COGNITIVE PSYCHOLOGY 3, 193–209 (1972)

Sentence Memory: A Constructive Versus Interpretive Approach[1]

JOHN D. BRANSFORD
State University of New York at Stony Brook

J. RICHARD BARCLAY
University of Minnesota

AND

JEFFERY J. FRANKS
Vanderbilt University

The present studies investigated the adequacy of an interpretive linguistic approach to the description of the knowledge communicated by sentences by asking whether sentence retention was primarily a function of memory for the semantically interpreted deep structural relations underlying the input sentences or a function of memory for the overall semantic situations that such sentences described. Results were shown to be primarily a function of memory for the semantic situations. A constructive approach to sentence memory was outlined that dealt with memory for individual sentences as well as memory for sets of semantically related sentences contributing to the same overall idea.

Under normal circumstances a listener's memory for sentences may be inaccurate at the level of word-for-word recall but accurate at the level of semantic paraphrase (e.g., Sachs, 1967). A major task for psychology is to characterize the nature of the abstract semantic information that is retained. Most recent attempts to account for sentence

[1] The initial experiments in this article were conducted while all three authors were predoctoral fellows at the University of Minnesota. The authors wish to express their most sincere appreciation for advice and support received there. Special thanks go to J. J. Jenkins for his helpful criticism and advice. The authors also wish to thank Gary Cross for conducting some of the experiments reported here. Preparation of this paper was supported, in part, by grants to the University of Minnesota, Center for Research in Human Learning, from the National Science Foundation (GB-17590), the National Institute of Child Health and Human Development (HD-00098), and the Graduate School of the University of Minnesota, and to the University of Minnesota, Institute of Child Development, from the National Institute of Mental Health (5-T01MH06668-13).

memory have relied heavily on concepts developed within transformational linguistic theory. For example, the distinction between the deep and surface structures of sentences has had considerable influence in this regard. The surface structure of a sentence is said to characterize its phonological shape but its deep structure is considered necessary to characterize its meaning (Katz & Postal, 1964). A number of investigators have presented evidence for the importance of deep structural relations in characterizing what is retained (e.g., Blumenthal, 1967; Blumenthal & Boakes, 1967; Rohrman, 1968; Sachs, 1967).

It is important to note that the deep structural approach to linguistics generally assumes an *interpretive* approach to semantics. Katz and Postal (1964), for example, have proposed that the deep structure of a sentence represents the input to the semantic component of the grammar. With few exceptions (see Katz & Fodor, 1963) the semantic interpretation assigned to a sentence is presumed to provide ". . . a full analysis of its cognitive meaning" (Katz & Postal, 1964, p. 12). Thus a semantically interpreted deep structure is assumed to provide a sufficient characterization of what is stored.

While the present authors heartily endorse the use of all available linguistic information in formulating a theory of sentence retention the purpose of this article is to demonstrate some of the possible pitfalls of the above-mentioned linguistic approach to sentence memory. It will be argued that a theory of sentence retention that restricts itself to a purely interpretive theory of semantics is not sufficient. An adequate deep structural analysis of input sentences may be necessary for a complete characterization of what one remembers, but it will not be sufficient to characterize what is retained.[2]

An alternative to the interpretive approach to sentence memory is one in which sentences are not viewed as linguistic objects to be remembered. Instead they are viewed as information which Ss can use to construct semantic descriptions of situations. These constructed descriptions may contain more information than is represented in the linguistic inputs, and hence a purely linguistic analysis of the input sentences will not adequately characterize the information available to the listener. The experiments to be outlined in the present paper represent an initial attempt to contrast the interpretive versus constructive approaches to sentence memory. Essentially these experiments ask whether sentence memory is primarily a function of the deep structural information underlying the input sentences or a function of the semantic descriptions that such inputs suggest.

[2] On the question of the linguistic adequacy of deep structural characterizations of sentences see, for example, Fillmore, 1968; McCawley, 1968.

Consider the following two sentences.

(1). Three turtles rested *beside* a floating log, and a fish swam beneath them.

(2). Three turtles rested *on* a floating log, and a fish swam beneath them.

