

CONSTRUCTION AS A STORAGE PHENOMENON

by

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INTRODUCTION

Bartlett (1932) characterized remembering as a process of construction. Much of Bartlett's work was concerned with the recall of prose passages where subjects' recalls differed from the original stimulus passage in systematic ways.

Typically, a recalled passage included some information not presented in the original passage and did not include other information which was presented in the passage. A constructive memory was hypothesized which could produce a representation (in Bartlett's words, "increase the structure ") of the stimulus passage, recreated and modified by the individual's previous knowledge of the world, so that the constructed representation would conform with the individual's world view. The constructed representation is gained at the expense of accuracy of comprehension of the new information through "simplification," described by Bartlett (1932) as

due to the omission of material that appears irrelevant, to the construction gradually of a more coherent whole, and to the changing of the unfamiliar into some more familiar counterpart (p.138).

For Bartlett construction occurred during "remembering," or retrieval. Once-new information is reconstructed from the "schemata" of memory and the output of the retrieval process reflects the simplification which has occurred in reconstruction (i.e., retrieval).

It is significant to note the fact that Bartlett considered "that even the most elementary looking perceptual processes can be shown frequently to have the character of

inferential construction (p.33)," because within the last ten years, as human learning experimenters have turned toward Bartlett's construction hypothesis, their research has been concerned almost exclusively with the role of inference¹ in language comprehension.

Dawes (1966) reported two experiments studying his subjects' recognition and recall of the set relations between groups of people and their social organizations which had been either explicitly stated in or inferrable from two prose passages the subjects had read. The same passages were used in each experiment. In Experiment I subjects were given 12 forced-choice recognition questions, each containing two statements, one of which was directly inferrable from the previously read prose passages:

- (1) a. No rancher voted for construction of the canal.
- b. Not all but some ranchers voted for construction of the canal.

Subjects were asked to circle the correct alternative, either (1) a. or (1) b. In Experiment II subjects were asked to recall all the set relations which they could remember. Dawes found that simplification of these relationships occurred in both experiments. In Experiment I subjects more often chose (or recalled in Experiment II) (1) a., although the passage stated that most of the ranchers voted against construction of the canal. Simplification was illustrated by alteration of the disjunctive "not all but some" relationship into a "no" relationship. Dawes con-

curred with Bartlett's idea that simplification of written material increases its structure, and Dawes hypothesized that logical fallacies were made due to simplification.

Bransford, Barclay, and Franks (1972) tested the constructive memory hypothesis by having subjects study sentences and passages containing logical relationships such as

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

and then testing subjects on their identification of new sentences which were necessarily logically consistent and therefore implied by those studied such as

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

They found that subjects consistently identified new, logically implied sentences like (2) b. as "old" while making no such false recognition of (2) b. if they had heard sentence (2) a. with the word "beside" substituted for the word "on." In a second experiment reported in the same paper, subjects consistently recalled sentences like (2) a. as (2) b. This evidence further supported a constructive theory of memory which involved inferential thinking. Bransford, et al. identified this as a retrieval process.

Johnson, Bransford, and Solomon (1973) presented stories to their subjects and found that subjects did more than merely simplify new information. The subjects in their experiment recognized as "old," sentences which had additional details not explicitly stated in the original study material. For

example, subjects heard

(3) a. John was trying to fix the bird house.

He was pounding the nail when his father came out to watch him and to help him do the work.

and recognized

(3) b. John was using the hammer to fix the bird house when his father came out to watch him and to help him do the work.

as old. In this example an instrument (the hammer) was inferred from the study paragraph. In other items certain actions were inferred by the subjects as well. It is interesting to note as did Johnson, et al. that in no case was the instrument or action necessarily or logically implied (as in the Bransford, et al. study) by the study paragraph, e.g., in (3) a. John could have been pounding the nail with his shoe or with a brick.

Johnson, et al. closed with a suggestion to other experimenters to determine whether such constructed, probabilistic inferences are made during storage or during retrieval. This uncertainty about where construction occurs was a clear departure from the strict construction-on-retrieval interpretation of Bartlett which was held, for example, by Bransford, Barclay, and Franks (1972) and James, Thompson, and Baldwin (1973). James, et al. were completely satisfied with merely supporting construction in general and took it for granted that construction occurred in retrieval:

It has been assumed that...these elements, which:

can be likened to Bartlett's stimulus traces and key words, provide the raw material from which a recollection must be constructed (p.53).

Little work has in fact been done to definitively locate the reliable process of construction at either storage or retrieval. (Much work, however, has been done to refine the concepts of inference, implication, and logical fallacy, the focus of much of the constructionists' work; and this research will be considered as the question of construction-in-storage versus construction-on-retrieval is examined in more depth.)

Recent theoretical formulations have attempted to incorporate some form of the constructive memory hypothesis. In stating the requirements for a theory of memory, Brockway, Chmielewski, and Cofer (1974) stated that

a theory of memory must postulate mechanisms or processes which a) represent the temporal and other features of experienced episodes, b) are capable of producing accurate recall and recognition, c) on occasion produce highly inaccurate reconstructions of what was presented in the past, d) identify the conditions which control the occurrence of accurate versus inaccurate performance, and e) provide for operations which, working on the contents of memory, can generate information not previously stored as such (p.195).

Conditions c), d), and e) were included by Brockway, et. al.

to account for the results obtained by Bartlett and other experimenters that supported construction.

The LNR memory model of Rumelhart, Lindsay, and Norman (1972) and Norman and Rumelhart (1975) met the Brockway, et al. criteria. Individual propositions (similar to Bartlett's schemata) are abstracted from input to the memory system and are stored at different nodal points in the system. During retrieval these nodal points are tapped for their information which is then used to construct a response. Inaccurate performance could be a result of loss of information at input, during storage of propositions, or during retrieval from the nodal points (construction of the output). Generation of information not presented as the original stimulus would be most likely to occur during retrieval if a few wrong nodes are tapped. The LNR model is consistent with the strict construction-on-retrieval hypothesis of Bartlett.

Although similar to the LNR model in that it uses propositions, Kintsch's (1974) memory model differs in at least one significant respect--locus of the construction process. Kintsch stated that "what is stored in memory are the products of the subject's constructions (p.254)." Predicating his argument on one's capacity to infer information from a text, Kintsch states that the text information is used to construct inference propositions which are then stored along with propositions of information explicit in the text. Further construction occurs as more information comes into memory--propositions already stored may be further structured

and interrelated. Retrieval consists of merely tapping this fully constructed text base for its information, rather than reconstructing a representation from stored schemata.

