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The incidental learning effects of discrimination which would be required in searching for and selecting related information in a text were explored. Sixty-one students from three educational psychology classes at Fairleigh-Dickinson University participated. Subjects were randomly assigned to four experimental groups and were given reading search tasks. The present study indicates that when a reader is involved in reading for specific information, substantial learning effects may be produced by the discriminations involved in the search. A delayed retention test indicated that these learning effects may be relatively stable over time. Even stimuli which are not the targets of search can be influenced by searching if they are encountered repetitively during the search. The results suggest that when stimuli are evaluated against a criterion, the comparisons involved influence the retention of both the criterion and the stimuli which are evaluated against it. References, tables, and notes are included. (WB)

Incidental Learning Effects of Searching for Related Information in a Text

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In a variety of instructional tasks, important learning effects are often incidental to what the student perceives as the response requirement. A student might be asked to find the most important historical figure in a reading passage, and in the process of finding that name he will learn facts about several historical figures. Similarly, the experienced programmer is aware that the important stimulus in a frame is not the word which fills the blank, but the blank itself (Anderson, 1967). The nature of the blank determines the behaviors which the student must engage in to fill it, and although the student may intend to find a particular word, what he actually learns may be much more significant.

Learning can thus be incidental in the sense that the student does not consciously attempt to learn certain information, but he does respond to the orienting task--a question, direction, or blank. The nature of such incidental learning has been given a good deal of attention by experi-

mental psychologists (cf. McLaughlin, 1965), but the topic has not received much explicit consideration from workers concerned with instructional processes. Research in this area might contribute to our understanding of the basic processes involved in important instructional activities, such as learning from discovery or from reading which is guided by the use of questions or other adjunct aids.

In principle, it should be possible to develop different orienting tasks which have the effect of programming encounters with important facts or principles while reading ordinary text. These important encounters would be the necessary conditions for executing the orienting instruction. The purpose of the present paper is to explore the incidental learning effects of discriminations which would be required in searching for and selecting related information in a text.

In a previous study (Frase, 1969), Ss (subjects) read a passage describing three attributes of ten fictitious planets in order to find the name of the one planet having a certain unique combination of attributes. All Ss were given the same orienting instruction, but were not told to learn anything (a Type I incidental learning task; Postman, 1964). When the sentences were grouped in paragraphs describing each attribute, Ss recalled significantly more names. The orienting task required that S find the sentences describing

each planet until he could determine whether the planet met all the required criteria. Search is thus defined as the selection and comparison of stimuli with some criterion. The task was simple if each paragraph contained all the information about a particular planet, because it only involved search for the attributes involved. But if some of the related sentences (each sentence contained a planet name and an attribute) were located in other portions of the passage, S had to search for those sentences, as well as the attributes, and consequently remember that he was looking for the next sentence related to planet "X". Thus, separating information about planets required that S adapt by producing a new criterion (the name identifying the missing sentences) in addition to the attributes specified by the orienting instruction. The names encountered in different sentences would then be compared to this criterion name to determine the relevance of the sentences, otherwise Ss could not solve the problem. Since both the criterion name and the names which are compared with it must be discriminated during a search for related sentences, the learning of all names might be promoted, even if they are not criterion names (for which missing information must be located). This hypothesis would be consistent with the view that discriminations are a sufficient condition for learning. An alternative hypothesis would be that the covert rehearsal involved in remembering

and looking for a name is a necessary condition for learning, and hence the names which are only compared to the criterion name would not be learned.

The present study attempted to replicate and extend the results of Frase (1969), by varying the number of sentences which must be located. Also, in the previous study information had to be located for all planets, hence all names were used as criteria during search. In the present study the materials were arranged so that some planets could be rejected early in the reading passage, but those names also occurred in sentences of latter paragraphs in which Ss would be searching for other names. The present study thus provides information on whether learning will occur for the names which need not be used as criteria during search, but need only be compared with names for which information is sought.

Method

Subjects

Sixty-one students participated from three educational psychology classes at Fairleigh-Dickinson University. The Ss were randomly assigned to four experimental groups.

