Degree of priming in the retrieval of authors' names from long-term memory¹

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Retrieval from long-term memory was investigated in two experiments in which S was shown a title and asked to say the surname of the author. Some of the author names had been studied in a previous paired-associate task in which they were paired with different titles than those used in the test phase, i.e., the names were primed. The results indicated that very little priming is necessary to produce considerable facilitation in author naming. When the frequency of priming exposures was small an increase in the frequency of either study or test trials in the priming phase resulted in increased facilitation. Study trials during priming appeared to produce greater facilitation than did attempts at retrieval during priming, and the effects of the two kinds of priming trials were additive.

It has been demonstrated by Hopkins & Atkinson (1968) that retrieval of proper names from long-term memory can be facilitated by priming, i.e., by study of the names prior to the test phase but in a task quite different from the test task. Specifically, they found that pictures of well-known people were more accurately named when the correct name had been among those recently studied in a multi-trial free-recall task than when the correct name was not in the free-recall list. Furthermore, for some stimulus pictures S was informed whether he had or had not studied the correct name during the priming session (I conditions), and for some he was not so informed ($\bar{I}$ conditions); the observed facilitation was nearly as great in the $\bar{I}$ as in the I conditions. This finding, in conjunction with a simple model of memory, was taken as evidence that the principal locus of facilitation from priming was in a recovery or output phase of the retrieval process, rather than in the memory-search component of that process. The weight of the argument was the following: priming might be expected to facilitate search by limiting the extent of memory to be searched; however, such a factor would seem not to be important in $\bar{I}$ conditions where there was, nevertheless, considerable facilitation observed; thus, the authors concluded that the bulk of the facilitation was attributable to another aspect of retrieval; the recovery of the target name once it has been located, a process described briefly by Hopkins & Atkinson (1968) and in more detail by Atkinson & Shiffrin (1968), seemed a logical possibility for the locus of the priming effect.

Subsequent research in the series of studies on retrieval from long-term memory of pre-experimentally acquired associations (Hopkins & Atkinson, in press) has employed as stimuli both pictures of well-known people to be named and titles for which the author was to be named. However, only the facilitative effects of first-letter clues and increasing amounts of stimulus information were considered in that report. It seemed useful to investigate priming effects in the author-naming task for two reasons. First, the clue effects observed by Hopkins & Atkinson (in press) appeared to be invariant across the classes of stimulus materials, and it was anticipated that the priming effect could be extended to the title materials. More importantly, since several titles were available for each author these materials permitted more flexibility in the nature of the priming task.

In the experiments to be reported a title-author pair was studied (and/or tested) in a paired-associate priming task; subsequently another title by the same author was presented for test and S was asked to say the author's surname. The numbers of study and test trials in the priming task were independently manipulated in factorial designs. In Experiment 1 items received either one or two study exposures and were tested either zero, one, or two times during priming. No item was tested during priming if it had not been previously studied. Control items received neither study nor test exposures during priming. In Experiment 2 an item received

either zero or one study and zero or one test exposures during priming. Thus, for one condition of Experiment 2 a test exposure was unaccompanied by a previous study trial, so the effects of practice at retrieval in the absence of feedback or study could be investigated.

It was anticipated that, in addition to demonstrating a facilitation of author naming by priming, the results would show that an increase in the number of study trials in the priming task would increase the facilitation via a strengthening of the associative connections in memory (cf., Hopkins & Atkinson, 1968). Furthermore, an increase in test-trial frequency was expected to increase the facilitation from priming through simple practice in retrieving the target name. No prediction was made concerning the relative effectiveness of study and test priming trials, or the interaction of those effects. In neither experiment was S informed as to whether a particular response had been primed; hence, if the earlier interpretation is correct, most of the observed facilitation from priming will be in the recovery component of the retrieval process.

METHOD

In Experiment 1 seven conditions were determined by the treatment during the priming phase. One or two study trials were factorially combined with 0, 1, or 2 test trials to yield six experimental conditions. The seventh condition was a control for which no study or test exposures were administered during priming. In Experiment 2 four conditions were determined by the factorial combination of zero or one study trials and zero or one test trials during priming. In each experiment the conditions will be designated by two digits, where the first digit indicates the number of study trials and the second the number of test trials during the priming phase. For example, Condition 0-0 is the control, Condition 2-1 consists of those items receiving two study and one test exposures, and Condition 0-1 designates those items receiving zero study and one test exposures during the priming.

