AMERICAN JOURNAL OF PSYCHOLOGY
June 1981, Vol. 94, No. 2, pp. 209-222

0002-9556/81/0600-0209$01.40/0

Coordinate organization: The holistic representation of word pairs

George Mandler
University of California, San Diego

Jan C. Rabinowitz
Erindale College, University of Toronto

Robert A. Simon
University of Minnesota

The proposition that the preferred mode of representing and storing word pairs is in a coordinate, holistic fashion was explored in free recall, cued recall, and recognition tests. Subjects were given randomly paired nouns and tested for free recall of whole pairs, cued recall of one member of a pair given the other member, and recognition of old and new pairs and single items. All three tests indicated that the originally presented pairs had been stored as coordinate, holistic units. The major part of free recall was of intact pairs, and additional analyses indicated that retrieval of one member of the pair implicates the retrieval of the intact pair. Recognition of old pairs also involves more than the recognition of their component members. The data are related to other results with the paired associate paradigm and to a more general view of different structures that may be used in the storage and retrieval of syntactically unrelated memory units.

In a previous discussion of the types of organizational structures that are available for the organization of syntactically unstructured material, it was suggested that the preferred mode of structure for event pairs consists of a holistic, coordinate organization of the pair (Mandler, 1979a). The present paper explores the implications of that position for the acquisition of word pairs.

After a hiatus of a decade or so, while free recall reigned supreme, the last half dozen years have seen a revival of interest in the acquisition of event pairs. The paradigm has also undergone successive changes in name, as investigators have attempted to keep pace with changing fashions. What used to be called paired associate learning, using the designations of S and R to describe the members of the pair in the associationist tradition, then switched to the more neutral terms of A and B as associationism declined in popularity. The next step was the switch to the LC and TBR terminology, a step which seemed to be aimed at making the paradigm a very general one for memory search with lists. List cues (LCs) and to-be-remembered (TBR) items have the flavor of neutral and pervasive generality. Finally, the current fashion is to describe the terms as *context* and *target,* partly in response to the growing realization that contexts play an important role in memory retrieval. The present fashion is to call the left-hand member the context and the right hand member of the pair the target, though it is difficult in light of previous research to justify such a distinction in terms other than the particular mode of testing that is used. However, when all is said and done, we are back where we started with the same old paired associate paradigm. The major interest in presenting the data described here is to provide some baseline observations on the behavior of event (word) pairs. We shall have occasion to revisit some old controversies and to remind the reader that the paradigm is limited in applicability, that it has been well researched in the past, but that it still provides some interesting insights into the representation of memorial events.

The fashion of changing labels for an unchanging research paradigm also reflected theoretical biases about the event pair problem. When it was still called an S-R pair, the hope was that the data would illuminate stimulus-response learning in the human. One of the implications — and findings — that arises from such a bias is that it should be easier to produce a response given a stimulus than vice versa. The expectation was self-fulfilling in part because the pairs were typically acquired by presenting the S item and asking the subject to anticipate the R item. At the very least the pairs were typically shown successively in a left to right (S to R) fashion. Backward (R to S) evocation probabilities were usually low, thus "demonstrating" little backward learning or conditioning.

This S-R position was attacked vigorously from a Gestalt point of view by Asch and his associates. They argued that associations are established simultaneously and equally between two terms (see Asch & Ebenholtz, 1962). In the succeeding years various demonstrations showed that backward learning could, under some circumstances, be as hardy as forward learning of word pairs. The conclusion was that backward and forward learning were indeed symmetrical (cf. Murdock, 1966). Our argument is orthogonal to symmetry, namely that word pairs are encoded as a unit (see also Rabinowitz, Mandler, & Barsalou, 1977; Mandler, 1970, 1979 a, b; 1980). As a result of the holistic encoding, testing the various pairs for recall will give the appearance of associative symmetry; A items can access B items as easily as B items can access A items. However, the underlying basis for such symmetrical performance is not an associative mechanism of symmetry, but rather the unitary, holistic representation of the word pair. Thus, once one abandons the learning (conditioning) paradigm, different kinds of representations can be envisaged and explored.

