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Semantic versus Acoustic Coding: Retention and Conditions of Organization[1]

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Incidental learning techniques were employed in two experiments to investigate differences in semantic and acoustic coding with regard to retention and organization. The incidental task required subjects to judge pairs of words as being either related or unrelated on a specified dimension, acoustic or semantic. Intentional learning subjects received the same words but were instructed to remember. Instructions to learn enhanced recall and clustering of acoustically related words but had no affect on the usefulness of semantic relationships. Regardless of learning instructions, semantic relationships were more effective than acoustic ones. Results of Experiment II revealed no effects of acoustic similarity when it was unconfounded with orthographic similarity.

An approach that characterizes most contemporary theories of memory has been that of "divide and (hopefully) conquer." Several theorists have found it useful to divide memory into a number of separate stores, differing in capacity and type of information held (for example, Atkinson & Shiffrin, 1968; Norman & Rumelhart, 1970). A second type of division is concerned with the nature of the memory trace. It appears that the encoded version of a word is composed of several features including semantic, acoustic, orthographic, and a number of other attributes (Underwood, 1969; Wickens, 1970). Multistore theorists have attempted to identify these attributes with the separate memory stores. Acoustic information has been identified with short-term store, whereas information in long-term store is said to be primarily semantic in nature. Attempts to verify this distinction empirically have met with varying degrees of success (for a review, see Shulman, 1971). There is an additional conceptual problem if it is assumed that information enters long-term store by passing through short-term store. In this case, it would appear impossible for semantic information to enter long-term store if only acoustic information is contained in short-term store.

Multistore theories focus on the nature of the stores and assign a secondary role to memory attributes; differences in retention of the separate attributes can be related to the store with which they are associated. An alternative approach would be to disregard the separation of memory into stores and focus on differences in selection and retention of attributes. Selection of attributes for inclusion in the memory trace might depend on a number of factors including study time restraints (Shulman, 1970) and anticipated recall requirements (Jacoby & Bartz, 1972). With a rapid rate of presentation, there may be insufficient time for semantic processing so that stored information is primarily acoustic. Acoustic information might be sufficient to allow recall immediately after presentation so that a subject is likely to follow the rule of least effort and not store semantic information unless a delayed test of recall is anticipated. Past research suggests that semantic information is better retained (Cermak, Schnorr, Buschke, & Atkinson, 1970) and can be used as a basis of organization across a wider range of conditions (Bruce & Crowley, 1970) than acoustic information.

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The latter result suggests that semantic and acoustic information differ in terms of conditions governing their retrievability. The focus on attribute selection and retention is in keeping with the recent emphasis on control processes in short-term store (Atkinson & Shiffrin, 1968) and an approach described by Craik (in press).

Incidental learning techniques provide a means of investigating attribute selection and retention. In studies of incidental learning, subjects are not instructed to learn but are required to engage in a task (orienting task) to insure that they perceive the presented material. Variations in activity required by this orienting task can be employed to manipulate attribute selection, and retention differences can then be evaluated. A task requiring attention to the semantic attribute might produce higher retention than one requiring attention to the acoustic attribute, demonstrating superior retention of semantic information. If semantic information is better retained, it seems likely that subjects would code incoming information in this form when they are instructed to learn. Postman (1964) has made essentially the same point by noting that activities required by the orienting task may be of varying similarity to those most conducive to learning. An orienting task that requires attention to the semantic component might then be expected to produce a level of retention that is equivalent to that of subjects instructed to learn.

Hyde and Jenkins (1969) presented a list of high strength primary word associations and varied the orienting task employed in incidental learning conditions. When the orienting task required attention to the meaning of presented words, recall and associative clustering were equivalent to those of an intentional learning condition with no orienting task. Both recall and associative clustering were greatly reduced when attention to meaning was not required by the orienting task. However, these results do not necessarily imply a general superiority of semantic coding. Had presented items been acoustically rather than semantically related, there might have been no difference between an intentional learning condition and an incidental one that engaged in a task requiring attention to the acoustic properties of presented words. That is, the important factor might simply be the correspondence of the attribute emphasized by the orienting task and that along which relationships among items are most easily established.