These two sentences have identical deep structures that differ only in the specification of the lexical items *on* or *beside*, but the semantic situations suggested by the two sentences differ in at least one very important way. The description suggested by sentence (1) includes information about a fish swimming beneath the turtles. The description suggested by (2) also includes this information, but it includes something additional as well. Since the turtles were on the log and the fish swam beneath them, it follows that the fish swam beneath the log as well. This latter information (that the fish swam beneath the log) was not supplied by the linguistic input, however, but had to come from one's general cognitive knowledge of the world (in this case, knowledge of spatial relations). Of course, one might construct a dynamic description of sentence (1) that also contained this latter information, but the probability of doing so is much lower than for sentence (2).

Sentences like (1) and (2) above can be used to compare the interpretive and constructive views of sentence memory. Assume, for example, that Ss hearing either sentence (1) or (2) are presented with a recognition sentence that merely changes the final pronoun specified in the input sentence, i.e., (3) Three turtles rested (beside/on) a floating log and a fish swam beneath *it*. The two theories make different predictions about the probability that Ss will think they actually heard this sentence before (i.e., the theories make different predictions about the probability of false positives). According to the interpretive theory Ss store only the linguistic information underlying the input sentence. Hence Ss hearing either sentence (1) or (2) above should be equally likely to detect the pronoun change in sentence (3). The constructive theory makes a different set of predictions, however. Ss are assumed to construct wholistic semantic descriptions of situations. If they forget the information underlying the input sentence they should not be reduced to guessing, but should base their recognition ratings on the complete semantic descriptions presumably acquired. Given this view, Ss hearing sentence (1) should still reject sentence (3) since it is neither consonant with the actual input sentence nor the complete semantic description constructed. Ss hearing sentence (2) should be quite likely to think they heard sentence (3), however, since the latter sentence is consonant with the complete semantic description presumably acquired. In short, the constructive theory predicts that one's ability to detect the pronoun

change in sentence (3) depends on whether he originally heard sentence (1) or (2).

The first experiment was designed to contrast the interpretive and constructive theory by comparing recognition memory for sentences which have identical deep structures but differ in the semantic descriptions suggested. Two general types of sentences were used. The first type, exemplified by sentence (2) above suggested semantic descriptions that admitted a potential inference based on one's knowledge of spatial relations (i.e., that a fish swam beneath the log as well as the turtles). The second type, exemplified by (1) above did not suggest semantic descriptions that admitted the same inference. These two sentence types will be referred to as Potential Inference (PI), and Non-inference (NI) sentences, respectively. Of course, the term "Non-inference" is somewhat inaccurate, since the NI sentences used in the present study do offer bases for certain inferences. For example, from the fact that "Three turtles rested beside the floating log and a fish swam beneath it" (an NI sentence), one could infer that the fish did not swim under the turtles. The major differences between PI and NI sentences in the present study lay in the spontaneity and content of inferences they might provoke, and the sentences were intuitively chosen to exploit these differences. Thus, the convenient designation "Non-inference" is entirely relative to the present experimental situation.

EXPERIMENT I

Method

Subjects. The *Ss* were 18 female undergraduates enrolled in introductory psychology courses at the University of Minnesota. They were run in two groups, with 11 Ss in Group I, and 7 Ss in Group II.

Materials. Materials consisted of 14 sentence frames, such as *Three turtles rested (on/beside) a floating log and a fish swam beneath (it/them)*, and 7 filler (F) sentences. From each sentence frame it was possible to construct four different sentences. These differed among themselves in their PI vs NI status and/or in their final pronouns. One sentence from each frame was chosen for the acquisition list.

Each group of Ss received 21 acquisition sentences: 7 PI, 7 NI, and 7 F sentences. Sentence frame derivatives were counterbalanced across the two groups, such that each frame presented in PI form in one group was presented in NI form to the other group, and vice versa. For example, if sentence (1 above was presented to Group I, sentence (2) was presented to Group II. All PI and NI sentences dealt with relatively

simple spatial relationships. Some additional examples are as follows: *Two robins crouched (on/beside) their nest as the hawk flew above (it/them); The raccoons (raced up/looked over towards) the tree and the dogs circled around (it/them).*

For each group, 35 recognition sentences were also constructed. Fourteen of these were the PI and NI sentences presented during acquisition, and an additional 14 were their respective, alternative pronoun counterparts. For example, if a group heard sentence (1) above during acquisition, they heard both (1) and (3) during recognition. The remaining seven recognition sentences were Fillers. Three of these were presented in their original (acquisition) form; the other four were distortions of F sentences used during acquisition. As an example of the latter, during acquisition Ss heard *The contestant knew the quote but he couldn't remember where he had read it,* but during recognition they heard *The contestant knew the quote but he couldn't remember who had said it.* The distortions of F sentences were intuitively chosen to involve somewhat greater changes in meaning than the differences in meaning between the two versions of NI sentences.