The materials consisted of authors, and two titles representing each author, selected randomly from those used by Hopkins & Atkinson (in press). For Experiment 1, 96 authors were selected and 152 were used in Experiment 2. For each of the authors, Ss in a previous experiment (Hopkins & Atkinson, in press, Experiment 3) had ranked one of the titles high in association with the author (HA) and one title had been ranked medium in association with the author (MA). Only the MA titles were used in the priming phase and all the titles used in the test phase of each experiment were HA. The title-author pairs, or titles only (for test trials), were typed on 3 x 5 index cards in elite type. The 96 authors of Experiment 1 were divided into 16 sets of six authors each. Two sets were allocated to each experimental condition and four to the control. In Experiment 2, the 152 authors were divided into eight sets of 19 each. Two sets were allocated to each condition. In each experiment the sets of stimuli were, based on an earlier result, known to be approximately equivalent in overall difficulty, and four different assignments of the stimulus sets to the treatment conditions were used. No set was allocated to the same condition in more than one of the stimulus assignments.

The Ss were 44 Stanford University students of both sexes who were paid for their participation. Of the 44, 28 were in Experiment 1 and 16 in Experiment 2. Each S served in each condition of the experiment in which he participated. The Ss were assigned to the four stimulus-set allocations in pre-randomized blocks of four Ss so that each such stimulus-set allocation was used for an equal number of Ss in each experiment.

In Experiment 1, the priming phase (Stage 1) consisted of two study and two test trials on a changing paired-associate list of MA title-author pairs. The study and test trials alternated. In Experiment 2, only one study and one test trial were used with the study trial preceding the test. On study trials, S was given a pack of cards, each with a title-author pair typed on it; he studied the pairs, one at a time, by turning over a card each time a buzzer sounded, every 5 sec. On test trials of Stage 1 E presented cards with only titles printed on them, one at a time, and S was permitted 5 sec to say the surname of the author for each title. Only one response was permitted and no feedback was given. The cards to be used on each trial were re-shuffled for each S, and he was given no information as to which title-author pairs would never be tested, which would be presented for another study, etc.

The Stage 1 list changed from trial to trial to conform to the sequences of study and test trials required by the experimental treatments. In Experiment

Table 1
Proportions of Correct Responses and Mean Latencies of Correct Responses
(in parentheses) in Stage 2 of Each Experiment as a Function of Study and
Test Frequency of Exposure in Stage 1

Study Frequency	Test Frequency				
	Experiment 1			Experiment 2	
	0	1	2	0	1
0	.30 (2.63)			.33 (2.71)	.37 (2.45)
1	.38 (2.23)	.40 (2.24)	.45 (2.19)	.46 (2.33)	.50 (2.16)
2	.43 (2.50)	.44 (2.17)	.43 (2.30)		

In some of the conditions required sequences that could be distributed in more than one way across the two study and two test trials. The following rules were used to generate the priming sequences of Experiment 1: an item was never tested before it had been studied, and if it was to be tested at all an item was always tested on the trial immediately following its study and then on the subsequent test trial if necessary. With these restrictions two subsequences were possible for Conditions 1-0, 1-1, and 2-1. Six items were assigned to each of the subsequences in these three conditions. However, the difference in frequency of correct responses in Stage 2 between the two subsequences was not significant for any of the conditions ($t < 1$). Hence, the subsequences of each of the conditions were pooled in the analyses to be presented.

In each experiment, the test phase (Stage 2) consisted of a series of discrete trials. There were 96 trials in Experiment 1 and 152 in Experiment 2. On each trial E presented a different HA title card and S was permitted 5 sec to respond with the author's surname. Only one response was permitted and guessing was discouraged. If S made an error, or failed to say the correct name in 5 sec, the correct answer was provided by E. The S was given no information about the condition to which a test item belonged. In Experiment 1 the order of the stimuli was the same for all Ss in Stage 2, with items representing each experimental condition occurring twice and control items four times in each block of 16 trials; of course the order of the conditions was dependent on the stimulus allocation to which S was assigned. In Experiment 2 the cards to be presented were shuffled prior to presentation to each S. The latencies of Stage 2 responses were measured with a Standard Electric Timer. Mean latencies of correct responses in each condition were calculated for each S and served as the raw latency data.

RESULTS

Explicit consideration of Stage 1 performance is beyond the intended scope of this report. However, it may be noted that in those cases where appropriate comparisons could be made there was no evidence that any of the conditions was favored by the way in which stimuli were assigned to Ss.

The proportions of correct naming responses in Stage 2 and the mean latencies of those responses are presented in Table 1 for each condition in each experiment. The data are not separated into items correct in Stage 1 and items incorrect in Stage 1, even where possible, since such a breakdown is entirely confounded by selection effects.