The purpose of the present experiments was to provide evidence of differences in retention or retrievability of semantic and acoustic information. The general procedure was to employ an orienting task to bias toward one of the two types of coding and then measure retention. In the first experiment, subjects in two conditions were required to detect the presence of semantic relationships among presented words while those in a third were instructed to detect acoustic relationships Search for a particular type of relationship was expected to bias coding toward the attribute on which the relationship was based. For example, semantic coding was expected to dominate when subjects were searching for semantic relationships. Intentional learning conditions were presented with the same lists of words but subjects were instructed to learn and did not engage in an orienting task.

Experiment I

Method

Lists and materials. Each of three 60-word lists contained 15 pairs of related words and an equal number of pairs selected to be unrelated both acoustically and semantically. The type of relationship between members of a related pair was constant within a list and one of the three types: category, category name, or acoustic. Category pairs were constructed by choosing two of the five most frequent instances (for example, *knife-gun*) from each of 15 categories listed in the norms of Battig and Montague (1969). To construct category name pairs, a one-word name was chosen to describe each category and substituted for one member of the pair representing that category (for example, *weapon-gun*). To form acoustically related pairs, one member of each category was replaced by a word that rhymed with the remaining member (for example, *sun-gun*); it was necessary to depart from this procedure on two occasions because of the impossibility of finding a high frequency rhyming word for either member of a category pair. In all cases, members of an acoustically related pair differed only in their initial letter so that they were similar in spelling as well as in sound.

Words combined to form the 15 unrelated pairs were chosen from 30 additional categories; one word was selected from the five most frequent instances of each category. In selecting these words, an attempt was made to minimize semantic and acoustic similarity both within (for example, *house-book*) and between pairs. This set of unrelated pairs was common to the list containing category pairs and the one containing pairs of acoustically related items. For the category name condition, one word in each of the unrelated pairs was replaced by the name of the category it represented (for example, *building-book*).

Within a list, the order of related and unrelated pairs was randomly determined. The order of members within a pair was also randomly determined in the category and acoustically related lists. In the category name list, the presentation of the category name always preceded that of the category instance.

Procedure. Words were prepared as slides and presented individually at a 3-sec rate with members of a pair being presented successively. Prior to presentation, all subjects were informed that they were to be shown a list composed of pairs and that a portion of those pairs would contain related words. The nature the relationships contained in the list they were to receive was also specified. For example, subjects that were to receive acoustically related pairs were told that the words in some pairs would sound alike. The subjects in intentional learning conditions were not required to engage in an orienting task but were informed that they would be tested for recall. The subjects in incidental learning conditions were informed that they were to judge the presence or absence of the specified relationship for each pair in the list; they were not informed of the impending recall test.

For incidental subjects, a response box containing two buttons was provided; subjects were instructed to press the right button to indicate the presence of the relationship and the left button to indicate its absence. For example, subjects that were to receive acoustically related pairs were told to press the right button if two words in a pair sounded alike and the left button if they did not. Operation of a Hunter timer was initiated by the onset of the second item in each pair and stopped by the depression of either response button. Lights visible to the experimenter indicated a subject's decision, allowing the decision and its latency to be recorded. The subjects were allowed to practice with the response box until they became familiar with its operation; however, they were not informed that the latency of their decisions would be recorded.

After presentation of the list, all subjects were read five sets of nine digits formed by randomly arranging the digits 0 through 9, and asked to recall each set immediately after its presentation. The purpose of the digit recall task was to eliminate any short-term memory of list words. Next, subjects were asked to recall as many list words as they could. Recall was written with no maximum time limit on the recall period; a minimum of 5 min attempting recall was required.

Design and subjects. Two levels of learning instructions (Incidental and Intentional) were factorially combined with three types of relationships between pair members (Category, Category Name, and Acoustic) to form six between-subjects conditions. The factorial combination of two degrees of relationship between members of a pair (related and unrelated) and two positions within a pair (First and Second) were represented within-subject.

The subjects were 72 students in an introductory psychology class who participated for course credit; 12 subjects were randomly assigned to each of the combinations of learning instructions and relationship type. All subjects were tested individually.

Results and discussion

Decision accuracy and latencies. Decisions in the incidental conditions were generally accurate. Probabilities of recognizing related pairs as being such were .87, .95, and .96, for the category, category name, and acoustic conditions. In the same order, mean probabilities of a correct decision for unrelated pairs were: .96, .99, and .97. The latency of correct decisions for related pairs (1.78 sec) was shorter than that for unrelated pairs (1.89 sec), $F(1, 33) = 18.74, p < .001$. Relationship type also had a significant, $F(1, 33) = 4.27$, $p < .05$, influence on decision latency. In accord with the claim that acoustic processing is accomplished more rapidly, mean decision latency in the acoustic condition (1.72 sec) was shorter than that in either the category (1.94 sec) or the category name (1.85 sec) conditions.

