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Subsets of real world knowledge

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Subjects were presented with real world fact(s) about a famous person and then were asked to respond "true" or "false" to a target fact about that person. Results showed that priming with facts from the same hierarchical cluster as the target led to faster verification of the target fact than did priming with facts from a different hierarchical cluster. However, increasing the number of priming sentences did not increase the resulting effect. These results are explained in terms of knowledge subsets, in which any particular knowledge domain can be partitioned into subsets. Verification occurs more rapidly when the target and prime are from the same subset than when they are from different subsets. Because an increase in the number of primes did not have an effect on verification time, however, the priming process appears to be automatic.

Memory retrieval exhibits two very different tendencies. The first is evident in the fact that we never seem to retrieve irrelevant knowledge from memory: If we are trying to recall the name of a state capital, we do not usually have familiar telephone numbers, names of past presidents, or important birthdays come to mind. On the other hand, retrieval is not so efficient that any established bit of knowledge is immediately recalled. Knowing something does not ensure that we can remember it. Many times, it is necessary to expend a certain amount of cognitive effort in order to recall someone's name or to remember the answer to a particular question on a test.

Because retrieval excludes a great number of facts without effort, it seems reasonable to conclude that the efforts we do make are discriminations among a certain set of nonexcluded facts. As with a search through a house for a lost object, improbable memory locations would be excluded from the search, but those memories that were part of the probable location would be included (James, 1890). This notion of a memory set is evident in the concept of a fanning effect (Anderson & Bower, 1973), where the speed at which a retrieval process can be completed is a function of the size of the set of facts involved. The more facts there are to consider during the retrieval process, the longer it should take to retrieve any one of those facts.

McCloskey and Bigler (1980) added to our knowledge of the fanning effect and its implications for the notion of a memory set in an experiment that we will briefly describe. Subjects learned a set of facts about a certain concept. These facts were of the form, "The <occupation> likes <category exemplar>." Subjects were taught sentences such as "The baker likes Italy" and "The baker likes France" with each sentence about the baker containing the name of a different country until the subjects learned five such sentences. Subjects were then given a sixth sentence about the baker containing a word from a different category, such as "The baker likes oranges." After subjects had learned all of the sentences, they were asked to verify whether a presented sentence had been previously learned, and response times were recorded. Results showed that response times were significantly longer when the sentence was one from the group of five concerning the countries than when it was the one concerning the fruit.

These results allow one to suggest that not all recently learned facts about a specific topic, such as *baker*, will be part of the to-be-discriminated sentences of a memory retrieval process, but, instead, only a subset of those facts might be involved. The purpose of the present study is to investigate the characteristics of memory subsets of intact preexperimental concepts. In particular, we were interested in retrieval of specific facts about famous people.

Two types of mechanisms that have been proposed to be at work during retrieval are relevant to the current study (Neely, 1977; Posner & Snyder, 1975). The first is an automatic spreading activation that predisposes all relevant items to at least a cursory kind of activation. The result of this activation is that subsequent retrieval of any fact within this relevant set of facts is accomplished more quickly. The second mechanism is an attentional mechanism that suppresses or inhibits retrieval of facts not included in the retrieval process. If we apply the logic of these two mechanisms to our proposal that knowledge is divided into probable and improbable locations during memory retrieval, then we can suggest the following: When a prime is from the same group of facts as the target, retrieval of the target will be enhanced. Furthermore, when a prime is from a different group of facts than is the target, retrieval of the target will be more difficult. In addition, we can determine the extent to which such priming is strategic or automatic by presenting subjects with *several* primes from the same set as the target or a different set. If the prime serves to attract the attention

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of the subject, who uses the prime to strategically anticipate the set of possible target sentences, then increasing the number of primes should increase the availability of items in the set of included facts and decrease the availability of items in the set of excluded facts.

The question of interest for the present study is whether these conclusions about the nature of retrieval mechanisms are applicable to memory sets only, or whether they extend to memory subsets as well. Can we, for instance, prime only some facts about the baker, and at the same time inhibit other facts about him/her? In addition, we are interested in whether or not the notion of a subset is applicable to the realm of facts learned outside of the experimental session (real world facts), and if so, whether it is possible to discover the membership of those subsets of real world knowledge with subjective judgments by a group of people. Subsets will be defined by a hierarchical cluster analysis of the similarity of facts about famous people. Subjects will verify target statements that are primed by either same-subset facts or different-subset facts. The measure of interest will be the time required to verify the target statement.

METHOD

Design

The basic design of the experiment was patterned after semantic priming studies. Both the primes and the targets used in the study were facts about famous people that were collected during the course of two separate norming experiments described below. Two factors were manipulated in the experiment. The first factor was the type of prime or primes given to the subject. The priming sentences were selected to be from within the same memory subset as the target sentence (within) or from a different subset as the target sentence (between). The second factor was the number of primes presented. Subjects were given either one priming sentence or three priming sentences prior to presentation of the target sentence. The design was thus a 2 × 2 (prime type × number of primes) completely within-factors design.

