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Superiority of Free Recall to Cued Recall with "Strong" Cues

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Summary. Subjects encoded homographs (e.g., *iron*) in one of two contexts, produced by preceding them with words from two different categories to which the item belonged (e.g., items that were *metals* or *utensils*). Later, subjects were tested either under free-recall conditions, or with one or the other of the category names that were either congruous or incongruous with the original encoding of the targets. Recall with cues that were congruous with the encoding of the target produced performance superior to free recall, but free recall was superior to cued recall when the cues were not congruous with the original encoding. The results were interpreted within the encoding specificity framework, in particular as confirming the debated proposition that a cue strongly associated to a target item may be ineffective in promoting retrieval of the target if the relation was not encoded when the target was studied. Previous failures to confirm this prediction may have been due to inadequate manipulation of the encoding context in order to provide distinctive encodings.

The encoding-specificity hypothesis is that: "Specific encoding operations performed on what is perceived determine what is stored, and what is stored determines what retrieval cues are effective in providing access to what is stored" (Tulving and Thomson 1973, p. 368). This idea is most useful in interpreting results from memory experiments in which encoding conditions and retrieval conditions are shown to interact. The same nominal stimulus may be studied by different groups of subjects under conditions designed to effect two distinct encodings and then the trace of the event may be probed with different retrieval cues (e.g., Tulving and Osler 1968; Fisher and Craik 1977; Morris, Bransford, and Franks 1977). Often cues that are effective following one type of encoding are shown to be ineffective following others, while different cues (formerly ineffective) can be shown to be effective with the

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new encoding. Such results show how various encodings of the same nominal stimulus affect its retrievability under different conditions. This is in line with the general thrust of the encoding specificity hypothesis as stated above.

One interesting implication of the encoding-specificity hypothesis is that even a retrieval cue strongly related in meaning to a target event may not provoke recall of the event if the event was originally encoded in an unusual way. Thomson and Tulving (1970, Experiment 2) provide evidence for the proposition that "no cue, however strongly associated with the TBR (to-be-remembered) item or otherwise related to it, can be effective unless the TBR item is specifically encoded with respect to that cue at the time of its storage" (p. 255). In two practice lists, subjects were given weakly associated pairs of words to remember (e.g., *knife - steak*) and then were asked to attempt to recall one member of the pair (*steak*) when the other was provided as a retrieval cue. On the third trial, in three critical conditions subjects again studied weakly related pairs, but were then tested in one of three retrieval conditions with either (a) the original weak associates as cues (e.g., *knife* in the example pair given here), (b) strong associates as cues (e.g., *meat*), or (c) no cues (free recall). The results showed that subjects recalled targets much better when tested with the original weak associates than with no cues, the percentage of items recalled in the two conditions being 82.5% and 29.5%, respectively. This finding agrees with the encoding specificity hypothesis as well as with most any other reasonable theory of recall. More interesting was that when subjects were tested with cues strongly associated with the target words after studying the targets in the presence of weak associates, they recalled the target words no better than under free-recall conditions. In fact, recall with strong cues was slightly – but not reliably – worse: 22.9% vs 29.5%. These results were interpreted as supporting the corollary of the encoding specificity hypothesis which states that even retrieval cues strongly related to a target would fail to effect recall of the target if the relationship between them was not encoded at the time the target was studied. (Several control conditions ruled out some uninteresting possibilities – for example that the strong cues were simply ineffective under any conditions).

In the intervening years since 1970, the encoding-specificity hypothesis (or principle) has been subjected to extensive experimental scrutiny. The two areas of greatest concern have probably been the aforementioned attempts to study interactions between encoding and retrieval conditions and the recognition failure of recallable words (Flexser and Tulving 1978; Tulving and Thomson 1973). Tulving (1983, chapters 11–13) has recently reviewed evidence on these issues. The interesting corollary that preexperimentally strong retrieval cues may be ineffective under certain conditions has received less attention, with the little that has been directed at it often failing to confirm Thomson and Tulving's (1970) original observations.

