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ABSTRACT

Two experiments examined the effects on recall of encoding and retrieval "depth" (the extent to which subjects process the semantic as well as the phonetic and orthographic attributes of verbal material), encoding-retrieval cue compatability, and subject versus experimenter generation of cues. In the first experiment, 117 undergraduates, divided into three groups, saw and heard a list of 72 target words. One group was told to write down an associate for each word--one a rhyme, and one just to learn the list for later recall. Rhyming or associate cues were then given on a recall test. Results indicated that encoding depth has an impact on memory performance over and above encoding-retrieval cue compatability. Semantic processing seemed to produce cued recall superior to phonetic processing even if the cues provided at recall were incompatible with those encountered during encoding. Recall was still maximized by compatible cues. Using 84 subjects and the same 72 target words, the second experiment added the question of subject versus experimenter generation cues to the questions about encoding depth and compatibility. Results of this experiment confirmed the importance of encoding depth while also indicating that subjects perform better when they generate their own cues. (JL)

Levels of Processing and Encoding Specificity:[1]
Does Processing Depth Make a Significant Independent Contribution to Recall Performance?

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Running Head: Levels of Processing

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Levels of Processing and Encoding Specificity: Does Processing Depth Make a Significant Independent Contribution to Recall Performance?

Craik and Lockhart (1972) maintained that the durability of a memory trace is a function of the "depth" to which information is analyzed. Depth was operationalized in terms of the extent to which subjects processed the semantic in addition to the phonetic and orthographic attributes of verbal material. Although this framework received empirical support (e.g., Craik & Tulving, 1975; Till & Jenkins, 1973; Walsh & Jenkins, 1973), a number of studies indicated that a complete account of remembering required the consideration of other variables as well. For instance, Morris, Bransford, and Franks (1977) argued persuasively that deep (semantic) processing would produce superior memory only if the test was semantic in nature; a test which assessed memory for "shallow" attributes indicated that "shallow" processing was superior to "deep" processing. Accordingly, they asserted that the levels of processing framework should be replaced with one emphasizing the transfer of appropriate processing, a concept related to the encoding specificity principle of Tulving and Thomson (1973). Both positions suggest that the optimal method of processing depends upon its compatibility with the demands of the memory test. If a memory test requires subjects to "process deeply," then they will perform best if rehearsal involves "deep processing." If the demand is for "shallow processing," then that should be practiced.

Fisher and Craik (1977) argued that a complete account of remembering must include reference to both the depth of encoding and the compatibility between encoding and retrieval cue, neither of which, by itself, is sufficient to describe performance. Fisher and Craik (1977) reported data that seemed to indicate that although compatibility between depth of processing during encoding and the depth of the retrieval cues was important, depth of encoding also seemed to make a significant and independent contribution to performance on a recall test. For example, semantic encoding followed by a semantic cue gave higher performance levels than rhyme encoding followed by a rhyme cue. They thus concluded that depth of processing was an important variable in addition to trace-cue compatibility.

Tulving (1978) questioned even this modification of the levels of processing framework. He has proposed a complete relativity view stating that "once we accept the propositions that retrieval is determined by the compatibility between trace and cue information, there is no need to postulate anything in addition about the relevance of encoding, trace, or retrieval factors" (p. 418). Tulving argued that an explanation of Fisher and Craik's (1977) data required nothing more than his encoding specificity principle. The present authors feel that Tulving's (1978) view is not completely compatible with Fisher and Craik's (1977) data. In particular, it is troublesome that semantic encoders recalled as many rhyme-cued words on the recall test (.43) as did the rhyme encoders (.40).

The question of whether "deep" encoding yields a more durable memory trace even if the test is "shallow" in nature is very important to practitioners in the field of education. Schmeck (1980) has suggested that students should be encouraged to process information "deeply" regardless of the nature of the recall test. Schmeck has offered specific suggestions as to how such deeper processing can be taught as a learning strategy. The present study was designed to provide additional information concerning whether encoding depth has any impact over and above that of encoding-retrieval cue compatibility.

Most studies that have investigated the compatibility of encoding and retrieval cues have provided the subjects with the cues to be used in encoding and retrieval. However, a number of studies (e.g. Bobrow & Bower, 1969; Slamecka & Graf, 1978) suggest that whether the subject generates the cues or the experimenter generates the cues can significantly influence cued recall with subject-generation producing recall which is superior to experimenter-generation. Thus, the act of production may be another variable affecting memory performance independent of encoding depth and encoding-retrieval cue compatibility.

