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COGNITIVE STRATEGIES AND CHILDREN'S ABILITY TO MAKE INFERENCES FROM LINGUISTIC INFORMATION

by

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Much interest has been focused on an individual's ability to construct holistic semantic ideas from linguistic information (Bransford, Barclay, and Franks, 1972; Barclay, 1973; Bransford and Johnson, 1973). Implicit in this constructive theory of memory is that "extra-linguistic" factors play a prominent role in one's ability to comprehend connected linguistic information. Put differently, evaluation and comprehension of verbal information will vary dependent upon a speaker's knowledge and beliefs about the world. This is a position that speaks to linguistic performance. The investigations cited above have supported the suggestion that prior cognitions will enable an individual to "know" more information than that which is contained in a linguistic utterance.

Comprehension and retention of verbal information apparently is facilitated by the additional cues provided by visual input. Adults, for example, had poor success understanding and remembering a descriptive passage which provided little contextual information. However, when the same passage was preceeded by the picture it described, comprehension, and hence memory, were substantially enhanced (Bransford and Johnson, 1972). Paivio (1971) and Bower (1972) suggest that a dual processing system (visual for spatial organization and imagery, and verbal for sequential processing), is actually operating with two memory modalities interacting; i.e. visual and linguistic. When imagery content is high we may be unaware that we are formulating

propositions. This would be what occurs for example, when viewing a painting. Sometime later, although a number of details have been lost to memory, we have no difficulty reconstructing an image, and recalling, propositionally (i.e. via language), the appearance of the painting. What seems to be remembered about events in the world then are (1) appearances or images of events, (2) perceptual inferences and (3) propositions we formulated about past events.

The appearances or images, and the inferences we make about what we see and what we hear are stored and organized in memory by an active process of construction and integration of information (Anderson, 1975; Neisser, 1966; Piaget and Inhelder, 1973; Bartlett, 1932). The way in which one integrates and constructs sensory information will depend on the specific strategies employed for the type of task which is to be solved. If the task is one requiring rote memorization for linguistic information, for example, there is little need for making inferences and generalizations. Items to be remembered are rehearsed for a specific purpose. Hence less processing occurs and the result will be a shorter memorial life for that information. On the other hand, when plans are initiated for comprehension of linguistic material, among the many variables that are operating are rehearsal strategies mentioned above, as well as imagination, strategies for ordering information relative to time and space, and strategies for making inferences about these temporal and spatial events. In addition, as linguistic information is

processed for comprehension, the individual, as an information processor, is assimilating and integrating the new information with prior cognitions. This new information "enters into consciousness already charged with its relation to something that has gone before" (Head, in Bartlett, 1932). The resulting knowledge structure (in the case of linguistic information, this would be the semantic product) actually may contain more, or less information than the linguistic input contained. Bransford, Barclay, and Franks (1972) for example, found that subjects who had previously heard a sentence such as "the chair is to the right of the tree" subsequently falsely recognized hearing "the tree is to the left of the chair." False recognition of the second utterance occurred because of subjects' prior knowledge of spatial relations and their recognition of semantic synonymy. This is precisely the type of memory activity hypothesized by Bartlett (1932) when he describes an organism who would "somehow construct or infer from what is present the probable constituents and their order which went to build them up..."

Piaget (1952) has described the intellectual development of the child in much the same way (vis. a vis. assimilation and accommodation) and in subsequent writings Piaget and Inhelder (1973) pointed out that memories which the developing child reconstructs can be no richer or more complex than the level of cognitive development at which he is operating. Put differently, plans for information retrieval would include locating the bits of information needed

and "re-constructing" them for either memorization or comprehension. How the information is organized will depend on the mechanisms the developing child has available for organization; classification, conservation, seriation, reversibility and transitivity are a few of the operations which may be used for organizing information. Thus errors a child makes when asked to motorically reconstruct, from memory, a series of sticks of graduated length, do not occur because of poor memory, but occur because the necessary underlying cognitive operations have not been acquired.

Barclay's assimilation theory (1973), a constructive theory of memory, has correctly predicted the ability of adults to retain previously presented semantic ideas and falsely recognize new linguistic information "...from the interplay of sentential information, the context of knowledge to which that information is being assimilated..." The assimilation theory and the construction of holistic semantic ideas has parallels in the Piagetian theory of intellectual development in that the individual assimilates information which is then integrated with prior cognitions. Recent studies investigating this ability in children (Barclay and Ried, 1974; Paris, 1975; Paris and Carter, 1975) indicate that with certain types of utterances children have the ability to abstract and integrate semantic information implied within sentences.

In an extensive survey of Soviet memory research projects, Smirnov and Zinchenko (1969) found that the activity

connected with to-be-remembered material "represents the most general and necessary condition for people to form an image of it and demonstrate involuntary recall of it." (They fail to explain exactly what is meant by "image".) These activities may be motoric, as in the early stages of development (Bruner, Olver, and Greenfield, 1966; Piaget, 1952) or may be mental operations which take the form of imagery and/or language (Bruner et. al., 1966; Paivio, 1971; Piaget and Inhelder, 1973; Vygotsky, 1952; Werner, 1963). When they are mental operations it has been suggested that certain cognitive abilities must be operative in order that an individual may employ these activities (i.e. conservation, seriation, transitivity, classification, reversibility, etc.) for appropriate comprehension and retention of verbally presented discourse and visual contextual information (Bruner et. al., 1966; Piaget and Inhelder, 1973; Paris, 1975; Potts, 1975).

In a study investigating the relation between transitivity for concrete objects and transitivity for linguistic information describing those objects, Glick and Wapner (1968) found that children performed significantly worse on the verbal portion of that task. The same task was presented to adults, and they too had less difficulty solving the problem with concrete objects present than with verbal information alone. After examining memory integration for pictures and for verbal discourse, each requiring inferences to be made, Paris and Mahoney (1974) not unlike Glick and Wapner, found

that second and fourth graders had less difficulty integrating information from pictures than from verbally presented stimuli. A similar study, in which retarded children were subjects (Paris, Mahoney, and Buckhalt, 1974), indicated that the use of imagery instructions served as additional cues to facilitate construction and retention of semantic ideas. Apparently concrete perceptual information is easier to process than its recoded counterpart, and when available, serves as a facilitator for comprehension.

The Dual Processing system mentioned above hypothesizes that visual information is processed in snap-shot fashion enabling the information to be organized in parallel, spatially. On the other hand, verbal information is used for sequencing information in a linear order. For example, if you attempt to image a two story house you can easily picture the spatial relationship of each of the rooms (rather like the effect of the outer wall having been removed, as on a theatrical set). To describe this image verbally, however, you can no longer deal with these relations in parallel, but instead they must be recoded into a linear string of lexical units containing the appropriate prepositions.

A study performed by DeSoto, London, and Handel (1965) evidenced support for the formation of a spatial image. They found that children tend to construct spatial images to facilitate comprehension of linguistic utterances. Huttenlocher and Strauss (1966) suggest that children have less difficulty comprehending utterances which contain subject

and object in the same logical order in which extra-linguistic (visual) information is perceived. Similar results were obtained with adults who were presented with recognition sentences relating to stories which contained a four term linear ordering--"her bread was better than her cake, her cake was better than her rolls, and her rolls were better than her pie" (Potts, 1975), and with children presented with word pairs describing concrete objects, six different colored sticks of graduated lengths (Trabasso and Riley, 1973). Apparently "subjects order the terms along some imaginary spatial continuum" (Potts, 1975). This linear ordering facilitates retrieval of information from long term memory.

