	4.75	4.76
9	6.60	6.93	1.13	4.87	6.40	4.90	1.67	4.32	4.61
10	7.00	6.00	2.33	5.11	6.33	6.00	2.53	4.95	5.03
Column Mean	6.95	6.25	1.57		6.50	5.33	2.11		

TABLE 2

MEAN NUMBER OF "YES" RESPONSES BY NORMAL CHILDREN
AS A FUNCTION OF SENTENCE IMAGE AND TYPE

Age	CONCRETE				ABSTRACT				Total Row Mean
	OLD	NEW	NON		OLD	NEW	NON		
7	6.47	6.80	0.00	4.42	5.67	6.53	0.00	4.07	4.25
8	6.47	6.33	0.00	4.27	6.33	6.80	0.00	4.38	4.33
9	6.47	6.33	0.00	4.27	5.73	6.47	0.00	4.07	4.17
10	7.07	5.87	0.00	4.31	5.00	6.53	0.00	3.84	4.08
Column Mean	6.62	6.33	0.00		5.68	6.58	0.00		

for LD (Learning Disabled) and NORMAL children ($F = 16.401$, $df = 1.112$, $p = < .001$). Table 3 and Figure 2 show a significant CATEGORY X TYPE interaction ($F = 52.75$, $df = 2,224$, $p = < .001$). LD children responded "yes" a significantly greater number of times for OLDS ($p = < .005$) and NONS ($p = < .001$) than did NORMALS, with a significant drop for NEWS ($p = < .002$). In addition, a planned comparisons of the means indicated that LD children scored higher for OLDS than NEWS ($p = < .001$), whereas for NORMALS the mean number of "yes" responses for OLDS and NEWS was not significantly different (i.e., OLDS = NEWS).

For both CATEGORIES (LD/NORMAL) the total number of "yes" responses to OLD + NEW TYPES differed from NONS, accounting for the TYPE main effect ($F = 1228.054$, $df = 2,224$, $p = < .001$), and the IMAGE X TYPE interaction ($F = 14.329$, $df = 2,224$, $p = < .001$). The IMAGE effect ($F = 7.873$, $df = 1,112$, $p = < .005$) revealed, on the average, a greater number of "yes" responses for CONCRETE than for ABSTRACT sentence types.

Table 4 and Figure 3 show a significant CATEGORY X TYPE X IMAGE interaction ($F = 14.185$, $df = 2,224$, $p = < .001$). The number of "yes" responses of learning disabled children consistently and significantly decrease for every sentence TYPE, regardless of IMAGE (OLDS $>$ NEWS $>$ NONS). NORMAL children, on the other hand, do not distinguish OLD and NEW CONCRETE sentences, but score higher (greater number of

TABLE 3

MEAN NUMBER OF "YES" RESPONSES TO OLD, NEW, AND NONCASE SENTENCES BY LEARNING DISABLED AND NORMAL CHILDREN (CATEGORY X TYPE INTERACTION)

	OLD	NEW	NON	Row Mean
LD	6.725	5.792	1.842	4.786
NORMAL	6.150	6.458	0.000	4.203
Column Mean	6.437	6.125	0.921	

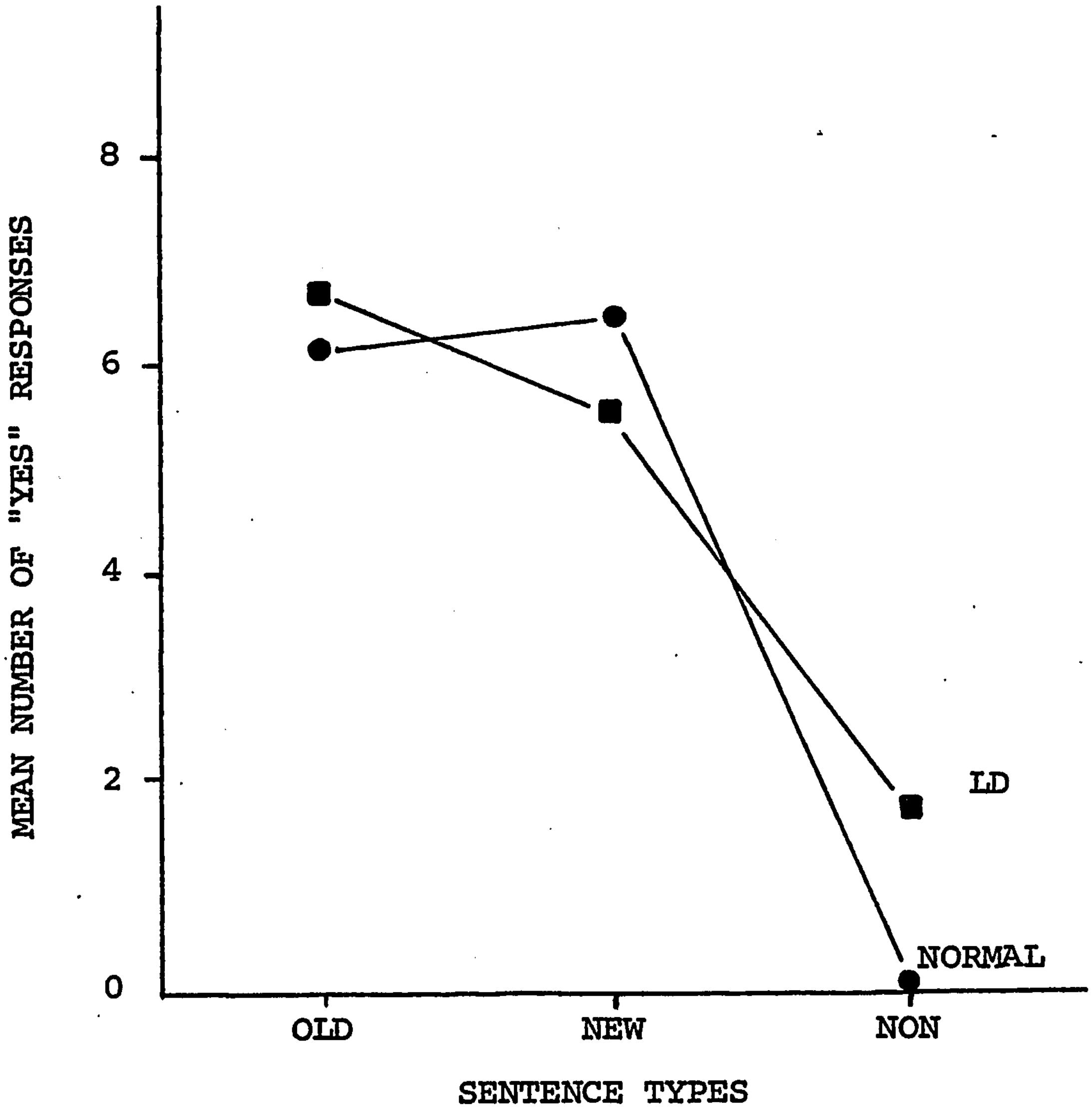

Fig. 2. Mean Number of "Yes" Responses to OLD, NEW, and NONCASE Sentences by Learning Disabled and Normal Children (CATEGORY X TYPE INTERACTION).

