1 Effects of Elaboration of Processing at Encoding and Retrieval: Trace Distinctiveness and Recovery of Initial Context

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One central point made by Craik and Lockhart (1972) in describing a levels-of-processing framework for the study of memory was the intimate association between memory and perception. In their view, the memory trace was characterized as the record of operations carried out initially for the purposes of perceiving and interpreting the stimulus array. It was also proposed that deeper, more meaningful analyses of perceived events would be associated with more durable memory traces than would relatively superficial analyses of the sound or appearance of incoming stimuli; and in support of their proposal, Craik and Tulving (1975) showed that words for which meaningful decisions are made show higher levels of retention in an incidental memory task than do the same words after decisions about their sound or appearance. However, although the levels-of-processing view has had some success in describing general features of remembering in many situations, some difficulty has been encountered in specifying precisely what is meant by ''deep'' and ''meaningful.'' Further, the view does not readily allow for distinctions to be made within the domain of meaningful analyses; it simply postulates that all events processed in terms of their meaning should be well remembered. In some instances, however, types of meaningful processing have been associated with quite poor retention (e.g., Mandler & Worden, 1973). Given a set of tasks, each requiring subjects to deal meaningfully with presented items, the original levels framework provides no basis for predicting differences, although such differences are found.

In later papers (Craik & Jacoby, 1975; Craik & Tulving, 1975; Lockhart, Craik, & Jacoby, 1976), the original levels formulation has been altered in a number of ways. Differences in retention are no longer explained purely in terms of depth of processing; additional mechanisms have been introduced. First, it has been suggested that processing differs in breadth or degree of elaboration as well as in level, thereby allowing an account of differences in retention that arise within a level of processing. Lockhart et al. also implicated discriminability as an important determinant of retention. By this was meant that the memory of a particular event must be discriminable from those of other events. Discriminability in turn was related to differences in the "depth" and "elaboration" induced by initial processing.

The present paper expands on these and related notions. First, the role of distinctiveness of encoding is examined more fully; the idea that distinctiveness is not an absolute characteristic but is always relative to some particular background or set of items is emphasized. Following from this idea is the second point—that the original context must be recreated at output if the encoded distinctiveness is to be effective in allowing discriminability of the wanted trace from others. Third, the notion is developed that retrieval, like encoding, is a matter of degree; just as an encoded item can be elaborated to a greater or lesser extent, so can retrieval information be processed more or less extensively. For example, the degree to which the initial encoding context is retrieved is largely under task control. Fourth, the point is made that some forms of recognition do not depend on retrieval of the encoding context; the parallels between context-dependent and context-free recognition on one hand and Tulving's (1972) notions of episodic and semantic memory on the other are explored. These ideas are illustrated by the results from some recent experiments.

Encoding Distinctiveness

One of the major difficulties with the original levels framework comes from the way that meaning was treated. Although not explicitly defined, there was a tendency in that paper to treat meaning as if it were a fixed entity; *the* meaning of a word was said to be either encoded or not encoded, depending on task demands. By this commonsense approach, each word has a single meaning or at most a few meanings. Such an approach quickly runs into difficulty, as can be seen in the simple situation of naming a given object. As pointed out by several writers (e.g., Brown, 1958; Garner, 1974; Olson, 1970), a concrete object does not have a single name or description. Rather, what an object is called or how it is described depends on the other objects from which it is to be discriminated. For example, a chair is a chair; but it is equally a piece of furniture, a thing, a wooden artifact, and any number of other descriptions, depending on what the chair is to be distinguished from. Similarly, the meaning of a word in a given context depends on distinctions that are to be conveyed by that word in that context.

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trated in considering synonymy. Anyone who has ever tried to construct a list of synonyms soon becomes convinced that there are no true synonyms in English. Paradoxically, however, almost any pair of words can carry equivalent meaning in some context. To the driver of a car, the consequences of a statement such as ''Look out for the ___'' are equivalent if the blank is filled by *tree, house, truck,* or generally any other concrete object name. Clearly, however, the words would not be synonymous in all other contexts. In contrast, words such as *woman* and *lady* seem more truly synonymous, because it is more difficult to imagine a context in which the choice of one word over the other would be meaningful. However, contexts that would distinguish the two words can clearly be found.

In perceptual research, several theorists have come to view perception as the process of describing a stimulus (e.g., Rock, 1975). In many cases, contextual factors such as the alternatives from which a stimulus is to be discriminated influence the description and, consequently, the perception of that stimulus. If we return to the original levels notion that memory for a stimulus is the record of perceptual analysis, we can then claim that the memory trace is functionally a description, or set of contrasts. The resultant view is similar to that advanced by multicomponent (Bower, 1967) or attribute (Underwood, 1969) memory theorists. The major difference between the present view and the previous ones is the claim that description is necessarily relative to a given context. That is, meaning is not simply an attribute that is or is not encoded. Rather, meaning is a set of contrasts resulting from distinctions required when interpreting the item in the context of some task.

It is useful to contrast the notion of distinctiveness with that of elaboration. By elaboration, it is often meant that a change in encoding is largely quantitative; that is, more information is added to the trace. By distinctiveness, however, we mean to emphasize the contrastive value of information. For example, learning that a particular person has a high school diploma adds information but has no contrastive value unless other people in the appropriate set failed to complete high school. Our notion is that perception and, consequently, memory move forward by a set of contrasts. If several events are described with highly overlapping or redundant dimensions, the events are not well-distinguished from each other. Additionally, if the same events are described with dimensions that do not overlap at all, they are also not distinguished because they have never been contrasted.