Other researchers (Amidon, unpublished doctoral dissertation; Bever, 1970; Clark, 1971; Ferriero and Sinclair, 1971) found that children tend to process and comprehend, significantly better, (i.e. correctly) those utterances which reflect the temporal order in which the original events were perceived. Thus sentences like "After he came in, he shut the door" will be remembered more easily than "Before he came in, he shut the door." (Clark, 1973) Put differently, the order of mention is the same as the order of occurrance and is cognitively less complex for comprehension.

In addition to finding support for the relation of imagery to language, several researchers have investigated the relationship of underlying cognitive operations to

language abilities. In a now classic paper, Slobin speculated that linguistic complexity may somehow be related to cognitive complexity:

> "It should be possible then, to rank linguistic forms in terms of the psychological, or cognitive complexity of the notions they express...Is it possible then, to trace out a universal course of linguistic development on the basis of what we know about the universal course of cognitive development? (Can one take Piaget as a handbook of psycholinguistic development?)" (1971)

Recently, Prawat and Cancelli (1976) in an attempt to find an isomorphous relationship between the cognitive operation of conservation and constructive memorial processes for verbal discourse, found that although there were no significant differences between them, conserving subjects tended to perform better than non-conserving subjects. The authors concluded that the constructive memorial process may be related to the more general cognitive abilities of assimilation and accommodation rather than to specific cognitive operations. Intuitively too, it seems likely that the integration of certain cognitive and perceptual strategies, rather than an isolated cognitive operation, facilitates the comprehension and retention of semantic ideas abstracted from verbal discourse. The use of these combined activities allows one to go "beyond the information given" in order to perceive, construct, and remember the information encountered. We may speculate, however, that the absence of certain cognitive operations could result in comprehension difficulties

for certain types of constructions.

In the present study we combine the evidence discussed above relative to the construction and integration of semantic ideas. We investigate two spatially relevant linguistic relations, in front of and in back of in connected verbal discourse. These prepositions are easily imaged and each of these locatives implies the reverse of the other. This characteristic is an important attribute when we consider that we can describe a given situation with two very different lexical arrays yet have both arrays impart identical spatial information (i.e. the ball is in front of the chair--or--the chair is in the back of the ball). In addition, the literature suggests that children have acquired the concept of these relations by 4 years of age (Piaget, 1973; Clark, 1973). However, although 4 year olds are credited with acquisition of these concepts, it is questionable whether they employ these locatives informationally, in the same way as adults, during connected discourse. There is some indication (Bryant, 1973; Weisberg, pilot research) that children may acquire a concept passively but not begin to use it actively until some time later. Thus, we may find that a child can respond correctly to "Put the ball in front of the chair" as an isolated linguistic event, but when the same spatial information is embedded in connected discourse, and modified semantically when presented in sentences to be recognized later, he may not perform as efficiently. For example, below is a story concerning spatial arrays and four

recognition sentences which contain spatial information which is either consonant with or dissonant to the semantic ideas described in the story:

> There is a table in the room with a bone on it and a dog is near the table. The table is in front of the dog. The dog is white with a black patch on one eye.
>
> (a) The table is in front of the dog.
> (b) The dog is in back of the table.
> (c) The bone is in front of the dog.
> (d) The table is in back of the dog.

We question whether children would have difficulty recognizing (b) as semantically synonymous with (a). In addition to the temporal order of lexical items being reversed, it is necessary to make an inference about the relations described in (b). The inference is: if object A were in front of object B, it logically follows that object B is in back of object A. Cognitively, then, sentence (b) is more complex than sentence (a). Sentence (c) also requires an inference to be made: if the table is in front of the dog, and the bone is on the table, then the bone is in front of the dog. Similarly, one's knowledge of spatial relations should result in rejection of utterance (d) as semantically untrue. Making inference from verbally presented information is possible because of not only linguistic knowledge, but too, because of one's knowledge of the world; for example, the organization of perceptual space. The cognitions one acquires relative to perceptual space (the relations that hold among objects in space) appear to be reflected in the way individuals organize information in memory. A striking

example of the organization of spatial arrays in memory has been reported by Bransford, Barclay, and Franks (1972). Subjects were presented with sentences of the following type:

(e) Three turtles rested beside a floating log, and a fish swam beneath them.
(f) Three turtles rested on a floating log, and a fish swam beneath them.

After hearing sentences like (e) or (f), subjects were presented with a recognition sentence that changed only the final pronoun of the original sentences: Three turtles rested on/beside a floating log, and a fish swam beneath it. A constructive theory of memory predicts that subjects construct holistic semantic descriptions of situations. If verbal information from the input sentence is forgotten one should not be reduced to guessing, but should base his recognition on the semantic description assimilated. And in fact, subjects rejected the recognition sentence with the pronoun change if they had previously heard (e) but not if they had previously heard (f). The recognition sentence was semantically consonant with the original input sentence, (f), but not with (e). Recognition was based on an abstracted semantic description of the originally described situation.

If we accept the position that an imaginal representation of spatial situations is formed, it becomes clear why utterances such as (b) in which the spatial term and subject have been reversed, are falsely recognized. The spatial relations remain the same even though preposition and lexical

order are reversed. Similarly knowledge of spatial relations will allow one to falsely recognize the true inference in (c), and to correctly reject the false information in (d). A question we pose is whether children, who are told to form images of spatial arrays, from linguistic information, will respond to temporally reversed recognition sentences (such as (b)) in the same manner as adults. Or, put differently, will children falsely recognize, as having occurred previously, new linguistic information which is consonant with the original semantic idea presented? Will they also tend to reject linguistic information which is not semantically synonymous with the original idea presented to them? A peripheral question we pose is: for children in whom the cognitive operations of transitivity, reversibility and decentration are not stable, will there be more difficulty recognizing inferential utterances than those which correspond exactly to the original acquisition story? Piaget (1967) observed that young children have little difficulty ordering objects (such as colored wooden beads) linearly; however, not until age 6 are they able to reverse the order of the same linear array. To perform this sort of task the cognitive operations of reversibility and decentration must be operative. Our question speaks to whether transitivity, decentration and reversibility for concrete objects bears a relation to operations performed on abstract linguistic information for which an individual forms a spatial image.

How does one process linguistic information for memory abstraction and integration? As suggested above one strategy we may use is imagery. Imagery is most beneficial when processing concrete referential information, such as spatial relations. It does become problematic when dealing with abstract information, i.e. "The intellect of Einstein is a miracle." (Paivio, 1971) Further, complex images are highly susceptible to distortion, and when recoded into verbal labels, much information is lost. However the images presented to our subjects are not referentially complex, but cognitively they may present problems.

A second strategy may be to attend to the temporal order of linguistic information describing an event. This becomes a problem when asked to recognize temporally reversed but semantically consonant linguistic information. Regardless of order, adults perform constructive memorial tasks rather automatically. Children, although they give some evidence of having the ability to construct semantic ideas, exhibit difficulty with linguistic information which reverses the order of a particular sequence of events. We question whether the difficulty young children display with temporally reversed utterances are strictly memorial in nature (which is unlikely given that the lexical entries in reversed utterances are as familiar as those in utterances which reflect the originally perceived temporal events), or whether the difficulty is more closely related to cognitive operations which have not become functional, or ones which

are functional but not stabilized.

Implicit in a constructive theory of memory, is that memory capacity does not increase with age, but rather that memorial strategies become more efficient and these strategies are a function of cognitive development. Olson (1973) has suggested that with the acquisition of a grammar this is precisely what is occurring. That is, that the grammar of a language is the first system of such complexity that the child encounters, and he is forced to develop more efficient strategies in order to become a proficient language user.

