11 On Relating the Organizational Theory of Memory to Levels of Processing

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It is fitting in this festschrift to focus on some of the themes that guided George Mandler's memory research, and relate those themes to contemporary developments in memory theory. For these purposes, we would like to briefly review the salient themes of one of Mandler's most influential papers, "Organization and Memory." It was published in the initial volume of the new serial *The Psychology of Learning and Motivation* edited by Kenneth and Janet Spence (1967). By chance, Bower also had an article in this same volume, and soon assumed editorship of that series.

TO ORGANIZE IS TO MEMORIZE

Mandler's thesis in that seminal article was that memory was strongly influenced by the way learners attempt to organize the to-be-remembered materials. After reviewing some earlier Gestalt ideas about memory, Mandler stated his theoretical program in a series of three propositions, as follows:

> First, memory and organization are not only correlated, but organization is a necessary condition for memory. Second, the organization of, and hence memory for, verbal material is hierarchical, with words organized in successively higher-order categories. Third, the storage capacity within any one category or within any level of categories is limited. (Mandler, 1967, p. 328)

Mandler also spelled out more specifically what he meant by organization:

> A set of objects or events are said to be organized when a consistent relation among the members of the set can be specified and, specifically, when membership of the

> objects or events in subsets (groups, concepts, categories, chunks) is stable and identifiable. (Mandler, 1967, p. 330)

Other ideas central in memory theory at the time Mandler was writing were George Miller's notions of *chunking* and that memory capacity was limited in terms of chunks (Miller, 1956). As applied to the memory task of interest to him, Mandler had a ready identification for what should count as the "chunks" for subjects learning to recall lists of words: Chunks should be the meaningful groups, clusters, and categories of list-words that subjects might notice and use to relate the words to one another. Evidence for such chunking in free recall had already been reported by Bousfield (1953), who described how subjects clustered in free recall taxonomically related words that had been presented to them in random order. In collaboration with Endel Tulving, his then-colleague at the University of Toronto, Mandler extended the underlying idea, believing that subjects would find their own organization and subjective chunks even when the list-words did not fall into simple taxonomic categories.

SUBJECTIVE ORGANIZATION

To study the formation and utilization of such subjective groupings, Mandler and Zena Pearlstone (1966) invented the experimental paradigm of unconstrained sorting of list-words followed by free recall. In that procedure, subjects sort the list words (on cards) into whatever meaningful categories or subjective groupings they may notice, going through the deck of word-cards repeatedly until they attained consistent groupings for two trials. Typically, subjects used two to seven categories (mean of 4.3) for a list of 52 unrelated words, reaching criterion of consistent sorting in about six trials. When asked unexpectedly for free recall of the list words, subjects recalled about 40% of the words; those who had settled upon a larger number of subjective groupings during the sorting task exhibited greater recall. In fact, free recall increased as a linear function of the number of subjective categories people discovered in the collection of words, with a positive slope of between 2 and 6 words per added category depending on conditions (see Figure 11.1). Thus, the more subjects divided and classified the list-words, the more they organized the material, and their memory for it improved.

In order to show that what was important for memory was organization rather than study trials, Mandler ran yoked control subjects. Each free-sorting subject was yoked to a control subject who was constrained to sort the words into the same number of categories as the first subject had freely selected. These yoked subjects took nearly twice as long to arrive at a consistent sorting; despite these extra trials, however, the yoked subjects recalled about the same number of words from the list. In further control experiments, Mandler found that recall was affected in the same positive manner by number of sorting categories whether (a)

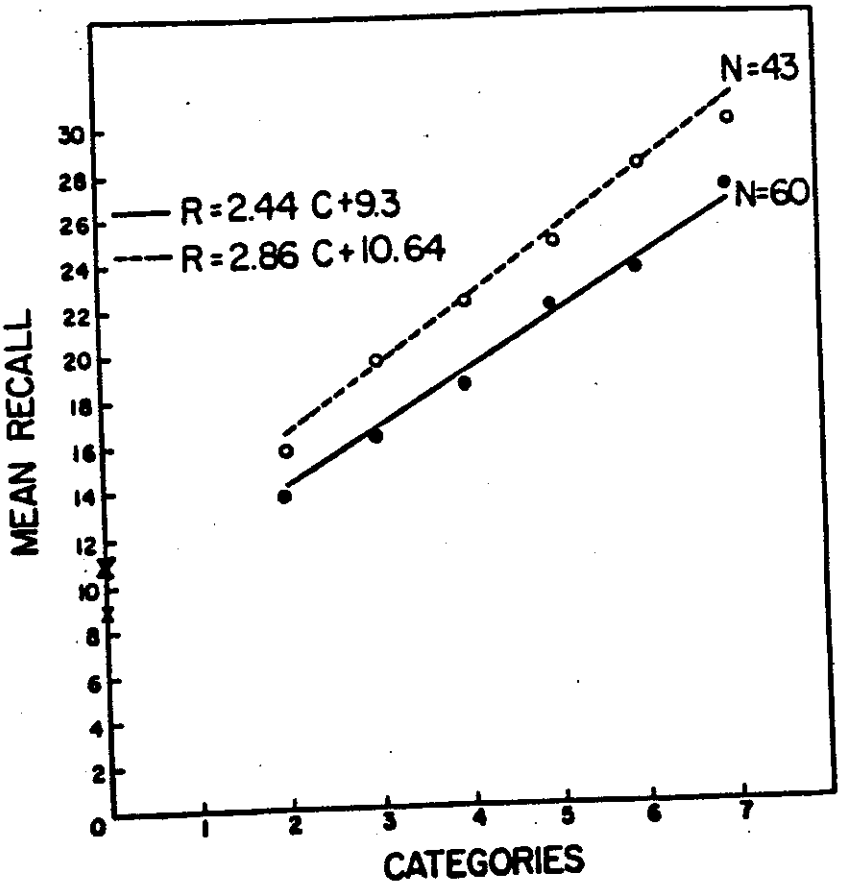

FIG 11.1. Mean recall as a function of the number of categories subjects were instructed to use in sorting 52 words. Filled circles are for all 60 subjects; open circles are for only those 43 subjects who used categories based on word meanings. Reproduced from Mandler (1967) "Organization and Memory" by permission of the author and the publishers, Academic Press.

the subjects did or did not expect a recall test after the sorting task (i.e., intentional versus incidental learning), and (b) the number of categories was self-selected by the free-sorting subject or was pre-specified by the experimenter, as in the yoking experiment mentioned above.

