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Memory for words recently classified*

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This paper describes research whose goal is to determine the implications of verbal classificatory judgments for recognition memory and recall. Toward this end, Ss were required to answer 100 queries of attribution and superordination (Is a TWINGE sudden? Is SPINACH ecstatic? Is a CORKSCREW an opener? Is a DUNGEON a scholar?) before being tested unexpectedly on their ability to remember either the uppercase "keywords" or the lowercase "descriptors." Lexical memory did not depend on whether a word had been part of an attributive or a superordinate query. But words from "incongruous" queries almost invariably were more poorly remembered—under conditions of free recall, cued recall, and recognition memory—than words from "congruous" queries. Congruous cues, but not incongruous ones, greatly facilitated recall, with keywords being more effective cues than descriptors. Recognition memory of keywords was uniformly superior to that of descriptors. It is argued that the large and pervasive memorial advantages of congruity arise because a congruous query, unlike an incongruous one, fosters a relational encoding of keyword and descriptor.

How an event is encoded sets limits on its memorability. Encodings are constrained by task demands and may vary with anticipated use of the information processed. The present research constrains lexical encodings by requiring judgments about certain semantic relations and renders idiosyncratic processing unlikely by keeping S ignorant of the fact that his memory would later be tested. The procedures used, as well as the specific results obtained may, therefore, be of interest to students of memory and language.

Our concern here is with unambiguous lexical relations and how decisions about their presence affect memory for the words involved. We shall examine the implications for free recall, cued recall, and recognition memory of answering queries about class membership and the possession of attributes. These queries and their lexical components will be described using the terms defined and illustrated below.

KEYWORD. The grammatical subject of a query and the word about which a classificatory judgment is made. Examples are *soprano* in "Is a SOPRANO a singer?" and *mustard* in "Is MUSTARD concave?"

ATTRIBUTE. The adjective in a query concerning a property of a keyword. Examples are *bereaved* in "Is an ORPHAN bereaved?" and *brave* in "Is VELVET brave?"

SUPERORDINATE. The category to which a keyword might belong in a query concerning class membership. Examples are *container* in "Is a BARREL a container?" and *servant* in "Is a GEYSER a servant?"

DESCRIPTORS. Attributes and superordinates, collectively.

CONGRUOUS. Appropriately used, as a keyword or descriptor in a query that calls for a positive response. In "Is a BUBBLE a sphere?" *bubble* and *sphere* are congruous. Such a query will itself be termed congruous. Note that the relations involved in congruous queries are definitionally, not merely contingently, true.

INCONGRUOUS. Inappropriately used, as a keyword or descriptor in an unlikely query that calls for a negative response. In "Is a CHAPTER slippery?" *chapter* and *slippery* are incongruous. Such a query will itself be termed incongruous.

Congruous queries of attribution and superordination will be symbolized by A and S, the corresponding incongruous queries by $\bar{A}$ and $\bar{S}$. A further example of each of these four types of query is given below for ready reference.

S	Is a CORKSCREW an opener?
$\bar{S}$	Is a DUNGEON a scholar?
A	Is a TWINGE sudden?
$\bar{A}$	Is SPINACH ecstatic?

Independent groups of Ss answered queries such as these before being tested on their memory for either keywords or descriptors. Any memorial difference that resulted, such as the general superiority of memory for congruity to that of incongruity, must be traceable to differences in processing that the different query types prescribe. Answering congruous queries, for example, should entail the "rediscovery" of known relations between keyword and descriptor, whereas answering incongruous queries should not. The questioning mode, of course, may not be necessary for the results achieved; alternative procedures calling for the same relational judgments would be expected to have the same memorial consequences.

METHOD

The experimental procedure had two parts. The first required yes-no responses to 100 queries concerning relations between

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pairs of words. The second was a previously unannounced test of ability to recall or recognize these words.

Queries could be congruous or incongruous and could involve relations of attribution or superordination. Each of the four types of query (S, $\bar{S}$, A, $\bar{A}$) had 25 representatives in the 100-query sequence. The queries were presented in a 5-page booklet, 20 queries to the page. Each page presented five successive permutations of the four types of query. Following each query were the letters Y and N. Ss were told to circle Y when it was immediately clear that an answer was "yes" and to circle N otherwise. Such instructions sought to prevent the discovery of metaphoric and other relations where no direct relation had been intended. Queries were to be answered in turn and as quickly as possible, while errors were to be avoided.