One of the earlier papers that reported evidence of subjects' attempts at unitizing the word pairs was a paper by Bugelski (1962). Bugelski reported the kinds of mediators used by subjects in trying to acquire word pairs, including forming a single word, a phrase, etc. Increasingly, it became apparent that instructing people to form single unit representations (e.g., visual images) significantly improved word pair performance (see for example Bower, 1972).

In a previous paper (Mandler, 1979a) three structural mechanisms were proposed for the organization of lists, i.e., memorial material that is not schematically or syntactically organized (cf. J. M. Mandler, 1979). These three types of structure are: (a) subordination — where a set of items is organized under some superordinate node, (b) proordination — where the items are organized in a linear, serial fashion, and (c) coordination — where two or more items are organized in a holistic unit. It is not proposed that these three structural representations are isomorphic with three kinds of tasks (e.g., lists, serial, and paired associates). Rather the tasks tend to encourage, as a function of instructions and retrieval requirements, one or another of these representations. Typically, all three kinds of structures are used in all tasks to some extent.

In the data presented below we are interested in the behavior of word pairs in response to three experimental paradigms: free recall, cued recall, and recognition. In order to investigate the representation (and retrieval) of pairs, the instructions will not be biased toward a serial, left-to-right ordering of the pair, but subjects will be instructed to store the pair so that if given one member they can retrieve the other one. The pairs themselves will be unbiased random pairings of words.

METHOD

Each subject studied three lists of 24 word pairs each. Following the presentation of each list three memory tasks were completed: free recall, cued recall, and recognition. The order of these three tasks was counterbalanced so that each task was given in each of the three testing positions equally often for each of the three lists.

Subjects

One hundred forty-four undergraduates at the University of California, San Diego, participated in the experiment for course credit. They were run in groups of 24 subjects. The experiment lasted approximately 1½ hours.

Materials

Six unique lists of 24 word pairs were constructed from a master list of nouns, three to six letters in length. The assignment of words to lists and specific word pairs was random. The stimuli were typed on slides, in capital letters. They appeared in the standard left-right paired associate format with a hyphen between the two members of the pair. Each subject saw three lists — either lists 1, 2, and 3, or lists 4, 5, and 6. The order of list presentation was counterbalanced so that each list was seen in each nominal list position an equal number of times across subjects.

Tasks

Free recall

Subjects were asked to recall as much of the list as they could. They were given a sheet of paper containing 4 columns, labeled A-B, A, B, and ?. All intact pairs were to be listed in the A-B column. If any single items were recalled, they were listed in either the A or B column, depending on the position in which the item had initially been presented. If the subject was uncertain of its position in the pair it was listed in the ? column.

Cued recall

For half of the pairs on each list subjects were asked to recall the B member, given the A member as a cue (A-?). This is referred to as forward recall. The other half of the pairs were tested for backward recall (?-B). The type of recall required for each pair was obvious from the presentation format, as in MOVE-?. Each pair was tested on a separate slip of paper. The 24 slips were arranged haphazardly (pseudorandomly) for each subject and stapled into booklets. Two tests were constructed for each list so that each pair was tested for forward recall and backward recall equally often.