Such results supported Mandler's general thesis. Memory was seen as a natural consequence or by-product of organizational (or item relating) processes carried out on the materials. Note that sorting items into meaningful groups requires comparing, relating, and contrasting their semantic features to one an-

other. The critical variable for recall was the extent of organization the subject was able to impose upon (or find in) the material, not the number of trials required to do so or the intention to memorize or the ability to select one's preferred number of categories. The results provided considerable support for Mandler's first and third themes mentioned above. The support for his second theme, of hierarchical retrieval schemes, was indirect and relied more on arguments about how subjects were ever able to recall more than seven chunks or categories. More direct evidence for hierarchical retrieval schemes came along later (e.g., Bower, Clark, Lesgold, & Winzenz, 1969).

BOWER'S RESEARCH ON ORGANIZATION AND MEMORY

Stimulated by Mandler's papers and those on his Toronto colleague, Endel Tulving (1962, 1964), Mandler began his own research on organizational factors in memory. Organizational theory in memory began as a revolt against stimulus-response association psychology, much as the Gestalt approach to perception also began in revolt against elementaristic associationism. In describing this revolt, the first author wrote:

> A modest revolution is afoot today within the field of human learning, and the rebels are marching under the banner of 'cognitive organization.' Although there is little altogether new under this psychological sun, the newer organizational man does have a different perspective and slant of attack on memory problems than do his S–R associationistic progenitors. The result has been a changing emphasis in what research gets done by the rebels and how they talk about it. (Bower, 1970, p. 18–19)

The research program carried out by Mandler during that period had several related theoretical themes, summarized in two review chapters (Bower, 1970, 1972): (a) that people stored materials in terms of how they organized them into subjective groups or units; (b) that these groups came to act almost as all-or-none units in recall and in causing interference; (c) that groupings were determined by numerous Gestalt perceptual factors surrounding the presentation of the materials; (d) that repeated material is not recognized if it is regrouped into novel perceptual units upon its repetition, with the consequence that reorganization caused by regrouping of materials into different chunks seriously disrupted the normal benefits of repetition on memory. Evidence was also obtained for how memory benefited whenever the learning materials could be organized into hierarchies of categories, so that recall of a top-level chunk could iteratively cue retrieval of subordinate chunks contained in it.

In addition, Bower was interested in how the overall organization of a list of material affected the encoding and memory for single items embedded in the list. This topic was pursued most thoroughly in the context of people learning paired-associate lists, in which the nominal stimulus and response terms of the entire list did or did not follow some simple rule. Example rules ~~showed~~ that the stimulus and response words of all pairs in the list were rhymes, or members of the same category, or related by simple inversion of letters, and so on. The point of the demonstration experiments was that learners were searching for rules characterizing entire sets of learning materials (S–R pairs), and that the difficulty of learning a single item or pair could not be assessed without considering whether it fit into a general rule covering the whole list. Such research was the verbal-learning equivalent of the Gestalt dictum that "the whole determines the parts" of a psychological field; the rule characterizing a set of S–R pairs would be an "emergent" property of the whole set, not an especially salient feature of any pair in the set when it was considered in isolation.

THE SUCCESS, THEN WANING OF ORGANIZATION THEORY

All of these findings were compatible with the "Mandler Manifesto" set forth in his 1967 article. By the early to mid-1970s, the organizational steamroller had taken over memory research, become the dominant theoretical stance, and "won the day." And then a curious thing happened: As organizational theory became the accepted doctrine, it lost its enthusiastic thrust, it lost its dedicated adherents, and several counter-revolutionary movements began to crop up. Moreover, several totally new areas of memory research developed attractively, areas to which organizational theory had relatively little to contribute. Some of the newer research topics were those pertaining to the semantic-episode memory distinction, the knowledge-base underlying semantic question-answering, memory-search strategies, and the relation between recall and recognition. Although Mandler contributed to these research areas (e.g., Mandler, 1980), it was not to make special pleadings for organizational theory.

Part of the counter-revolution was conducted by John Anderson in league with the first author (Anderson, 1972; Anderson & Bower, 1973). In fact, the Trojan horse of that counter-revolution was sneaked into the last section of Bower's (1972) paper at the "Organization of Memory" conference. To set the stage for that development, readers should be apprised that one of the organizational theorist's criticisms of association theory had been that the latter seemed unable to account for free recall: What were the "stimuli" and the "responses" that were being associated? A second objection was that associationism could not account for Old/New item recognition, for example, in the continuous recognition mem-

ory task introduced by Shepard and Teghtsoonian (1961). Clearly, subjects were not associating the response they made ("New") upon initial presentation of each stimulus; otherwise, they would not call it "Old" upon its later presentation.

Anderson effectively solved both these problems with his Free Recall from an Associative Network (FRAN) model. Anderson showed how association theory could be slightly modified to handle both recognition memory and so-called organizational effects in free recall. First, Old/New recognition was assumed to be based on the subject testing of an association between a presented item and a list-context marker; upon later testing with the item, the person presumably would attribute the strength of this association to the list marker, judging it to be Old (or from the presented list) if its strength was above a criterion set to reject most nonlist distractors (for details see Anderson & Bower, 1972, 1974). Second, free recall was supposedly simulated by a search process that followed list-tagged associative pathways connecting different words from the studied list. During study of each word, two processes were assumed to occur: (a) tagging that word node in memory as having occurred on the list, and (b) following associative pathways from that word node (in semantic memory), searching for other list-words, and tagging any such connections to use later as retrieval routes during recall. FRAN also established a special ENTRYSET of list items that was connected to the list tag, which were the most central, highly-connected items on the list, and from which the model (subject) began its free recall.