The present studies were designed to examine encoding depth, retrieval cue depth, encoding-retrieval cue compatibility and subject versus experimenter generation of cues. In Study 1 (using subject-generation of cues) it was predicted that there would be a main effect for encoding depth in addition to an encoding-retrieval cue interaction. In Study 2 (using both subject and experimenter generation) it was predicted that, in addition to the replication of the effects in Study 1, there would be a main effect for generation of cues with subject-generation producing performance superior to experimenter-generation.

Experiment I

Experiment I dealt specifically with the interaction between encoding instructions and retrieval cue type while having subjects generate their own cues. Fisher and Craik (1977) provided subjects with the cues to be processed at encoding, and thus when cues were "compatible" they were <u>identical</u>. In the present study, when cues were compatible, they were compatible in terms of depth (semantic versus phonetic) but not necessarily identical since subjects were generating their own encoding cues. The present authors felt that this was more comparable to conditions outside of the laboratory. Tulving's relativity position would be supported without recourse to other memory variables only if there was a significant interaction between encoding and retrieval conditions at the same time that there was no main effect due to either encoding or retrieval conditions. In addition, in view of Fisher and Craik's (1977) data, the present authors were especially interested in the recall of rhyme-cued words by subjects who had processed rhymes or associates at encoding.

The study varied three levels of encoding instructions between groups (incidental rhyme, incidental associate, intentional learn) with two levels of retrieval cue (rhyme, associate) varied within groups. The procedures differed from those used by Fisher and Craik (1977) in several ways. First of all, the present study varied encoding depth as a between-subjects factor, whereas Fisher and Craik varied it as a within-subjects factor. Secondly, as noted above Fisher and Craik used experimenter-provided encoding cues whereas the present study used a subject-generation procedure. Finally, the present study presented the stimulus items visually and auditorally, whereas Fisher and Craik presented the items only visually.

Method.

Subjects. The subjects were 117 undergraduate introductory psychology students of both sexes who were given course credit for voluntary participation.

Design. A 3 x 2 mixed factorial design was employed. Three types of encoding task (incidental rhyme, incidental associate, intentional learn) were crossed with two types of retrieval cue (rhyme, associate). The encoding factor was varied between subjects, the retrieval cue factor was varied within subjects.

Material and Procedure. A list of 72 target words were selected from all of the single syllable words included in Cluster 8 of Toglia and Battig's (1978) norms. Cluster 8 was characterized by words which were high on the dimensions of concreteness, meaningfulness, and categorizability. The words were selected such that: (1) each shared few associative and phonetic attributes with any other words in the list; and (2) the cues used at recall applied to only one word in the list as judged by the two experimenters.

Words were presented to the subjects both visually and auditorally at a rate of one word every eight seconds. The two groups receiving incidental learning instructions were told that for purposes of another study associative or rhyming norms were needed for each of 72 words. Thus, depending upon the incidental group to which they were randomly assigned, subjects were asked to write down on a numbered sheet of paper an associate or a rhyme to each of the presented words. The intentional group was simply told to learn the list for later recall.

Following list presentation, norm sheets were collected. Subjects were then given the cued recall test. Cues were of two kinds. Half of the words were cued by associates (e.g., "this word is a kind of fish"), and half of the words were cued by rhymes (e.g., "this word rhymes with 'bat'"). Words were randomly assigned to cue condition. Order of items on the cue sheet was randomized independent of list presentation order.

Results and Discussion.

The proportions of words correctly recalled for each encoding group under each retrieval cue condition are presented in Table I.

Insert Table I about here

In addition to a significant main effect due to encoding conditions ($F_{2, 114} = 18.73$, $p < .001$), there was a significant interaction between encoding conditions and retrieval cue ($F_{2, 114} = 30.98$, $p < .001$). The interaction indicated that associate processors recalled more associate cued words than rhyme cued words ($p < .001$), and rhyme processors recalled more rhyme cued words than associate cued words ($p < .001$). This result lends additional support to the conclusion of Fisher and Craik (1977), and Tulving (1978) that the compatibility between encoding conditions and cue condition is an important determiner of recall.

However, the significant main effect suggests that encoding depth has an impact on memory performance over and above encoding-retrieval cue compatibility (i.e. the interaction). Moreover, the recall performance of associate processors given <u>incompatible</u> (i.e. rhyme) cues was numerically superior to that of rhyme encoders given <u>compatible</u> (rhyme) cues but the difference was slightly short of statistical significance ($p < .10$). On the other hand, there was no indication of a main effect due to retrieval cue ($F_{1, 114} = 1.32$). Thus, it does appear that retrieval cue, depth contributes nothing to recall performance independent of the compatibility between encoding and retrieval cues.