Recognition

The recognition test required recognition of both single items and pairs. Recognition of single items always specified an item's original location in the pair (MOVE-xxxx or xxxx-BUILD). Subjects were informed that single items had either appeared in the position specified, or had not been presented at all. When pairs of items were presented in the recognition test, subjects were instructed to respond "old" only if both words were presented together in the input list. There were three types of new pairs — new-new, old-new, and new-old. There were no pairs in which both members were old and had been re-paired or in which an old word appeared in the wrong position. Of the 24 pairs in the original list, the A items from six of the pairs were tested alone and the B items from six of the pairs were tested alone. Six of the pairs were tested intact. The remaining six pairs were used to construct the mixed pairs. Three of these pairs contributed their A member to form old-new pairs while the B member of the remaining three pairs was used to construct three old-new pairs. The distractor items were taken from the corresponding pairs from the set of lists not shown to those subjects (e.g., distractor items for list 1 came from list 4, and those for list 4 came from list 1). The same procedure was followed for the other two sets of lists. The distractors included six single new items in the A position, six new single items in the B position, and six new pairs. Three A and three B distractors were also used to create the new-old and old-new pairs. Thus the recognition test had 42 test pairs, 18 of which required "old" responses while the remaining 24 required "new" responses. Each of the 42 test pairs was typed on a separate slip of paper along with the words OLD and NEW for the subject's response. These sheets were pseudorandomly arranged and stapled into a recognition test booklet for each subject. Four versions of the recognition test for each list were prepared so that each pair was tested in each of the four major conditions (A alone, B alone, A-B pair and mixed pair — old-new or new-old) equally often in each list and test position, across subjects. However, when a pair appeared in the mixed pair condition (old-new or new-old) it appeared in only one of the two subconditions, not both.

Procedure

At the start of the experimental session, subjects were given a detailed set of instructions detailing the nature of each of the three tasks. They read through the instructions along with the experimenter, who then answered any questions. Each subject was then given a packet of experimental materials. This packet contained the three test booklets for each of the three lists. Subjects were instructed to be sure to do the three tasks for each list in the order in which they were specified. The pairs in each list were presented for 4 sec each with an ISI of approximately ½ sec. The pairs were presented with a Carousel projector, with each slide showing a word pair, typed in capitals and separated by a hyphen. Following the presentation of each list, subjects completed all three memory tasks. Each task was self-paced and subjects were allowed unlimited time to complete each task. Each of the three tasks was preceded by approximately 3 min of simple math problems. Thus there was a buffer task between the presentation of each list and the first memory task and between each of the subsequent tasks.

RESULTS

It will be recalled that each of the 144 subjects received three lists, each of which was followed by a counterbalanced order of the three tests. For purposes of analyses we will present only those data in which each particular retrieval test was the first one tested (i.e., test position 1). Thus for each particular subject we present the data from the list on which he or she received the recall, cued recall, or recognition test first. Analyses of variance were performed for each of the dependent measures shown in Tables 1 to 3. For none of them was there any significant effect due to lists, list order, or their interaction. These variables will, therefore, be ignored in the discussion of the results. In order to assure that the data presented are not due to any

Table 1. Mean number of items, standard deviations, and probabilities of (free) recall

Item type	Mean[b]	S.D.	Probability
A-B	5.201	3.056	.217
A	.715	1.072	.030
B	.625	.911	.026
A?[a]	.535	.787	.022
B?	.542	.681	.023
Total	7.618		.318

[a] The ? indicates correct recall of single items where the subject could not recall their position in the pair.
[b] Each mean is based on recall out of 24 pairs for 144 subjects.

interaction with test order, since when a given task occurred in test position 1 it would for some subjects be the second or third list tested, we also performed analyses of variance on the complete data set. Only 5% of all the possible main effects and interactions were statistically significant, and most of these involved test position which is of course not a variable in the data used here. In addition we examined the data for each dependent variable on the first task of the first list for each subject. The pattern of the data was indistinguishable from that presented here.