With these assumptions, FRAN was able to simulate nearly all the classic results on free recall—the serial position curve, the effects of list length, study time, lengthened retrieval times, inter-item associations, category clustering, and so on. Importantly, FRAN showed the strong correlation between recall levels and degree of subjective clustering (sequential stereotypy in output) that formerly had been proposed as crucial evidence for the organizational view of free recall. And FRAN was a patently associationist model, albeit with a few novel wrinkles.

At that point, Bower became convinced that many of the memory phenomena ascribed to organizational processes could be recast as well in terms of an enriched model of associative processes, after incorporating perceptual processes (e.g., to deal with Asch's (1969) many demonstrations of mnemonic consequences of perceptual unity). Assuredly, organizing was relating, but what was relating of verbal items other than finding semantic, phonetic, or other kinds of pre-existing relations between these items in semantic memory, then tagging those relations as useful for recalling one item given the other? After FRAN, Anderson and Bower developed HAM (1973), a more general associative model of relational learning based on a presumed semantic network, and tried to show how that theory might deal with memory for sentences, facts, and inter-related clusters of facts. At the same time, Collins & Quillian (1969, 1972) were proposing their network model of hierarchical semantic memory and retrieval of facts by the spreading of activation through the network; Rumelhart, Lindsay, and Norman (1972; also Norman & Rumelhart, 1975) were elaborating their ELINOR model of episodic

and semantic memory; and Kintsch (1974) was elaborating his model of propositional encoding and retrieval to deal with people's memory for coherent text and stories. These developments regarding memory for facts and texts became prominent foci of research and theoretical activity over the ensuing decade.

THE LEVELS OF PROCESSING THEORY OF MEMORY

Alongside those developments, however, the interest of verbal-learning researchers in organizational factors in memory continued unabated. Some of the revolutionary fervor of organizational theory was picked up by a newcomer on the theoretical scene, namely the levels of processing (LOP) framework, also originated by luminaries of the "Ebbinghaus Empire" at the University of Toronto (Craik & Lockhart, 1972; Craik & Tulving, 1975). The main point of LOP theory was that memory for a verbal item depended greatly on the kind of cognitive processing the subject carried out on that item. The processing could be controlled by orienting questions referring to the item's meaning, sound, or visual appearance. The idea was that each level of processing set up a separate memory trace which persisted for more time the deeper the processing became.

As originally formulated, the LOP framework assigned little role to organizational processes in determining memory performance. Rather, it emphasized the processing of individual items and minimized the involvement of overall list organizational factors in memory. In a typical LOP experiment, for example, the list as a whole may have no obvious categorical structure, and subjects are instructed merely to answer whatever study question is asked of each item. Although the LOP framework is sometimes blamed for the waning interest in organization theory (e.g., Battig & Bellezza, 1979), it seems to us that, on the contrary, the organizational viewpoint has been kept alive by work within the LOP framework. The two approaches are not incompatible, despite their having generally focused on different aspects of the encoding process. As the LOP framework has been revised and developed (e.g., Craik & Tulving, 1975; Lockhart, Craik, & Jacoby, 1976), it has moved toward a synthesis of its ideas with those of organization theory. In the remainder of this chapter we examine how the LOP framework has been expanded and now includes organizational ideas.

In the paradigmatic LOP experiment, subjects are presented with a list of to-be-remembered (TBR) words. They encode these words according to study questions intended to induce semantic, phonetic, or structural encoding—one question for each list word. For a TBR word such as *DOG*, an example of a semantic question would be, "Is it a MAMMAL?"; of a phonetic question, "Does it rhyme with FOG?"; of a structural question, "Is it printed in upper case letters?" Of interest are differences in free recall or recognition of words processed according to these different questions. Unlike an organization experiment, the TBR words in an LOP experiment are not to be inter-related, and the subject

is not instructed (or even encouraged) to produce a hierarchical or associative grouping of the items in the list. Nonetheless, we believe that the study questions in a LOP experiment imply certain kinds of organizations. The question "Is it a MAMMAL?" asks subjects to relate the TBR word to that category. Similarly, the question, "Does it rhyme with FOG?" refers to the subject's knowledge of rhyming relationships among words, and suggests a group of words that rhyme with FOG. Even the structural question causes words to be grouped according to how they are printed, thus organizing them, at least on a superficial level. These study questions relate items to the subject's pre-existing knowledge of categories, rhymes, and orthographic styles.

COMPARING ORGANIZATION TO LEVELS OF PROCESSING

Organization has traditionally been a somewhat fuzzy concept, and our way of thinking about it may not agree with some operational definitions that have been suggested (e.g., Tulving, 1968, p. 15). However, our perspective on organization does coincide with Mandler's (1967) more theoretical definition quoted earlier in this paper. What Mandler believed to be important for memory was that the material to be learned should be grouped according to some relation at the time of encoding. In our view, a study question in an LOP experiment specifies just such a relation between the TBR item and some property or concept. Moreover, the LOP framework has demonstrated that grouping or associating items with their semantic categories is especially important for good retention.