The 100-query sequence was preceded by four sample queries, one of each type. It was pointed out that all queries were designed to be easy to answer and that our concern was with how rapidly Ss could make such classificatory judgments. When the last query had been answered, the booklet would so indicate, so that S could record the time (to the nearest 5 sec if possible) from a wall clock in front of him; the E, who had recorded the group's common starting time, could then determine the approximate elapsed time for each S.

Queries were typed with keywords in capital letters and descriptors in lowercase. All Ss made decisions about the same sequence of 100 keywords. For each keyword, however, four separate queries had been prepared, one for each type of queried relation (Is SPINACH a vegetable? an agency? leafy? ecstatic?). Consequently, there were four versions of the 100-query sequence, each using the same ordered set of keywords but differing completely in their accompanying descriptors. Thus, it would be possible to determine for each keyword the extent to which the type of queried relation was to affect its memorability.

The choice of keywords was governed by a number of considerations. Keywords were sought that adult users of English would likely define by applying a limiting adjective to a superordinate noun: SPINACH is a leafy vegetable, HATCHET a sharp tool. Such defining attributes and superordinates were used in the congruous queries. Nearly all incongruous queries violated selectional restrictions (see Katz & Fodor, 1963) and would not normally be posed: Is a DESERT lucky? The remaining few were unlikely queries that might conceivably be true for specific instances of the keyword or if poetic license were granted: Is a CORKSCREW sooty, Is a GUITAR prickly? An incongruous attribute was not permitted to be the antonym of an attribute that would have made the query congruous; queries such as "Is SNOW hot?" were, therefore, ruled out. No descriptor was repeated in any one of the four versions of the query sequence. Obvious relations among descriptors were also avoided: *loud* precluded *noisy*, *blue* precluded other color names, *decoration* precluded *decorative*. A list of the 100 keywords finally selected, together with the four descriptors used with each one, is available from the author upon request. These keywords had a median G count of 6.5 instances per million words, according to the Thorndike-Lorge (1944) compilation. Congruous adjectives had a median count of about 20, incongruous adjectives about 15. Congruous and incongruous superordinates had median counts of about 35 and 30, respectively.

After answering all queries, S turned his booklet face down and waited for the others to finish. Query booklets were collected when the slowest S in a group had completed the classificatory task. Ss were then told that "also of interest" in the experiment was the extent to which people could recognize (or recall) words they had recently classified. Instructions appropriate to each group were then read. Each group's task was illustrated by reference to the four sample queries that had preceded the classificatory task. Ss were told that the memory task, unlike the classificatory task, would not be carried out under time pressure. Not more than 5 min elapsed from the time the query booklets were collected until the Ss commenced work on the memory task.

Six experimental groups were defined by the three types of memory test–free recall (FR), cued recall (CR), and recognition memory (RM)–and the two classes of words to be remembered, keywords and descriptors. Within each experimental group, the four query-sequence versions were used by an equal number of Ss.

The FR_K group (N = 24) were asked to give written recall only of keywords, i.e., of only those capitalized words about which they had made classificatory judgments. The FR_D group (N = 24) were asked to give written recall only of descriptors. Ten minutes were allotted for these free recall tasks.

For the $CR_{K|D}$ group (N = 20), test booklets were supplied that listed the 100 descriptors each S had recently encountered. These were arranged on 5 pages, with 20 such "cues" per page. Next to each cue was space for the entry of the keyword that had accompanied it. Each page of the test booklet contained, in a random order, the same set of descriptors that had appeared on the corresponding page of S's query booklet, resulting in a Spearman rank-order correlation of 0.967 between input and test position. Since there had been four versions of the query booklet, four test booklet versions were required. For the $CR_{D|K}$ group (N = 28), keywords were supplied as cues and the appropriate descriptors were to be recalled. The sequence of keyword cues was the same for all Ss; correct responses, of course, depended upon which version of the query booklet had previously been used. The sequence of keyword cues was arranged to parallel the sequence of descriptor cues given to the $CR_{K|D}$ group. Both CR groups were told not to spend more than a few seconds attempting recall of any word and to consider each cue in turn, never returning to an earlier cue to write in a word that could not previously be recalled.