In one experiment, Postman (1975, experiment 1) tested the conditions of the original Thomson and Tulving (1970, experiment 2) design, but with some methodological changes and in the context of many other conditions. For present purposes, the most interesting finding was the failure to obtain the interaction between study and test conditions reported by Thomson and Tulving. Instead, Postman found that strong extralist associates were as effective as cues for the target words studied with weak associates as when the targets were studied alone. In addition, in both study conditions, the targets were considerably better recalled with strong extralist cues than under conditions of free recall. Thus, these results would generally argue strongly against the encoding specificity idea since the effectiveness of retrieval cues was in this instance not modulated by variation in encoding conditions. Among other things, Postman (1975) concluded that the encoding-specificity phenomenon holds up only under "narrowly circumscribed" conditions.

Another series of studies has been conducted by Newman and colleagues (Newman et al. 1982; Newman and Frith 1977). As a result of numerous comparisons, with many variations within basic experimental parameters, they generally found that strong extralist cues given to subjects following encoding of targets with weak associates produced better target recall than no cues – a fact they considered incompatible with Thomson and Tulving's (1970) encoding-specificity hypothesis. However, support for the hypothesis was deemed "mixed" because Newman et al. (1982) also typically found that recall with the weak associates presented at study was better than under free-recall conditions. Baker and Santa (1977, experiment 1) also reported greater cued recall than free recall when strong associates were presented as cues following encoding of weak associate-Target pairs. Thus, the corollary of the encoding-specificity hypothesis emphasized by Thomson and Tulving in 1970 seems to be disconfirmed by the experiments of Newman et al. (1977, 1982), Baker and Santa (1977), and Postman (1975).

On the other hand, at least one study has reported a case in which strongly related extralist cues were shown to produce performance inferior to that under free recall conditions (Roediger and Adelson 1980, experiment 3). In that experiment, subjects studied homographic target words encoded in the context of a synonym that biased one or the other of the meanings of the words. For example, the target *address* was studied in the context of either *talk* or *residence.* Later, subjects were tested either under conditions of free recall or with an extralist cue strongly related to the target (*speech*). The cue was chosen to be congruous with one encoding of the target, but incongruous with the other. Recall with the extralist cues following a congruous encoding was much better than free recall (36%–11%). However, for the present purposes, the interesting finding was that cued recall with the same "strong" cue following the incongruous encoding was reliably inferior to free recall following the same encoding (8% relative to 15%). This result provides evidence that not only can cued recall with preexperimentally strong cues be shown to be no more effective than free recall (as shown by Thomson and Tulving 1970), but in fact cued recall with strong cues can be worse than under free-recall conditions. This outcome can be interpreted within the encoding-specificity framework by suggesting that in some cases the invisible cues subjects use in free recall (Tulving 1974) can be more effective than strongly related extralist cues that follow encoding of a target in an incongruous context. A similar result was obtained in an earlier, unpublished study by Bobrow and Light, which was briefly reported by Bower (1970).

The purpose of the present experiments was to attempt to gather further evidence showing that free recall could be superior to cued recall with preexperimentally strong retrieval cues. One difficulty with the paradigm developed by Thomson and Tulving (1970) and examined repeatedly by others is that the encoding of the target words in the presence of a weakly associated context word may not cause a disparate enough encoding to prevent strong associates from being effective cues. That is, if the critical dimension providing for effectiveness of retrieval cues is the overlap between the information in the cue and that in the trace, then preexperimentally strong cues will be ineffective only so long as the weakly related context word engenders an encoding quite disparate from that provided by the strong cue. In the experiments of Newman et al. (1977, 1982) and Thomson and Tulving (1970), there was no systematic attempt to promote disparate encodings of target and strong extralist cues, as there was in the study by Roediger and Adelson (1980, experiment 3).