This investigation attempts to provide information about children's ability to construct and integrate semantic ideas from connected verbal discourse. Each of our subjects were assessed for the acquisition of the spatial concepts in front of and in back of. In addition, they had to demonstrate, on two Piagetian tasks, their ability to employ the cognitive operations of decentration, reversibility, and transitivity. Subsequently, each subject heard a series of acquisition stories containing the spatial relations in question. Following each story was a recognition memory task. This consisted of a series of sentences which either replicated or contradicted the semantic relations and temporal order of the information presented during the acquisition story. If subjects are constructing images, and are abstracting and integrating semantic ideas, we would expect differences only between correct and incorrect recognition

sentences. If subjects are constructing images but are rejecting reversed semantically consonant information, one could infer that certain cognitive operations have not generalized or become functional for linguistic information processing. Another possibility exists: that subjects treat the linguistic information only as events to be memorized. This hypothesis becomes untenable, however, if subjects are able to make any inferences. The ability to infer implies going "beyond the information given"--falsely recognizing an utterance which never actually occurred, and false recognition implies utilizing underlying strategies.

Method

Subjects: Subjects for this study consisted of 77 children between the ages of 4:4 and 10:4 from a suburban Long Island community (Table 1). The youngest children attended a private pre-school program and the remaining subjects were drawn from the kindergarten, first, second, third and fourth grade classes of two elementary schools. The 37 males and 40 females were chosen at random from each grade level. All subjects were assessed by their respective teachers as being within the normal range of intelligence, although they varied as being judged "very slow" to "exceedingly bright" within that range. Of all the children interviewed, two manifested laterality problems and one produced numerous articulatory errors. They were replaced by three other children. Thus none of the 77 subjects in this study presented evidence of speech or language disorders, learning problems, visual or hearing disorders.

Materials and Procedure:

Design: Children were seen individually on two separate occasions. The first occasion consisted of pre-testing to establish the child's understanding of the spatial terms to be used in this study, as well as to assess the development of several cognitive operations that were expected to be relevant to the later language processing task. These three conceptual tasks were controlled so that no task appeared first more often than any other task.

Grade Level	N-K	1-2	3-4
Sample Size	30	22	25
Boys	15	10	12
Girls	15	12	13
Mean Age (in months)	66.75	87.36	113.76
Age S.D. (in months)	7.96	7.25	7.11

Table 1. Subjects by sex and grade with age calculated in months.

Session 1: Conceptual Tasks

a) Spatial Concepts: This task allowed the subject to demonstrate his knowledge of the spatial relations in front of and in back of. Two different sets of pictures, each displaying two different objects in a variety of 4 spatial arrays were the stimulus items (Developmental Learning Materials, #125, 1976). For example, one set displayed a car which was either next to, in back of, in front of, or in a garage. When presented with this four way discrimination task, each subject was asked a series of questions about these displays.*

a) Show me a picture where the car is in front of the garage.
b) Show me a picture where the car is in back of the garage.
c) Tell me, where is the garage in this (pointing to A) picture?
d) Tell me, where is the garage in this (pointing to B) picture?

Many of our younger subjects, when asked to tell where an object was, responded with "right here." When this occurred they were prompted with questions like "is it on the garage?"

* During pilot research for this study 4 and 5 year old subjects had to be eliminated because, although they gave some evidence of understanding the terms in front of and in back of, their comprehension was unstable and they appeared to resort to guessing. It was noted that the instability of these spatial concepts was elicited contingent upon the order of mention of the questions pertaining to the spatial arrays. For example, if (a) was followed by (c) subjects for whom the concept was not yet stable would fail to give the appropriate response. When the present order was used this effect disappeared. One may argue, on the basis of this information, that the reciprocity of these spatial arrays has not been fully acquired.

This question always elicited a spatial term in place of the demonstrative. Seven subjects who were unable to perform the task were eliminated on this lenient criterion, since the subsequent sentence recognition task was dependent upon comprehension of these two spatial terms.

b) Reversibility: To assess the child's ability to perform a reversible operation and decentration for concrete objects, we presented him with a bowl of 12 brightly colored wooden beads and a piece of string. His task was to replicate a model of 7 beads, already strung in a linear order, and placed 24 inches in front and slightly to the left of him (Piaget, (1967, 1974) had found that young children are unable to carry out the one-to-one correspondence necessary for his task if the model is not directly in front of them).

The subject was told, "I'd like you to make a string of beads for me, just like this one." His task was to string the beads, in linear order from left to right. After completing this part of the task, the beads were removed from his string and returned to the bowl. The subject was then told, "Now I'd like you to string the beads again. But this time I want you to do them in the opposite direction, so that the last bead you put on before will be the first bead to go on this time." Very few of the younger children understood the word <u>opposite</u>. This was determined by asking them to explain what they were to do. In such instances the directions were repeated substituting either the word <u>backwards</u> or the phrase <u>the other way</u> in place of opposite. Our

concern on this task was the child's ability to reverse a linear order so it was essential that he understood the language which was directing his performance.

c) Transitivity: This task was employed to ascertain a subject's ability to make inferences about concrete objects (Bryant, 1974). The stimulus materials used were five different colored sticks equally graduated in length so that A>B>C>D>E (A=green, B=red, C=blue, D=yellow, E=orange). A rectangular box, one long side of which had five holes running in a straight line from left to right was used so that each stick fit into a hole and protruded one inch. When subjects viewed the box containing the sticks it appeared that all sticks were of equal length. The reason for the use of this apparatus will become apparent.

Each child was shown individual pairs of the five sticks separately; first AB, then BC, etc. As each pair was shown the subject was asked which stick was longer. If he did not respond with the name of the color he was prompted to do so. It was crucial that he be given sufficient opportunity to process and store each of these perceptual experiences so that when asked to make an inference about a pair which had not been directly perceived before, his inability to make the inference would not be due primarily to memorial factors but would result from the inability to integrate individual perceptual experiences.

After viewing the four separate pairs of sticks the child was shown the box with copies of the sticks exposed

one inch in length and was asked to tell which one of several pairs was longer or shorter, i.e. AC, AD, AE, BD, BE, CE. The only true inference the child can make is B D, since A is always longest and E is always shortest. In addition to recording responses as correct or incorrect we were interested in the reasons why a subject made his particular choice. A subject who chose correctly but gave a clearly inappropriate reason was not credited with the ability to make transitive inferences. For example, if a child made the appropriate B > D inference, and when asked "why" responded with "I can tell by looking that red is just a little bit longer, see?"--(This response occurred when the perceptual information was--all sticks extending one inch beyond the box) he was not given credit for making an inference.

Inability to perform on either the transitivity or reversibility task did not eliminate a subject from further investigation. Whether the presence or absence of these cognitive operations would influence the construction and comprehension of semantic ideas was one of the questions we were investigating.

Session 2: Sentence Recognition Task

Children, on this occasion, were presented with the language processing task. Each subject was told: "I am going to read some stories to you. I want you to listen very carefully and try to picture, in your head, the story you are listening to. After I read each story I will ask you some questions about it. Let's try one so you can get

the idea of what we'll be doing." The subject was then presented with a sample acquisition story. Following this he was told, "Now I'm going to tell you some things about the story. If you think you heard me say any of these things before, say 'yes.' If you don't think you heard me say them, say 'no.'" The sample acquisition story followed by sample recognition sentences were presented to familiarize him with the task requirements. Several of the four and five year old subjects required more than one sample during training for this task. If, by the third trial a subject was unable to perform, he was eliminated from the study (Two four year olds and one five year old were eliminated). None of the sample stories contained the locatives being investigated. The sample recognition sentences however, did consist of the type of sentence the child would encounter during the actual task (Appendix 1 contains sample acquisition stories and recognition sentences). The actual acquisition stories each contained the preposition in front of or in back of, which related three objects in a highly imageable situation. The stories were created to suggest experiences subjects would have been likely to encounter (Appendix 2 contains the six acquisition stories). In addition to the spatial terms, each of the stories suggested inferences concerning those spatial arrangements.