Distinctiveness requires change against some background of commonality. The phenomenon of proactive inhibition in short-term memory (e.g., Wickens, 1970) can be used to clarify this point. The buildup and release from proactive inhibition is likely to depend on characteristics of the whole series of lists rather than simply on the characteristics of words that appear in adjacent lists. If a set of lists is made up of unrelated words, one would expect no release from proactive inhibition to result when, for example, *dog* is followed by *coat*. This is true despite the change in category that is produced by this sequence of words. A change in category will be noted and serve as a basis for distinctiveness only if the commonality among prior words has been sufficient to establish a category that can serve as a background for change. Tversky (1977) has recently made a related point by demonstrating the importance of contrast for scaled similarity. In his experiment, the judged similarity of pairs of European countries (e.g., Italy–Switzerland) was increased when the list also included pairs of American countries (e.g., Brazil–Uruguay) that were to be judged rather than when it included only additional pairs of European countries. In the absence of variation with regard to continents, two countries being parts of the same continent added relatively little to their judged similarity. Tversky used the term *diagnosticity* to describe the above effect of contrast among other effects found in judged similarity. The work reported by Tversky makes it clear that judged similarity depends on diagnosticity and on the intensity or salience of attributes as well as on the number of attributes that two events potentially share. In considering memory performance, the notion of elaboration is insufficient to the extent that it denotes only a difference in the number of attributes encoded and ignores factors such as the diagnosticity of those attributes. By using the term *distinctiveness,* we mean to emphasize the importance of relationships among events—particularly the importance of contrast.

It is attractive to consider a memorable encoding as one that is easily discriminable or highly distinctive in the memory system. It seems quite possible that deeper, more elaborate encodings are more distinctive in this sense; a similar view has recently been put forward by Klein and Saltz (1976) and by Wickelgren (1977). The idea is that deeper encodings will be more discriminable from other encoded events and will be more easily retrieved, provided also that an appropriate retrieval cue is given (Tulving, 1974) and that the information is encoded in an organized, "recoverable" form (Norman & Bobrow, 1977). To make this point clearer, again consider the case of describing an object. The details of an object are more fully described when the object must be discriminated from a set of very similar objects; the description of a circle will be more complete if it is to be discriminated from other circles that differ in size and location than if it is to be discriminated from a set of squares. A more complete description results in the utility of the description being less reliant on reinstating the original set of alternatives. That is, the fuller description would also serve to specify the object among any less similar set of alternatives (within the same encoding dimensions, at least). Thus, more complete descriptions confer both greater distinctiveness and greater generality as a basis for discriminating one object from others. Similarly, in the case of memory for words, a more complete encoding or description of a word allows that word to be discriminated from a larger set of alternatives. The memory confusability of words that are similar, such as *lady* and *woman,* depends on the distinctions that are compelled by the study task and context. If *lady* were encountered in a list and *lady* and *woman* later appeared as alternatives on a recognition test, we would expect a high number of false recognitions of *woman* (Underwood, 1965). However, if the initial task required encoding of *lady* in terms of deportment as well as sex, fewer false recognitions of *woman* should result.

Let us stress again that distinctiveness is a context-relative term. A description that is highly distinctive for a particular set of alternatives is not necessarily distinctive for another set. Consequently, the distinctiveness of the description of an event cannot be specified without considering the alternatives from which it has been contrasted. If the set of alternatives is changed drastically, a previously distinctive description may be of very little use. A similar point has been addressed by Tulving and Thomson (1973) as encoding specificity. In agreement with Tulving and Thomson, we feel that it is necessary to focus on interactions between the manner in which initial encoding was carried out and the demands of the particular situation in which memory is assessed. However, it seems too extreme to argue that *all* aspects of the encoded trace are drastically modified by the context in which an event occurs (that is, that all aspects of the encoded description are relative to the specific context); presumably, some aspects are relatively invariant across contexts. It has been suggested, for example, that physical and structural aspects of words are relatively insensitive to changes in context, whereas semantic aspects are modified by context to a greater degree (Jacoby, 1974; Nelson & Brooks, 1974). The assumption that some aspects of an encoding or description are relatively invariant across contexts proves useful in a later discussion of retrieval processes.

Retrieval Processes

These ideas of distinctiveness and discriminability must be tied to some notions of how retrieval processes operate. We will assume a simple "feature overlap" model of recognition; that is, the probability of recognition increases with an increase in the number of common features activated at encoding and retrieval (or as a function of repetition of the same mental operations; Kolers, 1973). It follows that reinstatement at retrieval of the original encoding context enhances recognition by leading to an increase in the number of activated features in common between the study and test situations. Even out of context, re-presentation of an item may lead to some degree of recognition, and in this situation recognition can be enhanced by active reconstruction of the initial context. In this case the partial recognition may lead to constructions of plausible contexts ("Where might I have seen that person before?"); to the extent that one general line of reconstruction is associated with increased feelings of familiarity ("probably somewhere around the university"), that line is pursued until recognition reaches some acceptable level ("a student in my Introductory Psychology class"). In this sense, episodic and semantic information are thought to interact to enhance recognition (Lockhart, Craik, & Jacoby, 1976). One main point to be made here, and developed later, is that retrieval is not to be thought of as an all—or—none, automatic process. Rather, retrieval operations can be elaborated on or curtailed depending on task demands. The second point is that a distinctive encoding enhances recognition, because in this case when the encoding context is fully reinstated as retrieval information, such retrieval cues specify the prior event more precisely.

