WORD FRAGMENTS AND THEIR REDINTEGRATIVE POWERS

LEONARD M. HOROWITZ, PETER C. CHILIAN, AND KENNETH P. DUNNIGAN

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Fragments of a word vary in their “redintegrative powers”; some elicit the whole word more readily than others. The initial fragment is the best cue and the middle fragment the poorest. This study generalized previous results to the case of medium- and low-frequency words. Word frequency did not affect success in cued recall, and the redintegrative pattern applied equally well to all levels of word frequency.

A recent study by Horowitz, White, and Atwood (1968) examined the organization of a single word. In that study, S was shown a list of nine common words, one by one. Later a fragment of one word appeared as a cue, and S had to recall the word. The fragment that served as the cue was the beginning, the middle, or the end of the word. If “native” was being tested, the fragment was “n- a--e,” or “-a--e,” or “-a--e.” This procedure was repeated with lists of six-letter words and lists of nine-letter words.

The results showed that the beginning fragment is the best cue for eliciting the whole word. It does so with a higher probability and with a shorter latency. Therefore, the beginning fragment is said to have the greatest “redintegrative power.” The middle fragment is the poorest cue, so it has the least redintegrative power.

This pattern of redintegrative powers—strongest for the initial fragment and weakest for the middle fragment—might be called the redintegrative pattern of a word’s parts. The above experiment was performed entirely with common words, so it is not known whether this pattern holds as well for words of low frequency. Alternative hypotheses could be stated. The pattern may hold for any letter string that follows the statistical properties of English, including low-frequency words and nonsense words. Or it may only hold for “good gestalts”—i.e., high-frequency words: as a word grows more and more frequent in English, its parts may come to vary in their redintegrative powers. According to the first hypothesis, high- and low-frequency words would not differ in their redintegrative patterns. According to the second hypothesis, high-frequency words show the pattern, while low-frequency words would not.

The present study is designed to generalize the results of the earlier study across a broader range of word frequencies.

Method.—The S was tested on four different lists. Two lists contained six-letter words and two contained nine-letter words. After S mastered a list, he saw a fragment of one of its words, and he had to recall the whole word. This entire arrangement was replicated three times with different lists and different Ss.

The four lists of a given S contained 36 words. Twelve of them were high-frequency words, the same ones used by Horowitz et al. (1968), and all had frequencies of 35 or more in the Thorndike-Lorge (1944) word count. There were also 12 medium-frequency words (6–8 times per 18 million) and 12 low-frequency words (4 or fewer times per 18 million). The 36 words were divided into four lists. Two lists contained six-letter words and two contained nine-letter words. In each list there were 3 words of each frequency.

The four lists that were used for testing one group of Ss follow (the letter in parentheses tells that word’s frequency level). List 1: locale (L), chemic (L), marish (L), scarab (M), fencer (M), abreare (M), minute (H), twelve (H), length (H). List 2: fiber (L), sundew (L), volant (L), papery (M), groggy (M), ocelot (M), simple (H), divide (H), second (H). List 3: under- vest (L), vasomotor (L), pugnacity (L), vegetable (H), president (H), universal (H). List 4: pronghorn (L), spiritism (L), committal (L), laudatory (M), torpidity (M), reservist (M), otherwise (H), physician (H), religious (H). Eighteen Ss were tested on these lists.

Four other lists (36 words altogether) were prepared for testing 18 other Ss. And another four lists (36 more words) were prepared for testing a final group of 18 Ss. The three sets of 36 words were so prepared that a high-frequency word in one was matched in several respects with a medium-frequency word in a second set and with a low-frequency word in the third set. The matched words were equated as far as possible for starting letter, number of letters, number of syllables, and the general vowel-consonant pattern. For example, vegetable (a high-frequency word) appeared in one set, verbosity (medium-frequency) in another set, and vasomotor (low-frequency) in the third set. Any one group of Ss, though, saw only one of these words.