Such disparate encodings were attempted in the present experiments by again using homographs that belonged to two different categories. Subjects studied a long categorized list containing the critical test words presented with other members of the category. For example, subjects studied *blocks* in a list with other toys or *iron* with other metals. Later some subjects were given a free-recall test while others were given strongly related cues in the form of category names. However, these category names were either *congruous* with the original encoding context (*toys* and *metals*) in the example above or *incongruous* (*units of measurements, utensils*). The incongruous category cues are, of course, strongly related preexperimentally to the critical target words, but the encoding context induces a distinct encoding which makes (according to the encoding-specificity hypothesis) the preexperimental association ineffective for retrieval of the critical targets. In this situation we expected that under conditions of free recall, in which subjects could cue themselves to the best of their abilities with the encoded congruous category names, performance would likely be superior to that under incongruous cued-recall conditions, despite the fact that these category names were strongly related preexperimentally. Such a finding would support the corollary of the encoding specificity hypothesis that "no cue, however strongly associated with the TBR item" can be effective without being encoded in a form congruous with a recall target.

Experiment 1

Method

Subjects. Ninety-six Purdue undergraduate students enrolled in an introductory psychology course participated to receive course credit. Subjects were tested in groups of 5–27.

Design. Two separate groups of 48 subjects were presented alternate forms of an 80-word list. One-third of the subjects in each group received a free-recall test, another third received a cued-recall test in which the recall cues were congruous with the encoding of the targets engendered by the acquisition list (congruous cued recall) and the remaining third of the subjects was given a cued-recall test in which the cues were incongruous with the encoding of targets promoted by the acquisition list (incongruous cued recall). Thus the design was a 2 x 3 (list x test) between-subjects design.

Materials. Two lists of 80 words each were constructed as follows: Each list (list *A* and list *B*) consisted of 20 categories with 4 items per category. Ten of these categories were identical for both lists and items from these categories served as buffer items. The remaining ten categories contained one critical item (a homograph) plus three additional category exemplars. These ten critical homographs were presented in both lists. For example, *rose* was presented in list *A* following *tulip, pansy,* and *lily,* while in list *B rose* was presented following *ellen, linda,* and *jane.* Both lists, therefore, contained the same ten critical items. The two lists are presented in the Appendix.

All items were typed and prepared as slides. Each slide contained the four category exemplars from an individual category typed in a single column, with the critical homographs always presented last. The order of category presentation was as follows: three buffer categories, followed by the ten critical categories, followed by the remaining seven buffer categories.

The presentation order of the ten buffer categories was identical for lists *A* and *B*. Presentation order of the categories of critical targets was matched across lists in such a way that the same critical items appeared in the same presentation positions. For example, the first critical category in both lists contained *rose,* the second critical category contained *iron,* etc.. Furthermore, since the critical targets always appeared as the last items in the column, each critical target appeared in the same ordinal position in both lists.

Two separate cued recall tests were prepared and given to half the subjects who studied each list in the cued recall conditions. The cues consisted of 25 category names, 20 for items that had appeared in the list and five others that had not. For the congruous cued-recall group, 20 of the 25 category names matched the encoding format (ten critical categories plus ten buffer categories). For the incongruous cued-recall group only ten category names matched the encoding format (the buffer categories), while ten others tapped the critical items. The five additional category names were added to encourage subjects to try to recall list items from unfamiliar category names. The two test lists constructed (*A* and *B*) differed only in the ten category names for the critical items. The *A* test sheet had 20 category names appropriate for the categories studied in the *A* list, whereas the *B* test sheet had names appropriate for the alternate list. The order of category names was randomly determined for the *A* test; for the *B* test the ten alternate category names for the critical targets were inserted in place of the ten names appropriate for list *A*.

Procedure. Subjects were assigned to groups on the basis of their order of arrival at the experiment. Free-recall subjects were tested separately from those in the two cued-recall conditions, which were tested simultaneously. In the congruous cued-recall condition, the subjects were tested with the recall test containing the names of the categories that had been presented in the acquisition list they had studied. Thus, a subject in the congruous cued-recall condition who was presented with list *A* (or *B*) at acquisition was tested with test *A* (or *B*). In the incongruous cued-recall condition the subjects were given the alternate form of the cued-recall test. Thus, subjects in the incongruous cued-recall condition who had studied list *B* were tested with test *A*, and vice versa. For both list *A* and *B*, then, one-half of the subjects who received cued-recall tests were given congruous cued-recall tests while the remaining half were given incongruous cued-recall tests. When subjects were given congruous tests, 20 of 25 category names were appropriate to the list; when given incongruous tests, only ten were appropriate.