These results lead to the conclusion that, for the conditions used in the present experiment (e.g., self generation of encoding cues), semantic processing produces cued recall which is superior to phonetic processing even if the cues provided at recall are incompatible with those encountered during encoding. However, recall is still maximized by providing retrieval cues which are compatible with encoding conditions.

It is interesting that the intentional learning group performed intermediate to the two incidental learning groups under both retrieval cue conditions. This may be due to individual differences in encoding style under the intentional instructions. Thus, half of the subjects may have used phonetic cues and half may have used semantic cues producing recall intermediate to the phonetic and semantic incidental groups.

It is difficult to maintain that compatibility between encoding and retrieval conditions is all that is needed to describe memory when semantic processing produces recall that is superior to that of rhyme processing under all cueing conditions. Moreover, the estimated proportion of variance (w^2, Hays, 1973) accounted for by encoding style (.19) was greater than that accounted for by cue compatibility (.07). However, since subjects in Experiment I generated their own encoding cues and then had to respond to cues provided by the experimenter, it could be argued that compatibility was weak under all conditions. Experiment 2 compared subject-generated and experimenter-generated encoding cues.

The finding in the present study that associate processors given rhyme cues recalled at a marginally superior level to rhyme processors given rhyme cues differs from Fisher and Craik's (1977) findings. One major difference between the two studies is that the present study used subject-generation of encoding mediators whereas the earlier study used experimenter-generation. A number of studies (e.g. Bobrow & Bower, 1969; Slamecka & Graf, 1978) have found subject-generated cues to be more effective in aiding retrieval than experimenter-generated cues. Experiment 2 provided the opportunity to make an overall comparison of recall performance when cues are self-generated and when they are provided by someone else.

Experiment 2

The purpose of Experiment 2 was to replicate the interaction of encoding depth and retrieval cue depth obtained in Experiment 2, as well as the encoding depth main effect. In addition, the study provided an opportunity to test the influence of subject versus experimenter generation of encoding cues as an independent contributor to performance and as it interacts with the other conditions.

<u>Method</u>.

<u>Subjects</u>. The subjects were 84 male and female undergraduates who were given credit in the introductory psychology course for participation in the study.

<u>Design</u>. The design of the present experiment was a 2 (subject versus experimenter-generation of cues during encoding) X 2 (associate versus rhyme encoding) X 2 (associate versus rhyme retrieval cues) mixed design. Subject versus experimenter generation of cues was a between subjects

comparison, as was associate versus rhyme encoding. Associate versus rhyme retrieval cues was a within-subjects comparison (all cued recall tests had half associate and half rhyme cues).

Procedure and Materials. The 72 target words were identical to those used in Experiment I. Half of the subjects (2 Subject-Generation groups) were presented the target words as in Experiment 1 and asked to generated associates or rhymes for purposes of norming the target words. Words were presented both auditorally and visually at an 8 second rate. One of these Subject-Generation groups received the incidental rhyme instructions given in Experiment 1, the other group received the incidental associate instructions given in that study.

The other half of the subjects (the 2 Experimenter-Generation groups) were given a rhyme or an associate along with the target word, again using both visual and auditory presentation and an 8 second presentation rate. The target word in each case was in the first position and typed in capital letters, the associate or rhyme was in the second position and typed in lower case letters (e.g. TROUT - fish). The subjects in these two groups were given the following incidental learning instructions: "For purposes of another experiment we need to know the probabilities that certain words will elicit other words as associates (or rhymes in the case of the rhyme group). Thus, we are going to present to you pairs of words and on the sheet of paper that you have been given we would like you to rate on a four point scale the likelihood that the first word you see would be given as an associate (or rhyme) to the second word in the pair. Thus, for example, if you think that the word 'BOOK' is very likely to be given as an associate (or rhyme) to the word 'author' ('look'), you would circle the 4. If you think that it is very unlikely that it would be given, you would circle the 1. Are there any questions?"

Following list presentations, the "norm" sheets were collected and the subjects were given the cued recall test. The Experimenter-Generation subjects were told to use the cues to recall the first member of each word pair on the word list, "the one in capital letters." For the Subject-Generation subjects, the cued recall instructions were more straight forward since they had seen only single words rather than pairs.

The method of cueing was like that used in Experiment I with half the words cued by rhymes and half cued by associates. Thus, for all subjects half of the target words were cued by compatible cues (rhyme-rhyme or associate-associate) and half of the words were cued by incompatible cues (rhyme-associate or associate-rhyme). For the Experimenter-Generation groups the compatible cues were identical to those processed during encoding. Of course, in the subject-generation groups no control over the degree of similarity was possible; thus, they saw one-half of the cues that were congruent (in terms of "depth") with encoding style and one-half that were incongruent.