To illustrate the close relation of organization to semantic processing, we will consider several findings in the LOP tradition from an organizational perspective. A frequent result in LOP experiments is that semantic encoding produces better free recall and recognition memory than does phonetic and other forms of nonsemantic encoding (e.g., Craik & Tulving, 1975; Hyde & Jenkins, 1969). This finding has been interpreted as indicating that semantic encoding causes memory traces that are either more resistant to interference (Craik & Lockhart, 1972), or more elaborate (Anderson & Reder, 1979), or more distinctive (Moscovitch & Craik, 1976). However, this finding can also be viewed as evidence that classifying the word-lists semantically provides stronger retrieval cues for later recall than does classifying the words by phonetic or print groupings. Thus, the categories provide meaningful cues with strong associations to facilitate recall of the TBR words related to them. Grouping by rhyme relationships causes poorer memory because rhyming leads to less distinctive memory traces.

Another common finding in LOP experiments, first reported by Craik and Tulving (1975), is that "Yes" items which fit the category of their study question (e.g., Is is a MAMMAL?–DOG) are later better recognized and recalled than "No" items which do not fit their category question (e.g., Is it a MAMMAL?–

APPLE). This Yes–No difference in recall is typically explained in terms of elaboration (Anderson & Reder, 1979; Craik & Tulving, 1975); that is, a positive relation between a study question and its TBR word offers a greater number of informative links between the item and the category of the study question that can be stored and later used in retrieval. This connecting of TBR words to permanent memory structures, which can later serve as retrieval cues, is seen as a primary determinant of memory performance (Hunt & Mitchell, 1978; 1982). This idea is similar to a basic thesis of organization theory that memory depends on whether items can be grouped under or associated to some higher order cue (Mandler, 1967; 1972).

When people answer a category question in the LOP paradigm, or when they group together items in one of Mandler's sorting experiments, they are not *creating* an organization or an association. These relationships between items exist in the subject's permanent memory. What LOP or organizational study instructions do is direct the subject to *attend to*, encode, or reactivate a particular pre-existing association between the list items and semantic or phonetic categories. The LOP question leads the subject to consider, among the many possible associations and relations, a specific association to represent the "episode" of having studied a particular item in the list. Thus, whether relating an item to a question (as in LOP experiments) or grouping it with other list items (as in a sorting experiment), subjects are led to attend to various relations between items in their pre-existing memory structures, with the consequence that they recall these subjective groupings together. A difference between the two is that organization theory has concerned itself primarily with relations between TBR items in a list, whereas LOP theory has dealt with relations between TBR items and extralist categories or words.

DIFFERENTIATING WITHIN THE SEMANTIC LEVEL OF PROCESSING

An incompleteness of the initial LOP framework was that it failed to differentiate further within the various levels of processing. Surely, many types of semantic and phonetic questions can be asked about any given TBR word, and all the many variants of semantic and phonetic processing cannot be expected to yield equivalent memory performances. One can also ask how memory for an item would vary if it were presented and processed two or more times during study, each time perhaps in a different manner. Craik and Lockhart (1972) originally hypothesized that continued processing of an item at the "same level" or in the same manner would yield no improvement in memory upon its repetition. Although initially supported by the weak enhancement of recall produced by massed phonetic rehearsal of a word, their hypothesis was soon disputed and modified by later results showing memory enhancements due to well-spaced

repetitions of words processed in the same manner (e.g., see the review in Zechmeister & Nyberg, 1982). Much of the follow-up research investigated how memory varied with the type and number of semantic questions asked of a TBR word during its presentation.

An early example of such research was a study by Klein & Saltz (1976). They selected four semantic dimensions (happy-sad, pleasant-unpleasant, fast-slow, big-little) along which their subjects were to rate a set of TBR words. Pilot subjects rated the happy-sad dimension as highly correlated with the fast-slow and pleasant-unpleasant dimensions, but there were low correlations among the size and speed dimensions. Subjects in the memory experiment rated a list of words according either to only one of the dimensions, or to two uncorrelated dimensions (e.g., pleasantness and size), or to two correlated dimensions (e.g., pleasantness and happiness). In a later free recall test, subjects showed greater recall for words that had been rated on two correlated dimensions as opposed to just one dimension, but greatest recall of all for words rated on two uncorrelated dimensions. Klein and Saltz concluded that specifying a word on several meaning dimensions improved its memory, and more so when the dimensions offered nonredundant information about the word. An alternative interpretation is that these uncorrelated attributes can serve as independent, nonredundant retrieval cues to guide recall of the items satisfying both groupings.

A related study by Johnson-Laird, Gibbs and deMowbray (1978) extended Klein and Saltz's findings to rating tasks involving conceptual categories. In the Johnson-Laird et al. study, subjects categorized words according to whether or not they were "natural consumable solids." Recall was higher as the number of categories that a word satisfied increased, going from all three (e.g., apple), to two (e.g., coal), to only one (e.g., coca cola), to zero (e.g., perfume). This study clarified the parallel between semantic encoding and categorical organization: Study tasks that relate an item to more categories result in much better retention and memory performance.

Working in Bower's lab, Brian Ross (1981) found that elaboration for memory was best conceived in terms of the number of categorical/organizational relations subjects noticed about a word. He demonstrated that memory for a word was related to the number of such decisions a subject had to make about it earlier. Ross replicated the Johnson-Laird et al. study, but with subjects making Yes-No decisions about list words according to one of three criteria: the ALL group responded "Yes" only if a TBR word matched all three properties of the category (natural, consumable, solid); the ANY group responded "Yes" if a TBR word matched any one or more of the three properties; and the EACH group made a separate "Yes/No" decision for each of the three properties for each word. Assuming a serial self-terminating search through the properties for making the encoding decisions, Ross calculated the expected number of decisions subjects would make in each condition according to the number of properties a TBR word actually possessed (see Table 11.1). Subjects in the ALL condition needed to

TABLE 11.1
Expected Number of Decisions for the Three Orienting Tasks of Ross's (1981) Experiment 2

	Number of Target Properties			
Task	*0*	*1*	*2*	*3*
ALL	1.00	1.33	2.00	3.00
ANY	3.00	2.00	1.33	1.00
EACH	3.00	3.00	3.00	3.00