The Kintsch model, though inconsistent with a strict construction-on-retrieval interpretation of Bartlett's hypothesis, is supported by other experimental work. Dooling and Mullet (1973) found that the theme of an otherwise obscure passage presented immediately after presentation of the passage did not enhance recall of the passage significantly compared to a control group who did not receive the theme. Performance was significantly better for an experimental group that received the theme prior to passage presentation, suggesting that the locus of the thematic effect was during storage. However, it is naive to think that the storage and therefore the construction of interrelated stimulus information, such as a passage, is completed upon termination of stimulus input by the experimenter. In fact storage and construction of interrelated facts probably continues for a period of time following such termination. And the determination of what is and what is not related is a problem which must be considered (Dooling & Mullet seem to think that a passage and its theme are only related when the theme is presented prior to the passage). The Dooling and Mullet results may, in fact, be attributed not to construction-in-storage but rather to the fact that the passage they employed is sufficiently unintelligible so that it makes no sense unless the theme is given prior to passage presentation. Additional information supplied immediately following a

passage which is comprehensible without this information should affect the construction of that passage which is, presumably, still going on. However, additional information supplied after the storage of the passage is complete should not aid in the construction of that passage unless construction occurs on retrieval.

Haviland and Clark's (1974) Given-New Strategy experiments provide intuitive support for construction-in-storage. Their study showed that since language is primarily a means of transferring new knowledge to a listener, it is "the listener's [purpose] to extract the new information and integrate it with old information already in memory (p.513)." The old information may be contained in the same sentence as the new information, in a preceding sentence, or in the subject's stored knowledge of the world. Haviland and Clark have characterized the listener as actively trying to integrate new information with old information during encoding. It is this active, integrative process which is characteristic of construction-in-storage.

Experimental work by Kintsch (1974, pp.153-196), designed to test his model, could have lent further support to a construction-in-storage hypothesis. His results were inconclusive, apparently resulting from confounded experimental materials and design. In effect, he did not take into consideration the refinements of the concepts of inference and implication alluded to above. Two paragraphs were designed around a theme. The first paragraph explicitly stated a relationship between items:

- (4) a. A carelessly discarded burning cigarette started a fire. The fire destroyed many acres of virgin forest.

The second paragraph, supposedly, implicitly stated the identical relationship between items:

- (4) b. A burning cigarette was carelessly discarded. The fire destroyed many acres of virgin forest.

A test item was constructed which related the idea of the paragraphs:

- (4) c. A discarded cigarette started a fire.

Subjects were instructed to pay close attention to the presented paragraphs because they would be later questioned on them. Following presentation of either (4) a. or (4) b. the subject was presented with (4) c. and asked to respond "true" or "false." Kintsch predicted that subjects who heard (4) b. would respond "true" as often as subjects who heard (4) a., thereby confirming his hypothesis that inferred text information was constructed into a proposition in the same manner as explicit text information. His prediction was not verified. Subjects who heard paragraphs like (4) b. more often responded "false" when presented with test sentences than subjects who heard paragraphs with explicit information like (4) a.

A cursory analysis of Kintsch's "implicit" paragraphs reveals that test sentences were not in fact implied in any logical sense by these paragraphs. In example (4) b., it is possible that a cigarette could be carelessly discarded and

that a fire could destroy a forest but that the cigarette did not cause the fire. This would mean that paragraph (4) b. pragmatically implies (4) c. Paragraph (4) a., however, logically implies (4) c. because a cigarette which causes a fire that destroys a forest must have started a fire. The distinction between a logical and a pragmatic implication was developed and made clear by Brewer (Note 1):

The term "logical implication" will be used to refer to those semantic relationships where one sentence seems to be necessarily implied by another...A sentence pragmatically implies another sentence when the information in the first sentence leads the hearer to expect something neither explicitly stated nor necessarily implied in the first sentence (p.4).

Harris and Monaco (Note 2), in an extensive review of the implication literature, have extended Brewer's definition of pragmatic implication to include the highly probable interpretation of one or more sentences which is not necessarily implied by the sentences themselves. This extended definition covers probable interpretations of paragraphs as well.

It was possible that Kintsch's subjects were not responding inappropriately to test questions, given his procedure. For example, (4) c. is true with respect to paragraph (4) a., but is not "necessarily" true with respect to (4) b. and thus was often judged false with respect to (4) b., when presented with only the alternatives "true" and "false." When Harris, Teske, and Ginns (1975) tested juror-subjects on memory for

witnesses' testimony in a mock-courtroom study, they presented subjects with statements similar to Kintsch's test questions; however, these statements were followed by three possible alternatives, "true," "false," or "indeterminate," with respect to a witness' testimony. The alternative "indeterminate" was included because pragmatic implications/inferences are only highly probable interpretations and their truth value can neither be positively asserted nor denied but merely judged indeterminate. A second set of paragraphs used by Kintsch helpsto illustrate this:

(5) a. Police are hunting a man in hiding.

The man is Bob Birch whose wife disclosed illegal business practices in an interview on Saturday.

b. Police are hunting a man in hiding.

The wife of Bob Birch disclosed illegal business practices in an interview on Saturday.

Kintsch's test statement was

(5) c. Bob Birch is the man who is hiding.

Paragraph (5) a. logically implies sentence (5) c., but paragraph (5) b. only pragmatically implies sentence (5) c. by Brewer's and Harris and Monaco's definitions. And the truth or falsity of (5) c. is logically indeterminate with respect to paragraph (5) b.

The Harris and Monaco extension of the term "pragmatic implication" to include highly probable but not necessary interpretations of more than one sentence is cri-

tical if such work in human learning and memory is to proceed much further. In any given context of communication the listener relies heavily on probable interpretations of the speaker's word and sentence meanings, since such words and sentences are often highly ambiguous. It has been demonstrated that hearers make use of pragmatic inference in applied settings such as the courtroom (Harris, et al., 1975) and in ordinary conversation (Harris & Monaco, Note 2) in order to restrict the number of possible interpretations of the speaker's message. Furthermore, the study of the construction process itself (following the tradition of Bartlett, Dawes, Johnson, et al., etc.) is particularly amenable to the concept of pragmatic implication. Pragmatic inference is a type of simplification. An interpretation of Kintsch's paragraph (5) b. as the pragmatic implication (5) c. will easily fit Bartlett's criteria of simplification (the ironic fact is that Kintsch himself made the pragmatic inference by assuming that (5) b. logically implied (5) c.). Bartlett himself was concerned with the similarities of inferential construction and simplification. Bransford, et al. (1972, p.208) realized the importance of inferential construction when they stated that, if the constructive process works to integrate new knowledge with old knowledge which differs in each individual, then "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." In fact the listener may understand implications (pragmatic) which the speaker did not have in mind.

An interesting question is raised by the preceding analysis of Kintsch's work. Brewer (Note 1) and Brewer and Lichtenstein's (1975) subjects, instructed that they would be given a recall test, consistently made pragmatic inferences of presented sentences during cued recall. For example, The ice-cream was not hard was frequently recalled as The ice-cream was soft, even though it is possible for ice-cream to be neither hard nor soft. Yet many of Kintsch's subjects did not falsely recognize pragmatically implied test sentences. This is not a task artifact of cued recall versus recognition because Harris, et al.'s juror-subjects recognized new, pragmatically implied sentences as old. In terms of construction, Kintsch's subjects were less likely to construct a pragmatic inference than were Brewer's, Brewer and Lichtenstein's, and Harris, et al.'s.

