Levels of Processing

Procedure

In *Levels of Processing I*, you make simple "yes/no" judgments about words while the computer measures your decision times. There are three types of judgments. One type requires you to determine whether or not a word has a certain pattern of vowels and consonants. Another requires you to say whether or not a word rhymes with another word. The third type of judgment requires you to determine whether or not a word or, more precisely, its referent, belongs to a given conceptual category. Full instructions for the task are given to you at the beginning of the *Levels of Processing I* program. After the computer has presented these instructions to you, it will also offer the option of having them shown again. Because it is important that you fully understand the task before proceeding, make sure that you review the instructions if you have any doubts about the procedure.

The experiment in *Levels of Processing II* is also concerned with the speed with which you can make decisions about words. In this experiment you will be shown a series of sentences. Each sentence is missing one word. Immediately after you see the sentence, you will be shown a word, and your task is to determine whether or not the word fits meaningfully into the sentence blank. Again, full instructions for this task are given to you at the beginning of the program. Before you start the experiment, the program will ask you how many trials you wish to be given. The number of trials must be less than or equal to 40 and must be divisible by 4. Your instructor will tell you how many trials you should run.

Theoretical Background

For a number of years, psychologists thought that the human information processing system consisted of three separate memory stores plus processes that transferred information from one store to another. This view of memory is called the multistore model of memory. In 1972, Craik and Lockhart published a paper in which they argued that existing experimental evidence did not provide much support for the multistore model; they showed that the distinctions between the different memory stores were, at best, very fuzzy. They argued, therefore, that memory theorists should abandon the notion of discrete memory stores and, instead, think of memory as a continuum of mental processing. They termed this view the levels of processing framework.

So that you will be able to appreciate the levels of processing framework and the theoretical importance of the experiments in which you just participated, we will first give you a brief introduction to the multistore view of memory. Then we will summarize Craik and Lockhart's criticisms of this approach, finally, we will present the levels of processing framework and its predictions for the experiments in which you just participated.
The Multistore Model of Memory

Multistore models assume that there are three distinct types of memory stores: sensory stores, short-term store, and long-term store. When a stimulus is first encountered, it enters one of the sensory stores. Which sensory store receives information is determined, of course, by the modality of the stimulus. Input to the sensory store can occur regardless of whether or not the subject is attending to the information; that is, sensory stores are preattentive. Sensory stores represent information in a rather literal form. They have a relatively large capacity, compared to short-term store, but they retain the information for only a brief period of time - 1/4 to 2 seconds - before it decays.

If the subject allocates attention to the information in sensory store before it decays, it will be recognized as corresponding to some knowledge structure. This process is referred to as pattern recognition. Pattern recognition is the process by which information is read out of the sensory store and transferred into the short-term store. Typically, the result of transferring information to the short-term store is to make the subject conscious of the stimulus. Information in the short-term store differs from its representation in the sensory store in that it is no longer a literal copy of the stimulus. It has been transformed by the pattern recognition process into a conceptual category. For verbal information, the representation in short-term store is usually in terms of its sounds - phonemic coding. Short-term store differs from the sensory stores not only in how the information is represented, but also in terms of capacity and the duration of information. Short-term store has a much smaller capacity than the sensory memories, yet it is able to retain information for longer periods of time, up to 30 seconds. Also, information can be maintained in short-term store indefinitely through rehearsal or continued attention. Because the sensory stores are preattentive, no such mechanism for maintaining information is available for the sensory stores.

Rehearsal not only serves the purpose of maintaining information in short-term store, it also serves to transfer the information into long-term store. The long-term store, like the sensory and short-term stores, was defined by the multistore model in terms of its capacity, coding of information and duration of information. Whereas short-term store has a very limited capacity, long-term store has no known limit. Also, while verbal information is usually coded in terms of its sounds in short-term store, it is usually coded in terms of its meaning in long-term store. Finally, information is usually completely forgotten from short-term store within 30 seconds or less; forgetting from long-term store may take years and, in some instances, may never occur.

Figure 2.1 presents a schematic depiction of the multistore model for verbal memory. The defining characteristics of each of the memory stores, summarized in this figure, are what formed the basis of Craik and Lockhart's (1972) critique of the multistore model. They argued that these three criteria did not provide satisfactory grounds for distinguishing between separate stores. The next section summarizes the problems with each of the three criteria.
Arguments Against the Multistore Model

Coding. The multistore model assumes that the coding of information in short-term store is different from that in long-term store. Verbal information in short-term store is said to be coded in terms of sounds; that is, phonetically. Verbal information in long-term store is said to be coded in terms of its meaning; that is, semantically. These assumptions about the coding of information were derived from experiments in which subjects learned lists of words. More recent research, using more meaningful materials such as sentences, suggests that these assumptions are wrong. The evidence shows that verbal information in short-term store is coded semantically as well as phonetically. Thus, although type of coding may originally have seemed a good basis for the distinction between short- and long-term memory, the distinction no longer seems to be very satisfactory. Because memory coding is flexible, depending on the task and the type of material to be remembered, it cannot be used to distinguish one memory store from another.