A number of memory effects can be described in terms of the interactions between distinctive encodings and adequate retrieval information. First, if the original encoding is difficult to accomplish, later memory of the event will usually be good. It is argued that the initial difficulty is associated with the formation of a more complete "description" of the stimulus and thus with a more distinctive trace of the event. As initial encoding becomes easier (with practice, say), there is a concomitant decrease in the level of recognition (Kolers, 1975). The effects of difficulty of *retrieval* on subsequent retention of the event can also be described in this way (Gardiner, Craik, & Bleasdale, 1973; Götz & Jacoby, 1974). The role of distinctiveness in explaining effects of depth of encoding, of difficulty of retrieval, and of interference is described more completely later in the paper.

Our ideas on retrieval start from the assumption that successful recognition involves the activation of some critical number of features or operations that are then matched with the record left by the event on its previous occurrence. If there is a sufficient degree of overlap between the features encoded in the trace and the features presently active, then recognition occurs. We also assume that the trace of the event's initial occurrence incorporates information about both the event itself and its context. If the event is re-presented in the same context on the second occasion, there will be a greater degree of overlap between trace information and test stimulus information; and the probability of recognition will be increased. Further, due to the more precise description of the original event, fewer new events will be falsely recognized. However, rather than treat recognition as all or none, with the probability of the "all" state increased with increasing degrees of overlap, we prefer to think of degrees of recognition; that is, the present stimulus is judged to be more or less familiar depending on the degree of overlap.

So far, this description of recognition makes it appear a rather automatic, passive process. However, we would like to stress the *active* nature of the processes involved and also the likelihood that retrieval processes, like encoding processes, can be modified both by the subject's strategies and by task demands.

We assume that the encoding processes that occur on presentation of a stimulus for recognition are partly driven by the stimulus itself but also occur in part through more creative, reconstructive efforts on the subject's part. That is, the stimulus evokes its habitual, "normal" encoding, but this more or less automatic encoding response may be elaborated by further processing. The purpose of the more elaborate encoding in an intentional recognition situation is presumably to reconstruct the initial context in which the event occurred, thereby enhancing the overall likelihood of successful recognition. The question immediately arises as to how the system goes about reconstructing the initial context if the stimulus itself is uninformative in this respect. We assume that such further processing is a "bootstrapping" operation with creation of very general, plausible contexts occurring first; if one such general context is associated with an increase in recognition familiarity, then the reconstructive operations will be refined in this direction until either full recognition occurs or the reconstructive efforts lead to no further increase in familiarity. In this sense, the record of the initial occurrence can be thought of as guiding and shaping reconstructive retrieval processes (Lockhart et al., 1976). This account should be distinguished from "generate–recognize" models of remembering (described by Tulving, 1976) in that such models argue for complete generation of possible encodings that are then matched with the trace; in contrast, the present account stresses the interactions between reconstruction and trace information while the reconstruction is being carried out.

The two points we wish to stress at present are—first, the notion that retrieval processes, like encoding processes, can be elaborated to a greater or lesser degree and that greater degrees of elaboration (of the correct qualitaive type) increase the likelihood of overlap with the trace information and thus of successful recognition. The second point is that retrieval processes can be split into two components—those processes induced rather automatically by the stimulus itself and those directed by task demands. We refer to these two aspects of retrieval as "spontaneous" and "directed" retrieval, but it should be stressed that these labels refer to portions of an underlying continuum: The stimulus itself spontaneously induces a certain amount of encoding, and this by itself may be sufficient to recognize the event; if it is not, and if the situation demands it, the system is directed to make further reconstructive efforts in an attempt to achieve recognition.

A third point concerns the type of information about prior occurrences of the event evoked by the present stimulus. Either rather general information or more specific detailed information of the initial context can be retrieved. This distinction corresponds repsectively to Tulving's (1972) notions of semantic and episodic memory, although we would wish to give greater emphasis to the continuity between the two types of information. That is, the total record of a common event's many past occurrences will contain some information common to all occurrences (e.g., a word's spelling), some common to groups of occurrences (usual settings in which the event occurs), and some specific to each particular context in which the event has occurred. At the time of test, more or less of this stored information will be retrieved: If only the general information is retrieved, the subject will feel that he or she "knows" the event, it feels familiar; if specific details of the initial context are retrieved, then the event will be recognized as having occurred at a particular time and place. Task requirements, as well as the subject's set and motives, are seen as directing the system to retrieve greater or lesser amounts of such past information. It is interesting to speculate on the relative ease and difficulty with which different types of stored information can be evoked; plausibly it is the general ''semantic memory'' information that is more easily and spontaneously evoked by the stimulus, whereas ''episodic'' information may be more difficult to retrieve and is thus evoked only when directed by task demands or when facilitated by re-presentation of the same context.

It should be noted that whereas we have described retrieval as a somewhat one-way process in which the records of past experience are elicited by present stimulation and by reconstructive activities, it is considered more likely that stored information and the present stimuli affect each other in a more interactive fashion. That is, it seems probable that the cumulative record of past experience serves also as an interpretative framework within which the present stimulus is understood. When a stimulus elicits (or interacts with) general ''semantic memory'' information, we talk about the process as *comprehension*; when, in addition, specific details of the initial context are evoked, we talk about episodic *memory* of the event. In common with others (e.g., Bransford, McCarrell, Franks, & Nitsch, 1977; Kolers, 1973; Restle, 1974), we are thus stressing the essential similarity between processes of perception, comprehension, learning, and memory.