Three of these stories were presented in a manner which was considered easy to image and hence comprehend (where order of mention of items in the story corresponded

to a front-to-back placement of items in space) and three in an order which was judged to be difficult (where the order of mention and spatial position did not coincide with ease of imageability). The order of easy/hard of any presentation was controlled so that easy and hard stories always alternated, so that for half the subjects in a group the first story was easy, and for the other half the first story was hard. Over all stories the order encountered for any given story was controlled in a latin square design. Each story occurred in first position an equal number of times.

Following exposure to each story the child was asked to perform an interpolation task. He was then presented with a selection of 4 from a set of 8 recognition sentences. These sentences were generated by alteration of three underlying dimensions which governed the relation of recognition sentence to story. The dimensions of change involved a change of preposition with respect to the acquisition story; a change of order of mention, and/or a change of item not explicitly related in the original story. These changes called for an integration of and hence inferences about previously presented information. A complete complement of these dimensions of change yielded 8 recognition sentences, 4 of which were semantically correct (those in which the preposition and order of mention were the same as in the acquisition story (eg. the nest is in front of the bird) and those in which the preposition and order of mention changed

together (eg. the bird is in back of the nest). Four were incorrect resulting from a change in either preposition or word order in an independent fashion (Appendix 3).

Each subject received all eight types of recognition sentences over the set of six stories. However, a subject received only four recognition sentences per story. Half the subjects received sentences 1 - 4 in connection with an easy story and half received sentences 5 - 8 in association with an easy story. An acquisition story and its corresponding sentences are displayed below.

There is a bird in a tree and near the bird is a nest with some eggs in it. The nest is in front of the bird. The nest is made of yellow straw and little sticks.

1) The nest is in front of the bird.
2) The eggs are in front of the bird.
3) The nest is in back of the bird.
4) The eggs are in back of the bird.
5) The bird is in back of the nest.
6) The bird is in back of the eggs.
7) The bird is in front of the nest.
8) The bird is in front of the eggs.

Once a pairing between story and recognition subset was established by the first story that pairing was preserved for a given subject in subsequent encounters with that story type. However, the order within a subset was systematically varied across stories of each type so that, for example, sentence 1 did not appear in first position more often than any other recognition sentence from that set.

In the above sentences, for 1 - 4, the order of mention of objects is the same as the order in which they were originally perceived. Sentence 1 is an exact replication from

the story whereas 2 is a correct semantic inference. The difference between 1 and 2 is the presence, in 2, of a new word, not explicitly related to the subject during the acquisition story. Sentence 3 is an incorrect utterance in that the preposition has been changed destroying the original relationship. Sentence 4 presents an incorrect spatial array as well as a new word, and hence an incorrect inference. The set of recognition sentences which reversed temporal order, 5 - 8, were merely reversals of each of the first four utterances.

One may observe that not only are sentences 1 and 5 semantically synonymous with each other, as are 2 and 6, but they also retain synonymy with the acquisition story. The order of cognitive complexity among them increases so that 6 is more difficult than 5 (in 6 we have reversed word order, reversed preposition and a new word); 5 is more difficult than 2 (it presents reversed order and the reverse preposition); 2 is more difficult than 1 (2 presents a new word). Sentences which are semantically dissonant increase in complexity in a similar fashion, with $8 > 7 > 4 > 3$.

Results

The main source of data for this study consisted of subjects' responses of "yes" or "no" when presented with recognition sentences which were either semantically consonant or dissonant with previously presented acquisition stories. For each age group the differential effects of strong imagery (I+) versus weak imagery (I-), in the acquisition story was analyzed for each of the eight types of recognition sentences.

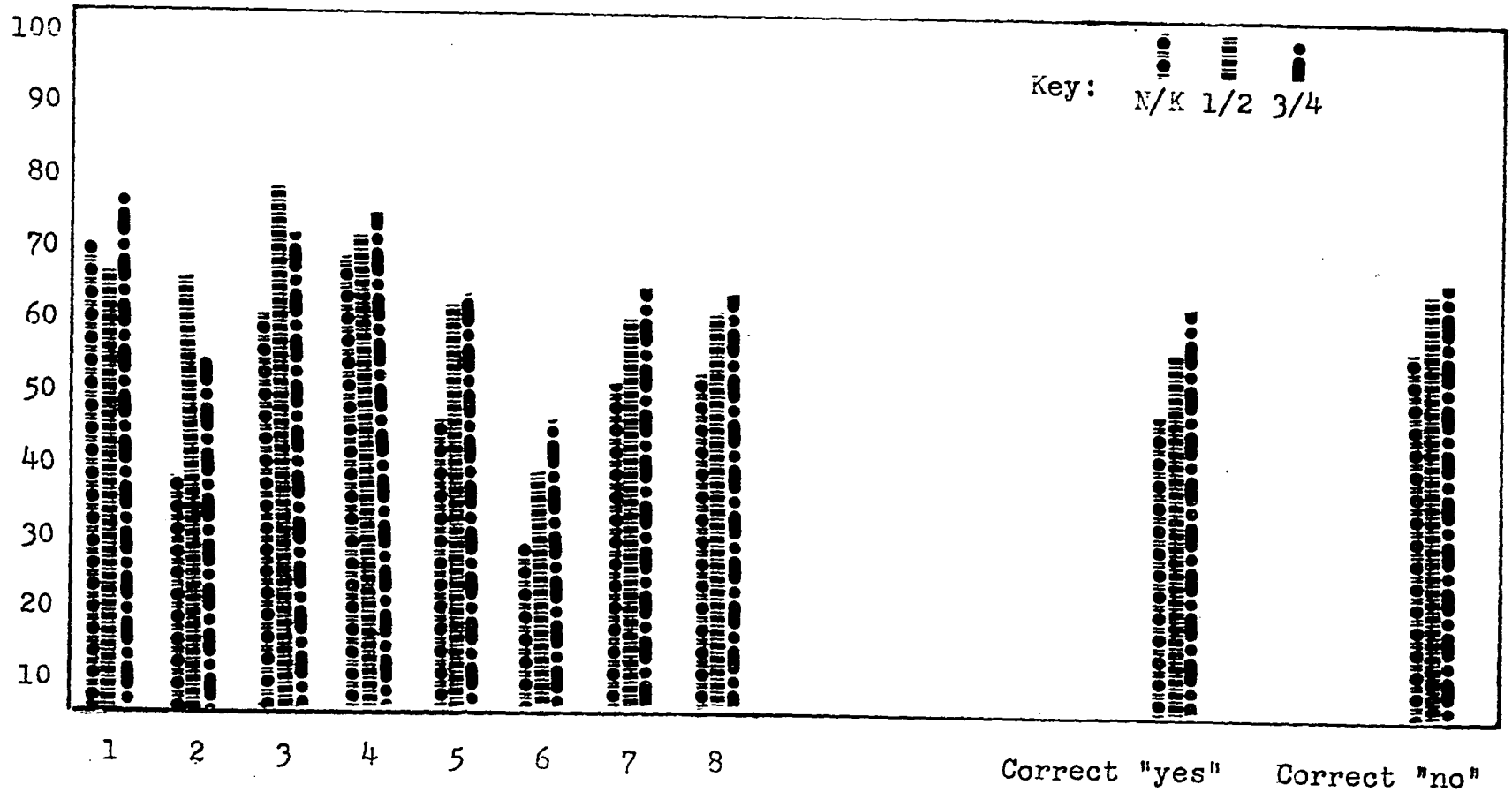
A second source of data was the information gathered from the two conceptual tasks presented during the initial session, i.e. the transitivity and reversibility tasks. Since decentration is considered a prerequisite for linear ordering and reversibility only one score was assigned to the subject contingent upon his performance on the bead stringing task. A score of 1 indicated the inability to perform the entire task whereas a score of 2 was assigned if the subject performed the forward and reversed sequence appropriately. Similarly a score of either 1 or 2 was assigned to a subject contingent upon unacceptable or acceptable performance on the transitivity task.