Procedure

Acquisition. Ss were instructed to listen carefully to a set of sentences to be read to them because they would be asked questions about these sentences later in the experiment. Twenty-one sentences were read by the *E* with approximately 10 sec pause between sentences. Sentences were read in a random order, with the exception that a Filler sentence began and ended each acquisition list. After one completion of the list Ss were given a 3 min break.

Recognition. After the 3 min break Ss were told that they would be read a list of sentences, all of which would be closely related to the ones they had heard during acquisition. Their task was to indicate which exact sentences they had heard during acquisition, and which they had not. In addition, they were asked to rate their confidence in each response, using a 5-point confidence scale ranging from VERY HIGH to VERY LOW. Ss were told that some sentences might be read twice during recognition, but that they were to respond *only* on the basis of whether they had heard a sentence during acquisition or not. Actually, no sentences were read twice during recognition; the above instructions were meant to allay any confusion that might have arisen if Ss mistakenly thought that they were hearing repetitions of recognition sentences. Recognition sentences were read in random order with the exception that a Filler sentence began the recognition lists.

Results

Ss' confidence ratings were converted into numerical scores as follows. YES responses (indicating recognition of acquisition list sentences) received positive values, and NO responses received negative values. A VERY HIGH confidence rating received 5 points, a HIGH confidence rating received 4 points, and so on down to 1 point for VERY LOW confidence. Thus a 10-point rating scale emerged, ranging from +5 to −5 (excluding zero).

Each S's mean recognition rating was computed for each of the following six categories of sentences: (1) Potential inference sentences presented during acquisition (OLD-PI); (2) Potential inference sentences not presented during acquisition (NEW-PI); (3) Noninference sentences presented during acquisition (OLD-NI); (4) Noninference sentences not presented during acquisition (NEW-NI); (5) Filler sentences presented during acquisition (OLD-F); and (6) Filler sentences not presented during acquisition (NEW-F). Data were further analyzed in terms of these means across *Ss*. The overall mean ratings across Ss for the six categories were computed and are represented in Table 1.

The results are quite clear. A two factor analysis of variance with repeated measures on both factors produced a significant interaction between recognition status (OLD versus NEW), and sentence type ($F(2,34) = 40.54$, $p < .001$). Tests on simple main effects revealed that for both NI and F sentences, OLD's were rated higher than NEW's ($F(1,17) = 26.72$ and 186.73, respectively, $p < .001$ in both cases). For PI sentences the small OLD versus NEW difference was not significant ($F < 1.00$). Thus, for PI sentences alone, Ss could not distinguish those sentences they had heard before from those they had not.

A significant sentence type effect was found for NEW sentences ($F(2,34) = 90.59$, $p < .001$), but not for OLD sentences ($F(2,34) = 2.38$, $p > .10$). The difference between OLD PI's and NI's is probably meaningful, however, since OLD PI sentences were in effect surrounded by more difficult recognition foils. The Newman–Kuels test showed that among NEW sentences all differences were significant ($p < .01$). Thus,

TABLE 1
Mean Recognition Scores for the Six Sentence Categories in Exp I

	OLDS	NEWS
PI	1.40	1.43
NI	2.22	−0.19
F	2.19	−4.15

NEW PI sentences received significantly higher recognition ratings than NEW NI sentences, which in turn received higher ratings than NEW F sentences. NEW PI's received higher recognition ratings than NEW NI's for 10 of the 14 sentence frames used to construct the acquisition list. The difference between NEW NI and NEW F sentences agrees with one's intuitive expectation that increases in the semantic differences between an OLD sentence and its NEW counterpart will allow such sentences to become more distinguishable in a memory task, although such results for F sentences are also confounded with primacy and recency effects.