Capacity. If a memory store is to be defined in terms of its capacity, then one would expect that all attempts to measure capacity should yield estimates that are relatively invariant across tasks and different materials. This has not been the case, especially with regard to the capacity of short-term store. Some tasks (e.g., serial position curves in free recall) yield estimates as low as two items for the capacity of short-term store. Memory span tasks, on the other hand, yield much larger estimates, on the order of 7-9 items. And sentence memory tasks yield estimates of 20 or more items. Furthermore, research by Chase and Ericsson (1979) shows that the capacity of short-term store, as measured by a digit span task, can be expanded from 7 digits up to 64 digits through practice. These facts are certainly inconsistent with the view that short-term store is a storage compartment of a fixed size. Like the data on memory coding, these data highlight the flexibility of the memory system. And just as coding cannot serve to distinguish between memory stores, so too, capacity estimates appear to be too variable to be able to use this notion to define memory structures.

Trace Duration. If memory stores are to be distinguished in terms of their forgetting characteristics, a minimal requirement should be that the retention functions ought to be
relatively invariant across different tasks. Unfortunately, this has not been found to be the case. Trace duration, in a short-term memory task, can vary drastically depending on the nature of the to-be-remembered items, the amount of study time, the type of memory test, and the relationship between study conditions and testing conditions. Thus, trace duration cannot be used as a defining characteristic of memory stores either.

The evidence we have just reviewed concerning coding, capacity and trace duration can be taken not only as evidence against the discrete memory structures proposed by the multistore model, but also as evidence for a continuum of mental processing where the type of coding or type of processing determines how much can be retained and for how long. This is in essence the basis of Craik and Lockhart's levels of processing approach to memory. We will now briefly summarize this approach.

**The Levels of Processing Framework**

The levels of processing framework regards the memory trace as a byproduct of perceptual processing. Perceptual processing is assumed to be a continuum of rapid analyses of the stimulus at a number of levels (or stages), rather than a series of transfers from one memory store to another as in the multistore model. Preliminary levels of processing are concerned with the analysis of physical or sensory features. Later levels are concerned with the extraction of meaning and with elaborating on this meaning by associating it with other cognitive structures. This conception of a series or a hierarchy of processes is referred to as "depth of processing," where greater depth implies a greater degree of semantic analysis.

Because the memory trace is a byproduct of perception, it can be thought of as more or less elaborate depending on the number and the qualitative nature of the perceptual analyses carried out on the stimulus. In other words, its coding and durability will be a function of the depth to which the stimulus is processed. Stimuli that do not receive full attention and are analyzed only to a shallow sensory level will give rise to very transient memory traces. On the other hand, stimuli that are attended to, fully analyzed, and enriched by associations or images will yield a deeper encoding and, consequently, a longer lasting trace.

In sum, the levels of processing framework states that memory for an event depends upon the nature of the processing it underwent when it was experienced or, as we say, encoded. The deeper the event is encoded, the more likely it will be remembered. The *Levels of Processing 1* experiment that you participated in was designed to test this prediction of the levels of processing framework. It is a modified replication of an experiment reported by Craik and Tulving (1975).
**Experiment 1: Depth of Processing as a Determinant of Memory Performance**

The experiment consists of two phases: an encoding phase and a memory test phase. In the encoding phase subjects are induced to process words to different depths by answering questions which require different types of analyses on the words. Subjects are not supposed to be aware that a memory test will follow the encoding phase. In other words, the memory test is incidental rather than intentional. The reason for employing an incidental memory test is that we want to be able to control, through the different types of questions, the type of processing that the subject employs when encoding the items. If the memory test were intentional, the questions would have less control over the type of processing because the subject would probably be trying to memorize the words, using any one of a number of different encoding processes.