Results and Discussion.

The proportions of words recalled by each encoding group under each retrieval cue condition are presented in Table 2. Again, a significant encoding-retrieval cue interaction ($F_{1, 78} = 46.50$, $p < .001$), indicates that compatibility between encoding activities and cue type significantly influenced recall performance. However, the significant main effect for encoding condition ($F_{1, 78} = 105.87$, $p < .001$) suggests that depth of encoding also contributed to the variability of recall performance.

Insert Table 2 about here

In this experiment the estimated proportion of variance (w^2, Hayes, 1973) accounted for by encoding-retrieval cue compatibility was again .07, but that for encoding depth alone increased to .44. Encoding depth seems to play a major and independent role in memory performance in addition to the compatibility between encoding and retrieval cues. This is dramatically evidenced by comparing the recall of associate processors given rhyme cues to that of rhyme processors given rhyme cues. Whereas in Experiment I this comparison was a little short of statistical significance, in the present study the associate processors clearly outperformed the rhyme processors in recalling rhyme-cued words (.50 to .32; $F_{1, 78} = 23.49$, $p < .001$).

In addition to the effects of encoding depth and encoding-retrieval cue compatibility, having subjects generate their own associates and rhymes during encoding also significantly influenced recall, $F_{1, 78} = 7.67$, $p < .01$, $w^2 = .03$. However, this variable did not interact with any of the others in the study. Subjects who had to produce their own retrieval cues performed better than those who had cues provided by the experimenter. It should be noted that this superiority of the subject-generation condition occurred in spite of the fact that the overall compatibility of encoding and retrieval cues was probably higher in the experimenter-generation condition. Total compatibility could be ensured in the experimenter-generation condition, but no such control was possible in the subject-generation condition since the experimenters had no way of knowing the precise cues that the subjects would generate. They could only match the cues in terms of whether they were rhymes or associates. Thus, it would appear that searching for one's own retrieval cue is another significant, independent source of variance in recall performance.

Also, this effect places no limits upon the effects of cue compatibility and depth of encoding.

General Discussion

The results of these two experiments do not support Tulving's (1978) position that encoding specificity is all that is needed to account for cued recall performance. Although encoding-retrieval cue compatibility accounted for a significant proportion of variance in both experiments, encoding depth accounted for even greater proportions. Thus, the suggestion of Fisher and Craik (1977) that both depth and compatibility are important to cued recall performance seems most in agreement with our data.

Likewise, the results contradict the position of Morris, Bransford, and Franks (1977) that shallow processing is the best way to prepare for a shallow test. In both the experimenter-generation groups and the self-generation groups the associate processors consistently out-performed the rhyme processors under conditions of rhyme cueing. This seems to indicate that deep processing is superior to shallow processing even when the recall test demands only shallow processing. Craik and Lockhart (1972) maintained that the memory trace was simply a by-product of the analyses carried out upon the informational stimulus. Furthermore, it was assumed that deeper (semantic) analyses would leave a more enduring, accessible trace than shallow (phonetic) analyses. The results of the present study would seem to indicate that the trace left behind by deeper analyses is more enduring and accessible regardless of what cues are provided at retrieval.

Experiment 2 replicated the effects shown in Experiment 1 and also indicated that the source of the rhymes or associates processed during encoding significantly affects recall with a search for personal encoding cues enhancing performance even though the retrieval cues could not be precisely matched to them. This finding is in agreement with Bobrow & Bower, (1969) and Slamecka & Graf (1978) who also found a superiority for self-generation. Craik and Tulving (1975) suggested that, in addition to depth, information processing could also vary in breadth. It is possible that self generation of encoding cues increases breadth of encoding (i.e., elaboration) and thereby improves the quality of the memory trace in yet another way.

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Table 1. Proportions of words recalled on the cued recall test under the three encoding conditions and two retrieval conditions.

		Encoding Condition		
		Incidental Rhyme	Incidental Associate	Intentional
Retrieval Cue	Rhyme	.38	.47	.42
	Associate	.27	.62	.42

Table 2. Proportions of words recalled on the cued recall test under the four encoding conditions and two retrieval conditions.

		Encoding Condition			
		Rhyme		Associate	
		Experimenter Generation	Subject Generation	Experimenter Generation	Subject Generation
Retrieval Cue	Rhyme	.28	.38	.46	.55
	Associate	.20	.29	.65	.68