The subjects were told that they would be shown a long list of words to remember and that then would be given instructions concerning the testing phase of the experiment. All subjects were informed that the words would be presented in a series of slides and that each slide would contain four words. No mention was made of the fact that the words within each slide would all be members of a common category. Subjects were also instructed to carefully study each word in every slide.

Following these instructions, the slides were presented at an 8-s rate. Immediately after list presentation, subjects were given test instructions appropriate to the condition to which they had been assigned. Subjects in the cued-recall conditions were told that their test sheets contained a number of cue words that should help them to recall items from the list. They were further instructed to try hard to recall words even from cues that might not seem familiar. A paced recall procedure was used whereby subjects were given 15 s to recall items to each cue. As soon as a 15-s recall period was over, subjects were instructed to slide their separate cover sheets down to expose the next cue word. This procedure was continued until the subjects had attempted recall to all 25 cues. They were instructed to work only on the most recently exposed cue word during any 15-s period. Finally, subjects were informed that when they had finished the cued-recall portion of the test they would be given 2 min to recall any additional list items they could remember. These additional items were to be written at the bottom of the test sheets.

Subjects in the free-recall conditions were told that they would be given about 8 min in which to write down any items they could remember from the list. The free-recall subjects were actually given 8.25 min for recall in order to equate precisely the total recall time with the cued recall conditions. Also, in order to equate the duration of the cued recall and the free recall instructions, the free-recall subjects were given additional instructions concerning the nature of free-recall tests. As part of these additional instructions, the free-recall subjects were encouraged to use the entire test period to recall items.

Results

All subjects were scored for their recall of the ten critical items. The results reported here are based on a lenient scoring criterion by which subjects were given credit for recalling an item if the item appeared anywhere on their test sheets. Thus, subjects in the two-cued recall conditions were given credit for correctly recalling a critical item even if the subject wrote the item beside an "incorrect" cue (e.g., writing *iron* beside *flower*) or at the bottom of their test sheet. Using a strict scoring criterion in no way changes the pattern of results, although it dramatizes slightly the main finding here.

Table 1. Proportion of critical items recalled in Experiments 1 and 2

	Acquisition list	Recall test Free recall	Congruous cued recall	Incongruous cued recall
Experiment 1	List A	0.31	0.44	0.03
	List B	0.22	0.36	0.06
	M	0.27	0.40	0.05
Experiment 2	List A	0.29	0.57	0.09
	List B	0.33	0.57	0.13
	M	0.31	0.57	0.11

The mean number of critical items correctly recalled in each condition is presented in Table 1. A large difference is apparent in recall across the three test conditions and the pattern of results was the same for both lists.

As can be seen in Table 1, the congruous cued-recall group's performance was much higher than that of the free-recall group. However, this superiority of cued recall over free recall was not obtained in the incongruous cued-recall groups whose performance was much worse than that of the free-recall groups.

The results of a 2 x 3 (list x test) analysis of variance supported these observations. (All reliable effects exceed the 0.01 level of confidence). There was a highly significant effect of test, F (2,30) = 67.87, MSE = 1.53, but no significant effect of list, F (1,15) = 1.34, MSE = 3.75, and no list x test interaction, F (2,30) = 1.44, MSE = 2.12.

Since there was neither a main effect of list or a list x test interaction, the results were collapsed across *list* and a post hoc Newman-Keuls test was performed. The results of this analysis showed that every test condition was significantly different from every other condition. The main aim of this experiment – to show that under appropriate encoding conditions free recall of targets could be superior to their recall with strong cues – was fulfilled. Discussion of this outcome will be deferred until a second replication experiment is briefly described.

Experiment 2

This experiment was conducted to replicate the findings of the first with one significant methodological change; category size was reduced from four items per category to two. Thus, the meaning of the ten critical homographs was biased by only one context word rather than three as in experiment 1.

Method

Ninety students were solicited from the same source as in experiment 1. The design and procedure were exactly the same as in the prior experiment, except that the list length was reduced to 40 words by presenting only two items for each of 20 categories on slides and the presentation rate was reduced to 4 s per slide from 8 s per slide. For the ten critical categories in each list, the two items presented were the last two of the four presented in experiment 1 (see the Appendix). Thus in experiment 2 each critical target followed a single context word. The testing procedure was the same as in experiment 1.