Discussion

Results indicate that PI and NI sentences were remembered differently in that Ss' inability to differentiate OLD from NEW sentences was generally confined to sentences in PI form. These results are consonant with the constructive approach to sentence memory, but additional controls are needed before one can rule out the purely linguistic approach. Specifically, it is possible that sentences in PI form are just *generally* more poorly comprehended. Perhaps the prepositions used to construct PI sentences (e.g., ON) cause all the semantic information in these sentences to be less easily remembered. If one forgets information about the turtles resting on the log, for example, he is likely to forget information about the appropriate pronoun as well, and hence he will not be able to differentiate OLDS from NEWS. Such a generalized memory decrement for PI sentences would not support the constructive hypothesis which, under the present circumstance, assumes that memory differences between PI and NI sentences are pronoun specific. For PI sentences, the constructive theory assumes that information about turtles resting on the log can be very well remembered. Ss should only be unsure of whether the input sentence indicated that the fish swam beneath *them* or *it*. It is possible to show that memory differences between PI and NI sentences *are* pronoun specific by the following procedure: Ss can be asked to recall the entire sentences heard during acquisition. If the PI form of a sentence causes it to be generally less poorly remembered, PI sentences should show a lower probability of recall than NI sentences even when one disregards the final pronoun that was remembered. If the memory differences between PI and NI sentences are pronoun specific, however, PI and NI sentences should be remembered with equal accuracy when one disregards the final pronoun that was recalled. Exp. II investigated memory differences between PI and NI sentences in a recall task.

EXPERIMENT II

Method

Subjects. The Ss were 17 undergraduates enrolled in introductory psychology courses at SUNY at Stony Brook. They were run in two groups with 9 Ss in Group I and 8 Ss in Group II.

Materials. Materials consisted of 14 sentence frames, and 7 fillers. Fillers were identical to those used in Exp. I. Since Exp. II included conditions that allowed a replication of Exp. I as well as conditions allowing a test of the pronoun-specificity of the memory differences between PI and NI sentences, a new sample of 14 sentence frames was chosen from a larger master list constructed after running the first experiment. Hence some sentences overlapped with those used in Exp. I, and some did not.

Each group received 21 acquisition sentences: 7 PI, 7 NI, and 7 F sentences. Sentence frame derivatives were counterbalanced across the two groups as in the first experiment. Acquisition sentences were randomized as in Exp. I. Recall prompts which consisted of the subject noun phrase of each sentence were constructed for the 7 PI and 7 NI sentences.

Procedure

Acquisition. The acquisition task was identical to Exp I.

Recall. During recall, Ss were read the sentence prompts (i.e., the subject noun phrases) for each PI and NI sentence. After hearing a prompt, Ss' task was to recall the rest of the sentence. Sentence prompts were randomized with respect to acquisition order and PI and NI sentences were equally distributed across both halves of the recall list.

Results

In order to pinpoint the locus of the memory differences between PI and NI sentences, data were analyzed in two ways. First, sentence recall scores were computed without regard for accuracy of recall of the final pronoun. Second, pronoun recall scores were computed for sentences which were otherwise correctly recalled.

The first analysis indicated that 34% of all sentences were paraphrased correctly (when accuracy of final pronouns was disregarded). Of these sentences 54% were PI sentences, and 46% were NI sentences. A randomization test for matched pairs indicated that recall scores were not significantly different ($p > .10$). However, given correct recall of the rest of the sentence, the second analysis yielded pronoun accuracies consonant with those found in the preceeding experiment. Percent correct

pronoun recall (given correct recall of the rest of the sentence) was 57%, and 76% for PI and NI sentences, respectively (by the randomization test, $p < .025$). For 10 of 14 sentence frames, PI sentences showed a lower probability of accurate pronoun recall than sentences in NI form. The less sensitive recall procedure thus replicated the results found for the first experiment, and in addition results showed that memory differences between PI and NI sentences were specific to memory for the particular pronoun forms.