Preliminary screening of the data was performed to determine which scores might be combined. No effects of order of presentation of the six acquisition stories or of the presentation of randomly ordered recognition sentences was found. In order to determine whether the effects of practice or fatique would result in variability of perfor-

mance, subjects' responses to the first two recognition stories was observed and compared to their responses on the last two stories. Initially a raw distribution of responses was tallied. Subsequently a distribution of difference scores was obtained for which + signified better early performance and - signified better late performance. No evidence of fatigue or practice effects was found.

Subjects' responses to the eight types of recognition sentences, based on semantic integration ability, clustered at chance levels. Figure 1 describes subjects' responses to each of the eight sentence types based on their ability to integrate semantic ideas. When responses were tallied within age groups positive variation from chance was observed for all ages for sentences 1, 3, 4, and 8. For the remaining sentence types, performance fell below chance for the youngest group only, with the exception of recognition sentence 6, for which all groups performance was less than 50% correct (The reason for this occurrance is discussed below). When responses for semanticity were summed across ages for all sentences, the scores clustered around chance. There was no general increase in subjects' ability to construct semantic ideas with an increase in age.

Because of the lack of full semantic integration, each recognition sentence was viewed with the underlying assumption that there were lexical and/or temporal sequential cues, which, when attended to, would result in incomplete processing of the recognition sentence (as indexed by a



Correct Response:

Yes Yes No No Yes Yes No No

Figure 1. Subjects' mean percent of correct responses to each recognition sentence based on the abstraction and integration of semantic ideas.

tendency to respond either "yes" or "no" based on tracking that cue alone). There are three intra-sentence variables which could serve as cues to elicit these responses, i.e. a change in preposition, a new word, and a change in word order. If any one or more of these variables differed from acquisition story to recognition sentence, the mismatch between the two would be a stronger perceptual cue to the subject than the meaning of the utterance and hence result in a contradictory or spuriously appropriate semantic response. Figure 2 describes the predicted response to each of the eight sentence types based on a match/mismatch model for each of the intra-sentence variables. If a subject, for example used the preposition as a basis for recognition or rejection he would respond correctly to sentences 1, 2, 3, 4 and incorrectly to sentences 5, 6, 7, and 8. In sentences 1, 2, 7, and 8 the preposition matches the preposition that the subject had heard during acquisition. The processing of this particular perceptual cue results in a correct response for sentences 1, 2, 3, and 4, albeit for the wrong reason (this becomes clearer when the response tendency for new word and temporal order is observed), and incorrect responses to 5, 6, 7, 8 for exactly the same wrong reason.

When the new word is the cue attended to, recognition sentences 1, 4, 5, and 8 would receive a correct response (the response tendencies match the semantic response), and 2, 3, 6, and 7 would receive incorrect (mismatched) responses. Similarly, using a match/mismatch model for word order,

	1	2	3	4	5	6	7	8
Correct Semantic Response	Y	Y	N	N	Y	Y	N	N
Response Tendency When Preposition Changes	Y*	Y*	N*	N*	N	N	Y	Y
Response Tendency When New Word is Presented	Y*	N	Y	N*	Y*	N	Y	N*
Response Tendency When Word Order Changes	Y*	Y*	Y	Y	N	N	N*	N*

Figure 2. Subjects' tendency to respond either "yes" or "no" when attending to lexical cues or temporal order of lexical items.

*matched response

sentences 1, 2, 7, and 8 would be responded to correctly because the recognition sentences lexical ordering matched that found in the acquisition story. Whereas 3 and 4 would be incorrectly accepted, and 5 and 6 incorrectly rejected.

A repeated measures, unequal N, ANOVA was used to assess the effects of match versus mismatch between acquisition story and recognition sentences for the preposition and new word factors. Previous analyses, using t tests, indicated that the word order factor was not significant (Only 3 of 24 possible comparisons using this factor were significant at the .05 level; see Table 2). Since this did not differ from a chance effect, sentences testing preposition and new word matching were pooled over sentences.

Additionally age effects and the effects of imagery conditions (to be explained below) were assessed within the same ANOVA (Data-Text System).

A model similar to the one described above was employed to ascertain what influence the construction of an image would provide for the acceptance or rejection of semantic ideas. Following the interpretations of Huttenlocher and Strauss (1966) and Clark (1973), children should have less difficulty constructing an image from linguistic information in which the order of mention of subject and object reflects the natural, positive order of a linear spatial array and too will have less difficulty comprehending an utterance containing an unmarked preposition rather than one which is marked. Given this assumption we are able to

Word Order[1]

	Match	Mismatch
N/K	1.63	1.54
1/2	1.85	1.76
3/4	1.98	1.88

Table 2. Average scores, by age group, of responses to recognition sentences based on the match or mismatch to word order.

[1]Expressed as an average score (out of 3) per sentence type.

create dichotomous conditions for the influence of imagery when subjects are presented with the two prepositions used in this study. In one condition a strong imagery factor (I+) is precipitated by the presence of an unmarked preposition (in front of) which leads to the order of mention of subject and object reflecting the front to back order in which subjects tend to construct images of spatial arrays. In the second condition imagery is weakened (I-) by the absence of the above events, i.e. the preposition is marked (in back of) and the image to be constructed is contradictory to what is proported to be perceptually easiest to comprehend.

Results of the ANOVA indicated no significant age effects but yielded significant main effects for preposition match/mismatch, new word match/mismatch, and imagery and a new word*imagery interaction. These results are displayed in tables 3, 4, 5, and 6.

We have already determined that reversed word order has no significant effects on subjects' recognition performance. The variables of preposition and new word, however, appear to be strong cues guiding recognition responses to previously presented utterances ($p < .001$, see Tables 3 and 4). Similarly, recognition performance was better under strong imagery conditions ($p < .001$, Table 5).

However, the strength of the new word match/mismatch comparison was found to depend upon the strength of the imagery factor ($p < .05$, Table 6). When the image that is

New Word

Match	Mismatch
3.745	3.167[x]

Table 3. Main effects of across age groups of responses to the new word, based on the match or mismatch model.

Preposition

Match	Mismatch
3.918	2.993[x]

Table 4. The main effect of a match or mismatch, across age groups, for responses to recognition sentences when the preposition is the cue attended to.

Imagery Conditions

I+	I-
3.825	3.057[x]

Table 5. The main effect across age groups of responses to recognition sentences under conditions of strong imagery versus weak imagery.

[x] $p < .001$

New Word X Imagery

	Match	Mismatch
I+	3.988	3.662
I-	3.483	2.632[xx]

Table 6. Interaction for new word x imagery, across age groups, for responses to recognition sentences based on the match/mismatch model.

[xx] $p < .05$

constructed is a strong one (in front of), presentation of a new word was a weak signal which was relatively unnoticed. Conversely, in the I- condition (in back of) because subjects could not easily construct an image for a back to front array, the new word became a strong cue signaling a difference in the recognition sentence and resulted in the tendency to say "no".

Table 7 presents the average number of correct responses by sentence, across age groups, when conditions of strong imagery are operative versus the absence of an easily imageable situation. Sentences 1, 4, 7, and 8 are not significantly discriminated under either imagery condition. The same data is displayed graphically in Figure 3, where variation in subjects responses under conditions of I+ and I- can be observed.