Recall

Table 1 shows the results for the (free) recall test. Of the different kinds of events recalled, intact correct pairs were clearly the predominant ones. Out of the mean number 7.618 items recalled, 68.3% were complete pairs. No pair was recalled in the incorrect sequence (B-A). The data also show another indication of the spatial representation of the pairs. Only 14.1% of the recalls represented items with no knowledge of their proper spatial position (the A? and B? items).[1]

There were relatively few intrusions in the recall protocols. The mean number of intrusions per subjects was less than one — .791. This represents only 9.4% of the total number of items recalled. The most frequent kind was an intrusion without indication of spatial position (mean = .229, probability out of total number of items produced = .027). The least frequent intrusion was an intact pair, both of whose members were not on the original list (mean = .014, probability = .002).

Cued recall

Table 2 shows the results for the cued recall test. Backward and forward recall were obviously equivalent at about .43. The percentage of correct out of all recalls was 74.4%. In other words, given a cue the number of intrusions is much larger than it is in free recall (26.6% in cued vs. 9.4% in free recall). One may assume that the intrusions were probably related to the target items, but given the idiosyncratic concepts that subjects are likely to generate for these random word pairs, it is not possible to determine the semantic relatedness of the intrusions. However, there exists some evidence that intrusions in cued recall are semantically related to the encoded unit (Roediger & Adelson, 1980).[2]

Recognition

Table 3 shows the recognition results for hits and the various kinds of false alarms. Hit rate for intact word pairs is higher (.859) than for either member of the pair, which in turn are equivalent (.764 and .772).[3] One of the interesting aspects of the false alarm data is that word pairs that consist of two new items are practically never called old (.060). On the other hand, single new items are called old three to four times as often (.181 and .232). It is presumably more likely that a single new word would lead to the erroneous identification of a pair as stored, than would a pair of new words. The notion that what is recognized is an old *pair* is also supported by the observation that new words paired with old words (A-B′ and A′-B) are called old less often than single new words.

Conversely, it can also be shown that the recognition of a pair does not involve some simple combination of the recognition of the two members of the pair, but that some other information is required.

Table 2. Mean number of items, standard deviation, and probabilities of cued recall

Item type	Mean[b]	S.D.	Probability
A-	5.250	2.924	.438
-B	5.118	2.835	.427
A-B′[a]	1.715	2.340	.143
A′-B	1.847	2.247	.154

[a] The prime sign (′) indicates that subjects recalled an incorrect second member to the cue.
[b] Each mean is based on 12 pairs for 144 subjects.

Table 3. Mean number of items, standard deviations, and probabilities for recognition

Item type	Mean[b]	S.D.	Probability
Hits			
A-B	5.153	1.171	.859
A	4.583	1.357	.764
B	4.632	1.291	.772
False alarms			
A'-B'[a]	.361	.805	.060
A'	1.083	1.168	.181
B'	1.389	1.341	.232
A-B'	.438	.698	.146
A'-B	.361	.646	.120

[a] The prime sign (') indicates that the item was a distractor.
[b] Except for the last two rows, each mean is based on six pairs for each of 144 subjects; the last two rows are based on three pairs.

If we compute the probability of calling a pair old on the assumption that it is called old as a result of the additive and independent recognition of the two constituent items, we arrive at a predicted hit rate of .946, when the actual level is .859. Applying the same reasoning to the false alarms for new A-B pairs, we arrive at an overestimation of the false alarm rate at .371, when the actual false alarm rate is .060. If one wishes to assume an independent storage of the two constituent items, then the expected (joint) probabilities would be .590 for the hit rate and .042 for the false alarm rate.

DISCUSSION

The results from all three kinds of retrieval tests support, in different ways, the notion that word pairs are encoded and retrieved as a unit. The majority of free recalls was of pairs, while there were essentially no intrusions of totally incorrect pairs which, theoretically, should not be represented in storage at all. We shall return shortly to a conditional analysis that will show that retrieval of any one item in free recall implicates the retrieval of an intact pair. The recognition data also indicated that the recognition of intact old pairs involves something other than the mere recognition of its component units.