Each RM group was tested using a two-alternative forced-choice procedure. Confusors were always drawn from the same word class as the "old" word to be recognized and were chosen to have similar distributions of Thorndike-Lorge frequency. Separate sets of confusors were selected for the RM_K and the RM_D groups. For the RM_K group (N = 24), keyword and confusor both appeared in capital letters (e.g., SPINACH — — DANCER), and S was instructed to place a checkmark in the space near the word he had recently classified. For the RM_D group (N = 28), descriptor and confusor both appeared in lowercase letters (e.g., leafy — — frequent). Each S was tested for recognition of the particular set of descriptors included in his version of the query sequence. There were, thus, four versions of the memory test in RM_D. The procedure was otherwise the same as in RM_K. For both RM groups, as for the CR groups, test-word position correlated perfectly with input position on a page to page basis; within each test page, however, word positions were randomly rearranged. On each test page, the old word appeared as the left-hand member in a random half of the pairs. Ss in both RM groups were advised not to take more than a few seconds to identify the old member of each pair.

Either one or two group testing sessions were required to obtain the number of Ss employed under each of the six experimental conditions. Ss, male and female, were drawn from introductory courses in psychology at the University of Virginia. Their "voluntary" participation helped to fulfill a course requirement.

RESULTS

The median S required roughly 210 sec to answer the 100 queries of the classificatory task. He erred in 5% of these judgments, 90% of the errors being failures to record a relation where one was intended.

The principal findings of the memory tests are displayed in Table 1. Results of the free recall, cued

recall, and recognition memory tests are described in turn below.

Free Recall (FR_K and FR_D)

Responses were scored as correct only if, aside from obvious spelling errors, they could be identified with a keyword (in FR_K) or with a descriptor (in FR_D). Synonyms, adjectival forms of nouns, etc., were scored as incorrect. The mean number of such "intrusions" was 2.4 (s = 2.7) in FR_K and 2.3 (s = 2.0) in FR_D. They constituted about 25% of all responses in each condition; one-sixth of the Ss contributed 50% of the intrusions.

Free recall was generally poor. For each of the four types of queried relation, keyword recall differed only insignificantly from descriptor recall. At the same time, congruity was better recalled than incongruity. Twenty of the 24 Ss in FR_K and 21 of 24 in FR_D recalled more congruous than incongruous words ($p < .01$ in each case, sign tests). Eleven Ss in FR_K and 15 in FR_D recalled no more than one incongruous word. Of the 71 keywords recalled by at least one S in FR_K, 59 were better recalled after congruous queries; 4 were recalled equally well after congruous and incongruous queries; and 8 were better recalled after incongruous queries. Free recall of incongruity was almost wholly idiosyncratic, the 68 tokens representing 64 types. Recall of congruity was less idiosyncratic, showing a token-type ratio of 1.45.

The superiority of congruous to incongruous recall contrasts with the absence of a difference in free recall between attribution and superordination. Within each FR condition, congruous keywords and descriptors were recalled equally poorly (10%-12% correct), as were incongruous keywords and descriptors (2%-4% correct). This suggests that decisions about attribution and superordination involve the same processes or encodings, although the possibility remains that they provide different memorial bases which fortuitously resulted in the same levels of free recall.

Cued Recall ($CR_{K\,D}$ and $CR_{D\,K}$)

No scoring difficulties presented themselves in $CR_{K\,D}$: virtually every response could be identified unambiguously as a keyword or not. Intrusions averaged 5.7 per S (s = 4.3) and constituted about 18% of all responses. In $CR_{D\,K}$ the mean number of intrusions was 8.1 (s = 4.8)—significantly more than in $CR_{K\,D}$ (Mann-Whitney U test, $p < .05$)—and constituted about 19% of all responses. In addition to these intrusions, Ss in $CR_{D\,K}$ averaged 1.5 responses (s = 1.3) that were morphemically similar to the word called for by the cue; these responses, like the other intrusions, were scored as incorrect. Intrusions made in CR will be discussed in more detail when the principal results have been dealt with.