The mean number of correct responses for each age group under I+ and I- conditions for each sentence type is presented in Table 8. Sentences 1 and 4 are relatively unaffected by either condition across age groups. If the new word is attended to (as in 4) a "no" response would result. If the preposition is the focal cue its reversal would also elicit a "no" response. Neither cue occurs in sentence 1 resulting in a "yes" response when "yes" is correct. Both occur in 4 resulting in a "no" response when "no" is semantically appropriate. Sentence 2, in I+ contains the acquisition preposition, a strong cue which in this condition elicits a higher frequency of semantically correct recognitions. In

	I+	I-	Significance Level
1	2.17	2.13	N.S.
2	1.92	1.13	$p < .001$
3	2.27	1.75	$p < .02$
4	2.12	1.94	N.S.
5	1.38	1.80	$p < .05$
6	.81	1.27	$p < .05$
7	1.40	1.80	N.S.
8	1.46	1.87	N.S.

Table 7. Mean scores for correct response tendencies for individual sentence types under conditions of I+ and I- across ages.

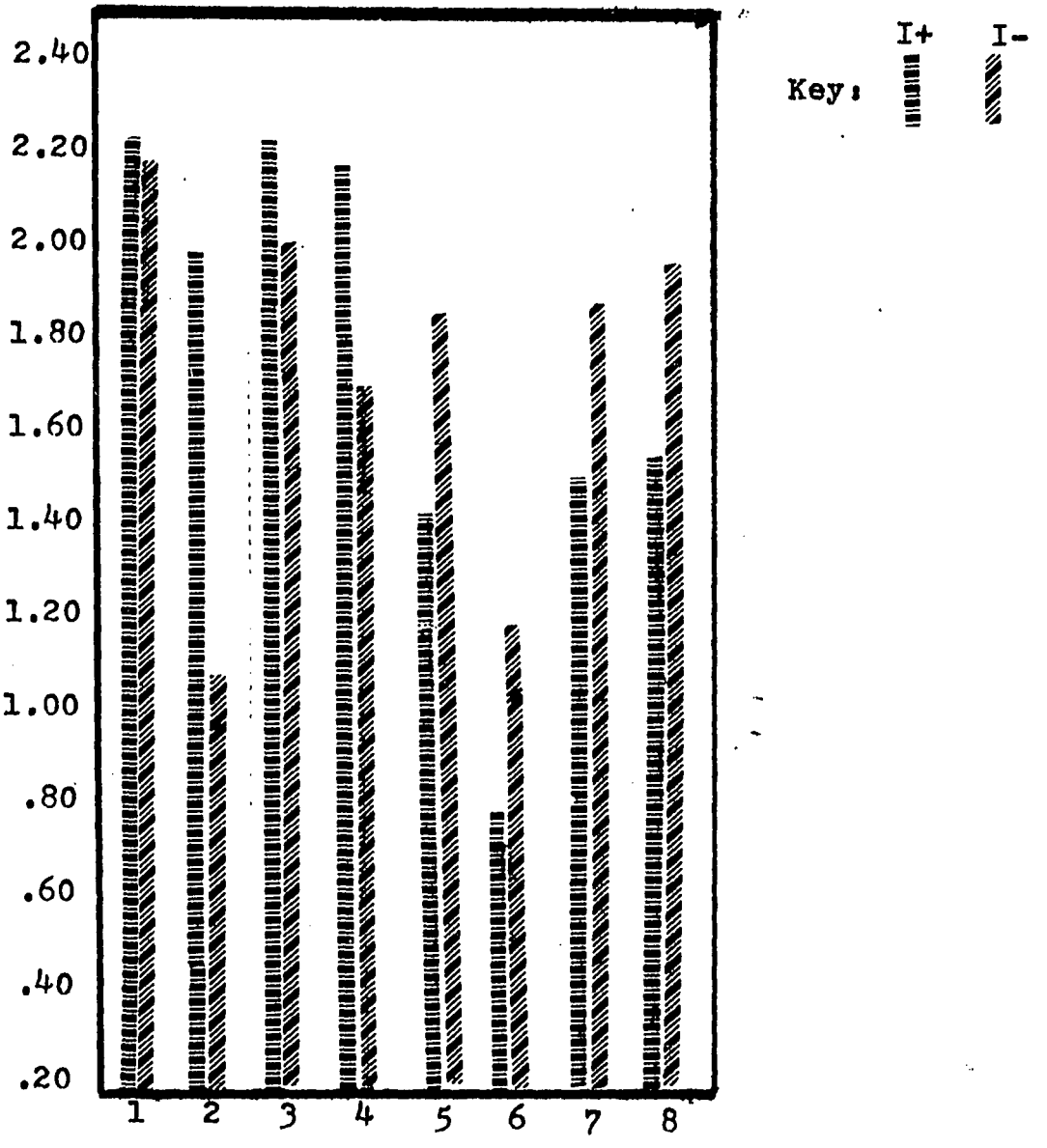


Figure 3. A graphic display of the average scores for correct response tendencies for individual sentence types under conditions of I+ and I- across ages.

		Imagery Factor							
		1	2	3	4	5	6	7	8
N/K	I+	2.01	1.62	2.06	2.06	1.14	.64	1.28	1.57
	I-	2.21	.78	1.57	2.00	1.62	1.12	1.56	1.85
	D=I+-I-	-.20	.84	.49	.06	-.45	-.48	-.28	-.28
1/2	I+	2.08	2.50	2.33	2.08	1.40	.80	1.60	2.00
	I-	2.00	1.30	2.20	2.00	1.91	1.08	1.75	1.58
	D=I+-I-	.08	1.20	.13	.08	-.51	-.28	-.15	.42
3/4	I+	2.38	1.92	2.54	2.23	1.42	1.17	1.75	1.92
	I-	2.25	1.25	2.08	2.08	2.00	1.53	2.08	2.31
	D=I+-I-	.13	.67	.46	.15	-.58	-.36	-.28	-.39

Table 8. Mean number of correct responses under strong imagery (I+) and weak imagery (I-) conditions for each of the recognition sentences by age groups.

the I- condition the new word is a much stronger cue resulting in a decrease in correct semantic recognition. Sentence 3 was positively affected under I+. Here too a change in preposition signaled a change in spatial array and was a strong cue which resulted in a tendency to say "no" when "no" was semantically correct. Under I- this same cue is weakened resulting in an incorrect "yes" response. Sentence 5 predictably was strongly affected by I+, where again the preposition functioned to elicit the tendency to say "no" when "yes" was semantically correct. Under both imagery conditions sentence 6 created the most difficulty for all subjects. In I+ the preposition change resulted in rejection of the recognition sentence and in I- the new word performed that same function. For the two remaining sentences, 7 and 8, under I+ replication of the preposition heard during acquisition prompts acceptance of the recognition sentence. In the I- condition, though, we found that subjects tended to accept 7 but reject 8. Recall that in weak imagery conditions the new word cue is strengthened.

No relationship was found between the Piagetian tasks of reversibility and transitivity and children's inferential abilities.

Discussion

The results of this study indicate that children between the ages of 4 and 10 years have difficulty recognizing semantically synonymous ideas and rejecting those which are semantically disonant with previously presented propositions. On a task requiring the construction and integration of semantic ideas our subjects performed at or near chance levels. A match/mismatch model was presented which accounted for the acceptance or rejection of recognition sentences based on the processing of lexical cues. The model attempted to provide an information processing framework which would account for the poor semantic integration abilities displayed by 4 - 10 year old subjects when confronted with recognizing propositionally similar linguistic utterances.