If what is stored, i.e., what is represented in memory, is some representation of the pair as a unit, then retrieval of one part of the unit should provide automatic retrieval of the other part. Conversely, if the task presents the subjects with one member of the pair, then retrieval of the whole unit is still required; the single member is a cue for the retrieval of the whole unit. This kind of contrast occurs in free and cued recall. In the former, no part of the pair is given to the subject, but if one of the members of the pair is retrieved, the whole unit should be available for output. In cued recall, even though one member of the pair is "given," the subject still needs to retrieve the whole pair. On the other hand, cues in cued recall should provide better access to the pair; no such direct cue is given in free recall. This argument predicts that recall of the pair should be worse in free recall than in cued recall, but that conditional recall of the other member of the pair should be better in the free recall than in the cued recall task.

The data show exactly this differentiation. The probability of recalling a pair of words is only .217, and the probability of recalling a complete or partial pair (two or one words from a pair) is only .318. In contrast, cued recall from the A and B items is .438 and .427, respectively. However, the probability of accessing B or A in free recall, given that A or B were *recalled at all* (in pairs, alone, or mispaired), is .791 and .801, respectively. Thus, retrieval of an item provides a high probability that the whole pair is retrieved, while presentation of an item (cueing) shows a much lower probability of accessing the other member of the pair.

In free recall the subject can retrieve any pair, and once a pair is accessed, it is likely that — given the output of one member of the pair — both items that constitute the pair will be produced by the subject. In cued recall, we require the production of a specific pair given the presentation of one of its members. In one case, the experimenter selects which pairs must be retrieved; in the other case, the subject's retrieval schemas and strategies determine which pairs are retrieved. Thus, it will necessarily be the case that the conditional probability of producing the other member given one member of the pair will be high for free recall. In cued recall, all pairs are tested and some of these cannot be accessed. Therefore, the probability of producing the second member, after the first member of the pair has been *given to* the subject, will be lower than in free recall.

There is a possible item selection artifact in these data that deserves further exploration. It is possible that the pairs recalled in free recall are easily recalled word pairs, while in cued recall all pairs (i.e., easy and difficult ones) are tested. It would be simple to test this possible artifact if there were some pairs that are and others that are not recalled in free recall. Actually all pairs were recalled by some subjects. However, some pairs were recalled more frequently than others in the intact form, and the following test of the item selection possibility was performed. For each of the 6 lists the 24 word pairs were ordered from easy (most frequently recalled) to difficult (least frequently recalled) and the resulting distribution was divided at the median or as close to the median as possible. On the average, the easy half of the lists had a recall probability of .36; for the difficult half it was .12. We can now compare easy and difficult sets of pairs for the probabilities of cued recall, as well as for the probability of recalling the second member of the pair, given that the first member is recalled. The six lists showed comparable data in this respect and were combined for this analysis. The average cued recall for the easy half of the lists was .46; for the difficult half it was .37. In the free recall task, recall of the second member given recall of the first was .83 for the easy half and .66 for the difficult half. Thus, while there is some slight effect of item difficulty, it does not affect the general conclusions offered here. In fact, cued recall of the easy pairs (.46) is still considerably below the free recall retrieval of the second member of the pair for the difficult pairs (.66).

We have assumed that in cued recall the subject retrieves the whole pair, even though what is *required by the experimenter* is a response with just one member of the pair. An analogous and illustrative result is presented by Murdock (1974). Subjects were given short lists of word pairs (2 to 6 pairs long) and were probed for recall by ordinal position. The probability of correctly recalling both members of the pair was .487 (Murdock, 1974, Table 5.1, p. 129). Here the retrieval cue contains no "copy" of any part of the pair, and yet the retrieval probability is comparable to our "cued" recall data. Thus it is not the nature of the retrieval cue that is important, but rather the accessibility of the pair as a whole given some cue that is unique for that pair (in this case, either one of its members or its ordinal position).