In summary, retrieval is seen as a process in which the encoded trace is matched with the presently active encoding. The present encoding, in turn, is partly driven by the stimulus and partly reflects the results of more elaborate reconstructive operations. Thus retrieval operations vary in their extensiveness; habitual encodings are evoked spontaneously and automatically by the stimulus, whereas further elaborate processing is evoked if directed by task demands or by feelings of partial recognition. It is assumed that retrieval processes mirror initial encoding processes and may thus also be described as varying in depth, elaboration, and distinctiveness. This point of view suggests studies of ''incidental retrieval'' in which retrieval processes are controlled by orienting tasks in the same way that encoding processes have been controlled in many recent studies. Also, for the distinctiveness of an encoded trace to be effectively utilized at retrieval, it is considered necessary to reinstate the original encoding dimensions.

A stimulus may be recognized on the basis of its general familiarity; in this case, recognition is ''context free.'' If a more specific retrieval question is asked, however, retrieval operations must be expanded by more active reconstructive activities in an attempt to reconstruct the original episodic context; in this case, recognition is ''context dependent.'' The final point was made that past experience may interact with present processing in two major ways. In the first, attention is focused on the current pattern of stimulation, and past learning serves as a context for interpretation of presented stimuli (that is, past learning aids present comprehension). In the second case, attention is focused on specific episodic details of the past experience, and the present stimulus is used to specify the type of information required (that is, present stimuli act as cues to evoke memories of past events). Whether the interactions between past learning and present stimulation result in "comprehension" or "remembering" will depend in turn on the subject's set, goals, and motives.

Bransford et al. (1977) have stressed the "stage-setting" role of past learning in allowing degrees of differentiation of present stimuli; this role corresponds to the "comprehension" mode described above. We agree that this is one way in which the system can operate but suggest the system can *also* operate in the more traditionally accepted manner of the stimulus functioning as a retrieval cue to evoke contextual details of an event's past occurrences.

EMPIRICAL ISSUES

Some important empirical effects can be described in terms of the foregoing analysis. Brief descriptions of such effects are now given before proceeding to outline some further recent studies.

Selective Encoding vs. Emphasis

The levels of processing framework, as originally formulated by Craik and Lockhart (1972), claimed that the orienting task acts to select particular attributes of an event for encoding. An attribute (e.g., the sound of a word) will be encoded only if the orienting task requires the subject to deal with that attribute. It now appears that this original selective encoding position is too extreme; attributes in addition to those involved by the orienting task are encoded. In retrospect, the original levels experiments provide evidence that this is the case. Those experiments demonstrated that retention is higher after decisions about the meaning of a word (e.g., Does the word refer to an animal?) than after decisions about the physical characteristics of a word (Is the word in upper or lower case?). As claimed earlier, these results illustrate that retention performance is tied to the nature of input processing. However, the important thing to note for present purposes is that retention performance in the conditions where subjects judged the "case" of presented words was substantially above zero. If in making case decisions, subjects had described the words only as having appeared in upper or lower case, retention performance should have been essentially zero; this is true because remembered information regarding case alone would be of no help in the later test of memory for the particular words that were presented. The nonzero level of retention performance provides evidence that information beyond the minimal amount necessary to accomplish the orienting task must have been encoded. Nelson (Chapter 3, this volume) provides more direct evidence that information that does not appear to be involved by the orienting task is, nonetheless, encoded.

If orienting tasks do not act solely to select particular attributes for encoding, what do they do? Nelson's answer to this question is that orienting tasks have their effect by emphasizing the attributes that are involved by them. Recent work by Spyropoulos and Ceraso (1977) can be used to expand on this suggestion. Spyropoulos and Ceraso demonstrated that a manipulation of orienting tasks can influence the accessibility of an encoded trace. In their first experiment, for example, a colored shape was classified by either its color or its shape. After this task, one property of the colored shape was presented as a cue for recall of the other property. Recall was found to be substantially higher when the property that had been used as a basis for classification, rather than the unclassified property, was presented as a cue for recall. Results of additional experiments, reported in the same paper, lend convincing support to the conclusion that this greater cue effectiveness of the classified dimension was due to a difference in accessibility; the classified property was more effective at providing access to the trace, although—as a colored shape is an integral stimulus—both the classified and the unclassified properties were available in memory. Spyropoulos and Ceraso suggested that when a unit is stored, it is also classified; direct access to the unit is then only possible via cues that are specified in the classification system. That is, attributes of an event that are emphasized by an orienting task comprise a classification system within memory, and this classification system must be used to gain access to unemphasized attributes. The effect of contrast in determining distinctiveness can also be considered in this light. Contrast acts to emphasize an attribute and to increase the probability that that attribute is involved in the classification system; the classification system is based on attributes with the greatest diagnosticity. By this view, our earlier discussion of description and distinctiveness characterizes the classification system rather than the memory trace of an event.