Note. From "The more the better?: Number of decisions as a determinant of memorability" by B. H. Ross, 1981, *Memory & Cognition, 9*, p. 27. Copyright 1981 by Psychonomic Publications. Reprinted by permission.

check every property of a word before saying "Yes," and could say "No" only after encountering a property missing in the TBR item. Thus, the expected number of decisions these subjects had to make increased with the number of properties of the TBR item. Subjects in the ANY condition needed to find only one property that the TBR item possessed in order to say "Yes," and could terminate their search upon finding a first such property. Consequently, the number of decisions they needed to make *decreased* as the number of properties the TBR item possessed increased. Finally, in the EACH condition, subjects were forced to make three explicit "Yes/No" decisions regardless of how many properties the TBR item possessed. Note that in this case, the properties corresponded to complementary categories whatever the answer to them: something not "natural" is "man-made"; something not "solid" is liquid, gaseous, or abstract. Thus, even a "No" decision about a specific property implied a "Yes" connection of the word to an alternative category; this may be why Ross observed no recall differences in his EACH condition depending on the number of "Yes" decisions.

Ross's data are shown in Table 11.2. It was not possible to find lists of words that could be used in all four conditions. Consequently, Ross used one set of words for the 0 and 3 decision conditions, and different words for the 1 and 2 decisions condition. Therefore, the only comparisons counterbalanced for word type are 0 versus 3, and 1 versus 2; these mean recall percentages are shown in Table 2. Those means show that recall conformed closely to the predictions derived from the number of decisions. For words with increasing number of properties (0 vs. 3; 1 vs. 2), their recall increased in the ALL group, but decreased in the ANY group. Recall was relatively constant and high in the EACH group where subjects made the same number of decisions for all items (0 = 3; 1 = 2). Apparently we may conclude that the greater the number of properties or categories to which subjects are forced to relate a given item, the greater will be their later recall of that item.

A simple account for the preceding findings can be provided based on stan-

TABLE 11.2
Proportion Recalled in Ross's (1981) Experiment 2

	Number of Target Properties			
Task	*0*	*3*	*1*	*2*
ALL	.227	.377	.178	.252
ANY	.367	.218	.233	.182
EACH	.404	.409	.209	.267

Note. From "The more the better?: Number of decisions as a determinant of memorability" by B. H. Ross, 1981, *Memory & Cognition, 9*, p. 27. Copyright 1981 by Psychonomic Publications. Adapted by permission. The only counterbalanced comparisons are those between 0 and 3 properties, and between 1 and 2 properties.

dard ideas within association theory (see Figure 11.2 as an aid to this discussion). Imagine that subjects learn the categories or properties in the questions that they are repeatedly asked regarding list-words in LOP experiments, learning them by associating these categories (like "metal" and "mammal") to a List node in memory. Imagine further that subjects implicitly recall these properties or categories to use as retrieval cues when they are later asked to recall the list-words. Suppose too, that each pre-existing association between a list-word and a property or category (such as "silver" to "metal") that subjects are forced to attend to as they study that word thereby becomes strengthened. These strengthened associations will be used to facilitate later recall of that word when it is implicitly cued with that property. In addition, the more implicit cues (properties or categories) the subject can generate from the List-node and the greater their associative connections to a given list-word, then the greater the probability of recall of that list-word.

These principles account for Ross's findings. The greater number of properties or relations noticed for a given list-word, the more property-to-word associations there are that are strengthened, so that the list-word's recall is boosted. The retrieval process proceeds by the spreading of activation along associative pathways, starting from the List-node in memory, thence to the category questions (like "natural," "consumable," and "solid"), and thence to the intersection of the activation spreading to the list words that satisfy these properties (see Figure 11.2). The Johnson-Laird et al. (1978) findings have the same explanation as do Ross's. The Klein and Saltz (1976) findings are also accommodated in that (a) two independent property cues serve as better retrieval cues than does one property, and (b) two redundant, overlapping properties do not provide separate retrieval routes (or associations) to facilitate recall of a list-word, and so are no better than a single cue. The connection between this associative theory and Mandler's position is that both emphasize the subjects' active attention to the

categorical associations of the list-words as they are studied, and hypothesize that subjects use these noticed categories as retrieval cues to aid later recall.

ORGANIZATIONAL FACTORS IN LOP EXPERIMENTS

Several researchers have recognized that free recall in standard LOP experiments is strongly related to the overall organization of the word-list in addition to the processing performed on each word (e.g., Bellezza, Cheesman, & Reddy, 1977; Einstein & Hunt, 1980). Much of this research, however, has been aimed primarily at comparing memory performance produced by whole-list organizational strategies in contrast to semantic processing of single items in the LOP format. For example, Bellezza et al. (1977) contrasted free recall of subjects instructed to link TBR words into a story (or to place large groups of items into mental images) versus others instructed simply to process each word semantically but separately, such as defining it or using it in a sentence. They found not only that story linking and interactive imagery produced better recall than separate semantic elaboration, but that variation in the quality of the organizational strategy had far greater influence on free recall than did variation in semantic tasks focused on single items. Perhaps the basic message of such experiments is that free recall of a list of words requires study methods that interrelate and organize the items, and that "deep processing" of individual items without regard to their relationships to other list items does little to promote free recall (although it may promote recognition). Mandler's Manifesto of organization still held true, indeed with an impact on free recall sometimes greater than the influence of different levels of processing.

Bryant (1990) has investigated the influence on free recall of a subtle organizational factor embedded in the standard LOP experiment. As noted, traditional LOP experiments focus exclusively on how the orienting question presented along with a TBR word affected its later recall. Relations between TBR items were ignored, as were relations between items and other questions asked within the study contest. But the associative analysis developed above, as well as Mandler's organizational approach, suggests that these inter-item and other category-to-item relations may be important determinants of free recall. Bryant's research illustrates a substantial impact of these whole-list organizational variables in a LOP experiment, specifically noting the influence on an item's free recall of the questions asked about other items in the list.