Materials

The reading task consisted of a 540 word passage describing 5 attributes of 15 planets. The planet names were paralogs (e.g., Tartan, Nimbus, etc.) of medium meaningfulness, familiarity, and emotionally (Runquist, 1966). The

attributes describing each planet were its distance from earth, its terrain, sunset coloration, its number of moons, and the variety of life it would support. The sentences describing each planet had the same form and the attributes always occurred in the same sequence for different planets. Sentences varied from 6 to 8 words in length. Only the planet names and attribute values changed across paragraphs. An example of one paragraph follows.

Twenty light years away is the planet Nimbus. Mountains cover a vast area of Nimbus' surface. Orange sunsets are seen on Nimbus. Two moons rotate around the planet Nimbus. Plant life can exist freely on Nimbus.

Each sentence thus contained a planet name and one characteristic of that planet. There were no redundant or irrelevant sentences.

The attributes of the planets were highly similar. For each attribute, three different planets were unique. For instance, 12 planets were twenty light years from earth, but one was 40, one 60 and one 80, and so forth for the other attributes. If Ss were given an instruction to find the planet which was 20 light years away and had certain other characteristics, it can be seen that they could eliminate three planets on reading only the first sentence of each paragraph. As will be seen below, Ss were asked to determine whether a planet (or planets) existed which had a co-

occurrence of attributes which were not present in the passage. However, the attributes of the planet to be found matched the most frequently occurring attributes in the passage. Thus, S could reject three planets after reading the first sentence of each paragraph, three more after reading the first two sentences, three more after reading the first three sentences, three more after reading the first four sentences, and the last three after reading all five sentences of each paragraph. The materials were thus arranged so that Ss would have to read a prescribed number of sentences for each planet. All planets would have to be considered because none matched the criteria stated.

For one group of Ss (Group 0) each of the 15 paragraphs contained all attributes of a particular planet. In reading the sentences to determine the attributes of these planets Ss would not be constrained to use the names of the planets as criteria, and could merely evaluate their attributes.

For another group (Group 3) the fifth attribute sentence of each paragraph was dropped. These sentences were combined in one paragraph which was placed at the end of the passage. Group 3 Ss could thus reject all but three planets when reading the first 15 paragraphs, and they would be forced to search the last paragraph for the fifth attribute for three different planets. For this group there were three criterion names, and three sentences had to be located.

The group designations refer to the number of sentences which have to be located. The serial order of names used in the first 15 paragraphs was maintained in the final attribute paragraph.

For Group 9 the last two attributes of each paragraph were dropped and combined separately to make two attribute paragraphs which were placed at the end of the passage. The Ss in Group 9 thus had to locate the same three sentences as Group 3, but in addition, they had to locate the fourth attribute for those three planets as well as the fourth attribute for three additional planets. For Group 9, a total of six criterion names were involved in the search, but nine sentences had to be located.

Group 18 had three attribute paragraphs at the end of the passage, thus having to locate 18 sentences (nine criterion names were now involved in the search).

The passages were multilithed on 8-1/2 × 11 paper and assembled into booklets having a cover sheet labeled "Booklet I."

Another booklet, labeled "II", contained the retention tests. On one page Ss were asked to write as many planet names as they could recall. On a later page Ss were asked to circle the names of the planets which they recognized from the passage, and they were cautioned not to guess since wrong choices would detract from their score. The correct

names were embedded in a list of 25 other paralogs of high and low meaningfulness, emotionality, and familiarity. The recall and recognition tests were separated by pages which masked the recognition stimuli on succeeding pages, and which told S not to turn back to the recall test.

Procedure

The experiment was conducted in class with three consecutive classes. The Ss received an instruction sheet before the reading and test booklets were distributed. The instructions told Ss that they were to read a passage about a new solar system which had 15 planets, and that five characteristics of the planets were known. The task for S was to read the passage and as fast as possible, find the name of the planet which was a certain distance from earth, had a certain terrain, etc. All five attributes were described in sentences which were identical to the descriptions occurring in the text. The Ss were permitted to refer to this description during reading. The Ss were cautioned that there may be more than one such planet, or none. When S found the information he was to turn over Booklet I and write the time (which was displayed on the blackboard) on the booklet. He was then to proceed to Booklet II and not to refer back to Booklet I.

After insuring that the instructions were understood, Booklets I and II were distributed. The Ss began reading on a signal from the experimenter (E). One E recorded digits

on the blackboard every 10 sec to provide a measure of time, while the other E monitored the classroom.