Recall collapsed across intentional versus incidental learning. Regardless of incidental versus intentional learning instructions, semantically related words should be recalled better than acoustically related ones if semantic coding is more effective for delayed recall. Differences in type of related pairs contained in a list might also bias the coding of items in unrelated pairs and thereby influence their recall. For example, items in unrelated pairs might be coded acoustically when presented with acoustically related pairs and their recall might suffer accordingly.

Means from the interaction of related versus unrelated pairs with relationship type are presented in Table 1. Analyses revealed significant main effects of related versus unrelated pairs, $F(1, 66) = 69.03, p < .001$, and type of relationship, $F(2, 66) = 14.97, p < .001$; means for these effects appear as column and row means in Table 1. The interaction of degree and type of relationship was also highly significant, $F(2, 66) = 10.03$, $p < .001$. Although differences were in the same direction, the effect of relationship type was significant among related pairs, $F(2, 66) = 19.31, p < .001$, but not among unrelated ones. Related pairs were better recalled than unrelated pairs in the category, $F(1, 66) = 38.10$, and the category name, $F(1, 66) = 49.77$, both $ps < .001$, conditions but not in the acoustic condition. The effect of degree of relationship in the acoustic condition will be further described in conjunction with the effects of incidental versus intentional learning instructions.

TABLE 1

Recall Probability as a Function of Type and Degree of Relationship Within a Pair

Degree	Relationship type: Category	Category name	Acoustic
Related	.40	.41	.21
Unrelated	.24	.22	.18

Degree of relationship interacted significantly, $F(1, 66) = 5.71, p < .05$, with position in a pair. The probability of recalling the first item in a related pair (.36) was higher than that of recalling the second (.33); the pattern of results was opposite (.20 versus .22) in recall of unrelated pairs. The superior recall of the first member of a related pair was representative of the acoustic (.24 versus .18) and to a lesser extent the category name condition (.42 versus .40), but not characteristic of the category condition (.40 versus .41).

The mean number of intrusions in recall was slightly higher in the acoustic condition (4.5) than in either the category (.92) or category name (1.17) condition, $F(2, 66) = 3.93, p < .05$. The majority of the intrusions in the acoustic condition (58 %) were contributed by two of the 24 subjects in that condition.

Incidental versus Intentional learning. The interaction of incidental versus intentional learning with relationship type was of primary interest. Earlier studies have found no effect of intentional learning instructions when items are semantically related and the orienting task requires attention to the semantic attribute. If retention of acoustic information does not differ from that of semantic, there should also be no effect of incidental versus intentional learning in the acoustic condition of the present experiment. In both the semantic and acoustic conditions, the dimension along which items were most easily related corresponded with that emphasized by the orienting task. Among the unrelated pairs, neither the main effect nor any interaction of other variables with instructional condition approached significance. In the acoustic condition, degree of relationship had no effect with incidental learning instructions. With intentional learning, the mean probability of recalling acoustically related pairs (.28) was higher than that of recalling unrelated pairs (.19), $F(1, 66) = 5.39, p < .025$.

Four dependent measures were employed in assessing the effect of relationship type and instructional condition in the recall of related pairs. Means for each of these measures are presented in Table 2. Mean recall probabilities are displayed in the first row of that table. With both incidental and intentional learning, recall of category and category name pairs was higher than that of acoustic pairs. In the acoustic condition, intentional learning produced higher recall than did incidental, $F(1, 66) = 6.64$, $p < .025$. The effect of incidental versus intentional learning did not approach significance in either the category or the category name conditions, both Fs < 1.

TABLE 2

RETENTION MEASURES FOR RELATED PAIRS AS A FUNCTION OF RELATIONSHIP TYPE AND INCIDENTAL (Inc) VERSUS INTENTIONAL (Int) LEARNING

	Relationship type					
	Category		Category name		Acoustic	
Measure	Inc	Int	Inc	Int	Inc	Int
Recall prob.	.39	.42	.41	.42	.14	.28
Category recall	6.58	6.83	6.50	6.75	3.08	5.58
Items/category	1.80	1.85	1.88	1.89	1.43	1.57
% Clustering	.69	.73	.77	.86	.30	.53

Mean category recall for each condition is presented in the second row of Table 2. Recall of either one or both members of a related pair was scored as a recall of one category. In the analysis of these data, the main effect of relationship type was significant, $F(2, 66) = 10.72$, $p < .001$; category recall in the category and category name conditions was higher than that in the acoustic condition. Intentional learning produced higher recall than did incidental learning in the acoustic condition, $F(1, 66) = 9.24$, $p < .005$, but did not increase performance in either the category or the category name condition, both Fs < 1.