In one of Bryant's experiments, subjects studied a list of words either by answering taxonomic or rhyming questions. Twelve questions were used in each list, with each question paired with four words for a list length of 48. Examples of the study questions and TBR words are shown in Table 11.3. Each question was paired with two positive or "Yes" items. Examples of "Yes" items in Table 11.3 are "Iron—METAL?" and "Blue—COLOR?". Each question was also paired

TABLE 11.3
Examples of Taxonomic and Rhyming List Structures Employed in Bryant's (1990) Experiment 1

Category Type	*Example*	*Response Type*	*Example*	*Related to:*
		TAXONOMIC LISTS		
Unrelated	A RELATIVE	Yes	Father	RELATIVE
	A RELATIVE	No	Echo	—
Related	A METAL	Yes	Iron	METAL
	A METAL	No	Music	—
Experimental	A COLOR	Yes	Blue	COLOR
	A COLOR	Yes/No	Steel	METAL
Rhyme Type	*Example*	*Response Type*	*Example*	*Rhymes with:*
		RHYMING LISTS		
Unrelated	LANE	Yes	Pain	LANE
	LANE	No	Salad	—
Related	FLOUR	Yes	Sour	FLOUR
	FLOUR	No	Paint	—
Experimental	GLOVE	Yes	Shove	GLOVE
	GLOVE	Yes/No	Hour	FLOUR

Note. From "Implicit associative responses influence encoding in memory" by D. J. Bryant, 1990, in press, *Memory & Cognition*. Copyright 1990 by Psychonomics Publications. Reprinted by permission.

with two negative items, of which there were two different types. Some of the negative items were unrelated to any category question in the list, such as "Music—METAL?" in Table 3; these were dubbed the pure "No" items. The other negative items were unrelated to the question asked of them, but were, in fact, related to a question presented earlier in the list; these were dubbed "Yes/No" items. An example in Table 3 is "Steel—COLOR?" which yields a negative answer, but is related to another, earlier category, namely metals. The type of negative item was the major manipulation in the study. Subjects completed a free recall test immediately after studying each list.

As noted before, the standard result we expected was for the "Yes" items to be recalled much better than the pure "No" items. The crucial question was whether the "Yes/No" items related to a question in the list would be recalled any better than the pure "No" items that were not related to any question in the list. The results of Bryant's Experiment 1 are shown in Table 11.4. Recall of "Yes/No" items in the taxonomic condition was intermediate between that of "Yes" and pure "No" items. In the rhyming condition, however, recall of "Yes/No" items was no better than that of "No" items. Thus, subjects were able to use the implicit semantic relationships between "Yes/No" words and category questions to improve their recall of those items, but apparently could not use the implicit rhyming relationships to aid recall.

TABLE 11.4
Proportion Free Recalled in Taxonomic and Rhyming Lists of Bryant's (1980) Experiment 1

	Item Type		
List Type	*Yes*	*Yes/No*	*No*
Taxonomic	0.52	0.29	0.08
Rhyming	0.20	0.08	0.09

Note. From "Implicit associative responses influence encoding in memory" by D. J. Bryant, 1990, *Memory & Cognition*. Copyright 1990 by Psychonomics Publications. Reprinted by permission.

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The *Yes/No* effect for semantic categories was the primary result of interest in this experiment. The associative model depicted in fragmentary form in Figure 11.2 can be used to explain these results as well as those of Ross and earlier LOP experiments. The circled words in Figure 2 denote nodes in semantic memory; the List node is set up to record the episodes in the study list. The categories Metal, Conducts Electricity, and Mammal refer to the questions asked of items in the list. The lines denote associative connections either set up or utilized during the list-presentation trial; illustrated are the prior associations for "Yes" items (such as "Silver to Metal") and for "Yes/No" items (such as "Iron to Metal"), and the weaker episodic associations encoding the temporal contiguity of the category question to "No" items (such as "Iron to Mammal" and "Apple to Metal"). The associations for "Yes" items are stronger than for pure "No" items because the former basically prime and reactivate a familiar, strong relation, whereas the latter association is only momentarily strengthened by temporal contiguity of the question category and the item yielding a "No" response. The connection for the "Yes/No" item (Iron to Metal) is a dashed line to indicate that its strength depends upon this connection being recognized and reactivated within the time the "Iron—Mammal?" episode is occurring.

Free recall is presumed to proceed, as noted before, by the spreading of activation from the List node to the categories and thence to the associated words in an amount increasing with their degree of association. Using the arguments about encoding outlined earlier, this retrieval model leads to the expectation that free recall would be best for a "Yes/Yes" item (such as copper), next best for "Yes" items, next for "Yes/No" items, and worst for pure "No" items. This was exactly the ordering of free recall Bryant found for his semantic conditions. The same analysis, for reasons difficult to summarize briefly, does not apply to the rhyming condition. Roughly speaking, the Yes/No effect may fail to appear with rhyming questions because rhymes are not as strongly represented or as salient in