One month later an alternate form of the recognition test was administered.

Design

The dependent measures were recall and recognition of the 15 planet names, and time taken to complete the task. A one way analysis of variance was used to compare Groups 0, 3, 9, and 18, followed by multiple comparisons. An additional analysis compared the group which did not search (0) to the groups which did, on retention of the names which presumably were never used as criterion names. The t-test was used because those items changed across search groups.

Results

Table 1 summarizes relevant statistics, including the results of the analyses of variance.

Insert Table 1 about here

The recall, immediate recognition, and delayed recognition scores show similar functional relations to the search conditions. Recall scores tended to be skewed (as in the previous study), so further analysis was conducted on recognition scores. The groups showed no differential tendency to select the distractors, and the frequency of such selections was low. Evidently, there was little guessing.

Duncan's multiple range test indicated that all search groups (3, 9, 18) differed from Group 0 ($p < .05$), as predicted. The only comparison which was not significant for immediate recognition was between Groups 9 and 18. Beyond a certain point, there seemed to be little advantage to additional search.

Figure 1 indicates how recognition of the names within each group was affected. The figure shows the proportion of Ss in each group who recognized names

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Insert Figure 1 about here

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which could be rejected on the first, second, third, fourth, or fifth sentence related to that planet. There are three names at each data point. The points for Group 0 are indicated in black--there were no criterion names for Group 0. For Group 3, the names which could be rejected on sentence 5 were criterion names. It is clear from Figure 1, that when only three sentences had to be located, the retention of all names was increased. Group 3 recognized 6.69 of the 12 names which should only have been compared to the three criterion names, while Group 0 recognized 4.29 of those names; $t = 8.9$, $df = 28$, $p < .001$. Similarly, Group 9 recognized 5.44 of the nine names which never occurred as criteria, while Group 0 recognized 3.00 of those names; $t = 11.3$, $df = 28$, $p < .001$. Group 18, recognized 3.57 of the six non-criterion names, while

Group 0 recognized 2.07 of those names; t = 2.45, df = 26, p <.025. It seems appropriate to conclude that S learned the names they were not required to locate.

We do not propose to discuss comparisons between Group 0 and the other groups on the recognition of criterion names because they represent a much smaller, and hence biased, set of names than the non-criterion names. We note, for the interested reader, that recognition of criterion names was significantly lower for Group 0 than for Groups 9 and 18, but not lower than Group 3. For the latter comparison only three names were involved (which could be rejected on the fifth sentence), and recognition was relatively high even in Group 0. The reader is also cautioned about making comparisons across items 1, 2, 3, 4, and 5 in Figure 1, because they were not counterbalanced for sematic content or position within the passage.

The behaviors which produced learning also took more time (Table 1). The correlation between time and recognition scores was .63; df = 55, p <.001. An analysis of covariance, using the log transformed time scores as a covariate, removed the treatment effects on recognition scores. The number of items recognized per minute of reading is also reported in Table 1 (Rate). The small F ratio lends support to the suggestion that the efficiency of the behaviors required, in terms of their learning consequences, did not

decrease when more search was required. Bugelski (1962), has suggested that, for certain behaviors, the amount of learning may be a constant per unit of time. His data relate to the presentation of stimuli under paced conditions.

Comparing the immediate and delayed recognition test scores indicates that the influence of search conditions was relatively stable over a one month period. Only half the Ss in Group 9 were available for that test, but their mean is not out of line with the other groups. No figure is presented for these data because they correspond closely to Figure 1.

Discussion and Summary

As Gagné (1966) has pointed out, even such vaguely defined activities as learning by discovery are based upon the processes of search and selection. This study explored simple discriminations as a basic component of these processes.

The present study indicates that when a reader is involved in reading for specific information, there may be substantial learning effects produced by the discriminations involved in that search, depending upon how much search is involved. The delayed retention test indicated that these learning effects may be relatively stable over time. Even stimuli which are not the targets for search can be influenced by searching if they are encountered repetitively during search. This latter finding suggests a modification of the model which was presented in the previous paper (Frase, 1969).