Considering the data for Experiment 1 first, it may be seen in Table 1 that the proportion of correct responses tended to increase with increases in either study or test frequency. However, the differences were very small. Analysis of variance for the number of correct responses in the six experimental conditions of Experiment 1 indicated that neither study frequency, test frequency, nor their interaction was a reliable source of variance ($F \leq 1.46$). Nevertheless, all of the experimental conditions resulted in significantly more correct responses than did the control condition ($t(27) \geq 4.17$, $p < .001$). Turning to the latencies of correct responses in Experiment 1, the analysis indicated that neither the study frequency nor the test frequency was reliable in its main effect on latency of correct responding ($p > .10$). However, the interaction of these variables was significant ($F(2,54) = 3.19$, $p < .05$). The latter seems to have been due to an unexplainably high mean latency in Condition 2-0, and appears to have little systematic import. With the exception of Condition 2-0, the mean latency of correct responses in each of the experimental conditions of Experiment 1 was faster than that for Condition 0-0 ($t(27) \geq 2.52$, $p < .025$). The comparison of Condition 2-0 and Condition 0-0

yielded a t of 1.27 with 27 df, clearly not significant. Thus, the conclusions for Experiment 1 seem to be about the same for both frequency and mean latency of correct responses. Facilitation due to priming was demonstrated, but the effect seems to have been nearly fully established after one study exposure. Thus, Experiment 1 failed to show that the extent of the facilitation was significantly related to the frequency of priming study and/or test trials.

The results for Experiment 2 are also presented in Table 1, where it may be seen that the differences among the conditions were somewhat larger than those in Experiment 1. In terms of the number of correct responses, both study and test frequency were reliable in their main effect on Stage 2 performance ($F(1,15) \geq 6.40$, $p < .025$), and their interaction was not significant ($F < 1$). The analysis of the mean latencies indicated analogous results with an increase in either study or test frequency leading to faster correct responses ($F(1,15) \geq 8.64$, $p < .025$), and the hypothesis that their effects combined additively could not be rejected ($F < 1$). Thus, in the latter experiment, with generally lower frequencies of priming exposure and with more observations per S in each condition, not only was the priming effect observed, but, as anticipated, the facilitation increased as either the study or test frequency increased. Comparison of Conditions 1-0 and 0-1 in Experiment 2 showed that one study trial lead to more correct responses than did one test trial ($t(15) = 3.22$, $p < .001$) suggesting that, under these conditions, the facilitation from priming study was greater than that from retrieval practice. Although the difference in mean latency between Conditions 1-0 and 0-1 was in the corresponding direction, the difference was not significant ($t(15) = 1.15$).

Comparing the results for the two experiments, it may be seen in Table 1 that performance was somewhat better in Experiment 2 than in Experiment 1. Since there are rather large individual differences in overall performance, this result is probably due to sampling error in obtaining Ss. However, there are also larger differences among the conditions in Experiment 2 than in Experiment 1 and the reason for this is unclear. Conditions 1-0 and 1-1, which occurred in both experiments, show greater superiority to the control in Experiment 2 than in Experiment 1. Perhaps some of the items used in Experiment 2 were more affected by the priming operations than those of Experiment 1. This possibility has not been independently investigated. Even though more Ss were employed in Experiment 1, the results of Experiment 2 probably have greater generality because of the greater number of stimuli employed and the larger number of observations per S.

DISCUSSION

The most remarkable finding of these experiments is that a rather large facilitation from priming can be obtained with very little exposure during the priming phase, at least with the paired-associate procedure. Under the conditions of Experiment 2, the frequency of study and test exposures were both variables. Only the lower limit of frequency variation was used in that experiment, although similar trends were obtained in Experiment 1. Furthermore, greater facilitation was produced by one study than by one test exposure in Experiment 2, and the effects of the two types of exposure appeared to be additive. Obviously, any model which is to account for the priming effects must take into account the fact that a considerable facilitation is observed even when S is not informed as to whether or not the items were primed. These data can be interpreted as supporting the model proposed by Hopkins & Atkinson (1968), which says that the principal effect of priming is to facilitate the recovery phase of the retrieval process via a strengthening of the associative connections among the units of information in memory concerning the target name. This interpretation is consistent with the finding in Experiment 2 that study effects were greater than retrieval-practice effects. However, other interpretations are possible and will have to be more clearly differentiated in future research.

REFERENCES

- ATKINSON, R. C., & SHIFFRIN, R. M. Some speculations on storage and retrieval processes in long-term memory. Technical Report No. 127, Institute for Mathematical Studies in the Social Sciences, Stanford University, 1968.
- HOPKINS, R. H., & ATKINSON, R. C. Priming and the retrieval of names from long-term memory. *Psychonomic Science*, 1968, 11, 219-220.
- HOPKINS, R. H., & ATKINSON, R. C. First-letter clues in the retrieval of proper names from long-term memory. *Psychological Reports*, in press.

NOTE

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