Mean item per category (IPC) recall is shown in the third row of Table 2. An IPC score was computed for each subject by dividing the total number of words recalled from related pairs by the number of categories represented in that recall. As in prior analyses, performance of the category and category name conditions was superior to that of the acoustic condition, $F(2, 66) = 27.17$, $p < .001$. In the acoustic condition, the IPC recall produced by intentional learning instructions was numerically larger than that produced by incidental learning; however, the difference was not significant, $F(1, 66) = 2.39$, $p < .10$. Again, the effect of incidental versus intentional learning did not approach significance with either of the other two types of relationships, both Fs < 1.

The last row of Table 2 contains mean percentage clustering scores for each combination of relationship type and instructional condition; the percentage clustering score is the same as that employed by Hyde and Jenkins (1969). Successive recall of members of a related pair, in either a forward or a backward order, was scored as a cluster. Recall of at least one member of a pair (recall of a category) was considered an opportunity for clustering. Percentage clustering was then determined for each subject by dividing the number of clusters by the number of opportunities for clustering. The pattern of results with percentage clustering scores was identical to that found in earlier analyses. Percentage clustering was higher in the category and category name condition than in the acoustic condition, $F(2, 66) = 21.20$, $p < .001$. Intentional learning instructions increased clustering in the acoustic condition, $F(1, 66) = 6.56$, $p < .05$, but had no significant effect in either the category or the category name condition.

It appears that semantic coding is more effective for later recall and in some way a superior basis of organization. The advantage of semantic (category and category name) conditions in number of categories recalled provides evidence that an item is more likely to be recalled if it has been coded semantically rather than acoustically. As reflected by item per category and percentage clustering scores, semantic relationships aided retrieval to a larger extent than did acoustic ones. The latter result could reflect a difference in degree with the two types of relationships; similarity of related items may have been higher in the semantic conditions. However, decision accuracy and latency results obtained in incidental conditions do not suggest that this was the case. Acoustic relationships were recognized at least as accurately and with a shorter latency than were semantic relationships.

With regard to incidental versus intentional learning, correspondence of the attribute emphasized by the orienting task and type of relationship was not the important factor. Results from conditions required to engage in semantic processing were in agreement with those reported by Hyde and Jenkins (1969). Merely noting that two items were semantically related was sufficient to produce organization of those items and aid recall. Additional activity, if any, engaged in by intentional learning subjects was not reflected in their performance. There was the same correspondence of orienting task and relationship type in the acoustic condition as in the semantic ones. However, recall of acoustically related items was enhanced by intentional learning instructions. With incidental learning, recall of acoustically related items did not exceed that of unrelated items. Additional processing that accompanies intentional learning instructions appears necessary for acoustic relationships to aid retention.

Greater semantic coding under intentional learning instructions could be used to explain the increase in number of words and categories recalled. It is difficult, however, to see how greater semantic coding could account for the observed increase in item per category recall and associative clustering. Regardless, the present experiment has demonstrated a difference in conditions conducive to organization on a semantic and on an acoustic basis.

Experiment II

Members of an acoustically related pair in Experiment I were similar in spelling as well as in sound; they differed only in the initial letter. This confounding of acoustic and orthographic similarity gives rise to at least two problems in interpretation. First, it could be argued that subjects in incidental conditions did not pronounce the presented words. Although they were instructed to judge acoustic similarity, requirements of the judgment task could have been satisfied by comparing the spelling of words in a pair. The subjects in intentional learning conditions may have been more likely to pronounce the presented words and note acoustic similarities. Thus, incidental versus intentional learning instructions might not have influenced the effectiveness of acoustic similarity once noted but rather the probability of that similarity being noted initially. There may have been no effect of incidental versus intentional learning if words in acoustically related pairs had been dissimilar in spelling, making pronunciation necessary for incidental subjects. Alternatively, orthographic similarity or the combination of acoustic and orthographic similarity might have been responsible for the results of Experiment I. There might have been no recall advantage for related pairs with either incidental or intentional learning had it not been for orthographic similarity.