TABLE 4

MEAN NUMBER OF "YES" RESPONSES BY LEARNING DISABLED AND NORMAL CHILDREN AS A FUNCTION OF SENTENCE TYPE AND IMAGE (CATEGORY X TYPE X IMAGE INTERACTION)

	CONCRETE			Row	ABSTRACT			Row
	OLD	NEW	NON	Mean	OLD	NEW	NON	Mean
LD	6.950	6.250	1.567	4.922	6.500	5.333	2.117	4.650
NORMAL	6.617	6.333	0.000	4.317	5.683	6.583	0.000	4.089
Column Mean	6.783	6.292	0.784		6.092	5.958	1.059	

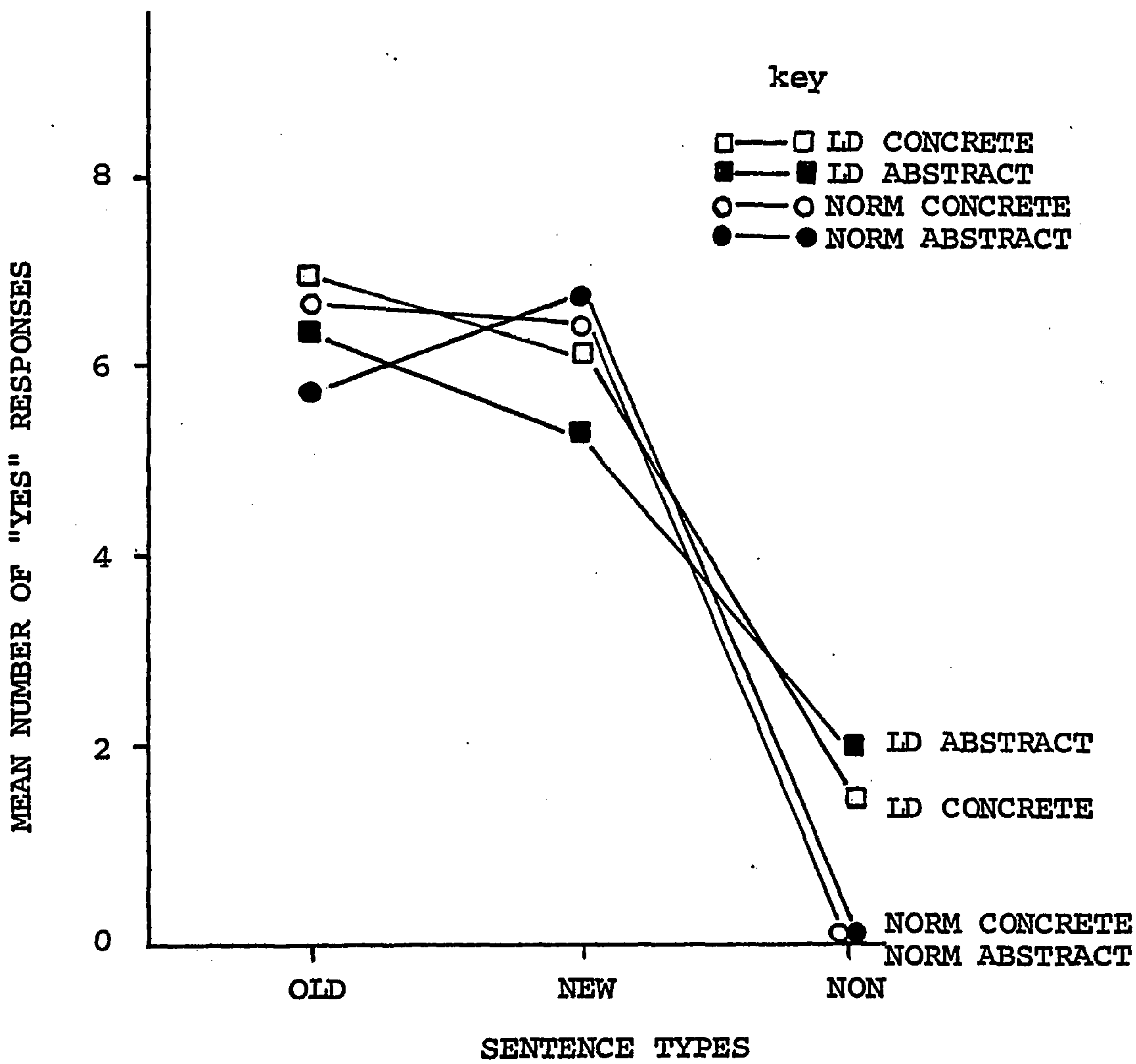

Fig. 3. Mean Number of "Yes" Responses by Learning Disabled and Normal Children as a Function of Sentence TYPE and IMAGE (CATEGORY X TYPE X IMAGE INTERACTION).

"yes" responses) on NEW ABSTRACTS than OLD ABSTRACTS. In addition, LD children have the lowest score for NEW ABSTRACTS as compared to other combinations of IMAGE X TYPE.

In comparison LD and NORMALS function similarly for CONCRETE OLDS and for CONCRETE NEWS. However, for ABSTRACT sentences, LD children score significantly higher for OLDS ($\underline{p} = < .002$) and significantly lower for NEWS ($\underline{p} = < .001$) than do NORMALS. Thus it is the ABSTRACT sentences which account for total results shown on Table 4.

In order to make appropriate comparisons within levels of the variables, a number of smaller analyses were done. While it is known that there are not enough degrees of freedom for multiple analyses, they were carried out for a more complete picture of the results. It is further justified in view of the fact that so many interactions were significant.

A separate analysis of variance was computed for the variables CATEGORY X IMAGE X TYPE (OLD/NEW) X ELEMENTS (ONE/TWO/THREE). The number of responses were averaged across two per element (thus two was the maximum number of "yes" responses recorded). Also NEW FOURS were eliminated from this analysis, inasmuch as there were no OLD FOURS for comparison. However, the NEW FOURS were subsequently analyzed for all categories and combined with the following results.

There were no significant AGE or CATEGORY main effects across ONE, TWO, and THREE elements sentences. The significant main effects were for IMAGE ($F = 16.238$, $df = 1,112$, $p = < .001$); TYPE ($F = 80.240$, $df = 1,112$, $p = < .001$); and ELEMENTS ($F = 169.764$, $df = 2,224$, $p = < .001$).

Table 5 and Figure 4 show that on the average, for all children, the mean number of "yes" responses are ordered such that: CONCRETE > ABSTRACT, OLDS > NEWS, THREES > TWOS > ONES.

Table 6 and Figure 5 distinguish between the performance of the LD and NORMAL children, showing the significant and extremely important CATEGORY X ELEMENT interaction ($F = 45.138$, $df = 2,224$, $p = < .001$). Collapsing over OLDS/NEWS and CONCRETE/ABSTRACT sentences, for NORMALS, the increase in the mean number of "yes" responses is a function of the increase in the number of ELEMENTS per sentence. However, for LD children, the mean number of "yes" responses significantly increases from ONES to TWOS ($p = < .001$), remains the same from TWOS to THREES, and starts to decline from THREES to FOURS ($p = < .01$). In addition, LD children scored significantly higher for ONES than did NORMALS, and converged at TWOS (the point at which the behavior of integration would start to occur). Then, the NORMALS significantly surpassed LD children at THREES ($p = < .001$) and continued the significant rise to FOURS ($p = < .001$).

TABLE 5

MEAN NUMBER OF "YES" RESPONSES BY ALL SUBJECTS AS A FUNCTION OF SENTENCE TYPE, IMAGE, AND ELEMENT (IMAGE X ELEMENT X TYPE INTERACTION)

	OLDS			Row	NEWS			Row
	ONE	TWO	THREE	Mean	ONE	TWO	THREE	Mean
CONCRETE	1.500	1.858	1.917	1.758	1.200	1.383	1.842	1.475
ABSTRACT	1.271	1.675	1.825	1.591	0.842	1.717	1.683	1.414
Column Mean	1.385	1.767	1.871		1.021	1.550	1.763	