**Design**

There are two independent variables in this experiment. One is the type of question; it has three levels - form, rhyme, and category. Form questions (e.g., "Is a CVCC?") are assumed to induce the shallowest encodings, category questions are assumed to induce the deepest encodings, and rhyme questions are assumed to induce an intermediary level of encoding. There are 20 instances of each of the three types of questions, for a total of 60 encoding trials. The second independent variable is response type; it has two levels - YES responses and NO responses. The questions are designed so that 10 of each type require a YES response and 10 require a NO response. Each subject receives a different random assignment of words to question types. So, for example, one subject may be required to encode the word SPEECH with a form question, but another subject may encode it with a rhyme question, and still a third subject may encode it with a category question. The 60 encoding trials are always presented in random order.

The memory test is a “yes/no” recognition task. It consists of a randomized presentation of the 60 words shown in the encoding phase plus 60 distractor items.

There are two dependent variables of interest. The main dependent variable is the number of words correctly recognized in the memory test as a function of question type and response type. The other variable of interest is the amount of time involved in the initial encoding of the word. Encoding times are measured from the time the word comes on the screen until the subject presses the YES or NO key for his or her decision.
**RECORD YOUR OWN LEVELS OF PROCESSING 1 DATA IN THIS TABLE**

**POSSIBLE 10 CORRECT PER ITEM TYPE**

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**NUMBER OF FALSE RECOGNITIONS = _________**

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**RECORD THE LEVELS OF PROCESSING 1 CLASS DATA IN THIS TABLE**

**POSSIBLE 10 CORRECT PER ITEM TYPE**

**NUMBER OF SUBJECTS = _________**

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**MEAN NUMBER OF FALSE RECOGNITIONS = _________**
Results and Discussion (You should use the class data summary to answer these questions.)

1. According to the levels of processing framework, the deeper the level of processing on an item, the more likely it should be remembered. Examine the average number of words correctly recognized for each of the three question types. Do the results support the prediction of the levels of processing framework? Explain.

2. Unlike the levels of processing framework, the multistore model of memory does not regard the type of processing as being very important to determining memory performance. Instead, the multistore model states that memory performance depends on the amount of time involved in the studying or encoding of the event. According to the multistore model, the longer an item is studied, the longer it will be maintained in short-term store and, thus, the more likely it will be transferred to long-term store. Examine the mean response times to each of the question types in the encoding phase and see how they are related to recognition memory performance. Is it true that the words that are remembered best are those that had the longest encoding times?

3. In Craik and Tulving’s original report of this experiment, they found that there was not much difference in the amount of time required to make a YES or NO decision in the encoding phase. However, they did find a difference in the frequency with which YES and NO items were remembered. Specifically, they found that, for rhyme items and especially for category items, words to which a YES response was given in the encoding phase were recognized better than those to which a NO response was given. Is this same pattern evident in your data? Why do you think YES items are recognized better than NO items? Also, why is this pattern not observed for items encoded under form questions?

4. In this experiment, we used an incidental memory test in order to ensure that the words would be processed to different depths according to the analyses required by the questions. Craik and Tulving also did an experiment in which the memory test was intentional. The results they obtained were very similar to those obtained when the memory test is incidental: category items were remembered best, followed by rhyme items, and form items were remembered the worst. Why do you think the same pattern of results obtains regardless of whether the memory test is intentional or incidental?

5. Do you think subjects could achieve high levels of recognition performance on shallowly encoded words if they were given a strong inducement to concentrate on these items? For example, suppose that, in addition to forewarning subjects that there will be a memory test, we tell them, before the encoding phase, that they will be paid for each word correctly recognized. Suppose that we offer 6 cents for each form item that is correctly recognized, 3 cents for each rhyme item, and only 1 cent for each category item. Do you think the results would differ from those we obtained in Levels of Processing I? If so, tell how they would differ and why. If not, tell why you think the money would have no effect.

6. Why do you think semantic levels of analysis lead to the highest levels of memory performance?
Experiment 2: Amount of Elaboration as a Determinant of Memory Performance

When Craik and Tulving found, in their original execution of the *Levels of Processing 1* experiment, that words to which positive responses were made in the encoding phase were remembered better than words to which negative responses were made, they were puzzled. This result did not seem to fit well with the notions of levels of processing. Why didn't it fit? It didn't fit because the levels of processing framework claims that higher levels of retention for a given word are solely the result of deeper levels of processing. Thus, to explain the result, they would have to assume that words involving YES responses are processed more deeply than words involving NO responses. However, there seemed to be no basis on which to claim that YES responses involved deeper processing than NO responses. After all, depth of processing cannot be determined by the answer to the question when the answer to the question is dependent on the processing. To assume that words which yield a YES response are processed more deeply than words yielding a NO response would thus be tantamount to assuming that the answer to the question is known prior to the processes invoked for the purpose of determining the answer. That, of course, is ridiculous.