Results

A lenient scoring criterion was again used so that subjects received credit for recalling a target if it was written anywhere on the sheet. The mean number of critical items recalled is presented in the bottom part of Table 1, where it can be observed that the pattern of results was identical to that in experiment 1. Again, there was little difference in recall of items in the two lists, but a substantial difference is evident in performance across the three testing conditions. Recall in the congruous-test condition was roughly twice that of the free-recall condition, but recall in the incongruous-test condition was only about one-third that of the free-recall condition. Once again, cued recall with preexperimentally strong cues was shown to be much worse than free recall of the same targets when the encoding and test conditions encouraged incongruous encodings of these targets.

Statistical analyses confirmed these trends. A 2 X 3 (list X test) analysis of variance indicated no reliable effect of list, $F(1, 14) = 1.02$, MSE = 1.32, but a highly reliable effect of test, $F(2, 28) = 56.91$, MSE = 2.78. The list X test interaction did not approach significance, $F < 1$. Newman-Keuls tests applied to the data of the three test conditions when collapsed across lists indicated that each condition was reliably different from the other two.

Discussion

The results of the two experiments reported here are consistent in showing a strong interaction between encoding and test conditions. The same nominal targets encoded in various contexts were shown to be differentially accessible, depending on the relation between the retrieval cues and the encoding context. When *squash* was studied in the context of other vegetables, it was well recalled (relative to free recall) when subjects were cued with *vegetables* but not when they were cued with *sports.* However, when *squash* was studied in the context of sports, the relative effectiveness of the category name retrieval cues was reversed. This pattern of findings replicates that of many others, showing a strong interaction between encoding and test conditions and is the empirical foundation for the encoding-specificity principle.

The more important contribution of the present experiments is to show that recall of targets with nominally "strong" preexperimental cues (category names) can actually be worse than free recall of the same targets. Both experiments revealed this outcome; in experiment 1 recall of targets in the free-recall condition was about six times greater than recall with incongruous (but preexperimentally strong) cues. In experiment 2, with less context preceding the target words during the study episode, free recall of targets was still three times better than cued recall in the incongruous test condition. These experiments, considered in conjunction with experiment 3 of the Roediger and Adelson (1980) series, strongly support the findings and interpretation of Thomson and Tulving (1970, experiment 2). In light of these data, the statement is certainly justified that "no cue, however strongly associated with the TBR item" can be effective without being encoded in a manner congruous with the encoding of the recall target. Apparent exceptions in the literature are probably attributable to ineffective manipulations of encoding context (Baker and Santa 1977; Newman et al. 1977, 1982; Postman 1975).

A critic might complain that we have obtained a superiority of free recall to cued recall with strong cues only under the most artificial of conditions, namely, when homographs are used as the targets and context biases one or the other of their meanings. From this view, we have not demonstrated facts generally applicable to remembering, but only to remembering of special and higly constrained materials. Martin (1975), for example, argued along this line in attempting to explain away the recognition failure of recallable words, another phenomenon studied in hopes of explicating the encoding specificity hypothesis. Indeed, the experiments reported here are similar in some respects to those, but are even closer in intent to experiments concerned with context shifts in recognition (Light and Carter-Sobell 1970; Thomson 1972). These researchers showed that a target homograph (*jam*) presented in one context (e.g., strawberry-*jam*) was better recognized when presented later in a context similar in meaning to the original (raspberry-*jam*) rather than different (traffic-*jam*).

From our view, the results of our experiments and these others do not reveal principles applicable only to memory for homographs. Rather, homographs merely serve as convenient vehicles by which encoding and test conditions for the same nominal stimulus can be strongly manipulated. This circumstance is necessary for an adequate test of the encoding specificity hypothesis and, as argued above, previous failures to find encoding-specificity phenomena may have been due to a failure to provide varied enough encoding conditions. However, it is certainly not the case that "encoding specificity phenomena" hold true only with artificial or constrained materials. Morris et al. (1977) have obtained strong interactions of study and test conditions with ordinary words and Barclay et al. (1974) found similar effects in the recall of objects in sentences. Similarly, the recognition failure of recallable words has been obtained with many types of material (e.g., Neely and Payne 1983; Tulving and Watkins 1977).