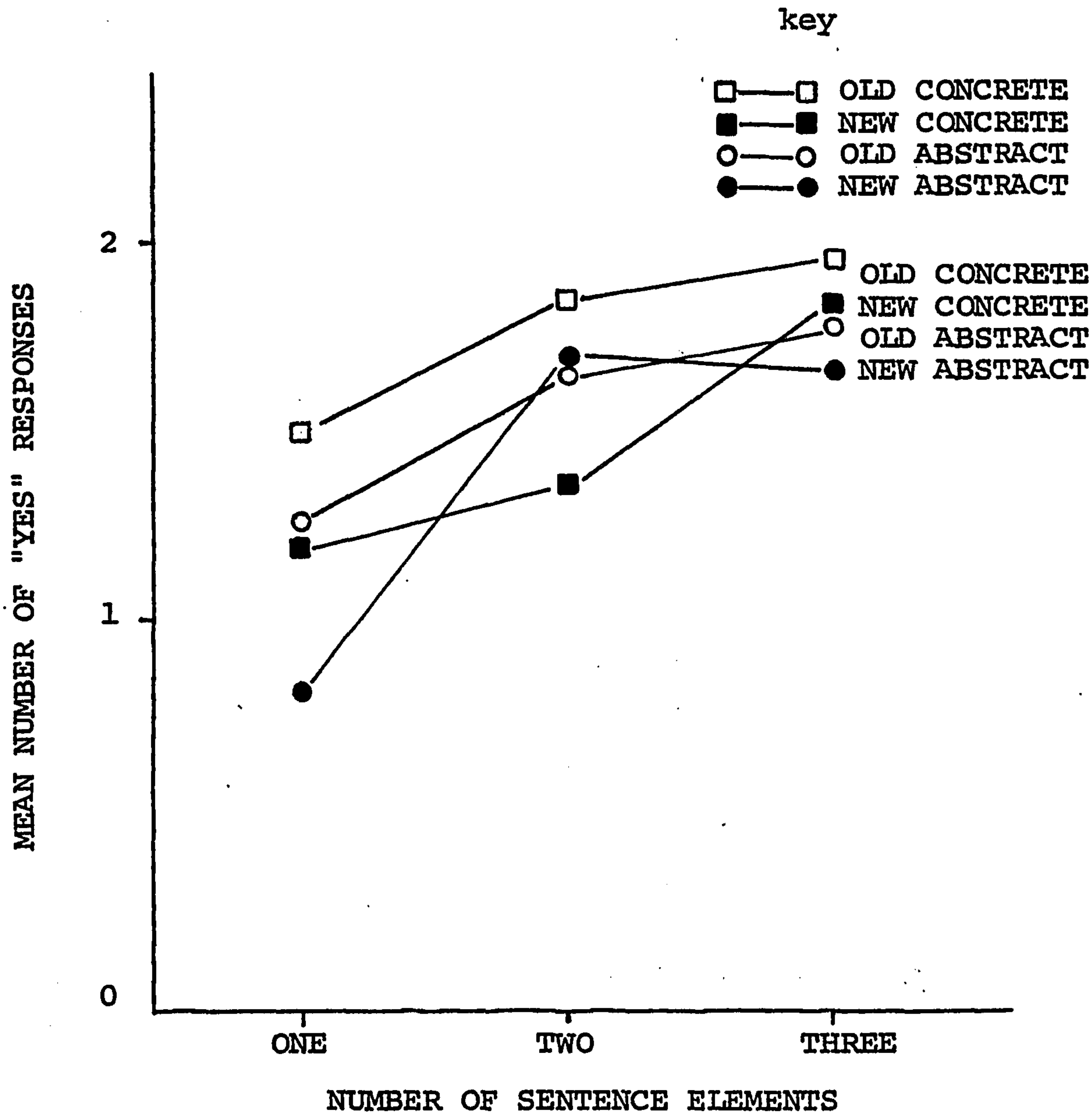

Fig. 4. Mean Number of "Yes" Responses by All Subjects as a Function of Sentence TYPE, IMAGE, and ELEMENT (IMAGE X ELEMENT X TYPE INTERACTION).

TABLE 6

MEAN NUMBER OF "YES" RESPONSES BY LEARNING DISABLED AND NORMAL CHILDREN AS A FUNCTION OF SENTENCE ELEMENTS (CATEGORY X ELEMENT INTERACTION)

	ONE	TWO	THREE	FOUR	Row Mean
LD	1.387	1.625	1.679	1.558	1.562
NORMAL	1.019	1.692	1.954	1.983	1.662
Column Mean	1.203	1.659	1.817	1.771	

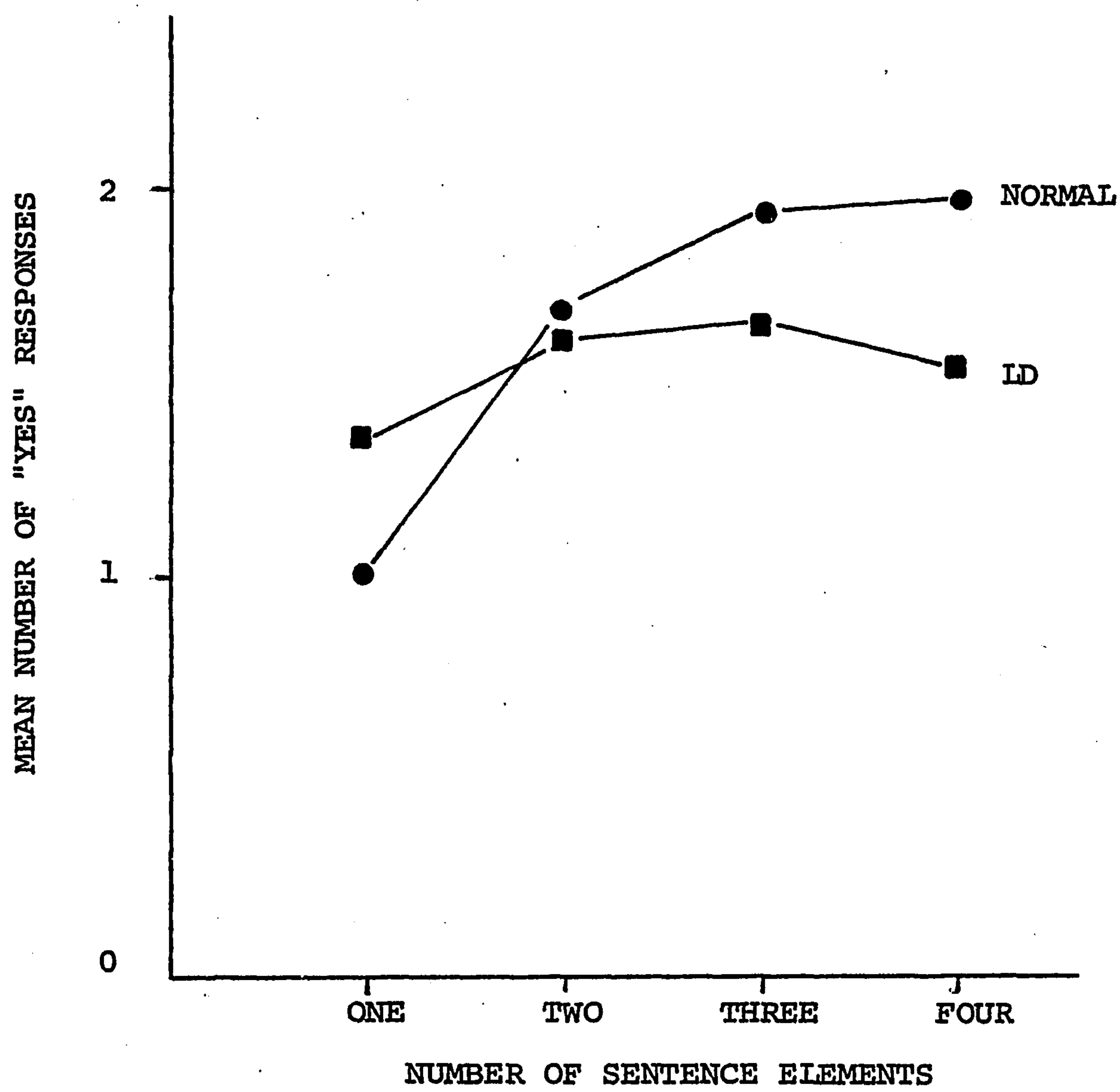

Fig. 5. Mean Number of "Yes" Responses by Learning Disabled and Normal Children as a Function of Sentence ELEMENTS (CATEGORY X ELEMENT INTERACTION).

Table 7 and Figure 6, Table 8 and Figure 7 respectively separate sentence TYPES (OLD/NEW) into separate ELEMENTS (ONES/TWOS/THREES). The same pattern for LD and NORMAL children occur within both OLD and NEW TYPES, as previously stated (i.e., LD ONES > NORMAL ONES; LD TWOS = NORMAL TWOS; LD THREES < NORMAL THREES).

However, the mean number of "yes" responses for each ELEMENT was greater for OLD sentences, for both LD and NORMAL children. In addition, the largest difference for LD/NORMAL performances occurred for NEW THREES.

The final set of data considered is for the NONCASES. TYPE I NONCASE contained combinations of elements (ONES) which were not consonant with any of the complete sentences; TYPE II NONCASES contained only a similar lexical item as those contained in the complete sentences. Data indicates that NORMAL children were quite sure that they had not heard NONCASE sentences. Table 9 and Figure 8 show the significant CATEGORY main effect ($\underline{F}$ = 91.634, $\underline{df}$ = 1,112, $\underline{p}$ = < .001) and CATEGORY X TYPE interaction ($\underline{F}$ = 107.161, $\underline{df}$ = 1,112, $\underline{p}$ = < .001).