Table 1
Percentage Correct in the Free Recall, Cued Recall, and Recognition Memory of Key Words and Descriptors*

Condition	Queried Relation** S	$\bar{S}$	A	$\bar{A}$
FR_K	9.8 (7.5)	3.0 (2.9)	11.3 (7.4)	3.0 (2.9)
FR_D	12.0 (7.5)	1.7 (2.8)	10.5 (6.7)	3.7 (4.0)
$CR_{K\|D}$	50.8 (12.8)	4.0 (4.9)	42.2 (14.0)	5.0 (3.6)
$CR_{D\|K}$	59.4 (16.2)	5.4 (5.8)	58.7 (15.2)	10.3 (8.5)
RM_K	95.8 (4.5)	86.0 (6.0)	94.2 (5.9)	88.0 (7.1)
RM_D	84.7 (6.8)	75.0 (11.5)	81.4 (11.5)	79.7 (7.2)

**Standard deviations are parenthetically noted.*
***A set of four reference queries is given in the Introduction. Examples drawn from this set of to-be-remembered keywords are CORKSCREW, DUNGEON, TWINGE, and SPINACH (for S, $\bar{S}$, A, and $\bar{A}$ relations, respectively). Corresponding examples of to-be-remembered descriptors are opener, scholar, sudden, and ecstatic.*

Cued recall of congruity far surpassed cued recall of incongruity. At the same time, cued recall of congruity was much better than its free recall. Incongruous descriptor cues, however, were of insignificant value, and incongruous keyword cues improved only slightly, though significantly (U tests, $p < .01$), upon FR_D levels of performance.

Keywords were more effective cues than descriptors after both A and $\bar{A}$ queries ($p < .01$ and $p < .05$, respectively); were marginally more effective ($.05 < p < .10$) after S queries; and were as ineffective as descriptor cues after $\bar{S}$ queries.

In other comparisons of interest, congruous superordinates in $CR_{K\,D}$ made better cues than congruous adjectives, while incongruous adjectives in $CR_{D\,K}$ were better recalled than incongruous superordinates ($p < .05$ for each comparison).

Most recall failures were omissions; in $CR_{K\,D}$ these were 12 times as likely as intrusions, in $CR_{D\,K}$ 7 times as likely. The incidence of intrusions for each query type is given in Table 2. The two conditions of CR yielded very similar proportions of intrusions for each type of queried relation. In absolute terms, more intrusions were made to congruous than to incongruous cues. But intrusions comprised more than 40% of all responses to incongruous cues and less than 15% of all responses to congruous ones. A substantial number of intrusions bore an obvious semantic relation to the word to be recalled. There was evidence, that is, for conceptual storage or for what Fillenbaum (1966) has termed "memory for gist." Moreover, when the keyword was the cue (in $CR_{D\,K}$), 104 of the 145 intrusions to congruous cues and 54 of the 80 intrusions to incongruous cues were of the same

Table 2
Intrusions in Cued Recall

	Queried Relation			
	S	$\bar{S}$	A	$\bar{A}$
$CR_{K\|D}$ (N = 20)				
Correct Recalls, C	254	20	211	25
Intrusions, I	32	18	45	19
Percent Intrusions, 100 I/(C + I)	11.2	47.4	17.6	43.2
$CR_{D\|K}$ (N = 28)				
Correct Recalls, C	419	39	410	73
Intrusions, I	57	32	88	48
Percent Intrusions, 100 I/(C + I)	12.0	45.1	17.7	39.7

part of speech as the word to be recalled. These obviously significant results provide strong indirect evidence that S may remember the type of relation processed despite failure to retrieve the specifically correct response (cf. the "tip of the tongue phenomenon," Brown & McNeill, 1966).

Recognition Memory (RM_K and RM_D)

Keyword recognition in RM_K far surpassed descriptor recognition in RM_D for each of the four types of queried relation ($p < .001$ for each comparison, U tests). In RM_K, keywords were better recognized when congruous than when incongruous (sign tests: $p < .001$ for queries involving superordination, $p < .01$ for queries involving attribution). In RM_D, only superordinates ($p < .01$) benefited from congruity; attributes, for unknown reasons, did not. As in free recall (and, to a large extent, in cued recall as well) recognition memory did not depend upon whether a query had involved an attributive or a superordinate relation.