The most precise theoretical account of the encoding-specificity principle has been offered by Flexser and Tulving (1978). They assume that the mnemonic representation of an event can be characterized as a bundle of features encoded about that event. Retrieval in recall, recognition, or any other form of memory query (feeling-of knowing, priming, transfer) depends on the matching or overlap of features in the retrieval environment with those in the engram. A sufficient match – whatever that may mean – is necessary for conscious recollection in the form of recognition or recall. [Flexser and Tulving (1978) make quite specific assumptions, unlike the general characterization of their ideas provided here.]

Even at this level of generality, the ideas of Flexser and Tulving (1978) help make sense of the experiments reported here. In free-recall conditions, subjects' recall is guided by the invisible cues of the cognitive environment, which in our experiments may be assumed to be some representation of the categorical structure of the list and the specific category control elements involved (Roediger 1973). Recall succeeds to the extent that these invisible cues match the information in the engrams representing the experience of having studied the list. The category names in the congruous test conditions can be assumed to facilitate recall by providing information that better matches that in the traces. However, in the incongruous test conditions the information in the cues fails to match that in the trace due to the disparate encodings in the two cases (study and test). In this last case, subjects would have been better off simply to cover up the cues and use the invisible cues of free recall, since these would have provided a better match to the stored traces.

Interpreting encoding-specificity phenomena in terms of a matching of hypothetical features is useful at one level, but raises as many questions as it solves. What is the nature of the features? How are they encoded? How can their number be measured, as well as the "strength" of any feature? In order to make precise predictions regarding retrieval cue effectiveness, these issues and others (a metric of quantifying overlap among features) must be addressed. At the present time there are not even tentative answers to these questions. Nonetheless, even in abstract form, the encoding specificity hypothesis may provide a general account of many memory phenomena, despite the occasional accusations of vagueness and circularity directed at it. Encoding specificity may provide the same sort of general understanding of memory phenomena that the law of effect does for instrumental conditioning. Despite similar allegations of circularity and vagueness, the law of effect has for some years now served as a workable principle in guiding and interpreting research.

Appendix A

Lists used in Experiment 1

List A

1. mosquito
spider
beetle
roach

2. pine
birch
spruce
dogwood

3. lincoln
eisenhower
roosevelt
kennedy

4. tulip
pansy
lily
* rose

5. gold
tin
brass
* iron

6. dentist
engineer
nurse
* ruler

7. sofa
desk
bed
* chest

8. skirt
gloves
necktie
* cape

9. association
group
society
* club

10. eagle
canary
pigeon
* cardinal

11. doll
train
tricycle
* blocks

12. polio
mumps
malaria
* cold

13. soccer
golf
hockey
*squash

14. copperhead
python
moccasin
anaconda

15. violin
clarinet
piano
trumpet

16. murder
robbery
arson
rape

17. england
germany
canada
italy

18. noun
adjective
verb
conjunction

19. uncle
mother
cousin
brother

20. chicago
seattle
boston
miami

List B

1. mosquito
spider
beetle
roach

2. pine
birch
spruce
dogwood

3. lincoln
eisenhower
roosevelt
kennedy

4. ellen
linda
jane
* rose

5. broom
dishwasher
toaster
* iron

6. thermometer
compass
yardstick
* ruler

7. hand
tooth
leg
* chest

8. valley
river
canyon
* cape

9. pistol
blackjack
rifle
* club

10. minister
rabbi
bishop
* cardinal

11. miles
yards
rods
* blocks

12. rain
snow
fog
* cold

bean
potato
carrot
* squash

14. copperhead
python
moccasin
anaconda

15. violin
clarinet
piano
trumpet

16. murder
robbery
arson
rape

17. england
germany
canada
italy

18. noun
adjective
verb
conjunction

19. uncle
mother
cousin
brother

20. chicago
seattle
boston
miami

*Items marked with an * served as the critical items.

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