The LD children accounted for all "yes" responses for TYPES I and II NONCASES. There was a significant TYPE main effect ($\underline{F}$ = 107.161, $\underline{df}$ = 1,112, $\underline{p}$ = < .001)--LD children scoring higher on TYPE I than TYPE II NONCASES.

TABLE 7

CATEGORY X ELEMENT INTERACTION AS A FUNCTION OF OLD SENTENCE TYPES

	ONE	TWO	THREE
LD	1.583	1.758	1.800
NORMAL	1.188	1.775	1.942
Column Mean	1.386	1.767	1.871

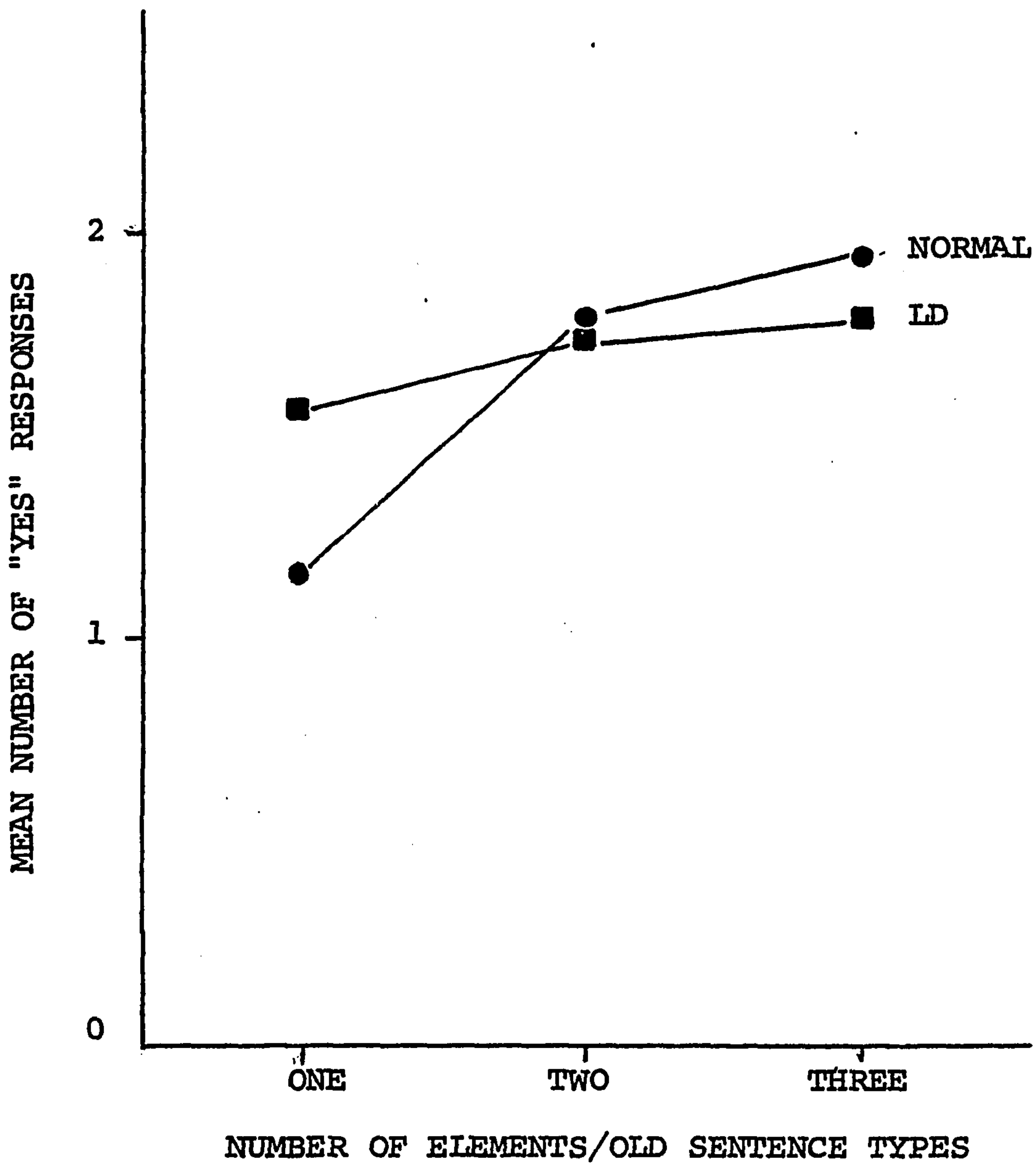

Fig. 6. CATEGORY X ELEMENT INTERACTION as a Function of OLD Sentence TYPES.

TABLE 8

CATEGORY X ELEMENT INTERACTION AS A FUNCTION OF NEW SENTENCE TYPES

	ONE	TWO	THREE
LD	1.192	1.492	1.558
NORMAL	0.850	1.608	1.967
Column Mean	1.021	1.550	1.763

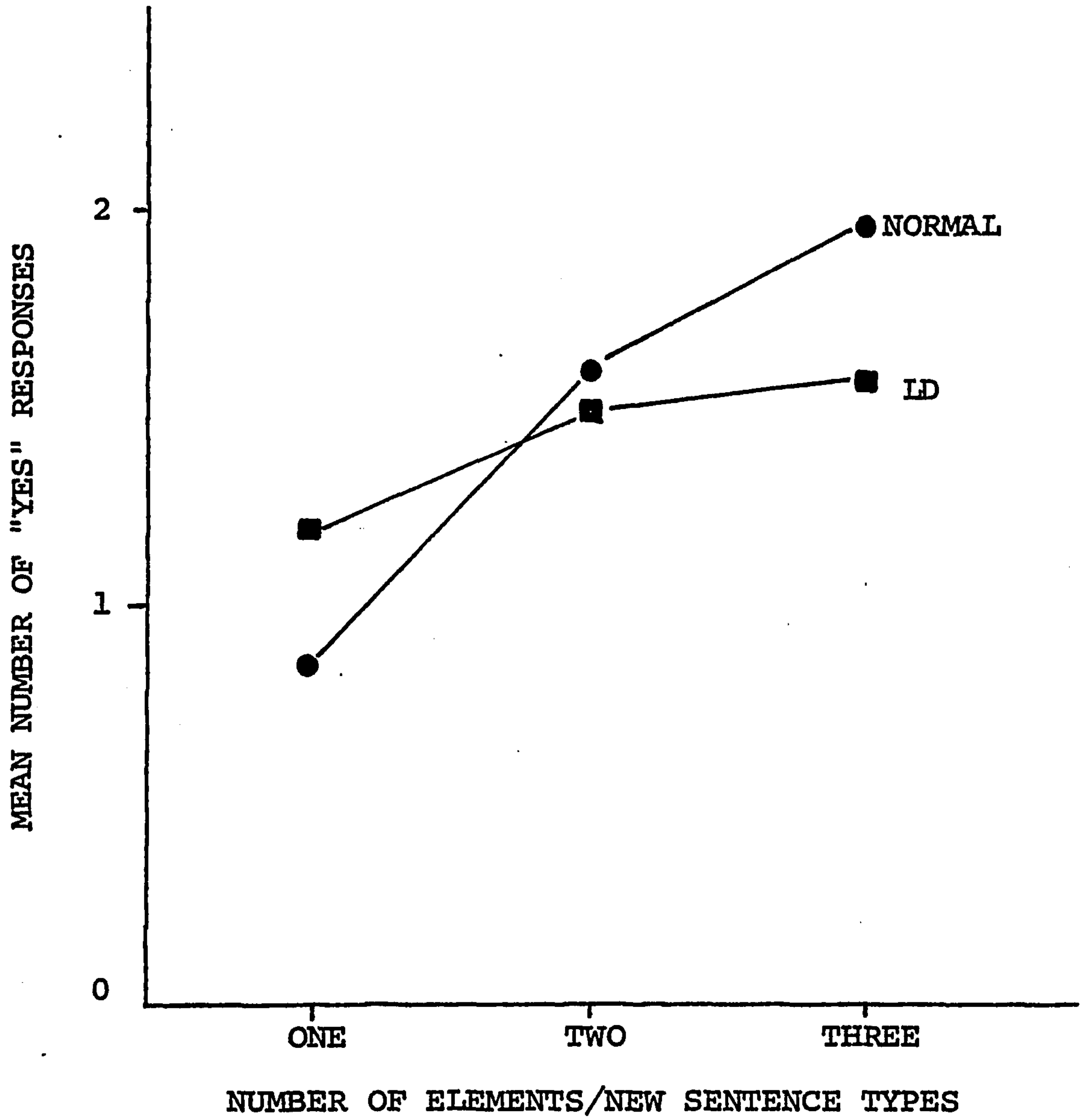

Fig. 7. CATEGORY X ELEMENT INTERACTION as a Function of NEW Sentence TYPES.