Method

A 60-word study list contained 15 pairs of acoustically related and an equal number of pairs of unrelated words. Acoustically related words were selected to be similar in sound but dissimilar in spelling. Examples are: *waist-taste*, *flower-hour*, *pain-reign*. As illustrated, one word in each pair held a homonymic relationship with an unpresented word (e.g., *waist*; *waste*). Spelling of the unpresented homonym differed only in the initial letter from that of the nonhomonymic member of a pair (for example, *waste*; *taste*). This procedure was emplyed to equate degree of acoustic similarity with that employed in Experiment I. The unrelated pairs and presentation order of related and unrelated pairs were the same as those employed in the first experiment. Position of words within pairs was randomly determined.

With the addition of a third group, the procedure was identical to that of the acoustic conditions in Experiment I. The third condition was given intentional learning instructions and also required to engage in the orienting task. Thus, the three conditions were: incidental-orienting task, intentional-orienting task, and intentional-no orienting task. The subjects were 42 volunteers from an introductory psychology class;

14 subjects were randomly assigned to each of the three conditions.

Obvious misspellings of a presented word and recalls of the unpresented member of a homonym pair were scored as correct responses. The latter type of error was relatively infrequent, occurring five times in the intentional condition without an orienting task and once each in the other two conditions. Dependent measures employed in the second experiment were the same as those employed in the first. Category recall, item per category recall, and percentage clustering scores were computed separately for related and unrelated pairs. Words in an unrelated pair were considered as members of the same category for purposes of these analyses; recall of at least one member of an unrelated pair was scored as a recall of one category.

Results

Decision accuracy and latencies. Decisions required by the orienting task were generally accurate. Probabilities of recognizing a related pair as being such were .98 and .99 in the incidental and intentional conditions, respectively; probabilities of a correct decision to an unrelated pair were also .98 and .99 for these same conditions. The latency of a correct decision to a related pair (1.76 sec) was slightly shorter than that to an unrelated pair (1.81 sec), $F(1, 26) = 3.20$, $p < .10$. Correct decisions were made with a shorter latency in the incidental condition (1.72 sec) than in the condition instructed to learn (1.85 sec), $F(1, 26) = 7.71, p < .025$.

If decisions were based on orthographic information in the first experiment and acoustic information in the second, decision latencies might be expected to be longer in the second experiment. However, a difference in decision latencies of this type was not obtained. Mean decision latency of the incidental condition in the second experiment was identical to that of the corresponding condition in Experiment I.

Retention measures. In Experiment I, recall of acoustically related pairs was higher than that of unrelated pairs only in the intentional learning condition. It was suggested that this result might have been due to items not being pronounced under conditions of incidental learning. If so, there should be no effect of incidental versus intentional learning in Experiment II since pronunciation was required to satisfy requirements of the orienting task. Alternatively, the advantage of related pairs in Experiment I may have been due to the confounding of acoustic and orthographic similarity and be completely eliminated when orthographic similarity is reduced.

Retention measures from the second experiment are displayed in Table 3. Comparing conditions that were also included in Experiment I, the most striking feature of those results is the nearly complete absence of an effect of related versus unrelated pairs. Intentional learning instructions with no orienting task did enhance performance as compared to incidental learning; however, the effect was as large for unrelated pairs as for related ones. With each of the retention measures, effects of incidental versus intentional learning were smaller than those observed in Experiment I. Related pairs held a

TABLE 3

RETENTION MEASURES FOR EXPERIMENT II

	Incidental		Intentional		Intentional-orienting	
Measure	Related	Unrelated	Related	Unrelated	Related	Unrelated
Recall prob.	.14	.14	.20	.21	.20	.16
Category recall	3.57	3.64	4.50	5.00	4.43	3.79
Items/category	1.21	1.23	1.31	1.31	1.31	1.27
% Clustering	.13	.10	.27	.20	.28	.12

consistent advantage only in the intentional learning condition that engaged in the orienting task, a condition not included in Experiment I.

Results of analyses provide general support for the description given above. The main effect of instructional condition was significant in both the analysis of recall probabilities, $F(2, 39) = 4.21$, $p < .01$, and that of category recall, $F(2, 39) = 3.89$, $p < .05$. Recall probability and category recall were higher in the intentional condition without an orienting task (.20, 4.75) than in either the other intentional condition (.18, 4.11) or the incidental condition (.14, 3.60). Mean percentage clustering for related pairs (.23) was slightly higher than that for unrelated pairs (.14), $F(1, 39) = 3.27$, $p < .10$, but still quite low. No other main effects or interactions approached significance.