A combination of the selective encoding and emphasis positions is desirable. It may well be that what is originally a difference in emphasis develops into selective encoding as a result of further experience with a given task. The idea is that processing is inefficient when a subject first engages in a task. As a consequence, attributes are dealt with in addition to those that are strictly required by the task; complete ignoring of these "irrelevant" attributes is accomplished only through extensive experience with the task. Returning to the original levels experiments, retention performance after subjects had made decisions about the case of presented words would be expected to reach zero only after subjects became highly experienced at making case decisions. In line with these notions, recent research and theorizing by Mackintosh (1975) make the point that learning to ignore aspects of an event plays an important role in selective attention. The effects of practice on a task are considered more fully in the following section.

Practice effects. As a result of practice, performance of a task usually becomes more efficient; the task is accomplished smoothly, rapidly, and with less effort. It may be suggested that the subjects has learned to become more selective in terms of the aspects of the incoming stimulus being dealt with; also, individual parts of the task are integrated into the task as a whole and so lose their individual identity. Whereas these changes are to the subject's advantage for performance of the task at hand, they lead to a decrement in later memory for individual occasions on which the task was performed. Through practice, the subject need perform fewer and less extensive analyses—particularly of peripheral (contextual) information. Also, he or she has learned to operate in terms of classes of events rather than with individual events. Overall, it is suggested that greater efficiency is gained at the expense of memory for the individual occurrences of the task. Perception of words and other events can be considered as skilled tasks and thus amenable to the same theoretical analysis. Kolers (1975) has described his experiments on reading transformed texts in these terms.

Spacing effects. It is possible to interpret the spacing effect (or ''lag effect''; Melton, 1967) in the above terms. The idea, basically, is that whereas repetition of an event confers a benefit for later recall, this benefit is attenuated progressively with proximity of the two events in time. That is, if an event is repeated closely after its first presentation, the system need perform less extensive analyses on the second occasion. For example, if you are given an arithmetic problem, 47 + 15 + 36 = ?, and after working out the answer, you are immediately given the same problem again, the answer can be given with less effort and with the involvement of many fewer operations. Similarly, the less extensive analysis of the repeated event attenuates the positive effects of repetition. The attenuation itself decreases as the events are spaced further apart, and the subject must indulge once more in a full analysis. Other plausible analyses of the spacing effect have been advanced by Hintzman (1974) and by Lockhart (1973).

Isolation effects. It has been known since the experiments of Von Restorff were reported that dissimilar or incongruous items in a set are better remembered than are the background items. What processes underlie this effect? Cooper and Pantle (1967) have claimed that the retention advantage of an isolated item is due to its greater rehearsal; the subject spends more time rehearsing the isolated item. By the present analysis, in contrast, isolating an event has its effect by necessitating fuller processing of the isolated event than of its background events (or that of a control event presented against a different background). The background events ''set'' the subject to deal with events of a particular class; because the isolated event is not a member of this prepared class, the isolated event must be dealt with more extensively. This fuller processing may occur in part as the result of an attempt to resolve the incongruity associated with the different event. Again, task demands or the general cognitive context will determine the effort put into the resolution of ambiguity. For example, readers will either struggle to find meaning in vague and obscure statements or dismiss them as nonsense, depending on the credibility of the source (cf. Mistler-Lachman, 1975). It would be expected that occasional nonsense coming from a usually credible source would benefit from extensive processing and be well remembered. Given that the anomalous item has been processed extensively and a distinctive trace formed as a consequence, good retention will also depend on the presence of an effective retrieval cue.

Decision difficulty. A difficult initial decision will usually be associated with high levels of retention for the reasons given above; namely, the difficulty necessitates more extensive processing, which then results in the formation of a more distinctive trace. Again, the level of retention will depend on other factors also; for example, the congruence of the retrieval cue with the encoded trace (Craik & Tulving, 1975) and the specificity of the relation between cue and trace (the ''cue-overload effect''; e.g., Watkins & Watkins, 1976). Illustrations of the relation between initial decision difficulty and later retention levels have been provided by Gardiner, Craik, and Bleasdale, 1973; Kolers, 1975; and Epstein, Phillips, and Johnson, 1975, among others. A parallel series of demonstrations has related the difficulty of initial *retrieval* to subsequent retention level (e.g., Bjork, 1975; Götz & Jacoby, 1974; Lockhart, 1973).

Distinctiveness in study and retrieval processes. Several investigators have attempted to eliminate differences in retention by controlling study processing. The usual procedure is to do what is essentially a levels experiment employing subjects from two different populations. If the performance of subjects from the two populations does not differ on the incidental test, it is argued that effects found with more traditional intentional learning procedures are due to differences in level of processing that are eliminated by means of employing orienting tasks and incidental learning instructions. If differences between the two populations remain with the incidental test, it is argued that some factor other than differences in processing is responsible for effects in retention. This strategy has been used to investigate developmental differences in memory among children (e.g., Brown, 1975), to assess the effects of aging (Craik, 1977), and to compare the memory of hospitalized individuals of different types with that of normals (e.g., Cermak, Chapter 6, this volume).

A weakness in the strategy just outlined is that it ignores potential differences in the processing of retrieval information. An experiment conducted by Karen Reay, under the guidance of the first author, can be used to illustrate this point. That experiment investigated age-related differences in memory among elementary-school students; level of processing was factorially combined with the form of the subsequent retention test. Effects of age were found to be larger when retention was tested by means of cued recall rather than by free recall. This was true although encoding processes are thought to have been equated across ages by means of orienting tasks and incidental learning instructions. A conclusion that can be drawn is that children of different ages differed with regard to the extent that they processed retrieval information. Just as younger children are less likely to extensively process items during study when they are instructed to learn, they are also less likely to fully process retrieval cues when they are instructed to recall. Variations in the distinctiveness of encoding during study will have relatively little or no effect if retrieval information is superficially processed. Further, due to an apparent similarity of the processes, deficits in retrieval processes might be expected usually to accompany deficits in encoding processes. To rule out processing or strategy deficits, it is necessary to attempt to equalize processing at retrieval as well as at encoding. Incidental testing procedures may be necessary to accomplish this end; there is no reason to believe that instructions to recall or recognize necessarily equalize processing among populations to any greater extent than do instructions to learn.