TABLE 9

MEAN NUMBER OF "YES" RESPONSES BY LEARNING DISABLED AND NORMAL CHILDREN AS A FUNCTION OF TYPE I AND TYPE II NONCASE SENTENCES (CATEGORY X TYPE INTERACTION)

	TYPE I	TYPE II	Row Mean
LD	0.337	0.123	0.230
NORMAL	0.000	0.000	0.000
Column Mean	0.169	0.061	

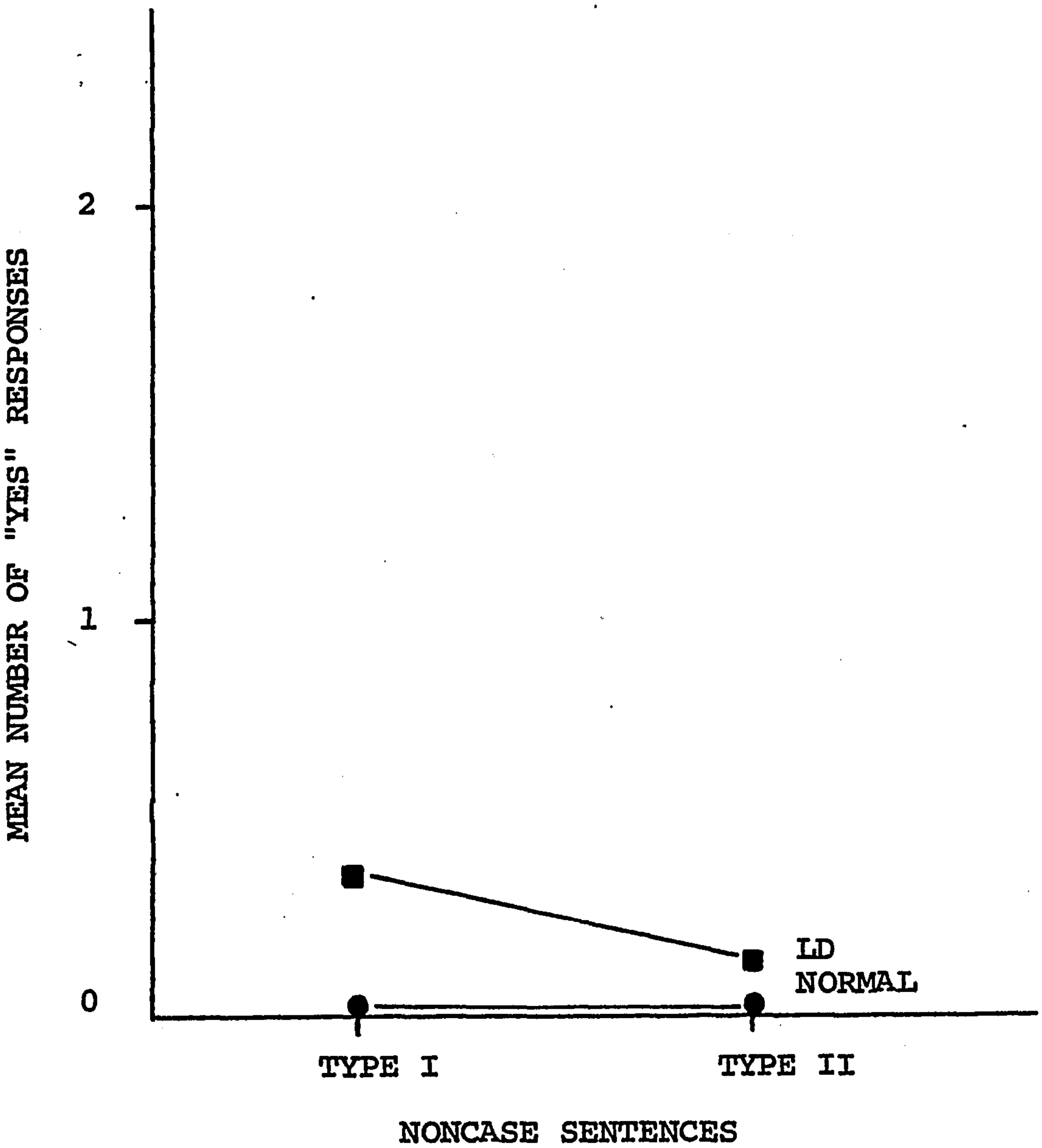

Fig. 8. Mean Number of "Yes" Responses by Learning Disabled and Normal Children as a Function of TYPE I and TYPE II NONCASE Sentences (CATEGORY X TYPE INTERACTION).

CHAPTER V

DISCUSSION

The present experiment was designed to determine whether learning disabled children, and normal children, would decode independently presented sentences as discrete events or would combine them into a more complex interrelating semantic system (via what has been defined as semantic integration). The mode of storage, or the performance of integration, was measured by testing the children's abilities to recognize sentences which were never actually presented, but could be derived through a comprehension of relationships among semantically related sentences.

Results of the experiment indicate that learning disabled and normal children significantly differ in terms of performance with respect to sentence TYPE, IMAGE, and ELEMENT classifications. Data indicates that normal children consistently exhibited the behavioral response pattern indicative of semantic integration. They thought they "recognized" novel sentences (NEWS) consonant with the ideas presented, but were quite sure that they had not heard NONCASE sentences. In addition, they were most confident of having heard those sentences expressing all the information characteristic of the complete complex sentence (FOUR);

the mean number of "yes" responses were ordered FOURS > THREES > TWOS > ONES, according to the semantic complexity of the sentences. The fact that normal subjects recognized NEW THREES and particularly NEW FOURS was important, inasmuch as these sentences contained combinations of semantic relationships never actually presented. The information contained in the NEW THREES and FOURS could only have been learned by integrating information from various sentences actually presented. The fact that the number of responses for TWOS and ONES were lower than for FOURS and THREES suggests that subjects were less sure that they heard the former. However, nearly all subjects knew they heard some short sentences and thus each individual subject said "yes" to some of those sentences.

Whether a sentence was OLD or NEW had very little effect on response patterns of normal children. In general, normal children were unable to discriminate novel sentences (NEWS) never actually presented to them from sentences they had heard (OLDS).

The effect of imagery was inconsistent for normal children. In general, the IMAGE variable did not appear to facilitate their performance.

In comparison, performance of learning disabled children appear to indicate that information is often decoded into discrete semantic units, independent of an organized semantic system. Learning disabled children consistently and significantly discriminated OLD from NEW sentences, and recognized more OLDS than NEWS as the sentences they heard. This occurred for both CONCRETE and ABSTRACT sentences. On the average, learning disabled children recognized a significantly greater number of CONCRETE, as opposed to ABSTRACT, sentences across all other variables.

The fact that learning disabled children responded "yes" most frequently to OLD sentence types could initially be indicative of "trace memory processing." However, although the number of responses for OLD vs. NEW sentences was significant, the children still responded to a considerable number of NEW sentences which were never presented. Learning disabled children were also sure that they heard many TYPE I and TYPE II NONCASE sentences (with a greater number of "yes" responses to TYPE I).

The significant difference between learning disabled and normal children's responses to OLD and NEW sentences occurred at the level of ABSTRACT sentences. Performance was similar for both groups for CONCRETE OLDS and NEWS. Learning disabled children recognized more ABSTRACT OLD sentences as the ones they heard than did normal children; on the other hand, normal children recognized significantly more ABSTRACT NEW sentences than did learning disabled children.

Performance patterns in relation to the number of sentence ELEMENTS must be considered for appropriate comparisons. Learning disabled children did not exhibit the observed ordering of elements as normals did. In fact, learning disabled children recognized significantly more ONES than normals. Similar performance occurred for both groups for TWOS, the point at which integration first appears. As normal children continued to integrate additional related information (at the point of THREES and FOURS), performance of learning disabled children remained constant from TWOS to THREES, and started to decline at FOURS. This pattern was similar for both OLD and NEW sentences.