It was evident that our subjects did indeed track linguistic information but not in the same way as adults. They tended to employ incomplete processing strategies that resembled rote memorization for lexical items rather than constructive memorial processes. The match/mismatch model discussed in chapter 3 efficiently predicts poor performance when subjects attend to either the lexical cues of preposition or new word as a basis for accepting or rejecting recognition of that item upon re-presentation, but not to a semantic or conceptual construct, which requires simultaneous tracking of preposition, new word, and word order. In all instances, across all age groups, when the lexical items of new word or preposition in the recognition sentence did not

match what was heard in the acquisition story, the rate of correct responses of our subjects fell significantly. We could state a tentative conclusion which will eventually need qualification. That is: the tracking of specific lexical items results in children's ability to significantly differentiate recognition sentences on the basis of a lexical match or mismatch, but simultaneously that tracking results in a deficit in processing linguistic information for semantic similarity.

The results of this study support the findings of Paris (1975) and Paris and Mahoney (1974). Children, under the age of 9 have great difficulty recognizing semantically similar recognition items as identical to the propositions suggested by the acquisition stories, and perform at or near chance levels. In the Paris and Mahoney study cited above, when subjects were given an integration and recognition task based on concrete visual information processing, their performance on semantic integration increased significantly. Bruner (1966) has suggested that children of these ages rely primarily on an imagistic system of representation. Both he, and Piaget and Inhelder (1973) agree that it is not until sometime later (somewhere near 11 years) that the child begins to use an arbitrary symbol system as a means for problem solving. Accepting that assumption, we can infer that the child would tend to handle easily imageable linguistic information with greater facility than linguistic information for which an image is more difficult to form. In an unpublished

doctoral dissertation, Kuhlman (in Bruner, 1966) spoke to just this issue. She observed that children who employed high imagery did poorly on tasks requiring conceptualization, whereas low imagery children were not as perceptually bound and hence were not distracted by perceptual (imagistic) cues when processing linguistic information. The implication of her findings on a task such as ours, requiring semantic integration, is that our subjects were found to be relying primarily on static visual perceptual cues and their association to arbitrary verbal labels rather than processing the conceptual framework suggested by the language they heard.

Unlike Kuhlman's study in which some subjects were high imagers and others were low imagers, we assumed that all of our subjects were operating with primarily an ikonic mode of representation since they were all within the ages of 4 to ten years. A reason for creating stories with concrete objects and scenes which were easily imageable was to facilitate semantic integration for this age group. Our results suggest, however, that the nature of the "to be formed image" may itself, be a contributing factor in the ultimate comprehension and integration of semantic ideas. For example, in the Paris and Mahoney research, normal children and retardates performed significantly better (i.e. more like adults), on a task requiring semantic integration and recognition when the stimulus items were pictures than when they were verbalizations (In both the verbal and pictorial tasks the relations requiring integration and recognition were spatial in nature). In this study, the information to

be processed relied solely on verbal stimuli for which an image was to be formed.

By subscribing to a model which considers only the perception of lexemes in a comprehension task such as ours, we are crediting the child with less comprehension and inferential abilities than he may actually possess. The discomfort with or inadequacy of such a model becomes even more powerful when one considers the proficiency displayed by children on tasks that employ visual information as stimuli to be processed as opposed to their apparent deficit when presented with similar information via an arbitrary symbol system. Apparently an attribute of the visual input, its explicitness, which arises from its perceptual concreteness, is functionally and cognitively less complex to manipulate mentally, than are the abstract symbols which represent a concrete array. Our findings suggest however, that not all visual images may be equally facilitating. Some spatial relations, for example, have been observed to be more complex than others. Their complexity may result from their markedness, the addition of a feature or features, either linguistic or perceptual, relative to a simpler, unmarked label. Following this line of reasoning, the locative <u>in front of</u> would be the unmarked member of the pair of spatial terms that are comprised of itself and its opposite, <u>in back of</u>. The former is easier to comprehend because objects described as being <u>in front of</u> are in a direction readily perceived by a speaker/hearer. "The front is the direction towards which

an animal moves, and the back is the direction from which an animal moves..." (Clark, H., 1973). The results obtained by DeSoto et. al (1965) and Huttenlocher and Strauss (1966) support a complexity hypothesis. Children tend to order, via imaginal spatial arrays in a positive direction, the referents suggested by linguistic information. They have difficulty ordering and hence comprehending linguistic information which suggests a negative direction.

Three of the acquisition stories employed in our study contained a preposition which, based on a complexity theory, would be easier to image, i.e. in front of. The remaining three stories contained a locative which was more complex, in back of, therefore, should result in greater difficulty for imaging, ordering and semantic integration. It was this consideration which suggested that there would be differential effects in inferential ability when imagery was facilitated as opposed to when a situation would be difficult to image.

We have observed the differences which occur between subjects recognition of utterances when lexical items are tracked and matched to the acquisition story. In part that accounts for variation in performance. Whenever a mismatch occurs (with the exception of word order as a perceptual cue) we observe a significant drop in recognitory ability. When When the lexical cues of preposition and new word are observed under the two conditions of strong imagery (unmarked preposition) and weak imagery (marked preposition) some rather interesting changes in recognition and semantic integra-

tion occur.

The most striking observation across all ages is that under strong imagery the ability of subjects to make a simple inference was enhanced (Table 3, sentence 2), but when an image was difficult to form the subjects had to revert back to reliance on lexical memory and their performance fell to below chance levels. When an image is easily constructed, relevant semantic information may be abstracted and integrated and one need not rely solely on verbatim memory. Since these subjects were assumed to be employing an ikonic mode of representation, the construction of an image was, for them, considered essential for the abstraction and integration of semantic ideas. Recognition sentences 1 and 4 remained relatively unaffected by either imagery condition; whether the preposition, or the visual array is being tracked, an appropriate "yes" or "no" response will result respectively. If imagery is weak, the reversion to reliance on tracking the new word will also result in an appropriate semantic response. In sentence 2, however, appropriate semantic responses occur more frequently under conditions of strong imagery. The large increase in appropriate semantic response for sentence 2 in each age group is rather striking support for the development of inferential abilities in easily imageable conditions.

When we observe subjects' performance on sentences 5 through 8, in all cases, across ages we find a decrease in recognition of semantic similarity. Under I+ and I- sub-

jects may be processing opposite spatial propositions as different images--not perceptually identical (A similar observation was made in the Paris and Mahoney study and they suggested that it may be the marked/unmarked distinction which caused their subjects' difficulty. The recognition difficulties of their subjects were reduced considerably when they had the advantage of pictorial displays paired with verbal propositions. Our subjects had no such visual aid and could rely only on the images they generated themselves). In addition, in recognition sentences 5 through 8 the perceived linear order of linguistic events is reversed, confusing the original percept. Our results indicated that reversed word order had no significant effects on subjects' performance. Since, in our stimulus items, a change in preposition, when semanticity was to be maintained, always necessitated a change in the order of subject and object, it was difficult to separate out word order from the effects of the preposition for semantically synonymous utterances. For a semantically dissonant utterance such as sentence 3, when imagery is facilitated a subject's ability to reject the utterance increased, indicating that the preposition (rote memory for words) is being tracked. If word order alone on this task were a salient perceptual cue, we should observe the frequency of correct responses falling sharply for sentences 5 through 8 in either conditions of imagery. In fact that did not occur. Apparently the preposition is the stronger cue and the one which determined the ordering of a visual

array and by implication the order of lexical items. Since all of our subjects were screened for knowledge of these spatial relations and displayed competence in understanding the relational nature of these terms in re: the relationship of the objects they were paired with, we can infer that they also comprehended the effects of the preposition on word order. They displayed no such difficulty dealing with the reversibility of subject and object when pictures were stimulus items.* When the task required self generated images, however, is when their proficiency became questionable.