Discussion

Results of Exp's I and II strongly support the constructive approach to sentence memory. Retention was primarily a function of the semantic descriptions generated by input sentences rather than a function of the actual information the latter contained. If Ss had merely stored linguistic information memory for pronouns in PI and NI sentences should have been roughly the same. Instead, pronoun memory was relatively good for NI sentences, but PI sentences produced very poor memory for those pronouns heard during the acquisition task. Memory differences were pronoun specific. When recall data were analyzed without regard for accuracy of the final pronoun, PI and NI sentences were recalled equally well.

The constructive approach to sentence retention can apply to memory for sets of semantically related sentences as well as memory for individual sentences. Various sentences can converge on a common semantic description, and knowledge of this wholistic description may be what is retained. Bransford and Franks (1970, 1971) have shown that Ss spontaneously integrated the information from semantically related acquisition sentences to construct wholistic semantic descriptions, and that these descriptions, rather than the exact sentences from which they were constructed, determined Ss' accuracy and response-confidence in a sentence recognition task. Bransford and Franks did not specifically investigate the construction of wholistic descriptions allowing extra-linguistic inferences, however. Some constructed descriptions should code more information that the whole set of acquisition sentences contained.

Consider the following description (Description A):

> There is a tree with a box beside it, and a chair is on top of the box. The box is to the right of the tree. The tree is green and extremely tall.

One can treat this example as a set of linguistic entities or as information specifying a general semantic description, and these two different characterizations will make different claims about the nature of the

information a listener may retain. Specifically, consider the sentence *The chair is to the right of the tree.* This information is not provided linguistically, but it is consonant with the description of the situation that most Ss would be likely to construct. Do Ss actually construct descriptions of situations that allow such "novel but appropriate sentences"? One can begin to answer this question by presenting Ss with the following 4 recognition sentences (Recognition Set A), and instructing them to pick which exact sentence they actually heard during acquisition. The interpretive and constructive theories make different predictions about the kinds of errors that Ss should make.

(a) The box is to the right of the tree.
(b) The chair is to the right of the tree.
(c) The box is to the left of the tree.
(d) The chair is to the left of the tree.

According to the constructive theory, comprehension of description A above should result in the construction of a wholistic description of the overall situation being communicated. Ss should generally remember something about the particular linguistic style through which the description was originally communicated, but given that they forget this they should not be reduced to total guessing. Instead they should tend to pick sentences consonant with the overall semantic descriptions constructed, even if such sentences were not heard during the acquisition task. Given the above set of recognition examples, for example, (Recognition Set A), Ss should thus be very likely to think they actually heard sentence (b). The interpretive linguistic approach postulates no overall wholistic description of the situation, however. Hence if one cannot remember which sentence he heard during acquisition he should be reduced to guessing or should tend to pick a sentence that is linguistically very similar to one heard during acquisition. Given those sentences in Recognition Set A above, Ss should thus be at least as likely to pick sentence (c) as (b), since (c) differs from the one actually heard at input only by the substitution of the word "left" for "right."

There exists an additional way one can use Description A above to compare the interpretive and constructive approaches to sentence memory. This involves the fact that there are many linguistically different ways to describe the same basic situation, and these linguistic forms can differ in deep structure as well as surface structure form. For example, the sentence *The tree is to the left of the chair.* is consonant with a description of the situation described by Description A above, but it is deep structurally very dissimilar to the input sentence actually heard (i.e., *The box is to the right of the tree*). One can present Ss with descriptions like A above, and then with the four recognition sentences

below (Recognition Set B). If recognition is primarily a function of linguistic information Ss should be very confused with these items. If recognition can be based on an abstracted semantic description of the situation, however, Ss should show a strong tendency to make "situation-preserving" errors. That is, they should be likely to pick sentences like (a) and (b) below.

(a) The tree is to the left of the box.
(b) The tree is to the left of the chair.
(c) The tree is to the right of the box.
(d) The tree is to the right of the chair.

Exp II compared the interpretive and constructive approaches using descriptive paragraphs like A above, and recognition sets like examples A and B.

EXPERIMENT III

Method

Subjects. The Ss were 45 undergraduates enrolled in a course in Experimental Psychology at SUNY at Stony Brook. They were divided into 2 subgroups of 25 and 20 Ss with the 2 subgroups receiving a different form of the recognition test.