It is of special note that 95% of congruous keywords were correctly recognized. Such good recognition memory can be expected for pictures (Shepard, 1967) but is unusual for words. The same keywords playing incongruous roles were recognized only 87% of the time, a level of performance more nearly in line with previous results (cf. Schulman, 1967) for unclassified words of their Thorndike-Lorge frequency.

Recognition memory declined over the course of the recognition test, but not so sharply as in other studies (Schulman, in press). Recognition of congruous keywords, for instance, was 98.8% over the first fifth of testing and 93.8% over the last three-fifths.

UNDERLYING ENCODING PROCESSES

The results indicate that answering unambiguous queries of attribution and superordination without an eye toward lexical retrieval (1) provides a poor basis for the free recall of congruity and almost no basis for the free recall of incongruity; (2) leaves a trace that often can be "redintegrated" (Horowitz & Prytulak, 1969) by a congruous cue but seldom by an incongruous one; and (3) provides a strong basis for the recognition of congruous keywords and a better basis generally for the recognition of keywords than of descriptors.

What emerges most clearly from this pattern of results is the large and pervasive memorial advantage of congruity. This advantage arguably arises because a congruous query fosters a relational encoding of keyword and descriptor, whereas an incongruous query, whose words mutually exclude each other's normal semantic context, fosters their independent encoding. A congruous query embodies a known definitional relation between keyword and descriptor whose rediscovery is likely to be attended by the encoding of that relation. An incongruous query, on the other hand, embodies no known semantic relation, and the incidental learning task precludes the discovery of new ones.

The present study, of course, confounds congruity with truth value, but it seems a remote possibility that memory might be substantially enhanced by saying "yes" irrespective of the reasons for doing so. That not all yeses are equal is shown, for example, in Schulman (1971), where semantically defined "targets" were better recognized than structurally defined ones. The same study showed that, for one type of structurally defined target (a word with all its letters different), yeses and noes were equally memorable. Where semantic processing is involved, there is reason to believe (Schulman, unpublished data) that lexical memory does not suffer if a word not in the questioned category is found to belong to another.

Free Recall

The encoding of some known or discovered relation may be necessary, though obviously insufficient, for lexical recall. If this claim seems excessive, consider the fact that a few queries intended as incongruous (e.g., Is a LEOPARD a lining?) were "falsely" reported as congruous. Their keywords and descriptors tended to be better recalled than words from clearly incongruous queries, so that the 2%-4% recall of incongruity may be spuriously high.

If encoded relations are what may be retrieved under conditions of free recall, congruous keywords and descriptors should not differ—as in fact they did not—in their recallability. Once a congruous relation has been retrieved, readout of keyword or descriptor should be equally simple. This amounts to saying that relational retrieval should be all or none, a conclusion supported by Begg's (1972) data on the recall of meaningful adjective-noun pairs. Begg's "integrated memory structures" and our "relational encodings" are obviously very similar notions.

Cued Recall

When a retrieval cue is provided, its connection to

what is encoded is crucial to recall. Tulving and Osler (1968) claim that a retrieval cue is effective "only if the information about it and its relation to the to-be-remembered item is stored at the same time with the to-be-remembered item," while Begg (1972) argues that "pairs must be integrated before they can be redintegrated." In the absence of a relational encoding, then, the cued recall of incongruity should not surpass its free recall. This was so for the cued recall of incongruous keywords; when these keywords were cues, however, and descriptor recall was required, a small but reliable improvement over free recall performance was obtained. It remains to be shown why incongruous keywords can serve this redintegrative function when incongruous descriptors cannot.

Unlike the recall of incongruity, congruous recall benefited greatly from the presence of a cue. But the type of congruous cue seemed to matter, keywords being more effective than descriptors. The extent to which this difference arises from uncontrolled and possibly confounded effects of concreteness, meaningfulness, etc., is unclear from post hoc analyses and cannot be resolved without further research. Keywords, for example, may have been somewhat more concrete than descriptors; their superiority as cues then would derive, at least in part, from their concreteness (Paivio, 1969; Kintsch, 1972). It may be worth noting, however, that classificatory judgments are *about* keywords that may be characterized by certain descriptors. The organization of an encoded relation may, therefore, involve the keyword in a focal role and the descriptor in an ancillary one. (Freedman & Loftus, 1971, similarly argue that the memory store is organized primarily into noun categories.) Such unequal roles would make it easier to remember how a given keyword had been classified than to remember a keyword that had been classified in a given way.