The implication of the previous paper was that only the stimuli which are used as criteria will be stored temporarily, and hence get into memory. The present results suggest that when stimuli are evaluated against a criterion, the comparisons involved influence the retention of both the criterion and the stimuli which are evaluated against it. Of course, our description of the process involved in the present search task is not proven by the data, but it seems in accord with other indications of what Ss do. In the previous study it was possible to observe, on a television monitor, that Ss search back and forth from page to page, often recording the names and checking them off as they rejected them. Comments of Ss also confirmed the process which was suggested by an analysis of the task.[1]

The finding that simple discriminations can produce learning is consistent with the results of Faust and Anderson (1967). They found that the inclusion of irrelevant material in programmed instruction improved retention of the relevant material, which the students perceived as the response requirement. Evidently, simple discriminations were involved. Our analysis suggests that previously learned stimuli might well be used as distractors on later frames, since these repeated discriminations would both maintain earlier learning and function to produce learning of the new items.

The suggestion that groups learned items at similar rates implies that the behaviors which were required from the different groups were substantially the same in terms of their learning consequences, except that more such behaviors were involved when search was needed. As a result learning consequences were not lessened even when much search was involved.

Obviously, an analogy between the processes operating in the present study and those occurring in discovery or guided reading tasks must be limited by the kinds of behaviors involved and retention measured. Our attempt was to make the materials complex, meaningful, and interesting for Ss. The names were moderately difficult and the sentence at which rejection occurred vaired from paragraph to paragraph. From the S's standpoint, this was relatively complicated. It was necessary to make several decisions based upon reading the material. A problem which we are now attempting to pursue, is whether a search model can be used as a basis for suggesting orienting tasks which produce more complex substantive learning. Our analysis implies that search involves comparing sentences with some criterion. Without modifying the written materials, it may be possible to phrase criteria such that many sentences in a passage must be evaluated in terms of several criteria.

The number, pacing, and complexity of these criteria are among the variables which seem amenable to experimental study.[2]

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Notes

1. An additional study was conducted, using word lists, which also verifies the importance of discriminations for retention. Eight Ss were presented with two 16 word lists, one containing 8 female and 8 male names, the other containing 8 vegetable and 8 fruit names. For one list S was told to check off all the names which were foods (or names of people), for the other list S was to check off all the name of vegetables (or males). The lists were counterbalanced for position (presented first or second), and whether discriminations were involved for that list. The hypothesis was that when Ss have to select a particular subset of words within a list, discriminations are required and hence recall should be higher. A free recall test of all words, given immediately after searching the second list, revealed that Ss recalled 7.13 words from the lists when discriminations were required, and 4.5 words when discriminations were not required; $t = 2.12$, $df = 7$, $p < .05$. There were no significant differences in time taken to search the discriminated and non-discriminated lists, nor in recall for the words which were targets in the discriminated list as opposed to those which were not.

2. We wish to thank K. H. Smith for his thoughtful comments concerning this paper.

TABLE 1

Summary of Group Performance on Dependent Measures. Means (M), Standard Deviations (SD), and number (N) of Ss in each group are reported.

		Recognition				
Group		Recall	Immediate	Delayed	Time (sec.)[c]	Rate[a]
0	N[d]	14	14	13	14	13
	M	1.21	5.79	5.92	150.71	2.53
	SD	1.05	2.43	2.87	71.63	1.13
3	N	16	16	13	16	16
	M	3.50	8.50	8.69	211.87	2.72
	SD	2.34	2.56	2.39	98.87	1.01
9	N	16	16	8	15	15
	M	4.31	10.75	11.37	256.67	2.65
	SD	1.54	3.53	2.07	116.66	1.14
18	N	14	14	15	14	13
	M	4.07	10.71	9.33	302.86	2.59
	SD	3.12	3.07	2.41	136.41	1.31
	df	3/56	3/56	3/45	3/55	3/53
	F	6.08	9.20	8.76	6.06	.073
	p	<.005	<.001	<.001	<.005	<.1[b]

[a] Number of names recognized per minute of time spent reading (averaged over Ss).