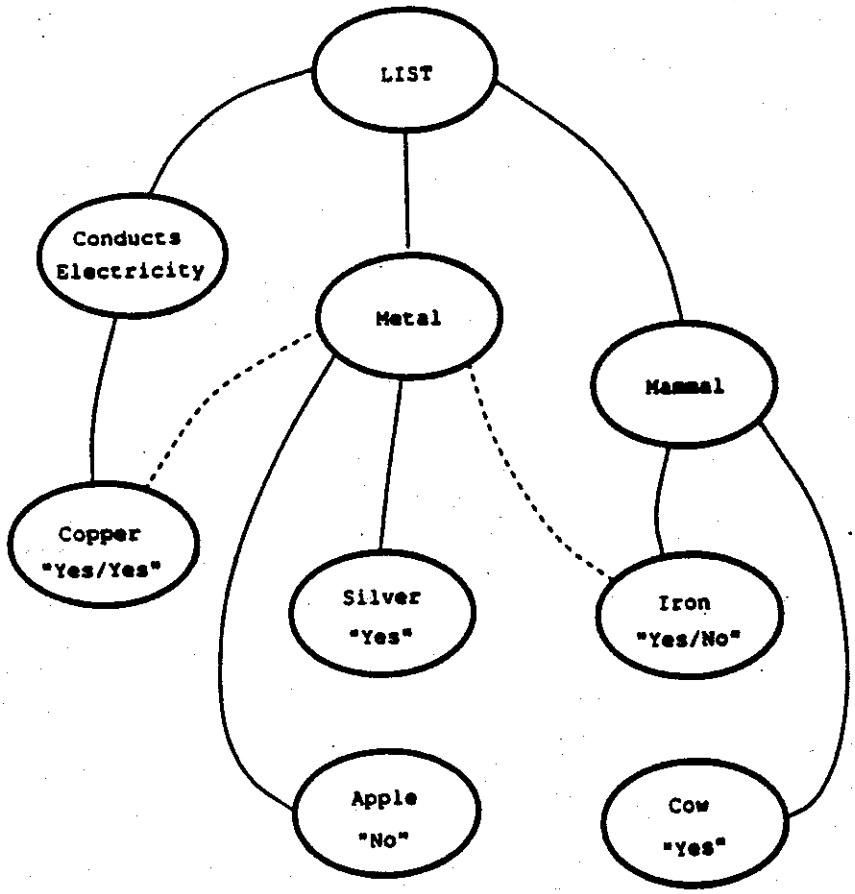

FIG 11.2. Hypothetical diagram of a fragment of associative memory showing various types of word nodes and their associative connections (lines between nodes). See text for explanation. Reproduced from Bryant (1980) by permission of the author and the publisher, Psychonomic Publications.

long-term memory, cause little elaborative activity during encoding, and so are less likely to enhance encoding of "Yes/No" items.

Subsequent follow up experiments by Bryant clarified the semantic Yes/No effect and supported the associative model illustrated in Figure 11.2. One control experiment found the semantic "Yes/No" advantage over "No" items even when the pure "No" items themselves could have been grouped into categories (of two or four). What was important was that the relevant category was primed (or associated to the List context) by its having appeared in the list being learned.

Another experiment showed that the less often a given semantic category question was presented during study, the weaker was the semantic Yes/No effect for items related to that category. Thus, if each category were presented only twice instead of four times, giving subjects less opportunity to notice its relationship to "Yes/No" items, the category provided less enhancement of recall of those "Yes/No" items. This can be understood in the model of Figure 11.2, since more trials of associating the question category to the List should enhance its accessibility to cue retrieval of the list words.

In addition, the theory predicts, and Bryant found, that inclusion of an additional category question related to a "Yes" item (e.g., Copper conducts electricity and is also a metal) boosted its recall. That is, the item on its single presentation was related to its question and to an earlier question category as well. This boosting of recall is reminiscent of Ross's (1981) results, except that Bryant's subjects were relating the items implicitly to an earlier category as well as encoding them with respect to their category question.

A final experiment by Bryant demonstrated that the Yes/No effect depended on subjects' consciously noticing the relation of a "Yes/No" item to an earlier category in the list. In this experiment, subjects were asked to make two decisions about each item: whether or not the word belonged to the category question presented with it, and whether or not it belonged to any other category question presented earlier in the list. Of interest was how well subjects later recalled "Yes/No" items they had earlier failed to recognize as being related to a category question in the list. In fact, subjects recalled these "Yes/No" items no better than pure "No" items. On the other hand, if subjects did recognize that there had been a category related to a "Yes/No" item presented earlier, they recalled the "Yes/No" item roughly as well as "Yes" items. Thus, when subjects could think back and make the connection between the current TBR word and a previous study question, they were able to use that category to encode the item. These results support the theory depicted in Figure 11.2. If the link of the "Yes/No" item to its category is not noticed so that it is activated and strengthened during the word's presentation, then the connection (dashed line in Figure 2) will be weak and inoperative during recall.

CONCLUDING COMMENT

Beginning with a review of one of George Mandler's seminal papers, we have traced some of the developments surrounding his thesis, that memory is a product of organization, especially when memory is measured by the free recall of large bodies of materials. Starting as a revolutionary doctrine in th mid-1960s, Mandler's thesis gradually gained adherents and empirical support. Moreover, the basic thesis is still alive and well in verbal memory theory, where it appears as a complementary factor to the levels of processing framework that seemed for a

while to have pushed organizational ideas off center stage. In our review of this literature, we have recast some of the organizational ideas in terms of a network of reactivated semantic associations which are used in encoding list items and in cuing their retrieval in inter-related clusters. Our review concluded by showing how a subtle organizational influence, the Yes/No effect in free recall of semantic associates, could be found as predicted by our associative analysis of the standard LOP experiment.

The thematic path of research we have traced is just one of many our field will associate with George Mandler. He has been a powerful, influential force for the past 35 years in determining the direction of research on human memory. The body of his memory research work, alongside his many other provocative writings on philosophy of mind, emotion, and value, stands as eloquent testimony to the generative originality of this brilliant scientist. We are much in his debt for having stimulated and guided our collective research enterprise.

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REFERENCES

Anderson, J. R. (1972). A simulation model of free recall. In G. H. Bower (Ed.), *The psychology of learning and motivation* (pp. 315–378). New York: Academic Press.

Anderson, J. R., & Bower, G. H. (1972). Recognition and retrieval processes in free recall. *Psychological Review, 79*, 97–123.

Anderson, J. R., & Bower, G. H. (1973). *Human associative memory*. New York: Wiley.