There is another comparable aspect of Murdock's data. He showed that the probability of recalling one of the members of a pair given that the other one is recalled is .88 and .87 respectively for the two members of the pair. We have already noted the data from our free recall situation. We also found that the probability of recalling the second member of the pair, given that one is recalled, is near .80. Thus, the use of the ordinal position as a cue requires (or generates) not some partial retrieval, but rather retrieval of the whole pair, similar to the retrieval in free recall. The conditional probabilities, as a result, are similar for both free recall and ordinal position cueing. What subjects are recalling is not some single member of a pair;

rather they retrieve the whole pair and then output whatever the task requires.

There is an interesting parallel between the free recall and the cued recall situation in this paradigm and the partial cueing effect found in the free recall of single item lists (Slamecka, 1968). In the case of pairs, cueing with one member produces less retrieval of the other member than cueing with an item provided by the subject (as in free recall). If one considers the pair as a minimal list of length two, this effect replicates the partial cueing effect; i.e., giving subjects part of a list produces lower recall (of the remaining items) than giving them no cues at all. This finding suggests a reasonable explanation for the partial cueing effect. We indicated earlier that coordination may occur not just with word pairs, but can be found in any recall task that involves some concatenation of individual items. Thus, if some of the items in a list are coordinately (holistically) encoded, then presenting some of them as a cue for recall will produce less recall of the other member(s) of the unit than if the subject produces both items without cueing (as in our free recall situation). In brief, the locus of the partial cueing effect might well be found in the coordinate encoding of some of the items in a list.

Most of the alternative views of the representation of word pairs implicate some (usually directional) link between the members of the pair plus some independent representation of the memory trace of each member. Such a position requires that access to one member of the pair — by whatever means — should make the "link" available which then should access the other member. The probability of producing the second pair member should be unaffected by the way in which the link between the two is retrieved or accessed. Our data clearly speak against such a view, since the production of the second member of the pair (and the operation of some associative link) is markedly different in the free recall and the cued recall tasks.[4]

The results of this study generally support the notion that coordination is a form of representation used, at least frequently, in the storage of word pairs. In line with previous research and speculation, we may assume that the coordinate stored representation of a pair is characterized by some conjoint meaning of the pair, be it a visual image, a concept, a Klang association, or whatever. This argument is, of course, consistent with the finding that semantic factors play a role in mnemonic storage and that word pairs represent a better unit for retrieval purposes than single items (e.g., Roediger & Adelson, 1980). What is of interest is the further specification of how semantic features are used in different kinds of representations. We now know a little about coordinate and subordinate (categorical or hierarchical) structures. Much less is known about the structure of proordinate (temporally and spatially ordered) representations of unrelated items. In addition, we know relatively little about the factors that determine the use of one or another of these structural representations. And finally, these data once again emphasize the point that generalizations about human memory should not be based on unqualified categories of experimental methods. Such *methods* of testing memory as free recall, cued recall, and recognition will yield results that will vary extensively with the kinds of material presented, the kinds of representations used to store the material, and the instructions as interpreted by the subjects.

A corollary of this argument is the conclusion that different kinds of tasks will be differentially appropriate for testing specific theoretical notions. To the extent that a paired associate task engenders a predominantly holistic, coordinate encoding of the constituent word pairs, it may not be the task of choice to test the function of cues for specific lists. Categorically (subordinately) organized lists may, for some theoretical purpose, provide a better testing ground. The question that must be asked of the theory to be tested is what predictions it makes for the retrieval of different kinds of representations and structures. There are no all-purpose memory tasks, as there are no all-purpose theoretical structures for the representation of events in memory. That hope was abandoned when general purpose strength theories were found to be inadequate.

Notes

The research reported here and the preparation of this paper were supported by National Science Foundation Grant BNS 79-15336. We are grateful to George O. Goodman for advice and assistance. Requests for offprints should be sent to George Mandler, Center for Human Information Processing C-009, University of California, San Diego; La Jolla, CA 92093. Received for publication June 24, 1980; revision received October 14, 1980.