It is unlikely that effects of incidental versus intentional learning in Experiment I were due to words not being pronounced in the incidental condition. Pronunciation would be required to judge similarity in Experiment II and mean decision latency was identical to that of Experiment I. Results of the second experiment also suggest that acoustic similarity alone may be insufficient to aid recall. Orthographic similarity appears to have played an important role in producing the results of Experiment I.

General Discussion

It appears that semantic information holds a special status for delayed recall. Both recall and clustering were higher in the semantic conditions of Experiment I, and instructing subjects to search for semantic relationships produced the same results as instruction to remember the presented words. In contrast, intentional learning instructions were necessary for acoustic relationships to aid recall; even this advantage disappeared when acoustically related items were chosen to be orthographically dissimilar. A first temptation might be to claim that these results are due to semantic information being contained in long-term store while acoustic information is placed only in short-term store. Intentional learning instructions then could have enhanced recall in the acoustic condition by encouraging subjects to code semantic information. This explanation appears equivalent to claiming that semantic and acoustic information differ in rate of forgetting. An alternative is that semantic and acoustic information are equally well retained but differ in retrievability. To the extent that retrieval is not required for recognition, there is some evidence (Cermak *et al.*, 1970; Craik, in press) that acoustic information is less available at the time of a delayed test. However, differences in retrievability might still play some role.

Clustering of related items during recall might measure the extent that recall of one member of a related pair is an effective retrieval cue for the other. If so, acoustic relationships did less to aid retrieval than did semantic relationships. A possible explanation is that subjects generally employ semantic retrieval cues but only rarely employ acoustic ones and these habits are brought with them into the laboratory. In this regard, studies of learning-to-learn with the two types of relationships would be of interest. It might be possible to train subjects to be equally effective in their use of semantic and acoustic relationships. A second possibility is that the use of a semantic retrieval cue differs from that of an acoustic one. Acoustic relationships might be used to restrict the number of alternative responses that need be considered as candidates for recall (Bower & Bolton, 1969). A recalled item could be used to generate acoustically similar ones that are then subjected to a recognition test; items that pass this test are given as overt responses. Accessibility provided by semantic relationships might be more direct. The mechanism involved in recall of semantically related pairs is seen as being similar to redintegrative memory as described by Horowitz and Prytulak (1969); recall of one item leads almost directly to the other. The use of acoustic relationships is viewed as involving a strategy on the part of the subject and does not require that acoustically related items be dependently stored during study.

The importance of orthographic similarity might be related to use of this generate-edit strategy. Acoustically similar words that are also similar in spelling are easier to generate than are words that are acoustically similar but orthographically dissimilar. This difference might influence the probability of the generate-edit strategy being employed or the success of that strategy if it is employed. The effectiveness of the generate-edit strategy would also depend on the subject's knowledge of when it is appropriate. This knowledge would be readily available if all words in a list were members of an acoustically related set (Nelson, 1969) or if only one set of acoustically related items was embedded in a longer list of words (Bruce & Crowley, 1970; Craik & Levy, 1970). In the first case, any recalled word could be used to generate additional list words. In the latter case, the set of acoustically related items is likely to be favored by an isolation effect that allows members of that set to be identified at the time of recall. The relative ineffectiveness of acoustic relationships found in the present investigations may have been due to the equal number of unrelated and related pairs contained in a study list. Attempting to use all recalled words as cues for the generate-edit strategy would probably not aid free recall. A list word could not be produced by generating items from a member of an unrelated pair, and the delay resulting from an attempt to do so might make it impossible to recall additional words that otherwise would have been accessible. The generate-edit strategy might not have been employed due to the inability of subjects to identify recalled items that were a member of a related pair. Coding that allowed members of related pairs to be identified as such could have resulted when learning instructions were given and been partially responsible for the recall and clustering advantages of intentional learning.

Present theories that divide memory into two stores could be replaced by a theory of memory attributes. A listing of attributes is a first step toward such a theory. A task of equal importance is the specification of interdependencies among attributes and differences in rate of forgetting and retrievability. It is felt that procedures that relate task demands to processing and retention will provide progress toward these goals.

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