It is possible that construction of inferences was manipulated by instructions to the subjects. Kintsch's subjects were instructed that they would receive a true-false test after each paragraph while Brewer's and Brewer and Lichtenstein's were given recall instructions prior to the study phase. Harris, et al.'s subjects were simply told that they would be asked some questions later. Underwood (1972) stated that

there does not seem to be substantial evidence that relates subject's prelearning expectation concerning the nature of the test and his recall and recognition performance. It may or may not be possible for the subject to influence ap-

preciably the composition of memory...(p.7)

Jacoby (1973) found that if a specific strategy for either free-recall or recognition of categorized lists had been developed by his subjects, it did not influence performance on the other or on a cued-recall task. However both Jacoby and Underwood were concerned with the study of lists of single words and the process of construction has little, if any, relation to this task. Sanders and Tzeng (1971), on the other hand, found in their first experiment that prior instructions significantly influenced both free recall and serial recall of lists of single words but in a second experiment did not influence recognition or recall of logical inferences or directly asserted material presented in study paragraphs. Pragmatic inferences made by the subjects were not examined.

If instructions to the subjects could be found to significantly influence their construction of pragmatic inferences, it would then be possible to directly test the construction-in-storage hypothesis. The following studies were therefore designed to determine under what conditions of instructions subjects would construct pragmatic inferences (Experiment I), whether inferences were constructed during storage or retrieval (Experiment II), and when the construction and storage of interrelated information may be said to be fully terminated (Experiment III). Two prose passages were presented to the subjects followed by true-false-indeterminate recognition-of-information tests. Instructions to the subjects indicated either a multiple-choice or essay test would follow the passages.

EXPERIMENT I

In Experiment I it was predicted that the subjects given multiple-choice test instructions would be less likely to judge test sentences which were pragmatically implied by the prose passages as True (as suggested by the Kintsch study where subjects identified pragmatic implications as False when given prior instructions indicating a multiple-choice test) than subjects given essay test instructions (as suggested by the Brewer, Brewer & Lichtenstein, and Harris et al. studies where subjects tended to recall, or falsely recognize as True, pragmatically implied sentences under recall or general instructions).

Method

Subjects. The subjects were 32 undergraduate psychology students at Kansas State University; they received extra course credit for participation and were run in small groups.

Materials. A 167-word descriptive prose passage describing a cabin and its surrounding environs and a 235-word narrative prose passage about the character Jose's return to school after a week-long absence were constructed.

Thirty test statements about the information expressed in the narrative passage were then written. Ten of the statements (filler) incorrectly paraphrased directly asserted information contained in the passage: Jose arose early in the morning was contained in the passage and Jose arose late in the morning was a filler statement, which was necessarily false with respect to the directly asserted information expressed in the passage. Ten of the statements (log imp) were logically implied by the passage: Alice's classroom was next door

to Jose's was contained in the passage and Jose's classroom was next door to Alice's was a log imp statement, which was not directly stated but nevertheless true with respect to the information expressed in the passage. The final ten statements (prag imp) were pragmatically implied by the passage: He ate breakfast and then went over to the neighborhood school was contained in the passage and He walked over to the neighborhood school was a prag imp statement which was logically indeterminate as to its truth value from the information expressed in the passage. These thirty statements were randomly ordered and numbered with the provision that no more than two statements of a given type (filler, log imp, prag imp) could occur together. The test for the narrative passage consisted of these thirty statements, listed in their random order, with each statement followed by the words True, False, and Indeterminate. The instructions Please Underline Correct Answer headed the test.

A second test, also containing thirty statements, was written for the descriptive passage by following the same procedure outlined above.

The instructions for each test group and the two passages were recorded onto a cassette tape by a professional actor.

Design and Procedure. The experiment was a 2 x 2 design consisting of an instructions variable and a passage-presentation-order variable. One half of the subjects were in the multiple-choice instructions condition. They heard taped instructions stating that they would hear the opening passages

of two stories, introducing characters, places, and their relationships to one another, and that after hearing these passages they would be asked to answer multiple-choice questions about them. One half of these subjects heard the narrative passage followed immediately by the descriptive passage, while the other half heard the descriptive passage followed by the narrative passage.

The second half of the subjects were in the essay instructions condition. They heard taped instructions stating that they would hear the opening passages of two stories, introducing characters, places, and their relationships to one another, and that after hearing these passages they would be asked to write essays ending the stories. One half of these subjects heard the narrative passage followed immediately by the descriptive passage while the other half heard the passages in the reverse order.

After hearing the passages subjects were immediately given the two recognition-of-information tests described above. If the descriptive passage was heard first, the recognition-of-information test on the descriptive passage was given first. If the narrative passage was heard first, the recognition-of-information test on the narrative passage was given first. Subjects were allowed to work at their own pace. After the subject completed the first test, the experimenter gave him/her the other test. Subjects were again allowed to pace themselves.

Results and Discussion

Subjects' responses were scored on each of two dependent variables: number of logical inferences correctly made, i.e., number of such test items answered True, and number of pragmatic implication test items correctly identified as Indeterminate. As indicated in Table 1, neither instructions, passage order, nor their interaction significantly influenced the number of logical inferences made by the subjects. The cell means for the four groups are presented in Table 2. This is consistent with the results reported by Sanders and Tzeng (1971).

The summary of the analysis of variance performed on responses to pragmatic implication test statements is presented in Table 3. Only the instruction variable was significant, $F_1(1,28)=8.58$, $F_2(1,19)=12.60$, $\min F'(1,47)=5.10$, $p < .05$. Inspection of the cell totals and means in Table 4 indicates that, as predicted, subjects given multiple-choice instructions correctly identified more pragmatic implication statements as Indeterminate (made fewer pragmatic inferences). The combined means of the multiple-choice and essay groups, irrespective of passage order, were 9.25 and 6.25, respectively. A two-tailed t-test performed in addition to the item analysis (F_2) between number of pragmatic implication correctly identified on the narrative versus the descriptive passage revealed no significant difference, $t(19)=1.42$, $p < .20$. The means for the narrative and descriptive passages are 9.36 and 14.40, respectively, indicating that fewer pragmatic inferences were correctly identified for the narrative test.