EMPIRICAL STUDIES

Three recent studies are described to illustrate some of the theoretical points already made.

Experiment 1

The point of this study was to examine the effects of initial decision difficulty on subsequent cued recall and recognition, while also varying the degree of association between the ''decision'' word and the word used later as the retrieval cue.

On each trial, the subject was given a card that had one word (the ''focus word'') printed on one side and two words printed on the reverse side. The subject's task was to study the focus word, then turn over the card and pick the word from the two that was more highly related to the focus word. Words on the reverse side were either high or low associates of the focus word or were unrelated to the focus word; the two words were either both highly related to the focus word (High–High), one high associate and one low associate (High–Low), or one high associate and one unrelated word (High–Unrelated). Similarly, other conditions were Low–Low, Low–Unrelated, and Unrelated–Unrelated. Decision difficulty was assumed to depend on the relative degrees of association of the two words to the focus word; thus difficult decisions would be involved in the High–High, Low–Low, and Unrelated–Unrelated cases; the easiest decisions should occur in the High–Unrelated case. Thus, for example, if the focus word was *water* and the two words on the reverse were *lake* and *ocean* (High–High), the decision was assumed to be difficult; if the focus word was *chair* and the two words were *table* and *grass* (High–Unrelated), the decision was assumed to be easy. The word picked out is referred to as the *target* word. The initial (incidental learning) task was followed by either cued recall—in which focus words were presented as cues for recall of the chosen target word—or by recognition of *focus* words, followed by recognition of *target* words.

The results (Fig. 1.1) show that both initial decision difficulty and the strength of prior association between focus and target words have strong effects on cued recall. Recognition of focus words is consistently higher than recognition of target words (possibly reflecting either the greater attention paid to focus words or the fact that target words were recognized later in the test sequence), and both sets of recognition values are less affected than are cued-recall scores by the strength of association between focus and target words. Decision difficulty does have some effect on recognition of focus words but essentially none on recognition of target words. Finally, it should be noted that cued-recall scores are higher than recognition scores for the highly associated focus–target materials but that this superiority of cued recall drops for low associates and reverses for unrelated words.

The main points we wish to make from this study are that retention level is a function both of the nature of encoding and of the effectiveness of the retrieval information to enable formation of mental operations that will match the trace. Decision difficulty is assumed to affect the distinctiveness of the encoded trace, but clearly the ease with which the focus word can facilitate reconstruction of the focus–target complex is important too. In line with the preceding theoretical analysis, it is argued that more difficult decisions required the target words to be described more precisely—to be differentiated to a greater degree. Thus not all aspects of meaning are encoded ''automatically''; encoding depends on task demands.

Since the focus words are given as a cue for the target words, those aspects of

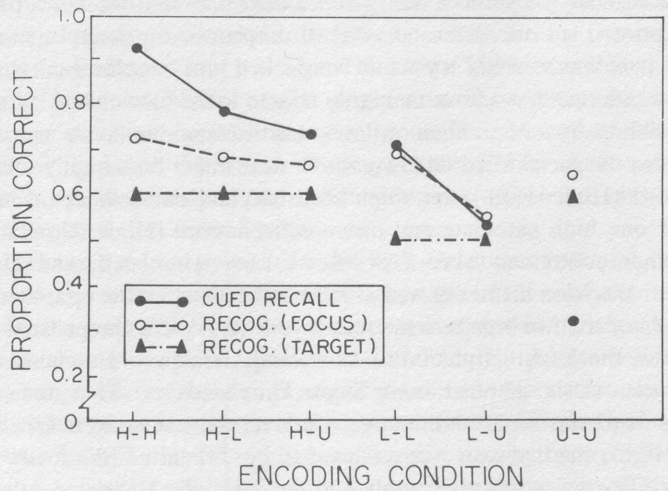

FIG. 1.1. Proportions of words recalled and recognized as a function of experimental condition (Exp. 1).

the encoded trace concerned with focus–target interactions are particularly relevant for cued recall. However, recognition of target and focus words is less dependent on these aspects of the trace; other features of the general experimental context plus context-free aspects of the encoding may also help to facilitate recognition. The finding that recognition of focus words *is* affected by decision difficulty to some extent suggests that in this case retrieval processes are "expanded" to make some use of the focus–target interactions that took place at encoding. The crossover between recall and recognition levels emphasizes that retention level depends both on the distinctiveness of the trace and on the effectiveness of the retrieval cue to reconstitute the encoded information at the time of retention. This last point is taken up again in Experiment 2.