Norming Studies

Two norming studies and a clustering analysis were used in order to determine the facts to be used in the actual experiment. In the first norming study, 48 subjects were given the names of 36 famous people. For each famous name, subjects were allowed 1 min to write down as many facts about that person as they could.

Following this study, a second group of 48 subjects was presented with the facts generated from the first study (excluding idiosyncratic responses) and was asked to separate those facts into groups so that facts judged as the most similar would be in the same group (Miller, 1969). The subjects were presented with facts pertaining to only one famous person at a time. Subjects were given as long as they needed to complete the task.

Results of the second norming study were used to construct similarity matrices of the facts for each of the 36 famous people. These data were analyzed using a hierarchical clustering, complete linkage, program (Bailey, 1974) found within the Biomedical Computer Programs package.

The clustering analysis revealed probable fact subsets for every famous person. Those facts that clustered together according to the clustering procedure were considered to be part of the same memory subset. The cluster analysis for Abraham Lincoln appears in Figure 1.

Subjects

Forty introductory psychology students from the University of Oklahoma participated as part of a course requirement. Subjects were required to have been born and raised in the United States.

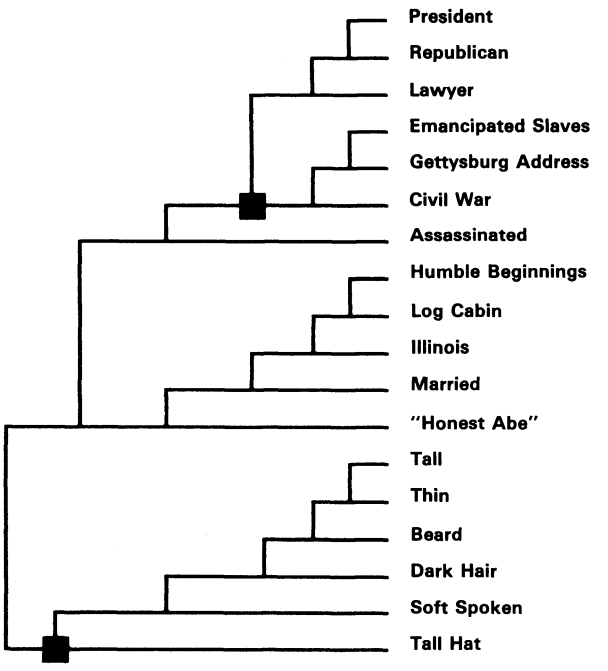

Figure 1. Hierarchical clustering result for Abraham Lincoln. The farther to the right two lines join, the sooner they form a cluster. The black squares denote a subset boundary.

Apparatus

The experiment was conducted using a NorthStar Horizon microcomputer interfaced to a Panasonic Model TR-930 video monitor and a Televideo Model 950 keyboard.

Materials

Twelve facts, 1 about each of 12 different famous people, were used as the primary target sentences in the study. These facts were chosen using the results of the clustering analyses described earlier. Some of the criteria used in choosing which facts were to be the target sentences were: (1) the fact was generated by a relatively large percentage of the subjects in the first norming study, thus ensuring that the fact would be known to the subjects; (2) the fact appeared in a cluster that contained at least 3 other facts (the within primes); and (3) there were, in addition, 3 more facts in at least one other cluster (the between primes). An example of the primes selected and the target sentence used for Abraham Lincoln is given in Table 1.

In addition to the 12 facts used as primary targets, 36 facts were collected for use as targets. Twenty-four of these were altered slightly so as to be rendered false and the other 12 were designated as "within filler" targets. Priming sentences for those targets designated as within filler were always chosen from what was assumed to be the same subset as the target. The purpose of the within filler targets was to predis-

Table 1
Example of Priming and Target Sentences Used in the Experiment

Same-Subset Priming Sentences:	Abraham Lincoln was very tall. Abraham Lincoln was thin. Abraham Lincoln wore a tall hat.
Different-Subset Priming Sentences:	Abraham Lincoln was a Republican. Abraham Lincoln was a lawyer. Abraham Lincoln wrote the Gettysburg Address.
Target Sentence:	Abraham Lincoln wore a beard.

Note—When only one priming sentence was presented, it was always the first one listed above.

pose a subject toward assuming that the priming sentences were closely associated with the targets so as to increase the likelihood that a subject's attention would be directed strategically toward the most probable subset.

Procedure

Each subject was given two practice trials followed immediately by 48 experimental trials. Each trial consisted of a warning signal that remained on the screen for 500 msec, the presentation of one or three priming sentences, a second 500-msec signal indicating that a target sentence was about to be presented, and finally, the presentation of a target sentence. Each priming sentence was presented for 3 sec and each target remained visible until the subject pressed a key on the keyboard. There was an intertrial delay of 1 sec.