Table 1

Summary of Analysis of Variance Performed on Logical
Inferences Correctly Made by Subjects

<u>Source</u>	<u>df</u>	<u>MS</u>	<u>F</u>
Instructions (A)	1	3.13	.65
Order (B)	1	4.50	.93
A x B	1	1.13	.23
Error	28	4.83	

Table 2

Mean Number of Logical Inferences Correct

Passage Order	Instructions	
	Multiple Choice	Essay
Narrative first	16.38	15.38
Descriptive first	16.75	16.50

Table 3

Summary of Analysis of Variance Performed on Pragmatic
Implications Correctly Identified as Indeterminate by
Subjects

<u>Source</u>	<u>df</u>	<u>MS</u>	<u>F</u>
Instructions (A)	1	72.00	8.58*
Order (B)	1	12.50	1.49
A x B	1	.50	.06
Error	28	8.39	

p < .01

Table 4

Mean Number of Pragmatic Implication Statements Correctly
Identified as Indeterminate

Passage Order	Instructions	
	Multiple Choice	Essay
Narrative first	9.75	7.00
Descriptive first	8.75	5.50

The most significant finding was that the subject's construction of pragmatic inferences could be and was manipulated by prior instructions (as indicated by the previous analysis of the Kintsch, Brewer, etc. studies). First, this indicates that different study strategies by students do exist and that they specifically determine whether or not pragmatic inferences will be constructed. It is of particular interest to note that college freshmen (approximately three quarters of the subjects in this experiment) demonstrated this ability to study selectively according to their test expectancy. This suggests that it is an ability which may be developed by successful undergraduates. Further, the student deficient in this ability may be at a disadvantage in relation to his/her peers. Research in this area may lead to useful diagnostic techniques which will spot such a disability in a student's performance and aid him/her in developing this ability.

Second, the fact that construction of pragmatic inferences was manipulated by instructions given prior to passage presentation supports the hypothesis that construction occurs in storage. One alternative hypothesis remains, however:

the possibility that different instructions influenced the retrieval of stored information differentially when subjects were responding to the recognition-of-information tests.

This hypothesis is incompatible with the interpretation that prior instructions influenced the storage of passage information, but it is clearly not inconsistent with the results of Experiment I.

EXPERIMENT II

Experiment II was designed to directly test the construction-in-storage hypothesis. A 2 x 2 x 2 factorial design manipulated the between-subjects variables of passage presentation order (Order) and sequence of instructions (Sequence)--either no instructions prior to first passage presentation and essay instructions prior to second passage presentation or no instructions prior to first passage and multiple-choice instructions prior to second. The within-subjects variable was tests (Test) for the first and second passages.

A construction-on-retrieval hypothesis would predict a main effect of Sequence with no interactions because the effect of either multiple choice or essay instructions, given only prior to the second passage, should exert their effect on the retrieval of both passages. The construction-in-storage hypothesis, however, predicts an interaction of Sequence and Test because either multiple choice or essay instructions should exert their effect only on the storage of the passage immediately following these instructions.

Method

Subjects and Materials. The subjects were 40 undergraduate psychology students at Kansas State University; they received extra course credit for participation and were run in small groups. The materials were the same as in Experiment I.

Design and Procedure. The experiment was a 2 x 2 x 2 factorial design. The three independent variables consisted of passage presentation order(Order), sequence of instruc-

tions (Sequence), and tests (Test)--one for the first passage and one for the second. The Order and Sequence variables were between subjects, the Test variable was within.

Ten of the subjects heard the passages in the order descriptive followed by narrative (Order 1); the first passage was preceded by no instructions about the subsequent tests and the second passage was preceded by the essay instructions from Experiment I (Sequence 1). Ten of the subjects heard the passages in the order narrative followed by descriptive (Order 2); the first passage was preceded by no instructions and the second passage was preceded by the multiple-choice instructions from Experiment I (Sequence 2). Ten heard the passages in Order 1 with Sequence 2 instructions. The final ten heard the passages in Order 2 with Sequence 1 instructions.

After hearing the second passage, all subjects were immediately presented with the first of the two recognition-of-information tests. Subjects were allowed to work at their own pace. Immediately after completing the first test, the subjects were presented with the other test. They were again allowed to pace themselves. Test order presentation for each subject corresponded with passage order presentation, e.g., if the subject heard the narrative passage first, he/she received the test for the narrative passage first.

Results and Discussion

Subjects' responses were again scored on the two dependent variables: number of logical inferences made and number of pragmatic implications correctly identified as

Indeterminate. Separate analyses were performed for each dependent variable.

Table 5 summarizes the analysis of variance performed on the number of logical inferences made by the subjects while Table 6 presents the means for each cell. Both the main effects of Sequence and Test were significant; but, more importantly, the Sequence by Test interaction predicted by the construction-in-storage hypothesis was also significant, $F_1(1,36)=10.98$, $F_2(1,9)=7.22$, $\min F'(1,38)=4.35$, $p < .05$. These results clearly support a storage interpretation of the construction of logical inferences. Instructions (multiple choice or essay) differentially influenced storage of the following passage only, rather than retrieval of the stored information from both passages at the time of test.

Although these results clearly supported the construction-in-storage hypothesis for logical inferences, the analysis of pragmatic implications identified correctly as Indeterminate did not support either the construction-in-storage or the construction-on-retrieval hypothesis. As indicated in Table 7, only the Order by Test interaction was significant. When inspected closely, as in Table 8, it is clear that the Order by Test interaction corresponds to the order of passage and therefore test presentation--in Order 1 the descriptive passage is presented first followed by the narrative passage, the descriptive test, and the narrative test in that order. In Table 8 it is clear that subjects' performance on the test for the descriptive passage (Test 1) was far superior to their performance on the test

Table 5

Summary of Analysis of Variance Performed on Logical Inferences

<u>Source</u>	<u>df</u>	<u>MS</u>	<u>F</u>
Between Subjects	<u>39</u>		
Order (A)	1	.45	.17
Sequence (B)	1	11.25	4.23*
A x B	1	.80	.30
Error	36	2.66	
Within Subjects	<u>40</u>		
Test (C)	1	9.80	12.74***
A x C	1	1.25	1.62
B x C	1	8.45	10.98**
A x B x C	1	.80	1.04
Error	36	.77	

* $p < .05$ ** $p < .005$ *** $p < .001$

Table 6

Mean Number of Logical Inferences Correct

Order 1

	Test 1	Test 2
Sequence 1 (Essay)	8.70	6.90
Sequence 2 (Multiple Choice)	8.40	8.30

Order 2

	Test 1	Test 2
Sequence 1 (Essay)	8.20	7.30
Sequence 2 (Multiple Choice)	8.70	8.70

Table 7

Summary of Analysis Performed on Pragmatic Implications
Correctly Identified as Indeterminate

<u>Source</u>	<u>df</u>	<u>MS</u>	<u>F</u>
Between Subjects	<u>39</u>		
Order (A)	1	.45	.10
Sequence (B)	1	4.05	.97
A x B	1	1.25	.30
Error	36	4.19	
Within Subjects	<u>40</u>		
Test (C)	1	.05	.04
A x C	1	18.04	12.79*
B x C	1	.05	.04
A x B x C	1	4.05	2.87
Error	36	1.41	

*p < .005

Table 8

Mean Number of Pragmatic Implications Correctly Identified
as Indeterminate

Order 1

	Test 1	Test 2
Sequence 1 (Essay)	4.10	3.70
Sequence 2 (Multiple Choice)	5.30	3.90

Order 2

	Test 1	Test 2
Sequence 1 (Essay)	3.70	4.30
Sequence 2 (Multiple Choice)	3.50	4.90

for the narrative passage. The same result holds for Order 2 where the order of the passages and therefore the tests was reversed--performance by these subjects was again far superior on Test 2, the test for the descriptive passage. That such a difference between either passages or tests exists is not surprising. That this difference is in the realm of pragmatic rather than logical inferences, however, is noteworthy and demands further attention.