Summary

It is obvious from the results that normal children spontaneously integrate the information expressed by a number of nonconsecutively presented, but semantically related, sentences; learning disabled children do not. Learning disabled children appear to attend to smaller units, short sentences (ONES), as well as words (as demonstrated by their responses to NONCASES). In addition, their performance is similar to normals at the level of TWOS, where integration begins. Perhaps they can integrate up to a certain point, beyond which any additional information is in excess of their integrative capacities. Further, imagery appeared to have facilitated performance for learning disabled children, perhaps providing additional cues to organize and decode verbal information into holistic descriptions of situations.

It appears to be the case that learning disabled children did not adopt a recoding strategy similar to normal children. Such a strategy would have allowed for a more efficient processing of the information because a much smaller number of discrete events would then have to be remembered. Learning disabled children appeared to have attended to individual sentences as well as to specific sentence constituents in an attempt to remember information. They were not capable of abstracting semantic relationships in a manner qualitatively similar to normal children, but appeared to be functioning at the level when integration begins.

The present study also indicated that there were no developmental differences in the performance of children from 7 to 10 years of age, similar to findings of Paris and Carter (1973) using children of comparable ages. Results of the Paris and Upton (1974) study suggested that children from 6 to 11 years of age increased the amount of both explicit and implicit information that they comprehended from paragraphs, however the main difference was between the two youngest age groups.

Moeser (1976) carried out a series of experiments (with normal subjects ranging from kindergarten through college age) in which semantically related sentences were presented to subjects as discrete items. Inference tests were given to measure the degree to which the similar information had been stored in memory. Often the subjects could not derive inferences, although performance on memory questions indicated that the information had been remembered. These results appear to parallel performances of learning disabled children in the present experiment.

In Experiment I, subjects ranging in age from 5 years 7 months-14 years 8 months were given identical verbal information but showed different response patterns depending on how the information was presented. When the related sentences were presented in a single syntactic unit (complete sentences, as "FOURS"), there was no significant difference in the way subjects performed in retrieving inferential or memory information. When the related premises (i.e., the set of simple sentences, "ONES," comprising the complete sentence) were presented in a temporal order, subjects were better at retrieving inferential information than they were when the related premises were presented in a nontemporal order. In these latter two conditions, inferential performance was inferior to memory performance, indicating that the information from the sentences had been remembered as discrete memory units which were independent of an organized semantic system.

The data obtained from Experiment II (with subjects 5 years 2 months to 19 years 5 months) also supported this conclusion. Subjects were supplied with transitional cues which explicitly showed how the information in one unit was related to that in another unit. For example, after hearing "The doll was in the small crib" and "The small crib was under the tree," the subjects were asked whether "The doll is in the crib under the tree" or whether "The doll is in the crib on the sidewalk." Transition cues did not improve performance on the inference tasks.

Experiment III (subject mean age 18 years 6 months) was designed to "change" encoding strategies, observed thus far, by duplicating Experiment I with the addition of repeating acquisition sentences either two or six times. It was suggested that perhaps if items were presented enough times subjects would notice the similarities among them. Results indicate again that the majority of subjects were not combining information. Finally, in Experiment IV (subject mean age 25 years) subjects instructed to combine the related information showed approximately chance performance on the inference questions.

It appears as though the performance of learning disabled children was duplicated in Moeser's experiments, with normal subjects, where subjects in both cases encoded independently presented items as discrete units, and where there was no connection between stimuli even when they contained semantic similarities. However, even if this reasoning is correct, it should be possible to set up a learning situation in which additional information could be integrated into pre-existing knowledge. Perhaps these children need additional contextual information to assist in the integration of material into a structured whole.

The development of integrative skills involves the composite of many factors. Jenkins (1974) sums it up:

> Surely these studies imply that we cannot deal with memory without dealing with instructions, perception, comprehension, inference, problem solving, and all the other processes that contribute to the construction of events. . . . To study memory without studying perception is to invite disaster in one of two ways: on the one hand, failing to understand the inputs to the subject or, on the other hand, pushing all the difficult problems out of memory into the unknown perceptual domain for someone else to study. To study memory without studying inference is to be baffled by the transformations that the subject puts on his experience. To study memory without studying language is to be confounded by paraphrase and the issues of meaning. And so on. (p. 794)

The structure of memory investigated emphasized a view of learning as an active, integrative process, rather than relying on repeated exposure to specific stimuli as the basis of acquiring information. In principle, the understanding of a concept continues to be elaborated and embellished even though the concept may never be directly encountered again. This continuous accumulation of the stored information within the memory system has profound effects on the way new information is acquired. It appears that for a normal child, each new concept has to be initiated with a great deal of rote learning. Understanding is slowly elaborated as properties are accumulated. Initially, most concepts will be only partially defined and will not be well integrated with other learned information.

Later on, with the accumulation and organization of interconnected data, new information can be learned primarily by analogy or association.

It was found that the processes for manipulating and reorganizing information are similar among "normal" individuals, both adult and children. Normal children and adults may be able to relate new experiences to those encountered in the past. However, learning disabled children, who are in the midst of acquiring information, are apparently having difficulty associating new information with past experiences.

Educational Application

The principles underlying the experimental tasks presented are similar to the principles which underly children's everyday experience in school. They are required to comprehend and remember meaning from stories, films, and teacher's instructions. Understanding and retaining the meaning of these various contextual events are the goals of the child's language processing.

It is feasible to speculate that academic training for learning disabled children does not directly enhance integrative abilities of these youngsters. Teachers are made aware of, and are taught to limit, the amount of auditory-vocal stimulation presented to learning disabled children. These children are frequently exposed to explicit, discrete directives and verbalizations, as it is assumed that they are unable to handle more. The present experimental results suggest the need to change remedial teaching procedures in order to maximize learning.

Chalfant and Scheffelin (1969) note reservations concerning remediation of memory. Research on memory disfunction is limited and there is little research showing that memory can be improved through outside intervention. However, Chalfant and Scheffelin conclude that educators should identify the specific memory problem of the child and intervene with specific techniques designed to improve memory and, hence, learning.

Associative functions are developed when the teacher helps the children to relate subject matter with later ideas discussed in class. To this end, what she or he teaches should be presented in an integrated form, e.g. in teaching "units." It is desirable both to cut across subject matter within a given unit and to refer to the content of one unit in another unit. Many teachers do not present subject matter in an integrated form. The child may learn on one occasion about "the rain" and other aspects of the climate and on another occasion about "flowers and plants," without it being shown on either occasion that the one affects the other. Often such connections between concepts are taught years after the separate concepts themselves were introduced. A related tendency consists of the repetitions of subject matter in successive grades without taking into account the complex and related events which, at the later age levels, may be taught successfully (Bortner, 1970).

In the past there has been a division between basic and applied research in the study of developmentally related problems. Although the origins of the research reviewed and carried out in this paper are theoretical in nature, the research can be related to practical problems raised in an applied setting (e.g. the classroom).

This paper was not intended as a training manual for educators. There have been suggestions that learning disabled children are inadequate at integrative skills, and this paper has empirically investigated some of these processing deficiencies. Without this evidence, the outlook for educational benefits from intervention programs might be limited.

Our research with learning disabled children is still far from a position where it can provide definitive answers to the nature of their integrative problems. However, by specifying the problems, additional effective research can be initiated. The present study was geared to providing basic information concerning learning and memory strategies of learning disabled children, as well as a foundation for future educational applications.

APPENDIX A

SENTENCES COMPRISING IDEA SETS FOR SECTION I

APPENDIX A

SENTENCES COMPRISING IDEA SETS FOR SECTION I

FOUR

The big bear ate the chocolate candy in the woods. (NEW)

ONES

The bear was big. (OLD)
The candy was chocolate. (OLD)
The bear was in the woods. (NEW)
The bear ate the candy.

TWOS

The bear ate the candy in the woods. (OLD)
The bear ate the chocolate candy. (NEW)
The big bear ate the candy.
The big bear was in the woods.

THREES

The big bear ate the chocolate candy. (OLD)
The big bear ate the candy in the woods. (NEW)
The bear ate the chocolate candy in the woods.