Materials. Materials consisted of 6 descriptive passages like example A presented above, and 4 filler passages. All passages consisted of 4 sentences. The 6 experimental passages suggested descriptions of situations which allowed inferences about the relations among objects: 3 used relations "to the right of," and three used relations "to the left of."

Two sets of recognition sheets were constructed that were analogous to Sets A and B presented above. First consider Recognition Set A. For each of the 6 experimental descriptions (plus two of the fillers) there was a block of 4 sentences: One was the old sentence actually heard during acquisition (OLD); one was a permissible inference (I); A third sentence (CHANGE R) merely changed the spatial relation described by the OLD sentence (e.g., change "right" to "left"), and a fourth sentence (CHANGE R and N) changed both the relation and the subject noun. These four sentence types are illustrated in Table 2.

Recognition Set B changed the linguistic format of all sentences, and hence there were no sentences that were actually OLD. Set B was identical to Set A except that the subject and object nouns were reversed as well as the spatial relations. Hence if an OLD for Set A was *The box was to the right of the tree* it would read as follows for Set B: *The tree was to the left of the box.* For Set B we shall refer to sentences like the latter as OLD′ since they preserve the semantic objects specified in the

TABLE 2
Examples of Recognition Sentences for Exp. III

Recognition Set A	OLD	The box is to the right of the tree.
	I	The chair is to the right of the tree.
	CHANGE R	The box is to the left of the tree.
	CHANGE R & S	The chair is to the left of the tree.
Recognition Set B	OLD′	The tree is to the left of the box.
	I′	The tree is to the left of the chair.
	CHANGE R′	The tree is to the right of the box.
	CHANGE S & R′	The tree is to the right of the chair.

input string. Similarily, we thus have a NEW′, a CHANGE R′, and a CHANGE R and S′ which each correspond to the other 3 sentences in Recognition Set A. Examples are shown in Table 2. For both Sets A and B sentences were randomized within blocks, and order of blocks was randomized with respect to the order of passages in the acquisition list.

Procedure

Acquisition. All 45 Ss heard 10 acquisition passages: 6 experimental descriptions and 4 fillers. A filler appeared at the beginning and end of the acquisition list as well as in positions 4 and 7. Passages were read with normal intonation, and there was a 7-sec pause between each one. Ss were instructed to listen carefully to the passages and to attempt to comprehend them because they would later be asked some questions about their meanings. After reading each passage once there was a 3-min break.

Recognition. After the 3 min break Ss were told that they were to be given a recognition sheet with blocks of sentences typed on it, and they were to indicate which sentences from each block they had actually heard during the acquisition task. Recognition sheet A was given to 25 Ss and 20 Ss received recognition Sheet B.

Results

The response percentages for each type of sentence were computed separately for Recognition sets A and B. Results are presented in Table 3. First consider results for Recognition Set A. A difference T test showed OLDS to be recognized more often than I's ($T(24) = 1.81$, $p < .05$), indicating that Ss had some tendency to remember the linguistic form in which the information was originally expressed. However, given that Ss could not remember the actual form of the input (i.e., did not pick the OLD) they were most likely to pick an I sentence consonant with

TABLE 3
Percentage of Recognition Responses for the Sentence Categories Used in Exp. III

	Situation-preserving responses		Situation-distorting responses	
Recognition Set A	OLD 42%	I 29%	CHANGE R 16%	CHANGE S & R 13%
Recognition Set B	OLD′ 33%	I′ 37%	CHANGE R′ 22%	CHANGE S & R′ 8%

the complete semantic descriptions presumably constructed. A difference T test showed I sentences to be picked more often than the next highest contender (i.e., CHANGE R sentences; $T(24) = 2.50$, $p < .01$). By combining ratings for both OLD and I sentences one can compute the number of responses consonant with the complete semantic descriptions suggested by the passages. For recognition set A this value is 71%.