The main conclusion that one can draw from Experiment II is that logical inferences are in fact constructed in storage rather than retrieval. The fact that no clear evidence was found concerning the locus of construction of pragmatic inferences serves to demonstrate further the qualitative distinction between these two phenomena of human memory.

EXPERIMENT III

Although Experiment II supported a construction-in-storage hypothesis unequivocally for logical inferences, the same could not be said for pragmatic inferences, where the results supported neither hypothesis. Also, the fact that the experimental manipulation of instructions affected construction of pragmatic inferences and did not affect construction of logical inferences in Experiment I but the sequence of instructions affected construction of logical inferences and not pragmatic inferences in Experiment II is vexing. Experiment III was designed, employing a new experimental manipulation, in order to test the construction-in-storage hypothesis for both pragmatic and logical inferences within the same experiment and to determine when the construction of a representation of thematically interrelated information may be said to be fully terminated. Dooling and Mullet (1973) held that the theme of a passage presented immediately after presentation of the passage itself was only available upon retrieval of the passage. It was argued in the Introduction that the theme of a passage, obviously related to the passage itself, as well as any related information presented immediately after the passage should be stored with the passage, because storage of the passage would not yet be terminated and construction of the representation of the passage itself should still be taking place.

The passages used in the first two experiments contained many interrelated facts from which the recognition-of-information tests for the passages were constructed. These relationships were often hierarchical in nature such

that if a subject makes one pragmatic inference, the probability of making other related pragmatic inferences increases. For example, in the narrative passage the age and occupation of the main character, Jose, are never stated--he may be a student or a teacher. As Table 9 indicates, only four out of seventy-two subjects (approximately 5½%) responded correctly to this statement (Indeterminate). Eighty-nine percent of the subjects in Experiments I and II made the pragmatic inference that Jose was in fact a student, and this increased their probability of inferring that Jose walked to school, that his friend Alice is also a student, etc.

In Experiment III, the key information that Jose is a teacher was manipulated between two groups of subjects. One group (Storage) was given this information as the last sentence of the narrative passage about Jose and prior to hearing the descriptive passage. The second group (Retrieval) was given this information after hearing the narrative and

Table 9

Subjects' Responses to the Logically Indeterminate Statement

Jose is a student in the third grade.

Experiment I

	True	False	Indeterminate
Essay	13	2	1
Multiple Choice	14	0	2

Experiment II

Order 1, Test 1	19	1	0
Order 2, Test 2	18	1	1

descriptive passages in that order and prior to the recognition-of-information test on the narrative passage. The construction-on-retrieval hypothesis as well as the conception of storage and retrieval as represented by Dooling and Mullet predict no difference in performance between the Retrieval and Storage groups because both have the key information about Jose at retrieval. The construction-in-storage hypothesis, as well as a conception of storage as a continuous process of constructing a representation of related information until unrelated information terminates the process to begin construction on the new information, however, predicts a significant difference between the Storage and Retrieval groups because the Storage group has the key information while the relevant passage is still being processed.

Method

Subjects. The subjects were 18 undergraduate psychology students at Kansas State University; they received extra course credit for participation and were run in small groups.

Materials. The materials from Experiments I and II were modified for Experiment III. One three-word phrase in the narrative passage was eliminated and two questions on the narrative test were changed so that there would still be ten pragmatic implication items. Although both passages were presented, the test for the descriptive passage was not used, since only the subjects' responses to the narrative passage were of interest. Instructions, both passages, as well as the phrase "Jose is a teacher," were recorded on a cassette tape for presentation to the subjects.

Design and Procedure. The experiment manipulated one independent variable: time of presentation of the key information "Jose is a teacher." One half of the subjects (Storage) heard the multiple-choice instructions used in Experiments I and II, the narrative passage with the key information as the last sentence of the passage, and the descriptive passage in that order, followed by the modified test for the narrative passage. The other half of the subjects (Retrieval) heard the same instructions, the narrative passage without the key information, the descriptive passage, and then the key information in that order, followed by the same test. All subjects were allowed to work on the test at their own pace.

Results and Discussion

Two two-tailed t -tests were performed between the Storage and Retrieval groups of Experiment III: on the number of logical inferences correctly made and on the number of pragmatic implications correctly identified as Indeterminate. The results summarized in Table 10 demonstrate that significant differences were found between groups for both logical inferences and pragmatic implications. The direction of these differences is indicated in Table 11. The Storage group made fewer logical inferences and identified more pragmatic implications correctly than the Retrieval group.

The fact that significant differences were found between the two groups on logical inferences confirms the finding in Experiment II that logical inferences are constructed during

Table 10

Summary of t-tests (Two-tailed) Performed on Logical Inferences
and Pragmatic Implications

<u>Comparison</u>	<u>df</u>	<u>t</u>
Logical Inferences		
Storage vs. Retrieval	17	2.26*
Pragmatic Implications		
Storage vs. Retrieval	17	4.58**
*p < .05 **p < .001		

Table 11

Means and Standard Deviations^a for Storage and Retrieval Groups

	Dependent Variable	
	Logical Inferences Correctly Made	Pragmatic Implications Correctly Identified
Storage Group	6.66 (1.11)	5.00 (1.50)
Retrieval Group	8.55 (0.52)	3.00 (2.17)

^aStandard deviations in parenthesis

storage. The significant difference found between groups on number of pragmatic implications correctly identified demonstrates that, as predicted, pragmatic inferences are also constructed during storage.

Furthermore, the storage and construction of a representation of related information, such as the narrative passage and the information that Jose is a teacher, is not fully terminated unless the related information is separated by unrelated information, such as the descriptive passage, contrary to the assumption of Dooling and Mullet.

GENERAL DISCUSSION

Although the results of each experiment have been discussed individually, an overview of all three experiments reveals unique insights in the area of human learning and memory.

Like those reported by Bartlett (1932), the experiments reported here have utilized prose passages, each with a unique set of interrelated facts, similar to the messages which a speaker might impart to a hearer in everyday life. New information was given (e.g., Jose and Alice were friends), some information was left out (e.g., Jose's age and occupation) and left up to the hearer to deduce in a manner analogous to Haviland and Clark's (1974) representation of everyday speaker-hearer communication.