FOUR

The old farmer milked the brown cow in the barn. (NEW)

ONES

The farmer was old. (OLD)
The cow was brown. (OLD)
The cow was in the barn. (NEW)
The farmer milked the cow.

TWOS

The farmer milked the cow in the barn. (OLD)
The brown cow was in the barn. (NEW)
The old farmer milked the cow.
The farmer milked the brown cow.

THREES

The old farmer milked the brown cow. (OLD)
The old farmer milked the cow in the barn. (NEW)
The farmer milked the brown cow in the barn.

TYPE I NONCASES

The cow was old. (ONE)
The brown bear was in the barn. (TWO)
The brown cow ate the candy in the barn. (THREE)
The old farmer ate the chocolate candy in the woods. (FOUR)

TYPE II NONCASES

The cow ate the grass. (ONE)
The bear climbed a tall tree. (TWO)
The old farmer put the eggs in a basket. (THREE)
The big wild bear attacked the scared man. (FOUR)

APPENDIX B

SENTENCES COMPRISING IDEA SETS FOR SECTION II

APPENDIX B

SENTENCES COMPRISING IDEA SETS FOR SECTION II

FOUR

The smart children did not understand the important new rules. (NEW)

ONES

The children did not understand the rules. (OLD)
The rules were important. (OLD)
The children were smart. (NEW)
The rules were new.

TWOS

The children did not understand the important rules. (OLD)
The children did not understand the new rules. (NEW)
The smart children did not understand the rules.

THREES

The smart children did not understand the new rules. (OLD)
The smart children did not understand the important rules. (NEW)
The children did not understand the important new rules.

FOUR

The proud poor people were disappointed by the high taxes. (NEW)

ONES

The people were poor. (OLD)
The taxes were high. (OLD)
The people were proud. (NEW)
The people were disappointed by the taxes.

TWOS

The proud people were disappointed by the taxes. (OLD)
The people were disappointed by the high taxes. (NEW)
The poor people were disappointed by the taxes.

THREES

The poor people were disappointed by the high taxes. (OLD)
The proud poor people were disappointed by the taxes. (NEW)
The proud people were disappointed by the high taxes.

TYPE I NONCASES

The people were smart. (ONE)
The smart children were poor. (TWO)
The poor people did not understand the new rules. (THREE)
The proud poor people were disappointed by the smart children. (FOUR)

TYPE II NONCASES

The children were confused. (ONE)
The angry people were busy. (TWO)
The children obeyed their parents and did necessary chores. (THREE)
The serious parents were upset by the children's mistakes. (FOUR)

APPENDIX C

SENTENCES AND QUESTIONS PRESENTED DURING SECTION I, PARTS 1 AND 2

APPENDIX C

SENTENCES AND QUESTIONS PRESENTED DURING SECTION I, PARTS 1 AND 2

Part 1

The cow was brown.	What color was the cow?
The bear ate the candy in the woods.	Where did the bear eat the candy?
The farmer milked the cow in the barn.	Where did the farmer milk the cow?
The candy was chocolate.	What was the candy?
The old farmer milked the brown cow.	What did the farmer milk?
The bear was big.	What was the bear?
The farmer was old.	Who was old?
The big bear ate the chocolate candy.	What did the big bear eat?

Part 2

1. The bear was in the woods. (NEW ONE)
2. The farmer milked the cow in the barn. (OLD TWO)
3. The big wild bear attacked the scared man. (TYPE II NON FOUR)
4. The big bear ate the chocolate candy. (OLD THREE)
5. The cow was old. (TYPE I NON ONE)
6. The old farmer milked the brown cow. (OLD THREE)
7. The candy was chocolate. (OLD ONE)
8. The brown cow was in the barn. (NEW TWO)
9. The old farmer ate the chocolate candy in the woods. (TYPE I NON FOUR)
10. The bear climbed a tall tree. (TYPE II NON TWO)
11. The bear was big. (OLD ONE)
12. The old farmer milked the brown cow in the barn. (NEW FOUR)
13. The brown bear was in the barn. (TYPE I NON TWO)
14. The big bear ate the candy in the woods. (NEW THREE)
15. The cow was in the barn. (NEW ONE)
16. The bear ate the candy in the woods. (OLD TWO)
17. The cow ate the grass. (TYPE II NON ONE)
18. The old farmer milked the cow in the barn. (NEW THREE)
19. The brown cow ate the candy in the barn. (TYPE I NON THREE)
20. The bear ate the chocolate candy. (NEW TWO)
21. The farmer was old. (OLD ONE)

22. The big bear ate the chocolate candy in the woods. (NEW FOUR)
23. The cow was brown. (OLD ONE)
24. The old farmer put the eggs in a basket. (TYPE II NON THREE)

APPENDIX D

SENTENCES AND QUESTIONS PRESENTED DURING SECTION II,

PARTS 1 AND 2

APPENDIX D

SENTENCES AND QUESTIONS PRESENTED DURING SECTION II, PARTS 1 AND 2

Part 1

The children did not understand the rules.
The proud people were disappointed by the taxes.
The children did not understand the important rules.
The people were poor.
The smart children did not understand the new rules.

The taxes were high.
The rules were important.
The poor people were disappointed by the high taxes.

What didn't the children understand?
Who were disappointed by the taxes?
Who did not understand the important rules?
What were the people?
What kind of children did not understand the new rules?
What were the taxes?
What were the rules?
What were the poor people disappointed by?

Part 2

1. The people were proud. (NEW ONE)
2. The children did not understand the important rules. (OLD TWO)
3. The serious parents were upset by the children's mistakes. (TYPE II NON FOUR)
4. The poor people were disappointed by the high taxes. (OLD THREE)
5. The people were smart. (TYPE II NON ONE)
6. The smart children did not understand the new rules. (OLD THREE)
7. The taxes were high. (OLD ONE)
8. The children did not understand the new rules. (NEW TWO)
9. The proud poor people were disappointed by the smart children. (TYPE II NON FOUR)
10. The angry people were busy. (TYPE II NON TWO)
11. The people were poor. (OLD ONE)
12. The smart children did not understand the important new rules. (NEW FOUR)
13. The smart children were poor. (TYPE I NON TWO)
14. The proud poor people were disappointed by the taxes. (NEW THREE)
15. The children were smart. (NEW ONE)

16. The proud people were disappointed by the taxes. (OLD TWO)
17. The children were confused. (TYPE II NON ONE)
18. The smart children did not understand the important rules. (NEW THREE)
19. The poor people did not understand the new rules. (TYPE I NON THREE)
20. The people were disappointed by the high taxes. (NEW TWO)
21. The rules were important. (OLD ONE)
22. The proud poor people were disappointed by the high taxes. (NEW FOUR)
23. The children did not understand the rules. (OLD ONE)
24. The children obeyed their parents and did necessary chores. (TYPE II NON THREE)

APPENDIX E

SENTENCES AND QUESTIONS PRESENTED DURING SECTION III, PARTS 1 AND 2

APPENDIX E

SENTENCES AND QUESTIONS PRESENTED DURING SECTION III, PARTS 1 AND 2

Part 1

The children played games in the park.	Where did the children play?
The bell on the engine rings loudly.	What rings loudly?
The doll has pretty hair.	What does the doll have?
The boy was surprised.	Who was surprised?
The house was on fire.	What was on fire?
The large family ate meat and vegetables for dinner.	Who ate meat and vegetables for dinner?
The pretty lady baked a chocolate cake.	What did the pretty lady bake?
The big white rabbit has a little tail.	What does the big white rabbit have?