Experiment 2

The point of this study was again to vary both initial decision difficulty and the effectiveness of retrieval information to reconstitute the trace in recognition and recall. Decision difficulty was manipulated by asking a category question (e.g., "Is the word a type of tree?" "Is the word a type of cloth?") and then presenting a target word in a tachistoscope, ostensibly in a decision-latency experiment. Of the 72 question/word trials, 24 led to "no" responses; these were filler items and are not considered further. In the remaining 48 trials, 16 questions were each used 3 times throughout the total 72 trials. These 16 questions were category labels for the Battig and Montague norms, and the 3 different target words for each question were drawn respectively from the top, middle, and bottom thirds of the normative lists. It was assumed that category decisions would be easiest for high-ranking exemplars, more difficult for middle exemplars, and most difficult for low-ranking exemplars. In order to avoid a confounding with word frequency in the language, words were chosen that were matched for frequency across the three levels of decision difficulty. After the initial task was completed, half the subjects were reprovided with the 16 relevant category names and asked to recall the target words; the remaining subjects were given a recognition sheet with the 48 target words mixed randomly with 144 lures (the lures were 9 nonpresented words from each of the 16 tested categories). The subject was asked to check exactly 48 items—those that he or she had seen earlier. Recall and recognition thus both followed incidental learning.

It was predicted that since low-ranking exemplars involved greater decision difficulty, and thus the formation of more distinctive traces, these words would be best recognized. On the other hand, the greater ease of reconstructing high-ranking exemplars from the category label (as indexed by the norms) might reverse the effect for recall.

The lefthand panel of Fig. 1.2 shows that decision latencies increased systematically from high to low exemplars. Arguably, then, decision difficulty increased from high to low. The righthand panel of Fig. 1.2 shows that recognition also

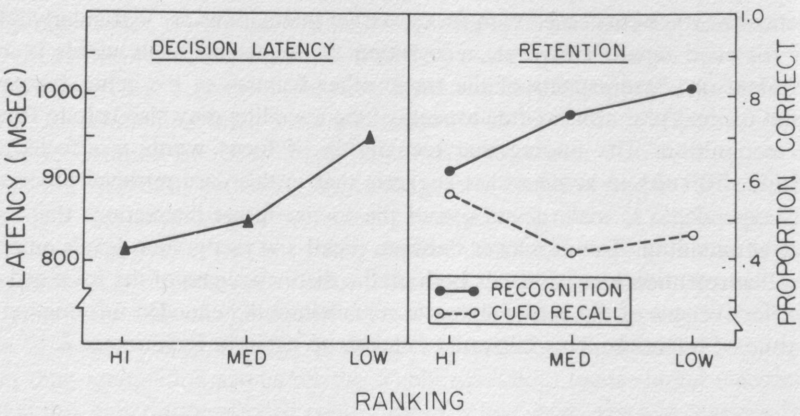

FIG. 1.2. Decision latency and proportions recalled and recognized as a function of ranking (Exp. 2).

rose from high to low but that cued recall was highest for the high-ranking exemplars. The interaction between rank and recall/recognition was significant (F, 2.60 = 15.1, $p < 0.01$).

The conclusions are the same as for Exp. 1. Greater decision difficulty is associated with higher levels of retention, but this effect must be qualified by the congruence or coherence of retrieval information with the encoded trace. In the present case it is argued that the beneficial effects of a difficult decision are swamped in cued recall by variations in the effectiveness with which the retrieval cue can reconstitute the trace. The same effect is seen in the recall data of Exp. 1 when a difficult decision with an ineffective cue (U−U) is compared to an easy decision with an effective cue (H−U).

Experiment 3

This final experiment was designed to illustrate the ditinction between spontaneous and directed retrieval. The notion is that recognition of an event does not necessarily involve retrieval of that event's prior local context; as with study processes, retrieval processes are under the control of task demands.

The effects of repetition on cued recall were studied in situations that did or did not require retrieval of the first encoding context at the time an item was repeated. A long list of words included pairs of synonyms (e.g., *baby−infant*) with the members of a synonym pair appearing successively in the list. In some cases (Single Item) the second member of the pair was not repeated, but in other cases (0-spacing) the second member of the pair was repeated immediately (e.g., . . . *baby infant infant* . . .). In still other cases, a varying number of unrelated items (3, 6, or 12) intervened between repetitions of the second member of a synonym pair (e.g., . . . *baby infant* . . . . *infant*). The subject's ostensible task was to detect whether or not a synonym of each word had been presented. In a "1-back" condition, subjects were instructed to detect this similarity with respect to the immediately preceding word only; that is, each word was compared only with the word that immediately preceded it. In an "*n*-back" condition, similarity was to be detected with respect to all previous words in the list. Thus, the spaced repetitions of the second member of a synonym pair were accompanied by the requirement to retrieve the first member of the pair (the prior local context) only in the *n*-back condition.

Subjects were later given an unexpected cued-recall test, with the second member of each synonym pair serving as the cue for recall of the first member. It is argued that the beneficial effects of repetition will require that the prior local context be retrieved at the time an item is repeated; repetition should facilitate later cued-recall only in the *n*-back condition. In contrast, relatively context-free recognition, of the type expected to result from repetition in the 1-back condition, might interfere with later cued recall. This is true, because repetitions of an item in that condition are embedded in totally separate contexts on their two presentations; for recall of the first member of a synonym pair (context of the first presentation of repeated items), this is roughly equivalent to an A–B, A–D retroactive inhibition paradigm. Another question of interest was: Does massed repetition enhance later cue effectiveness? The results are shown in Fig. 1.3.