Unlike Bartlett's studies, however, each passage was separately analyzed for directly asserted information, logically implied information, and pragmatically implied information--three distinct categorizations which must be distinguished in order to adequately characterize how and what information is comprehended by the hearer. Although Bartlett discussed inferences and inferential construction, only recently have experimenters paid such attention to their experimental analysis (Harris & Monaco, Note 2), realizing perhaps that the individual's ability to infer is one of the most important functions in human learning. The ability to store directly asserted information or events which one perceives is certainly a relatively static process involving only translation to some sort of memory code.

The ability to construct inferences, on the other hand, is a dynamic and often creative process, involving the transformation of information or a set of events which is often freely available to others (as in a book or a movie) into a new representation which is individualized. This is, perhaps, clearer by reconsidering Table 9 which shows that in Experiments I and II 89% of the subjects pragmatically inferred that Jose was a student while $5\frac{1}{2}\%$ responded with the correct alternative Indeterminate; another $5\frac{1}{2}\%$ responded False, that he was not a student. Did those who responded False pragmatically infer that he was a teacher? Perhaps one or two of those subjects inferred that Jose was a student-teacher. Depending upon the inference--teacher, student, student-teacher--the passage must have a different meaning. The story derives its meaning (which often differs between subjects as well as movie critics, for example) from the series of inferences which are made, although frequently one inference makes another all the more likely (e.g., inferring that Jose is a student makes it more likely that Alice is a student, that he was absent because he was sick, that he is younger than the principal, etc.).

The Effect of Instructions

The manipulation of instructions in Experiment I had an effect solely on the number of pragmatic inferences constructed by the subjects, while the sequential manipulation of instructions in Experiment II affected only the number of logical inferences constructed by the subjects. The effect of additional information in Experiment III produced decreases in both the number of incorrectly constructed pragmatic

inferences and the number of correctly constructed logical inferences for the Storage group in comparison to the Retrieval group of Experiment III. This evidence indicates that the logical-pragmatic distinction is not merely one of convenience for the experimenter. On the contrary, these experiments provide data indicating that since construction of logical and pragmatic inferences may be differentially affected by experimental manipulation, the logical-pragmatic distinction is psychologically distinct as well.

Experiments I and II demonstrated that instructions to the subjects could influence their construction of inferences. This finding suggests that salient instructions (e.g., multiple choice or essay) to the subjects along with meaningful material (e.g., passages, lectures) can and will affect performance on a subsequent test, contrary to the findings reviewed by Underwood (1972) and those of Jacoby (1973), where no effect of instructions was reported. Underwood and Jacoby reported experiments which used lists of words as stimulus material and typical verbal-learning instructions (e.g., serial recall, free recall, cued recall) and cannot be criticized for this choice. However, they can be criticized for attempting to generalize results from these experiments to the classroom situation, for neither the materials nor the instructions bear any serious resemblance to those found in the classroom. Sanders and Tzeng (1971) employed meaningful stimulus material in the form of paragraphs and found no effect of instructions; however, they analyzed only subjects' recognition of logical implications on true-false tests--handicapping themselves by paying attention to only a restricted

subset of the information conveyed in their paragraphs and, like Kintsch (1974), by their choice of the true-false test itself.

The fact that the construction of inferences can be manipulated by instructions raises the question of whether this ability is under the subject's conscious control. Bruno (Note 3) is currently examining this issue by attempting to develop a training procedure which will allow subjects to recognize implications in passages and decide whether or not they wish to construct the inference. In any event the fact that inferential construction can be manipulated supports the hypothesis that implications are processed separately or involve an extra stage of processing. A logical research step to add further support to this evidence would be a reaction-time study to determine whether the processing of implications takes longer than the processing of direct assertions. Kintsch has provided this further support for an extra stage by conducting just such an experiment. He measured subjects' reaction times to respond to statements about paragraphs containing either directly asserted information only or both directly asserted and implied information. At no delay, subjects took significantly longer to respond to statements about paragraphs containing both directly asserted and implied information than to respond to paragraphs containing only directly asserted information. After a fifteen-minute delay, however, subjects showed no difference in their mean reaction time to respond to the two types of paragraphs. Singer (1976) has replicated the "no delay" portion of Kintsch's study

using sentences. Monaco (Note 4) has interpreted this result as support for an extra stage of processing implication information. Taken together, the results of Experiments I and II and the reaction-time studies support a "decision to infer" stage in the processing of implications which is either under conscious or unconscious control.

Toward a Constructive Theory of Memory

The most important contributions of Experiments I, II, and III are those that add to the understanding of the construction process itself. That the subjects can construct an accurate or inaccurate representation of interrelated facts such as those in a prose passage presented as stimulus material has been demonstrated in each experiment. And whether this constructed representation is accurate or inaccurate may be partly controlled by experimental manipulation. Of more theoretical importance, however, are the demonstrations in Experiments II and III that the construction of this representation occurs during storage.

Experiment III went on to demonstrate that, although subjects could construct a representation of the narrative passage integrating the key phrase Jose is a teacher into their constructed representation of the passage when the phrase came in the continuous flow of narrative information, when the key phrase was separated from the narrative passage by an unrelated descriptive passage (and the subject's constructed representation of the narrative passage was completed and stored in memory), the new information in the phrase could at best be appended to, rather than integrated with, the previously constructed representation.

A clearer picture of human learning and memory begins to emerge from these results. The hearer constructs a representation of the speaker's message, using his "knowledge of the world" from memory and the direct assertions made by the speaker to draw highly probable inferences (logical inferences having a probability of one and pragmatic inferences ranging in probability between 0 and .999...). Once stored in memory, however, direct assertions and inferences are, for all intents and purposes, equal, since subjects recognize and recall direct assertions and inferences as if both had originally been part of the speaker's message (Brewer, Note 1; Johnson, Bransford, & Solomon, 1973; Harris, et al., 1975; Harris & Monaco, Note 2). However, it is not full justice to regard construction as merely a subroutine of storage, for it is clearly more than that. Construction is the dynamic process of integrating information in memory with direct assertions and implications of the speaker and of drawing inferences so that a total representation of the speaker's message may be stored.

Monaco (Note 4) has provided a model which is presented in Figure 1 of the construction process from the input of a speaker's message to final Storage of the constructed representation of that message in memory. It is possible to trace the stimulus material of Experiment III through this flowchart. The sequence of relevant information presented on tape to subjects in the storage group was:

(6) Passage one. Jose arose early in the morning.