Next consider recognition set B. A difference T test showed no difference between OLD′ and I′ ratings ($t(19) = -.60$, $p > .25$). This is to be expected, since no sentences are actually identical to those heard before. The results suggest that Ss were not simply responding by analogy to memory for the exact sentences heard during acquisition, however. If they were one would expect OLD′ sentences to receive more recognition responses than I′ sentences, since OLD′ sentences preserve the content nouns of the OLDS. The I′ sentences were picked significantly more often than the next highest contender (i.e., CHANCE R sentences), hence these results parallel those found for recognition set A ($t(19) = 2.83$, $p < .01$). A combination of ratings for OLD′ and I′ sentences indicated that 70% of all responses were situation preserving. A proportion test showed this value to be nonsignificantly different from the 71% found for recognition set A. These latter data provide especially strong evidence for the constructive approach to sentence memory. If Ss were simply storing information about which objects were described as "right of" or "left of" they should have been very confused by Recognition Set B, and hence should have picked many sentences that were not consonant with the wholistic descriptions acquired.

Overall Discussion

Results of Exp. III are congruent with those of the first two studies. Recognition was shown to be primarily a function of the complete semantic descriptions constructed rather than a function of just that information specified by the linguistic input strings. All three studies supported the constructive but not the interpretive theory. These results

suggest that the contribution of an interpretive linguistic theory to psychological studies of sentence memory and comprehension should be more cautiously evaluated than has heretofore been the case. Although a linguistic description of sentences is invaluable in developing an adequate psycholinguistic theory it should be remember that a sentence (or set of sentences) is not merely a perceptual object which the listener may recall or recognize. If it were a linguistic description might sufficiently characterize it as such. Rather a sentence is also a source of information which the listener assimilates to his existing cognitive knowledge. In the present examples the descriptions Ss constructed contained more information than was directly represented in the linguistic input strings.

Note, incidentally, that it is generally more efficient to code descriptions of situations rather than descriptions of inputs. For example, suppose someone communicated the following situation: "There is a driveway on the right, a tree on the left and a baby sitting between the two." Now suppose another piece of information is added to this description; namely that "a dog sat directly to the right of the baby and licked the baby's face." This latter statement allows a considerable amount of information about the relation of the dog to other objects; namely that the dog is to the left of the driveway and to the right of the tree. These latter two propositions did not have to be provided linguistically, yet this information appears to spontaneously be "filled in." New information is assimilated into the existing structures one has in mind. Depending upon the context into which they are assimilated, sentences can have semantic implications that extend beyond the information they directly express.

So far we have said nothing about the nature of the semantic descriptions constructed by Ss except that they cannot be completely characterized from an interpretive linguistic viewpoint. One way to characterize the semantic descriptions presumably acquired in the present experiments is, of course, to assume that they represent images of the situations being communicated. The present experiments all used easily imaginable situations, and imagery has been shown to be an important variable in other linguistic memory tasks (e.g., Begg & Paivio, 1969; Paivio; 1969, 1970). In addition, many Ss spontaneously noted that they constructed images of situations in the above experimental tasks. It is reasonable to suppose that imagery played an important role in the particular experiments outlined in the present paper, but it should be noted that the general constructive approach to sentence memory is not necessarily equivalent to a theory which states that concrete linguistic entities are stored in visual form. First, note that the emphasis of the

constructive approach is not simply on concretizing the information specified in the *linguistic* input. Instead one is assumed to use linguistic information in conjunction with previous knowledge to construct semantic descriptions. It is this synthesis of present input and previous knowledge which determines the nature of the semantic descriptions one constructs. The semantic descriptions suggested by the sentences used in the present experiments may seem to be completely specified by the linguistic inputs, but this is only because one's previous knowledge of spatial relations is so strong and intuitive that it is easy to overlook the determining factor this previous knowledge plays in specifying the nature of the descriptions one will construct. To put it another way, someone with a different spatial system would construct different descriptions of what took place.

In a broader sense the constructive approach argues against the tacit assumption that sentences "carry meaning." People carry meanings, and linguistic inputs merely act as cues which people can use to recreate and modify their previous knowledge of the world. What is comprehended and remembered depends on an individual's general knowledge of his environment. If a few words or sentences are sufficient to allow a listener to construct a description of a whole situation he is doing much more than simply concretizing the linguistic inputs. Instead he now has considerably more information at his disposal than he actually heard. The constructive approach thus argues that the act of comprehension generally involves considerably more than merely recovering or even concretizing the information specified by the input string.