Part 2

1. The bell on the engine rings loudly. (OLD THREE)
2. The school was on fire. (TYPE II NON ONE)
3. The boy was surprised. (OLD ONE)
4. The doll has pretty hair. (OLD TWO)
5. The children ate ice cream in the park. (TYPE II NON TWO)
6. The pretty lady baked a chocolate cake. (OLD THREE)
7. The new car has four red wheels. (NON FOUR)
8. The big white rabbit has a little tail. (OLD FOUR)

APPENDIX F

ANALYSIS OF VARIANCE TABLE

APPENDIX F

ANALYSIS OF VARIANCE TABLE

Classifying Factors
- Category (LD/NORMAL)
- Age (7/8/9/10)
- Image (CONCRETE/ABSTRACT)
- Type (OLD/NEW/NON)

Source	Sum of Squares	DF	Mean Square	F Test	Signif.	% of Total Sum of Squares
Category	61.250	1	61.250	16.401	0.001	0.99
Age	3.033	3	1.011	0.271	0.500	0.05
Category X Age	8.428	3	2.809	0.752	0.500	0.14
	418.261	112	3.734			6.75
Image	11.250	1	11.250	7.873	0.006	0.18
Category X Image	0.089	1	0.089	0.062	0.500	0.00
Age X Image	5.717	3	1.906	1.334	0.268	0.09
Category X Age X Image	2.567	3	0.856	0.599	0.500	0.04
	160.044	112	1.429			2.58
Type	4609.160	2	2304.580	1288.580	0.001	74.44
Category X Type	188.758	2	94.379	52.750	0.001	3.05
Age X Type	11.842	6	1.974	1.103	0.362	0.19
Category X Age X Type	8.431	6	1.405	0.785	0.500	0.14
	400.780	224	1.789			6.47

APPENDIX F--Continued

Source	Sum of Squares	DF	Mean Square	F Test	Signif.	% of Total Sum of Squares
Image X Type	28.658	2	14.329	14.946	0.001	0.46
Category X Image X Type	28.369	2	14.185	14.795	0.001	0.46
Age X Image X Type	20.908	6	3.485	3.635	0.002	0.34
Category X Age X Image X Type	9.642	6	1.607	1.676	0.128	0.16
	214.754	224	0.959			3.47
Total	6191.930	719	8.612			100.00

APPENDIX G

ANALYSIS OF VARIANCE TABLE

APPENDIX G

ANALYSIS OF VARIANCE TABLE

Classifying Factors

Category	(LD/NORMAL)
Age	(7/8/9/10)
Image	(CONCRETE/ABSTRACT)
Type	(OLD/NEW/NON)
Elements	(ONE/TWO/THREE)

Source	Sum of Squares	DF	Mean Square	F Test	Signif.	% of Total Sum of Squares
Age	0.684	3	0.228	0.293	0.500	0.12
Category	0.029	1	0.029	0.038	0.500	0.00
Age X Category	0.887	3	0.296	0.380	0.500	0.15
	87.090	112	0.778			14.81
Image	4.727	1	4.727	16.238	0.001	0.80
Age X Image	1.184	3	0.395	1.356	0.261	0.20
Category X Image	1.196	1	1.196	4.109	0.046	0.20
Age X Category X Image	0.814	3	0.271	0.933	0.428	0.14
	32.600	112	0.291			5.54
Type	19.021	1	19.021	80.240	0.001	3.23
Age X Type	0.223	3	0.074	0.313	0.500	0.04
Category X Type	1.771	1	1.771	7.471	0.008	0.30
Age X Category X Type	1.373	3	0.458	1.930	0.129	0.23
	26.550	112	0.237			4.51

APPENDIX G--Continued

Source	Sum of Squares	DF	Mean Square	F Test	Signif.	% of Total Sum of Squares
Elements	97.394	2	48.697	169.764	0.001	16.56
Age X Elements	1.401	6	0.234	0.814	0.500	0.24
Category X Elements	25.896	2	12.948	45.138	0.001	4.40
Age X Category X Elements	1.594	6	0.266	0.926	0.477	0.27
	64.255	224	0.287			10.92
Image X Type	1.029	1	1.029	3.805	0.054	0.18
Age X Image X Type	3.242	3	1.081	3.995	0.010	0.55
Category X Image X Type	4.279	1	4.279	15.818	0.001	0.73
Age X Category X Image X Type	1.337	3	0.446	1.647	0.183	0.23
	30.300	112	0.271			5.15
Image X Element	8.178	2	4.089	17.603	0.001	1.39
Age X Image X Element	2.284	6	0.381	1.639	0.138	0.39
Category X Image X Element	0.355	2	0.177	0.763	0.468	0.06
Age X Category X Image X Element	3.191	6	0.532	2.290	0.037	0.54
	52.033	224	0.232			8.85
Type X Element	3.971	2	1.986	10.186	0.001	0.68
Age X Type X Element	1.308	6	0.0218	1.118	0.353	0.22
Category X Type X Element	0.750	2	0.375	1.925	0.149	0.13
Age X Category X Type X Element	1.179	6	0.196	1.008	0.421	0.20
	43.666	224	0.195			7.42

APPENDIX G--Continued

Source	Sum of Squares	DF	Mean Square	F Test	Signif.	% of Total Sum of Squares
Image X Type X Element	7.613	2	3.806	16.762	0.001	1.29
Age X Image X Type X Element	1.155	6	0.193	0.848	0.500	0.20
Category X Image X Type X Element	0.900	2	0.450	1.982	0.141	0.15
Age X Category X Image X Type X Element	1.840	6	0.307	1.350	0.236	0.31
	50.866	224	0.227			8.65
Total	588.162	1439	0.409			100.00

APPENDIX H

ANALYSIS OF VARIANCE TABLE

APPENDIX H

ANALYSIS OF VARIANCE TABLE

Classifying Factors

Age	(7/8/9/10)
Category	(LD/NORMAL)
Image	(CONCRETE/ABSTRACT)
Type	(NONCASES--TYPE I/TYPE II)
Elements	(ONE/TWO/THREE/FOUR)

Source	Sum of Squares	DF	Mean Square	F Test	Signif.	% of Total Sum of Squares
Age	1.047	3	0.349	1.258	0.293	0.54
Category	25.438	1	25.438	91.634	0.001	13.01
Age X Category	1.047	3	0.349	1.258	0.293	0.54
	31.092	112	0.278			15.90
Image	0.501	1	0.501	4.250	0.042	0.26
Age X Image	0.185	3	0.062	0.523	0.500	0.09
Category X Image	0.501	1	0.501	4.250	0.042	0.26
Age X Category X Image	0.185	3	0.062	0.523	0.500	0.09
	13.192	112	0.118			6.75
Type	5.526	1	5.526	107.161	0.001	2.83
Age X Type	0.243	3	0.081	1.572	0.201	0.12
Category X Type	5.526	1	5.526	107.161	0.001	2.83
Age X Category X Type	0.243	3	0.081	1.572	0.201	0.12
	5.775	112	0.052			2.95

APPENDIX H--Continued

Source	Sum of Squares	DF	Mean Square	F Test	Signif.	% of Total Sum of Squares
Element	0.110	3	0.037	0.389	0.500	0.06
Age X Element	0.896	9	0.100	1.056	0.395	0.46
Category X Element	0.110	3	0.037	0.389	0.500	0.06
Age X Category X Element	0.896	9	0.100	1.056	0.395	0.46
	31.675	336	0.094			16.20
Image X Type	0.013	1	0.013	0.285	0.500	0.01
Age X Image X Type	0.339	3	0.113	2.478	0.065	0.17
Category X Image X Type	0.013	1	0.013	0.285	0.500	0.01
Age X Category X Image X Type	0.339	3	0.113	2.478	0.065	0.17
	5.108	112	0.046			2.61
Image X Element	0.114	3	0.038	0.700	0.500	0.06
Age X Image X Element	0.359	9	0.040	0.734	0.500	0.18
Category X Image X Element	0.114	3	0.038	0.700	0.500	0.06
Age X Category X Image X Element	0.359	9	0.040	0.734	0.500	0.18
	18.242	336	0.054			9.33
Type X Element	0.272	3	0.091	1.211	0.306	0.14
Age X Type X Element	0.851	9	0.095	1.260	0.258	0.43
Category X Type X Element	0.272	3	0.091	1.211	0.306	0.14
Age X Category X Type X Element	0.851	9	0.095	1.260	0.258	0.43
	25.192	336	0.075			12.88

APPENDIX H--Continued

Source	Sum of Squares	DF	Mean Square	F Test	Signif.	T of Total Sum of Squares
Image X Type X Element	0.335	3	0.112	2.116	0.098	0.17
Age X Image X Type X Element	0.271	9	0.030	0.572	0.500	0.14
Category X Image X Type X Element	0.335	3	0.112	2.116	0.098	0.17
Age X Category X Image X Type X Element	0.271	9	0.030	0.572	0.500	0.14
	17.725	336	0.053			9.06
Total	195.562	1919	0.102			100.00

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