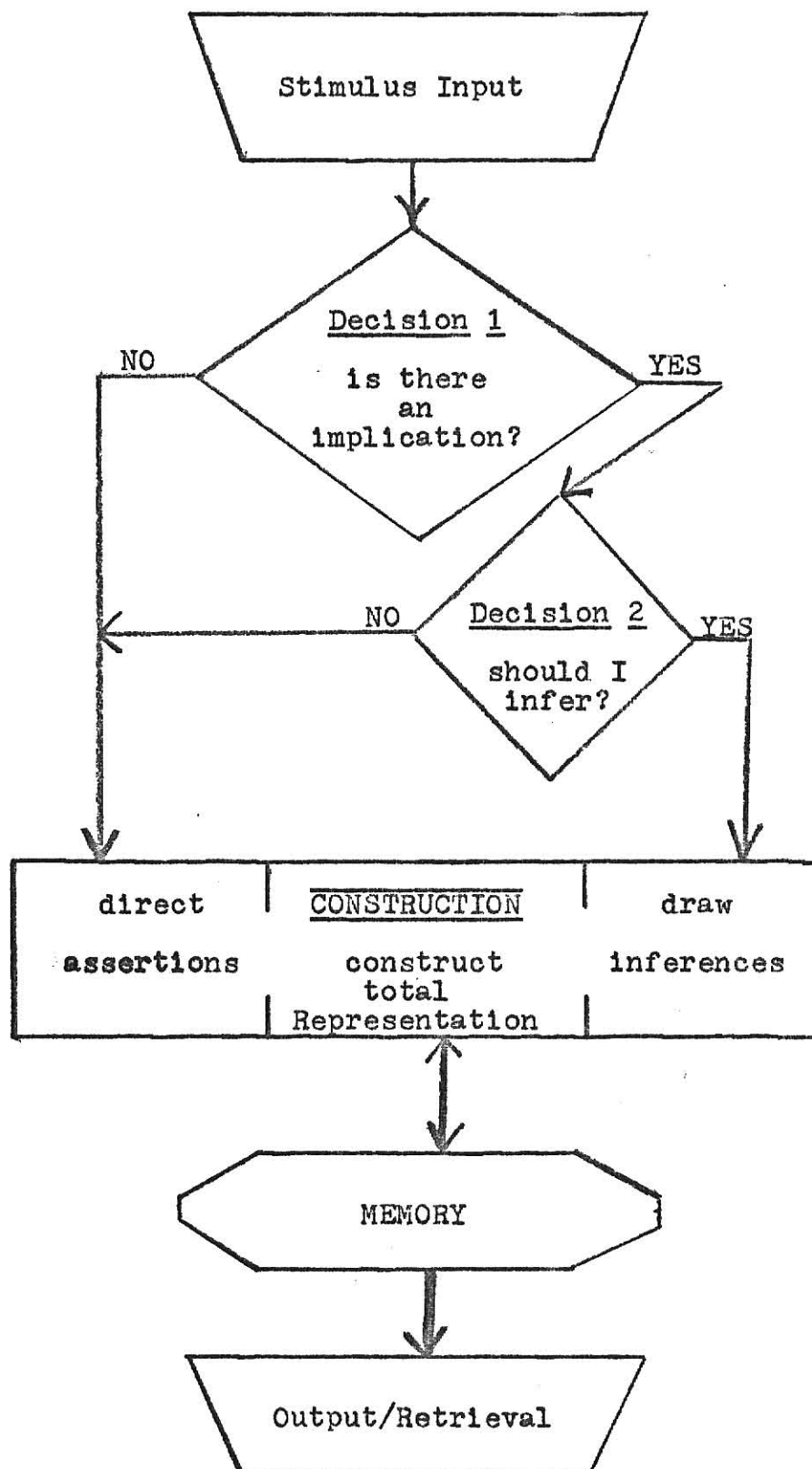
After dressing...Jose is a teacher. Passage two.

**THIS BOOK
CONTAINS
NUMEROUS PAGES
WITH DIAGRAMS
THAT ARE CROOKED
COMPARED TO THE
REST OF THE
INFORMATION ON
THE PAGE.**

**THIS IS AS
RECEIVED FROM
CUSTOMER.**

Figure 1

Model of the Construction Process from Monaco (Note 4)



The old cabin looked down from the hilltop...

they were set far apart.

Subjects heard the key information about Jose being a teacher in the direct flow of previous information about Jose. Subjects in the Retrieval group heard the key information after the last sentence of Passage Two, i.e., separated from its thematically related information by approximately 90 seconds. Following the flowchart, for both groups the key information would be searched for an implication at Decision 1. Since it carries no implication it would go directly to the Construction box as a direct assertion. For the Storage group, the construction operations for Passage One would still be occurring as the key information came in. The representation of Passage One would not yet have been stored and the key information should affect inferences already drawn and inferences still being drawn. As Passage Two information begins to enter the system, the constructed representation of Passage One would be stored in memory. However, for the Retrieval group a representation of Passage One should have already been constructed, without using the key phrase, and stored in memory when the key information entered the system following the conclusion of Passage Two. Thus when the key phrase entered the Construction box for the Retrieval group, the constructed representation of Passage One would be called up from memory (where direct assertions and inferences are equal) and at best appended to the representation, in no way altering any inferences which were previously drawn, and then the appended representation would reenter memory. The difference in operations between the two groups should and did manifest itself in a difference

on the subsequent recognition-of-information test.

Monaco's Decision 2 stage deals with whether or not an inference will actually be made. If information coming into the system is seen to carry an implication at Decision 1, a decision would have to be reached at Decision 2 as to whether or not the inference should be drawn. If the inference, or inferences in some cases, should be made the information is relayed to the area of the Construction box where inferences are drawn. If the decision is to not make an inference the information is sent to the direct assertion area where only the directly asserted information is used. As previously noted, the instructions to the subjects in Experiments I and II seemed to operate on just such a decision stage by causing them to make (essay) or to not make (multiple choice) the critical inferences.

Just as the research on construction presented in this paper has provided data pertinent to the fundamental storage-versus-retrieval issue, it is expected that further research on construction will cast in a new light, and may yield answers to, some of the most basic questions concerning human learning and memory. For example, it is likely that many subjects in Experiment III (both Storage and Retrieval groups) at some time made the inference that Jose was a student. The question arises as to what happened to that inference when it was contradicted. Was it lost from memory? Did the subjects "forget" that they made the inference? These questions are one aspect of the basic question that memory researchers have examined for years--what is forgetting--and

attempts at answering them from a construction point of view are being made (e.g., Monaco, Note 5). The fact that in Experiment III additional information does not affect a previously constructed representation is important to the study of human learning: how much information must be supplied in order to change an individual's previously constructed representation of a set of events? Also intriguing is the examination of what inferences are constructed by whom. For example, any projective test is really an examination of the inferences constructed by an individual about some ambiguous stimulus presented by the clinician.

As yet a constructive theory of memory needs to be more formalized than that presented by Monaco (Note 4). It has, however, advanced significantly beyond Bartlett's original formulation, primarily due to the return to the use of experimental stimuli such as passages which approximate more closely than lists of words the content of speaker-hearer communication combined with a more refined analysis of these stimuli such as the logical-pragmatic distinction provides. But if these advances come only in the realm of psycholinguistic research, then any formal theory of construction can only be limited in scope. Bartlett discussed construction in terms of social and perceptual, as well as psycholinguistic, phenomena. And it is expected that research on construction in these areas would further advance the generalizability of the theory. For example, in the area of person perception, the so-called "halo effect" may be due to one's construction of a representation of (including

inferences about) some other individual's behavior based on a first impression of that other individual. This representation is then stored in memory and later recalled as if one had actually witnessed those behaviors rather than merely inferred them.