Finally it should be noted that the constructive approach to sentence memory does not assume that the complete semantic descriptions constructed by Ss can be adequately characterized by images, even if one assumes that such images code more information than the original input sentences directly expressed. First, images must somehow be "read" or "interpreted" (e.g., see Elkind, 1969; Reese, 1970), and the nature of such "readings" or "interpretations" must be included in any theory of what is retained. Second, the constructive approach does not deny the psychological reality of some level of linguistic representation in memory. One can remember linguistic representations as well as the more general semantic descriptions suggested by the linguistic inputs. The constructive approach merely denies that a specification of the linguistic representations constitutes a sufficient characterization of the information available to a listener.

It is the present authors' belief that the constructive approach will prove to be very important for characterizing the processes of communication and comprehension. Intuitively one knows that language can

often be a very ineffective means of communication, whereas at other times it serves its purpose very well. In addition, the same inputs can be well comprehended by one individual, and be very poorly understood and remembered by someone else. Although lack of comprehension is due in part to lack of vocabulary (and perhaps lack of familiarity with some sentence structures) it seems clear that this constitutes only part of the problem. According to the constructive account efficient communication generally depends on shared knowledge which people can draw upon to construct descriptions of situations. Merely comprehending the information specified in the linguistic inputs is not sufficient to guarantee that a listener understands the implications that a speaker has in mind.

REFERENCES

Begg, I. R., & Paivio, A. Concreteness and imagery in sentence meaning. *Journal of Verbal Learning and Verbal Behavior,* 1969, **8**, 821–827.

Blumenthal, A. Prompted recall of sentences. *Journal of Verbal Learning and Verbal Behavior,* 1967, **6**, 203–206.

Blumenthal, A., & Boakes, R. Prompted recall of sentences: A further study. *Journal of Verbal Learning and Verbal Behavior,* 1967, **6**, 674–675.

Bransford, J. D., & Franks, J. J. Temporal integration in the acquisition of complex linguistic ideas. In J. J. Jenkins (Chm.), *Understanding Sentences.* Symposium presented at the Midwestern Psychological Association, Cincinnati, May, 1970

Bransford, J. D., & Franks, J. J. The abstraction of linguistic ideas. *Cognitive Psychology,* in press.

Chomsky, N. *Aspects of the theory of syntax,* Cambridge: M.I.T. Press, 1965.

Elkind, D. Developmental studies of figurative perception. In L. P. Lipsitt & H. H. Reese (Eds.), *Advances in child development and behavior.* Vol. 4 New York: Academic Press, 1970.

Fillmore, C. J. The case for case. In E. Bach and R. T. Harms (Eds.), *Universals in Linguistic Theory,* New York: Holt, Rinehart and Winston, Inc., 1968.

Humphrey, G. *Thinking,* New York: John Wiley, 1963.

Katz, J. J., & Fodor, J. A. The structure of semantic theory. *Language,* 1963, **39**, 170–210.

Katz, J. J., & Postal, P. M. *An integrated theory of linguistic descriptions.* Cambridge, M.I.T. Press, 1964.

McCawley, J. D. The role of semantics in a grammar. In E. Bach and R. T. Harms (Eds.), *Universals in Linguistic Theory.* New York: Holt, Rinehart, and Winston, 1968.

Paivio, A. Mental imagery in associative learning and memory. *Psychological Review,* 1969, **76**, 241–263.

Paivio, A. On the functional significance of imagery. *Psychological Bulletin,* 1970, **73**, 385–392.

Postal, P. M. Underlying and superficial linguistic structure. *Harvard Educational Review,* 1964, **34**, 246-266.

Rohrman, N. L. The role of syntactic structure in the recall of English nominalizations. *Journal of Verbal Learning and Verbal Behavior,* 1968, **7**, 904–912.

REESE, H. W. Imagery and contextual meaning. *Psychological Bulletin,* 1970, **73,** No. 6, 404–414.

SACHS, J. Recognition memory for syntactic and semantic aspects of connected discourse. *Perception and Psychophysics,* 1967, **2,** 437–442.

SAVIN, H. B., & PERCHONOK, E. Grammatical structure and the immediate recall of English sentences. *Journal of Verbal Learning and Verbal Behavior,* 1965, **4,** 348–353.

(Accepted May 22, 1971)