1. In the analyses of free recall, the production of an intact pair was scored as a single item. If we scored a pair as the recall of two items, we would be violating our theoretical analysis of the task, but increasing the recall probabilities even more in the direction of any predictions based on the holistic position.

2. In a separate study we found that the number of "intrusions" to new words presented for cued recall (A'- and -B') were much fewer than the intrusions to old items. Thus, number of new word responses to old items occurred 13.1% of the time, while responses to new words occurred 4.6% of the time. In other words, practically all the responses to new words are omissions. These data also suggest that incorrect responses to old single

words are words that "fit," since the baseline of responses to new words is much lower. It is interesting to note that recall and intrusion probabilities in this study were comparable to those in the main experiment. Thus, inclusion of new words as cues does not affect recall and intrusion performance.

3. The argument that recognition of pairs and members of a word pair is best represented by a model that assumes that familiarity and retrievability are additive variables has been presented in Rabinowitz, Mandler, and Barsalou (1977) and Mandler (1980). The data shown here were actually used to provide evidence for the model in Mandler (1980).

4. Our data were collected under instructions to the subjects that they should be able to retrieve one member of the pair given the other member. The holistic encoding that follows such instructions can, however, be manipulated. Begg (1978) used conditions that required either a unitary (interactive) mnemonic for the pair or a distinct (separate) mnemonic for each member of the pair. Cued recall was lower for the separate than for the interactive conditions (.08 vs. .51 in Experiment 1, and .50 vs. .84 in Experiment 2). A free recall test in Experiment 2 showed that 84% of the words recalled were recalled in intact pairs in the interactive condition, and a respectable 49% were recalled in pairs in the separate condition.

References

Asch, S. E., & Ebenholtz, S. M. The principle of associative symmetry. *Proceedings of the American Philosophical Society,* 1962, *106,* 135–163.

Begg, I. Imagery and organization in memory: Instructional effects. *Memory & Cognition,* 1978, *6,* 174-183.

Bower, G. H. Mental imagery and associative learning. In L. W. Gregg (Ed.), *Cognition in learning and memory.* New York: Wiley, 1972.

Bugelski, B. R. Presentation time, total time, and mediation in paired-associate learning. *Journal of Experimental Psychology,* 1962, *63,* 409–412.

Mandler, G. Words, lists, and categories: An experimental view of organized memory. In J. L. Cowan (Ed.), *Studies in thought and language.* Tucson: University of Arizona Press, 1970.

Mandler, G. Organization, memory, and mental structures. In C. R. Puff (Ed.), *Memory organization and structure.* New York: Academic Press, 1979. (a)

Mandler, G. Organization and repetition: Organizational principles with special reference to rote learning. In L.-G. Nilsson (Ed.), *Perspectives in memory research.* Hillsdale, N.J.: Erlbaum, 1979. (b)

Mandler, G. Recognizing: The judgment of previous occurrence. *Psychological Review,* 1980, *87,* 252–271.

Mandler, J. M. Categorical and schematic organization in memory. In C. R. Puff (Ed.), *Memory organization and structure.* New York: Academic Press, 1979.

Murdock, B. B., Jr. Forward and backward associations in paired associates. *Journal of Experimental Psychology,* 1966, *71,* 732–737.

Murdock, B. B., Jr. *Human memory: Theory and data.* Hillsdale, N.J.: Erlbaum, 1974.

Rabinowitz, J. C., Mandler, G., & Barsalou, L. W. Recognition failure: Another case of retrieval failure. *Journal of Verbal Learning and Verbal Behavior,* 1977, *16,* 639–663.

Roediger, H. L. III, & Adelson, B. Semantic specificity in cued recall. *Memory & Cognition*, 1980, *8*, 65–74.
Slamecka, N. J. An examination of trace storage in free recall. *Journal of Experimental Psychology*, 1968, *76*, 504–513.