Construction is an approach to human learning and memory which is applicable to the study of any area of human information-processing which involves the integration of a series of events and/or facts into a total representation, for it is this type of processing in which the individual most frequently engages in daily life.

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FOOTNOTES

¹The traditional dictionary distinction between implication and inference is followed here. A speaker's sentence or utterance makes an implication; a hearer or reader makes an inference.

APPENDIX I

Stimulus Passages

Descriptive:

The old cabin looked down from the hilltop onto a valley below. From the cabin the cry of a seagull could be heard. At the sound a squirrel scurried across the roof of the cabin, loosening shingles in its path, and jumped into the open arms of the nearby tree--the oak tree which had protected the cabin for generations; the old oak which had cooled the cabin with its shade during the hot, blazing summers.

The cabin had been sturdily built, but the wind from the valley now rattled and shook the cabin door. It was nearing the end of summer and the hot days had been gradually cooling as fall approached.

A pile of freshly cut logs and an axe lay in front of the cabin, but the cabin was now empty.

There was no porch in front of the cabin, just two chairs, there, to sit in on the frequently cool nights. The chairs were rustic looking and uncomfortable without pillows. They were set far apart.

Narrative:

Jose arose early in the morning. After dressing, he ate breakfast and then went over to the neighborhood school. He was pleased that the sun was shining today.

Many of the children in the 3rd-grade class greeted Jose as he sat at his desk. He didn't greet them back. Jose was nervous and anxious for class to start because he had been absent for over a week. Jose liked school and his mother was a teacher.

Alice, a friend of Jose's from the 2nd-grade class, said "hello" to him as she passed by--Jose sat near the door. Alice's classroom was nextdoor to Jose's, but they seldom saw one another during the day. Alice's classroom was larger and had more window space than Jose's, so that all of the 2nd-grade students were tempted to look out at the rooftops of the houses below.

The principal stopped inside of the 3rd-grade classroom and said "hello" to Jose. Jose thought that the jolly principal resembled a character in the comic strips although he would never tell anyone so. The principal was (an older man)* bald and pigeon-toed. All of the children and all of the teachers respected him. Jose was no exception.

At last the buzzer signaling the start of classes sounded and Jose lost his anxiety in the excitement of the day.

*The phrase in parentheses was not included in Experiment III.

APPENDIX II

Recognition-of-information Test Statements

Descriptive:

1. The tree was young.
2. The cabin was on a hill.
3. There were two chairs in front of the cabin.
4. The cabin was not sturdily built.
5. The cabin was above the valley.
6. The logs were cut with an axe.
7. There were shingles on the cabin's roof.
8. The wind came in from the sea.
9. The cabin was old.
10. Two people owned the cabin.
11. It was a log cabin.
12. The chairs were close together.
13. The cabin was near the sea.
14. There was never a cool night.
15. The summers were hot.
16. The cabin had no porch.
17. The logs were freshly cut.
18. The cabin was protected by the tree.
19. The chairs were old.
20. It was approaching the start of fall.
21. The cabin is a one-story building.
22. The squirrel fell into the tree.
23. The cabin had a fireplace.
24. The chairs were comfortable without pillows.
25. The cabin door was rattled and shaken by the wind.
26. The logs were behind the cabin.
27. The axe lay on top of the logs.
28. The tree was an elm.
29. The chairs had pillows.
30. A tree was near the cabin.

Narrative:

1. Jose said that the principal resembled a comic strip character.
2. The second-grade classroom was above the rooftops of houses.
3. Jose and Alice are friends.
4. Jose often saw Alice once class began.
5. Children were in the classroom with Jose.
6. Jose had been sick.
7. The principal was older than Jose.
8. Jose was calm before class.
9. Jose's classroom was smaller than Alice's.
10. Jose walked to school.
11. Jose is a student in the third grade.
12. The principal stopped outside Jose's classroom to say "hello."
13. Jose was older than Alice.
14. Someone rang the morning bell.
15. Jose woke late in the morning.

Narrative (cont.):

16. Alice's classroom had more windows than Jose's.
(Alice is a student.)*
17. The principal was bald.
18. Jose was absent from class for over seven days.
19. Jose said "hello" to the principal.
20. Jose's classroom was next to Alice's.
21. Jose's father was a teacher.
22. The sun was hidden by clouds that day.
23. The second-grade students often looked out the windows.
24. Jose didn't like school.
25. The door was near Jose's desk.
26. Jose ate breakfast before he dressed.
27. Jose is of Spanish descent.
(Jose lives with his mother.)*
28. Jose said "hello" to the children who greeted him.
29. The principal was heavy.
30. The third-grade children respected the principal.

*The statements in parentheses replaced the statements immediately preceding them in Experiment III.

Score Key

- | | |
|----------------------------|-------------------|
| 1. False | 16. Indeterminate |
| 2. True | 17. True |
| 3. True | 18. True |
| 4. False | 19. Indeterminate |
| 5. True | 20. True |
| 6. Indeterminate | 21. Indeterminate |
| 7. True (Indeterminate)* | 22. False |
| 8. False | 23. Indeterminate |
| 9. True | 24. False |
| 10. Indeterminate | 25. True |
| 11. Indeterminate (False)* | 26. False |
| 12. False | 27. Indeterminate |
| 13. Indeterminate | 28. False |
| 14. False | 29. Indeterminate |
| 15. False | 30. True |

*The answers in parentheses were used in Experiment III.

CONSTRUCTION AS A STORAGE PHENOMENON

by

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AN ABSTRACT OF A MASTER'S THESIS

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Bartlett (1932) hypothesized that upon remembering or retrieval from memory a representation of the original stimulus material was constructed, and he found that the accuracy of this constructed representation varied greatly among individual subjects. Recent research in the area of psycholinguistics and most especially that research dealing with inferences made by subjects has relied heavily upon Bartlett's original formulation of the construction hypothesis. The three experiments reported in this paper were conducted using prose passages as stimulus material in order to examine in greater detail and thus refine the precision of the construction hypothesis by determining: first, whether the subject's constructed representation of interrelated facts presented in the form of a passage could be experimentally manipulated; second, whether construction of this representation occurs at storage or retrieval; and, third, when the construction of a set of interrelated facts may be said to be fully terminated. Experiment I found that construction of inferences could be manipulated by prior instructions to the subject. Experiments II and III confirmed that construction occurs in storage and not during retrieval. Experiment III indicated that the construction of a representation of interrelated facts may be said to be fully terminated only after unrelated facts enter the storage system. Further work on developing the theory of construction is encouraged both within psycholinguistics and other related areas dealing with human information-processing.