Recognition Memory

Tests of recognition memory require S to distinguish items that occurred in a specified context from items that did not. Contextual recall should, therefore, benefit recognition memory. Since contextual recall was more readily cued by congruous keywords than by congruous descriptors, it was to be expected that the former's recognition would surpass the latter's. Contextual recall was probably not the only source of keywords' recognitive superiority, however, since incongruous as well as congruous keywords were more easily recognized than their descriptor mates. Note that the keywords' recognitive advantage was considerable, being at least as great as that of congruity over incongruity. It cannot be ascribed simply to differences in concreteness: Subsets of concrete and abstract words that differed in cue value did not differ in recognition memory. Neither can it be ascribed to differences in word frequency, which might have been expected to favor the less frequent keywords (McCormack & Swenson, 1972) but which in fact did not. No really satisfactory explanation presents itself, but one possibility, admittedly ad hoc, is that keywords may be "tagged" as words about which decisions have been made. Tags would make keywords more easily recognized than untagged descriptors, yet would lack retrieval value in free and cued recall.

GENERAL DISCUSSION

The present research reflects orienting attitudes akin to those outlined by Craik and Lockhart (1972). These authors urge the systematic use of incidental learning tasks in memory research in order to exert more "control over the encoding operations that subjects perform." They agree that what is encoded should depend on "the processing demands imposed by the experimental paradigm and the material to be remembered." And they argue that meaningful events—which presumably would include our congruous queries—"are compatible ... with existing cognitive structures," receive greater "depth of processing" than less meaningful events, and are consequently better retained.

That poor retention of incongruity may be a consequence of inadequate processing depth is consistent with Meyer's (1970) analysis of true/false reaction times to propositions of the form, all S are P. Meyer concludes that such true/false judgments involve either one or two stages of processing. During the first stage, S and P are examined for evidence of semantic "overlap." Only when such evidence is found does one proceed to determine, at the second stage, whether S is wholly contained within P. What we have called relational encoding would presumably occur during Meyer's second processing stage, and so would be effectively ruled out for the words of an incongruous query.

I have argued that the words of an incongruous query are encoded as unconnected semantic units, while the words of a congruous query are relationally encoded. While differences in processing depth may be behind this, it is important to realize that all our queries tap what is loosely termed "semantic memory," so that even the incongruous ones must receive some amount of semantic processing. Since recall of incongruity was vanishingly low, the general advantages claimed for semantic processing (Hyde & Jenkins, 1969) clearly need to be qualified.

In recent work that bears comparison to the present study, Horowitz and Manelis (1972) discuss the redintegrative memory of adjective-noun phrases. Their phrases were either anomalous (sour talk), meaningful (long story), or idiomatic (hot dog); only the first two phrase types will concern us here. Free recall, cued recall, and recognition memory were examined. Their results agree that nouns are easier to recognize than adjectives and that nouns make better retrieval cues, a result also found by Lockhart (1969), so long as

concrete nouns are used. Contrary to the present findings, however, Horowitz and Manelis report that (1) free and cued recall of anomalous words are quite good, (2) free recall of nouns is better than that of adjectives, and (3) recognition memory for nouns is no better after meaningful than after anomalous phrases. Discrepancy (1) may arise because their Ss had more time to consider each phrase and were aware, as ours were not, that their lexical memory ultimately would be tested. (Lockart, 1969, like Horowitz and Manelis, used an intentional learning procedure and obtained better than 50% correct for cued incongruous recall.) Mnemonists long have claimed memorial advantages for discovering and encoding precisely such bizarre relations as our incidental learning procedure was designed to prevent. Intentional learning procedures no doubt foster such encoding attempts which, even when they fail, might result in idiosyncratic "subjective organization" useful for recall. This could account for discrepancy (2) if nouns lent themselves more readily to subjective organization than adjectives. Finally, discrepancy (3) may have arisen at least in part because, unlike our congruous queries, the meaningful phrases of Horowitz and Manelis contain adjectives merely compatible with, and not entailed by, their nouns: Each adjective was a possible attribute of its noun but not an inherent one. As far as recognition memory is concerned, it may be better to encode a defining property of a word than an arbitrary one. Further investigation is clearly needed to determine the memorial consequences of variations in lexical processing.

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