One-third of the words were tested with the initial fragment as cue, another third with the middle fragment, and the remaining third with the final fragment. The three words at a given frequency level of a given list were each tested by a different kind of cue.
The nine words of a given list appeared one at a time on a Lafayette memory drum. Each word lasted 2 sec., and a 2-sec. blank space separated one word from the next. After S studied the list, he was tested on an MTA Scholar teaching machine for aided recall. A fragment of one word appeared, and he was told to think of the word as fast as he could. A timer began operating as soon as the word appeared. When S thought of the word, he pressed a button which stopped the timer and allowed E to record his latency. The S was allowed as much as 15 sec. for responding. When he responded (or when 15 sec. had elapsed), the next fragment appeared. The fragment was always one-third of the word—two consecutive letters of a six-letter word or three consecutive letters of a nine-letter word. The fragment was always the initial, middle, or final part of the word. Blanks appeared in place of the missing letters. The E recorded S's latency plus any errors that occurred. After S completed one list, he immediately transferred to the next list.

Altogether, 54 Ss were tested. These Ss were all students in the introductory psychology class at Stanford University.

Results and discussion.—Table 1 shows the mean number of correct responses for each experimental condition. The major variable that influenced the number of correct responses was the position of the cue, $F(2,106) = 41.71, p < .001$. The effect of word frequency was marginally significant since the low-frequency words were slightly better recalled, $F(2,106) = 3.13, p = .05$. The Position $\times$ Frequency interaction was not significant, $F < 1$.

It is not clear why low-frequency words were slightly better recalled. Perhaps, as unusual words, they benefitted from a von Restorff effect. Or perhaps unusual words contain unusual, distinctive letter combinations. This interpretation could be tested by an experimental design involving unmixed (homogeneous) lists. In any case, the effect of frequency in these data was a very small one.

In general, the initial fragment was the best cue for recall and the middle fragment the poorest. This pattern occurred in just that form in the means of 20 Ss of the 54. Other Ss showed some deviation from the exact pattern.

The same pattern of results held true for the latencies, as shown in Table 2. The S responded fastest on the average to the initial fragment and most slowly to the middle fragment. This pattern appeared at every level of word frequency. An analysis of variance showed a significant effect of position, $F(2,70) = 23.70, p < .001$. The data of a given S were only included in this analysis if that S emitted at least one correct response for each experimental condition; otherwise, no latency score was available. Only 36 Ss qualified for that criterion. Of these Ss, 18 showed the exact redintegrative pattern in their means. The effect of word frequency was not significant, nor was the Position $\times$ Frequency interaction, both $Fs > 1.94, p > .10$.

It is interesting that word frequency did not have more of an effect on the two measures. In part, this result may be due to the within-S experimental design. An unusual word may attract more attention, and perhaps for the brief delays required in this study, S had no trouble recalling these rare words. However, the data leave no doubt about the generality of the redintegrative pattern. It applies as well to low-frequency words as it does to high-frequency words. Further research is needed to tell whether this pattern also characterizes nonsensical strings of letters, especially those that bear the statistical properties of English.

An analysis of the errors was also performed. Of all the 1,944 responses (54 Ss x 36 items per S), 34% were errors. These errors were primarily failures to respond: 82% were failures to respond and 18% were overt intrusions. The 122 overt intrusions were further divided into two categories, partial errors and full errors. A partial error was a response that contained an error in just one of the three word segments—e.g., tabule instead of tabule. Such responses made correct use of the stimulus fragment and also contained one segment correctly recalled. All other overt intrusions were called full errors. Only 50 overt intrusions were partial errors and 72 were full errors. The partial errors were about evenly divided among the three types of fragments: 18 to initial fragments, 18 to middle fragments, and 14 to final fragments. In 24

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Position of fragment</th>
</tr>
</thead>
<tbody>
<tr>
<td>High M</td>
<td>1.84</td>
</tr>
<tr>
<td>SD</td>
<td>1.38</td>
</tr>
<tr>
<td>Medium M</td>
<td>1.56</td>
</tr>
<tr>
<td>SD</td>
<td>.69</td>
</tr>
<tr>
<td>Low M</td>
<td>1.69</td>
</tr>
<tr>
<td>SD</td>
<td>.75</td>
</tr>
</tbody>
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Note.—$N = 36$.  