Anderson, J. R., & Bower, G. H. (1974). A propositional theory of recognition memory. *Memory & Cognition, 2*, 406–412.

Anderson, J. R., & Reder, L. M. (1979). An elaborative processing explanation of depth of processing. In F. I. M. Craik & L. S. Cermak (Eds.), *Levels of processing in human memory* (pp. 385–403). Hillsdale, NJ: Lawrence Erlbaum Associates.

Asch, S. E. (1969). Reformulation of the problem of association. *American Psychologist, 24*, 92–102.

Battig, W. F., & Bellezza, F. S. (1979). Organization and levels of processing. In C. R. Puff (Ed.), *Memory organization and structure* (pp. 321–346). New York: Academic Press.

Bellezza, F. S., Cheesman, F. L., & Reddy, B. G. (1977). Organization and semantic elaboration in free recall. *Journal of Experimental Psychology: Human Learning and Memory, 3*, 539–550.

Bower, G. H. (1970). Organizational factors in memory. *Cognitive Psychology, 1*, 18–46.

invent

Bousfield, W. A. (1953). The occurrence of clustering in the recall of randomly arranged associates. Journal of General Psychology, 49, 2

Bower, G. H. (1972). A selective review of organizational factors in memory. In E. Tulving & W. Donaldson (Eds.), *Organization of memory* (pp. 93–137). New York: Academic Press.

Bower, G. H., Clark, M. C., Lesgold, A. M., & Winzenz, D. (1969). Hierarchical retrieval schemes in recall of categorized word lists. *Journal of Verbal Learning and Verbal Behavior, 8*, 323–343.

Bryant, D. J. (1990). Implicit associative responses influence encoding in memory. *Memory & Cognition,*

Collins, A. M., & Quillian, M. R. (1969). Retrieval time from semantic memory. *Journal of Verbal Learning and Verbal Memory, 8*, 240–247.

Collins, A. M., & Quillian, M. R. (1972). Experiments on semantic memory and language comprehension. In L. W. Gregg (Ed.), *Cognition in learning and memory* (pp. 117–137). New York: Wiley.

Craik, F. I. M., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior, 11*, 671–684.

Craik, F. I. M., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General, 104*, 268–294.

Einstein, G. O., & Hunt, R. R. (1980). Levels of processing and organization: Additive effects of individual item and relational processing. *Journal of Experimental Psychology: Human Learning and Memory, 6*, 588–598.

Hunt, R. R., & Mitchell, D. B. (1978). Specificity in nonsemantic orienting tasks and distinctive memory traces. *Journal of Experimental Psychology: Human Learning and Memory, 4*, 121–135.

Hunt, R. R., & Mitchell, D. B. (1982). Independent effects of semantic and nonsemantic distinctiveness. *Journal of Experimental Psychology: Learning, Memory and Cognition, 8*, 81–87.

Hyde, T. S., & Jenkins, J. J. (1969). Differential effects of incidental tasks on the organization of recall of a list of highly associated words. *Journal of Experimental Psychology, 82*, 472–480.

Johnson-Laird, P. N., Gibbs, G., & deMowbray, J. (1978). Meaning, amount of processing, and memory for words. *Memory & Cognition, 6*, 372–375.

Kintsch, W. (1974). *The representation of meaning in memory*. Potomac, MD: Lawrence Erlbaum Associates.

Klein, K., & Saltz, E. (1976). Specifying the mechanism in a levels-of-processing approach to memory. *Journal of Experimental Psychology: Human Learning and Memory, 2*, 671–679.

Lockhart, R. S., Craik, F. I. M., & Jacoby, L. (1976). Depth of processing, recognition and recall. In J. Brown (Ed.), *Recall and recognition* (pp. 75–102). London: Wiley.

Mandler, G. (1967). Organization and memory. In K. W. Spence & J. T. Spence (Eds.), *The psychology of learning and motivation: Advances in research and theory, vol. 1* (pp. 327–372). New York: Academic Press.

Mandler, G. (1972). Organization and recognition. In E. Tulving & W. Donaldson (Eds.), *Organization of memory* (pp. 139–166). New York: Academic Press.

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

Mandler, G., & Pearlstone, Z. (1966). Free and constrained concept learning and subsequent recall. *Journal of Verbal Learning and Verbal Behavior, 5*, 126–131.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review, 63*, 81–97.

Moscovitch, M., & Craik, F. I. M. (1976). Depth of processing, retrieval cues, and uniqueness of encoding as factors in recall. *Journal of Verbal Learning and Verbal Behavior, 15*, 447–458.

Norman, D. A., & Rumelhart, D. E. (1975). *Explorations in cognition*. San Francisco: Freeman.

Ross, B. H. (1981). The more, the better?: Number of decisions as a determinant of memorability. *Memory & Cognition, 9*, 23–33.

Rumelhart, D. E., Lindsay, P. H., & Norman, D. A. (1972). A process model of long-term

memory. In E. Tulving & W. Donaldson (Eds.), *Organization and memory* (pp. 197–246). New York: Academic Press.

Shepard, R. N., & Teghtsoonian, M. (1961). Retention of information under conditions approaching a steady state. *Journal of Experimental Psychology, 62*, 302–309.

Tulving, E. (1962). Subjective organization in free recall of "unrelated" words. *Psychological Review, 69*, 344–354.

Tulving, E. (1964). Intratrial and intertrial retention: Notes towards a theory of free-recall verbal learning. *Psychological Review, 71*, 219–237.

Tulving, E. (1968). Theoretical issues in free recall. In T. R. Dixon & D. L. Horton (Eds.), *Verbal behavior and general behavior theory* (pp. 2–36). Englewood Cliffs, NJ: Prentice-Hall.

Zechmeister, E. B., & Nyberg, S. E. (1982). *Human memory: An introduction to research and theory*. Monterey, CA: Brooks/Cole.