It is clear that cue effectiveness is not enhanced by repetition in the

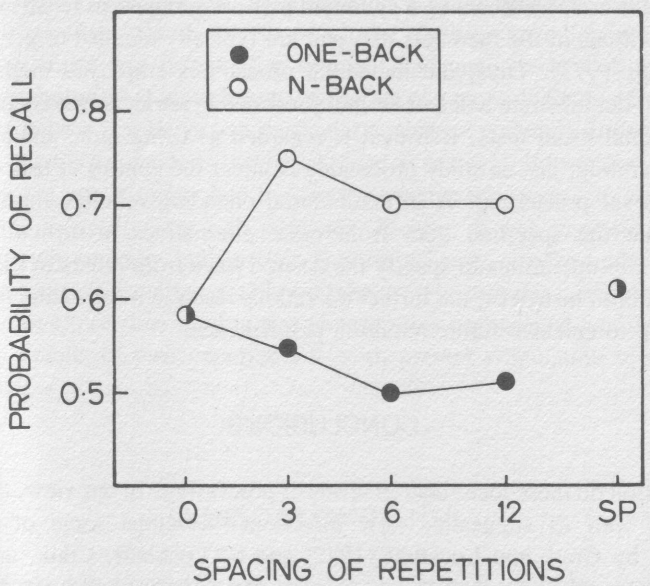

FIG. 1.3. Probability of recall as a function of spacing and experimental condition (Exp. 3).

''0-spacing'' case; immediate repetition results in no further useful encoding. With spaced repetition, cue effectiveness is enhanced relative to the single item case only under *n*-back conditions. The point again is that retrieval of the previous synonym during presentation of a repetition does not occur ''automatically'' but is under task control. In contrast, under 1-back conditions, spaced repetitions interfere with later cued recall. This interfering effect of repetitions provides evidence that there is recognition of repetitions in the 1-back condition. However, recognition in this case must be relatively context-free, since otherwise facilitation rather than interference would be expected. Further, there is also a ''spacing effect'' for repetitions in the 1-back condition. In the 1-back condition, however, that spacing effect reveals increasing interference rather than increasing facilitation. It is clear that in this situation, at least, the direction of the spacing effect is under strategic control. When prior local context must be retrieved, increasing the spacing of repetitions enhances cued recall; this is possibly due to greater difficulty of retrieval under spaced conditions. When the retrieval of prior local context is not required but comparison with an irrelevant word is, increasing the spacing of repetitions interferes with cued recall.

Overall, this experiment provides a demonstration that retrieval of a past event is a matter of degree—prior local context is retrieved to the extent that the task demands it. Recognition of one member of a previously presented synonym pair does not necessarily involve the other member of the pair. This is true even though in free recall a synonym pair fulfills the requirements for being considered a unit; members of a synonym pair are grouped in recall, and either both, or neither, of the members of a pair are typically recalled (e.g., Jacoby & Goolkasian, 1973). Thus, the incidental procedures employed in the present experiment demonstrate a degree of independence in retrieval that is not revealed by intentional-recall tests. Retrieval is regarded as being quite analogous to a second encoding; just as study processing is under the control of task demands, so is retrieval processing. A difficult initial encoding requires more work to differentiate the specified item from other alternatives; a difficult retrieval requires more operations to specify the desired trace from others in the memory system. In both instances, the further operations result in more distinctive traces, which help to enhance future retention performance.

CONCLUSIONS

What relation do these ideas bear to levels of processing? In our view, the present paper, as well as suggesting new directions, develops some of the ideas suggested by Craik and Lockhart (1972) and by Lockhart, Craik, and Jacoby (1976). The notion of ''depth'' is still retained to describe qualitative differences in encoding processes and to suggest that semantic processes are generally more abstract, less tied to specific input channels, and more interrelated. Such processes are ''deeper'' in the system in the sense that they typically require more attention and effort to achieve. However, further thought was needed on such issues as the reasons underlying different levels of retention within semantic processing.

The ideas emphasized in the present paper are—first, the notion that greater depth and greater degrees of elaboration of the stimulus allow formation of a more distinctive, discriminable trace. As others have also suggested (Eysenck, Chapter 5, this volume; Klein & Saltz, 1976; Norman & Bobrow, 1977; Wickelgren, 1977), the different levels of retention associated with structural, phonemic, and semantic processing may reflect differences in the underlying descriptive dimension of distinctiveness. (But beware!—we are not back to unidimensional, crypto-strength models. Distinctiveness requires specification of the qualitative dimensions in which distinctiveness is achieved; a green object may be more easily distinguished from a background of white objects than is a circle from a background of ellipses, but it would not be satisfactory to describe the green object as ''stronger'' than the circle. ''Strength'' is a shorthand notation for performance level, whereas ''depth'' and ''distinctiveness'' attempt to describe the processes underlying performance; they reflect different explanatory levels from ''strength''.)

Other ideas stressed in the present paper are that encoding and retrieval processes are very similar in many ways. In particular, whereas practice and familiarity with a stimulus lead to some aspects being encoded spontaneously and ''automatically,'' the degree to which the resulting encoding is elaborated (both during input and retrieval) is optional and under task control. Greater degrees of elaboration at input lead to formation of a more distinctive trace; since this distinctiveness is relative to a particular context or encoding dimension, this dimension must be reinstated at retrieval. Also at retrieval, information provided by the retrieval cue is elaborated by ''reconstructive processes'' to a greater or lesser degree depending on task demands. Finally, it was suggested that the extent to which episodic information is retrieved may also be under strategic control; the focus of attention is either on the present stimulus—with the general aspects of past experience serving as an interpretive background—or the focus is on specific details of past experiences—with present stimulation serving as a retrieval cue.

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