Another way of viewing the difference in performance for sentences 5 through 8 as opposed to sentences 1 through 4 is via Kuhlman's interpretation. Our subjects formed an image from which distinctive perceptual cues were abstracted. Attention to these percepts prevented them from abstracting a holistic concept. Therefore when similar information was presented to them under the guise of a different conceptual label, their original perceptual image remained dominant and they tended to reject the new information on the basis of a

* In retrospect it is plausible to consider that had the special ordering of questions pertaining to spatial arrays not been used, a more sensitive measure of comprehension would have resulted and a number of subjects might have been eliminated on the basis of not having acquired the full concept of the reciprocity of the two spatial arrays. Elimination of those subjects might have resulted in our observing an increased competency for abstracting and integrating semantic ideas, particularly in the easily imageable stories. Admittedly this is a flaw in the design.

perceptual mismatch.

It would seem now, that the conclusion reached earlier, i.e. tracking lexical cues, needs qualification. When acquisition conditions suggest a spatial term that is unmarked, children will have less difficulty constructing images and integrating semantic ideas. When the ability to image is decreased, children tend to have difficulty comprehending spatial terms and rely on verbatim recognition of lexical cues. At some point in linguistic and cognitive development children begin to integrate the image and the meaning of arbitrary lexical symbols and attend to each simultaneously rather than perceiving one or the other. This later operation results in the ability to treat propositionally similar utterances as semantically synonymous and to reject those utterances which are semantically dissonant. What we are suggesting is that it is the cojoining of two modes of representation which allow for the construction and integration of semantic ideas. Before these modes are used as complementary, the child is, in effect, centering on one or the other and the result is inefficient and incomplete processing. Both the images and the linguistic information need to be assimilated to the same organizational structures; in this instance a spatial array. If they are stored as different spatial constructs, or not completely organized due to imaginal complexity the child would be hard pressed to recognize relatively new information as conceptually synonymous or antithetical to a previously presented idea.

Our secondary thesis, that there would be some relationship between the concrete cognitive tasks of reversibility and transitivity and integrative abilities for verbally presented information was not supported. We can offer several reasons why the prediction did not hold up. First it is entirely possible that performance on concrete cognitive tasks such as those employed here, are not measuring the same operations utilized for linguistic processing. The concrete tasks utilized in this study were assessing operations. The sentence recognition task may well have required a level of performance not operative until the stage of formal operations, i.e. employing propositions to think about propositions (We have cited a number of studies which found significant differences between processing concrete and linguistic information). Second, we limited our assessment of cognitive structures to only two tasks. If a wider variety of problem solving tasks were presented to each subject a more sensitive and valid measure of cognitive competency might have been obtained. The information derived from them would very likely have more effectively sorted those subjects who were in a transition period. Third, the subjects who were likely to have been in a transitional period, in re: cognitive operations, fall into the 1/2 age group. An increase in sample size in this age group (6 and 7 years) along with the more varied assessment measures, may well have formed a basis for more strongly differentiating effects.

Taken conjointly the results of this study and others

cited herin, suggested that there may be a gap between the passive acquisition of a cognitive operation and a similar one at a productive level of symbolic representation. For example, Sinclair-De-Swart, investigating the relationship between cognitive operations and the comprehension and use of specific lexical items concluded that the acquisition of lexical items and their production and comprehension when embedded in syntactic constructions constituted a distinction between operational level and operational progress respectively. A verbal label would lead "subjects...to direct their attention to pertinent aspects of the problem... but it does not bring about the acquisition of operations" (1969). Beilin obtained similar results with children who were observed to be able to comprehend and produce passive utterances long before they were able to judge synonymy of active and passive utterances (1976). Bryant suggests that the gap which may exist in children is between their "potential and performance." When young children are given enough specific information they are able to make passive inferences. However, when they are called upon to generate, spontaneously, the data necessary to go "beyond the information given"--i.e. make an active inference, they are unable to do so. In other words, they have the ability to make inferences but do not "necessarily use these inferences when they make perceptual judgements" (1974).

These findings speak to the contention that there is a difference between partial and full control of a cognitive

operation as well as partial and full control of a linguistic operation. Perhaps then, the gap between understanding the reversibility of spatial relations in isolated utterances, when accompanied by visual displays is evidence of partial ability to abstract semantic ideas. The more complex cognitive activity of abstracting and integrating semantic ideas in connected discourse and making judgements about semantic synonymy is an operation that does not reach full efficiency until an individual can use language as a reflective instrument of thought and not be distracted by the strength of his perceptual images.

Appendix 1

Training Stories and Questions

There is a big box in the yard and in the box is a snake. The snake is long and skinny and wiggles a lot. There are children watching the snake.

1) There is a box in the yard.
2) The box is blue.
3) The children are in the yard.

There was a sandbox in the playground with a pail and a shovel in it. The pail was blue. The boys and girls liked to play in the sandbox.

1) The pail was in the playground.
2) There is a sandbox in the playground.
3) The boys played with a wagon.

Every morning the children went to school. In their classroom a big basket was filled with blocks. It was fun in school.

1) There were dolls in the classroom.
2) Every morning the children went to school.
3) There was a basket in the classroom.

Appendix 2

Acquisition Stories

1) There is a swing set in the park with some benches near it and children sitting on the benches. The benches are in front of the swings. The swings are painted yellow and orange.

2) A dog is in the yard and near the dog is a table with a bone on it. The table is in back of the dog. The dog is white with a black patch over one eye.

3) There is a car in the driveway and near the car is a boy playing with a ball. The boy is in front of the car. The car is brand new and silver.

4) A bicycle is in the garage and near the bicycle is a wagon filled with wood. The wagon is in back of the bicycle. The bicycle is very old and dusty.

5) There is a bird in a tree and near the bird is a nest with some eggs in it. The nest is in front of the bird. The nest is made of yellow straw and little sticks.

6) A horse is in the circus and near the horse is a bear balancing a cup on his nose. The bear is in back of the horse. The horse is wearing a hat of pink feathers.

Appendix 3

Recognition Sentences

1. The benches are in front of the swings.
2. The children are in front of the swings.
3. The benches are in back of the swings.
4. The children are in back of the swings. *

5. The swings are in back of the benches.
6. The swings are in back of the children.
7. The swings are in front of the benches.
8. The swings are in front of the children.

7. The dog is in back of the table.
6. The dog is in front of the bone.
5. The dog is in front of the table.
8. The dog is in back of the bone. *

3. The table is in front of the dog.
2. The bone is in back of the dog.
1. The table is in back of the dog.
4. The bone is in front of the dog.

4. The ball is in back of the car.
1. The boy is in front of the car.
2. The ball is in front of the car.
3. The boy is in back of the car. *

8. The car is in front of the ball.
5. The car is in back of the boy.
6. The car is in back of the ball.
7. The car is in front of the boy.

5. The bicycle is in front of the wagon.
7. The bicycle is in back of the wagon.
8. The bicycle is in back of the wood.
6. The bicycle is in front of the wood. *

1. The wagon is in back of the bicycle.
3. The wagon is in front of the bicycle.
4. The wood is in front of the bicycle.
2. The wood is in back of the bicycle.

4. The eggs are in back of the bird.
1. The nest is in front of the bird.
2. The eggs are in front of the bird.
3. The nest is in back of the bird. *

8. The bird is in front of the eggs.
5. The bird is in back of the nest.
6. The bird is in back of the eggs.
7. The bird is in front of the nest.

8. The horse is in front of the cup.
6. The horse is in back of the cup.
7. The horse is in back of the bear.
5. The horse is in front of the bear. *

4. The cup is in back of the horse.
2. The cup is in front of the horse.
3. The bear is in front of the horse.
1. The bear is in back of the horse.

* One half of the subjects received the sets of recognition sentences designated (*) and the remaining subjects were presented with the unmarked sets.

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