The subject was asked to read each priming sentence and then to rate the sentence on a scale of 1 to 7 according to how well they knew the information that was contained in it. Subjects called their ratings out loud, but the ratings were not recorded. The rating task was used simply to ensure that subjects actually attended to the information contained in the sentences.

Subjects responded to the target sentences by judging whether the sentence was true or false. They indicated their decision by pressing one of two keys on the keyboard in front of them. Subjects were told to press the button corresponding to the decision "false" if they did not know the answer. They were asked to respond both as quickly and as accurately as possible.

RESULTS

The mean correct response times for each of the four conditions, along with error rates for each condition, are presented in Table 2. As can be seen from the table, retrieval time in the within condition was less than retrieval time in the between condition [$F(1,31) = 3.17$, $p < .10$], as expected. However, no interaction effect was found and no significant effect due to the number of primes presented (one vs. three) was found. Thus, we found no evidence that increasing the number of primes slowed retrieval of information from the nonprimed subset. In fact, the mean reaction times suggest that increasing the number of primes decreases retrieval time.

It should also be noted that as reaction times increased, so did errors, which suggests that there was no speed versus accuracy trade-off. If we compare the number of errors in the within and between conditions, we find further support for the assumption that it is more difficult for subjects to verify target facts when the primes are not from the same subset.

DISCUSSION

The most straightforward finding in this experiment is that priming with a fact that has clustered with the test fact, according to subjects' judgments, aids in the retrieval of that test fact relative to priming with a fact from outside the cluster. This suggests not only that the subjective judgments of the subjects do indeed define which items are more closely associated, but also that hierarchical clustering analysis is a useful tool in making these delineations.

Table 2
Mean Response Time (with Percentage Errors) to the Target Sentences

	1 Prime	3 Primes	Mean
Within Subset Primes	1584 (.01)	1579 (.03)	1582 (.02)
Between Subset Primes	1719 (.07)	1658 (.05)	1690 (.06)
Mean	1652 (.04)	1619 (.04)	

Note—Response times are in milliseconds.

A second question was whether the presentation of a number of primes might lead to a further increase in the verification speed of a target within the same subset as the primes and a decrease in the verification speed of a target from a different subset. If the prime served to direct the attention of the subject to a specific set of facts about the famous person in question, it would seem likely that increasing the number of primes would serve to increase the subject's anticipation of those facts. The results of the study, however, did not support this conclusion. If anything, there only seemed to be a general (nonsignificant) increase in the verification speed of a target sentence, regardless of which subset it was in, when the number of primes was increased from one to three. A likely explanation of this result is that, despite there being the ability to predispose certain facts about a person to faster verification relative to other facts about the person, which facts those are is not necessarily available to the subject. Because the activation is nonspecific to begin with, it would seem unlikely that an increase in the number of primes would make it any more specific.

If the target sentence was "Abraham Lincoln had a beard," then the results of this experiment allow one to suggest that priming the subject with a sentence that draws attention to Abraham Lincoln's physical appearance, such as "Abraham Lincoln was tall," will speed verification of the target relative to priming the subject with an unrelated aspect of Lincoln, such as "Abraham Lincoln was a Republican." Increasing the number of sentences pertaining to Lincoln's physical appearance, or his politics, however, does not seem to lure a subject into the anticipation of either subset. Quite likely, subjects were not consciously aware that all the primes pertained to a particular aspect of the person.

This nonspecific activation can be modeled either by allowing activation of a subnode corresponding to the abstraction of, say, physical appearance or by allowing activation of all particular exemplars dealing with physical description. There is some suggestion that a subnode was activated in an all-or-none fashion because of the failure of three within facts to reduce latencies more than one within fact. In either case, it appears from the current data that retrieval of extraexperimental facts does depend on the previous retrieval of information. Particular facets of a person are made relatively more available than others because of the context in which they appear. However, we found no evidence that part of this contextual priming was due to a limited capacity attentional mechanism. It is tempting to speculate that the attentional mechanism was not involved because of the nonspecific nature of the activation.

REFERENCES

ANDERSON, J. R., & BOWER, G. H. (1973). *Human associative memory*. Washington, DC: Winston.

BAILEY, K. D. (1974). Cluster analysis. In D. Heise (Ed.), *Sociological methodology*. San Francisco: Jossey-Bass.

JAMES, W. (1890). *Principles of psychology*. New York: Holt.

MCCLOSKEY, M., & BIGLER, K. (1980). Focused memory search in fact retrieval. *Memory & Cognition*, **8**, 253-264.

MILLER, G. A. (1969). A psychological method to investigate verbal concepts. *Journal of Mathematical Psychology*, **6**, 169-191.

NEELY, J. H. (1977). Semantic priming and retrieval from lexical memory: Roles of inhibitionless spreading activation and limited-capacity attention. *Journal of Experimental Psychology: General*, **106**, 226-254.

POSNER, M. I., & SNYDER, C. R. R. (1975). Attention and cognitive control. In R. L. Solso (Ed.), *Information processing and cognition: The Loyola Symposium*. Hillsdale, NJ: Erlbaum.

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