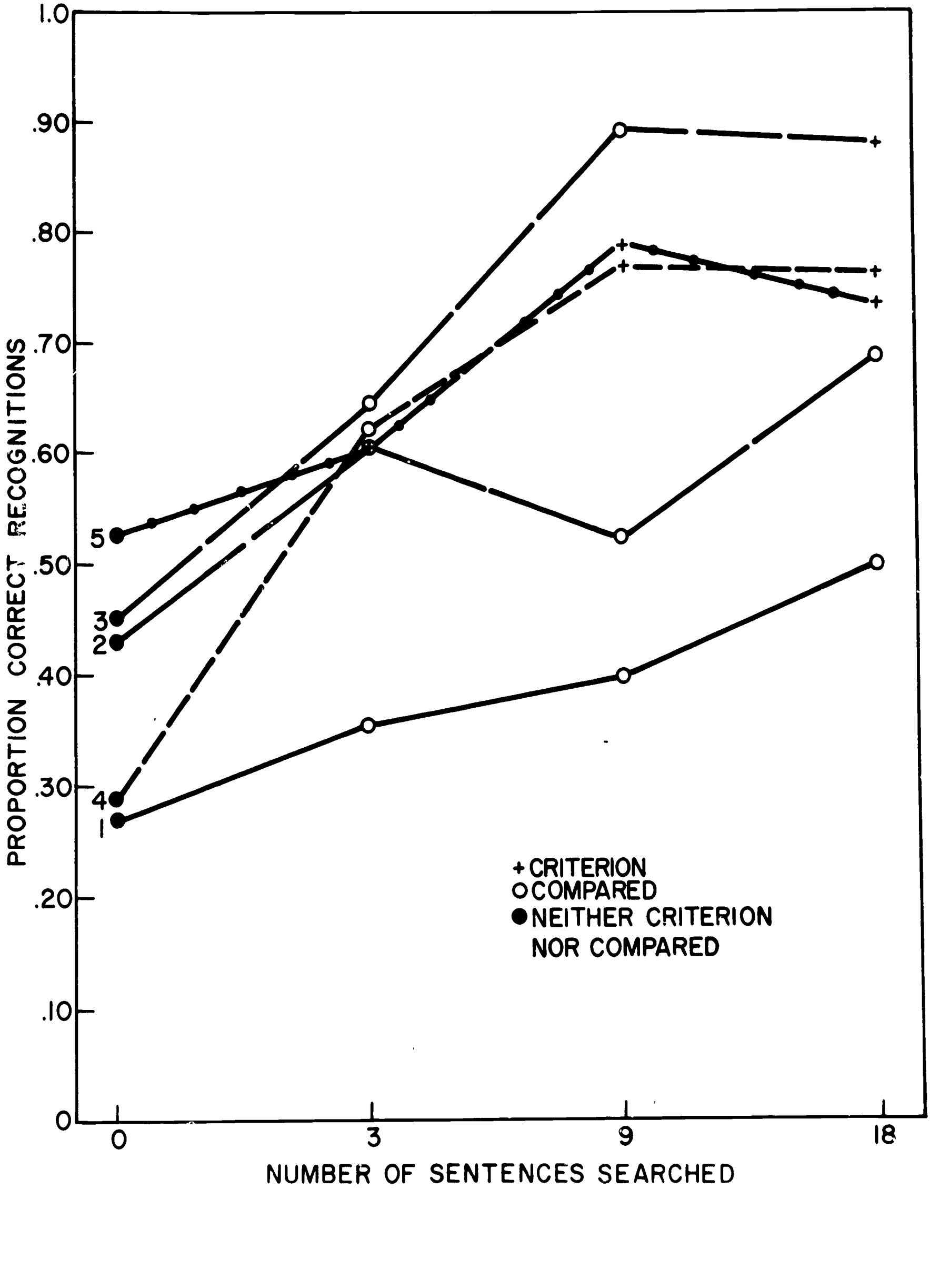
[b] This is the probability of an F as small as .073 (two-tailed test).

[c] Analysis was conducted on log transformed scores.

[d] N's differ because data for some Ss were not available on all measures.

FIGURE CAPTIONS

Fig. 1. Proportion of correct recognitions on immediate posttest for each experimental group for names which could be rejected on the first, second, third, fourth, or fifth sentence relating to those names. The function of those items (whether criterion, comparison, or neither) is also indicated for each group. Each point represents three names.


1.0
.90
.80
.70
.60
.50
.40
.30
.20
.10
0
PROPORTION CORRECT RECOGNITIONS
5
3
2
4
1
+ CRITERION
○ COMPARED
● NEITHER CRITERION
NOR COMPARED
0
3
9
18
NUMBER OF SENTENCES SEARCHED