### TABLE 1  
**NUMBER OF CORRECT RESPONSES TO THE FRAGMENTS OF EACH CONDITION**

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>High M</td>
<td>3.20</td>
</tr>
<tr>
<td>SD</td>
<td>1.22</td>
</tr>
<tr>
<td>Medium M</td>
<td>3.04</td>
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<tr>
<td>SD</td>
<td>1.23</td>
</tr>
<tr>
<td>Low M</td>
<td>3.26</td>
</tr>
<tr>
<td>SD</td>
<td>1.31</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>High M</td>
<td>2.20</td>
</tr>
<tr>
<td>SD</td>
<td>1.24</td>
</tr>
<tr>
<td>Medium M</td>
<td>2.15</td>
</tr>
<tr>
<td>SD</td>
<td>1.24</td>
</tr>
<tr>
<td>Low M</td>
<td>2.41</td>
</tr>
<tr>
<td>SD</td>
<td>1.33</td>
</tr>
</tbody>
</table>

### TABLE 2  
**LATENCIES OF RESPONSE TO THE FRAGMENTS OF EACH CONDITION**

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of these cases the word's middle was given incorrectly, in 17 cases the beginning was incorrect, and in 9 cases the ending was incorrect. This pattern does not relate clearly to the general pattern described above. Its interpretation is also made difficult by the very low incidence of such errors.

REFERENCES


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**TAXONOMIC CUES AS AIDS TO RECALL IN SHORT-TERM MEMORY**

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Short-term memory for word triads was tested in 120 Ss. The words belonged to common taxonomic categories, e.g., animals, countries, vegetables. Each trial contained words from three different categories, e.g., BEAR-CANADA-SPINACH. A brief presentation of a triad was followed by 10 sec. of digit recitation, and then Ss saw either (a) "Recall," (b) the names of categories, or (c) "Recall," and 6 sec. later, the names of the categories. Over a 12-sec. recall period, retention was significantly greater for c than for a or b. The results replicated previous findings by Loess and Harris (1968). The conclusion was that the superior recall of c was due to a real facilitation provided by the delayed taxonomic cues rather than an artifact of guessing strategies.

In a recent study of cued vs. noncued recall in short-term memory (STM), Loess and Harris (1968) reported that the recall of individual verbal items was facilitated when relevant taxonomic cues were presented near the middle, rather than at the beginning, of a brief recall period. In the first of two experiments, Ss saw on each trial three words representing three taxonomic categories (e.g., NURSE-LION-WREN). After a 10-sec. interval filled with digit recitation, control Ss saw the word "Recall" and experimental Ss saw three words representing the category names (e.g., PROFESSION-ANIMAL-BIRD). Recall did not differ significantly for these two conditions. However, some experimental Ss reported considerable subjective interference when the category names were presented.

To test whether such interfering effects may have canceled possible facilitative effects, a second experiment was performed. In that experiment, the word "Recall" was presented to all Ss at the start of each recall interval, and 6 sec. later the experimental Ss were given additional cues consisting of the taxonomic names of unrealled words. Under these conditions the experimental Ss recalled significantly more words than the control Ss. The results were interpreted as being consistent with formulations that assume (a) that material in short-term store (STS) is replaced by subsequent material and may be permanently lost if not transferred to long-term store (LTS) and (b) that some transfer to LTS is likely while an item is in STS (Atkinson & Shiffrin, 1967; Waugh & Norman, 1965). The present experiment was essentially a replication of the Loess and Harris (1968) study, but it was conducted as a single experiment, and response latencies were recorded in order to distinguish between words recalled before and after the presentation of taxonomic cues.

**Method.**—One hundred and twenty undergraduates at the College of Wooster served as Ss to fulfill a course requirement. The materials and general procedure were the same as in the Loess and Harris (1968) study. Briefly, on each trial, S saw a stimulus slide containing three words from three common taxonomic categories. Immediately following, there were five slides containing six-digit numbers. Then a cue slide appeared signaling S to try to recall the words on the stimulus slide. The nature of the cue depended on the experimental condition. The materials were presented with a