Craik and Tulving’s solution to the problem was to propose that there was another factor, in addition to depth of processing, that was serving to determine memory performance. This additional factor was the amount of associative elaboration involved in the encoding. They argued that when a subject answers YES to a semantic or rhyme question, the result might be a more elaborate and detailed coding of the target word than when the answer is NO. The elaboration derives from the ease with which the target word can be integrated with its question. For example, suppose you are asked to say whether the referent of a word is "type of building." If the target word is CHURCH (a positive response), you can integrate it into your detailed knowledge about buildings and how church buildings differ from other types of buildings. If, on the other hand, the word is FOX (a negative response), the information in the question (about buildings) cannot easily be integrated with your knowledge of a fox and, thus, the coding of FOX does not get as fully elaborated as the coding of CHURCH. In sum, target words undergo less elaborate coding for negative questions than for positive questions.

If this argument is valid, then questions leading to equivalent elaboration for positive and negative decisions should be followed by equivalent levels of retention. The form questions used in *Levels of Processing 1* might be considered to be an example of such a case. Another type of question that appears to involve equivalent integration for positive and negative responses is exemplified by the following: "Is the object bigger than a chair?". In this case both positive and negative items (MOUSE, PIN) require reference to knowledge about size relationships. Thus, both should involve equivalent degrees of elaboration since both can be well integrated with the question. Consequently, they should be remembered equally well. Craik and Tulving (1975) performed an experiment to test this prediction. The encoding questions they used all permitted elaboration for positive and negative responses, such as the one given above. Their results supported the prediction: positive and negative response items were remembered equally well.

In the *Levels of Processing 2* experiment, an attempt is made to manipulate encoding elaboration directly. The purpose of this experiment is to test the hypothesis that greater degrees of encoding
elaboration lead to higher levels of retention. Like *Levels of Processing 1*, this experiment is a modified replication of an experiment reported by Craik and Tulving (1975).

As in *Levels of Processing 1*, the experiment consists of two phases: an encoding phase and a memory phase. The memory test is, again, incidental. All encoding trials in this experiment involve the same depth of processing in that all require processing to a semantic level of analysis; the subject must determine whether a word fits meaningfully into a sentence frame. The trials differ, however, in the amount of elaboration they involve. Degree of encoding elaboration is manipulated by varying the complexity of the sentence frames to which the words are encoded.

**Design**

There are two independent variables in this experiment. One is the complexity of the sentence frames. This variable has two levels: simple, sparse sentence frames and complex, elaborate sentence frames. The second independent variable is type of response. It also has two levels: YES responses and NO responses. The sentence frames were designed so that half of each type require a YES response and half require a NO response. The position of the blank slot in each sentence is balanced across sentences so that approximately one-third of the time it is at the beginning of the sentence, one-third at the middle, and one-third at the end of the sentence. As in LOP1, each subject receives a different random assignment of words to conditions. The memory test in this experiment is a free recall task.

As in *Levels of Processing 1*, there are two dependent variables of interest. The main dependent variable is the number of words correctly recalled as a function of sentence complexity and response type. The other variable of interest is the amount of time involved in the initial encoding of the word.
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Results and Discussion

Use the class data summary, provided by your instructor, to answer these questions.

I. According to Craik and Tulving’s principle of encoding elaboration, the more elaborate the context in which a word is encoded, the more likely it should be remembered. Examine the average number of words recalled as a function of the complexity of the sentence frame. Do the results support Craik and Tulving’s prediction? Explain.

2. Recall that encoding elaboration can only occur when the word can be integrated with the encoding context. Thus, even if the encoding context is very complex, if the word does not cohere with the context, it will not get elaborated and thus will not be remembered any better than if the encoding context had been very impoverished. In which conditions of this experiment is it difficult to integrate the words with their encoding contexts? Is the amount recalled in these conditions less than that where integration can occur? Explain.

3. In *Levels of Processing 1*, we examined the data to see if the amount of time spent in encoding the items could provide an alternative, perhaps better, account of which items are likely to be remembered. Do the same for this experiment. Is it true that the conditions which involved the longest encoding times are associated with higher levels of recall?

4. Craik and Tulving’s principle of encoding elaboration states that memory performance is enhanced to the extent that the encoding context forms an integrated unit with the word presented. Why do you think an elaborate encoding leads to better memory? In answering this question, consider what effects encoding elaboration might have both on storage and on retrieval processes.

5. In this experiment, we used complexity of stimulus environment to manipulate elaboration of the memory trace. What other factors do you think might affect how elaborate the memory trace will be?
Significance and Evaluation

The levels of processing framework enjoyed almost immediate acceptance among a wide range of memory theorists, and multistore memory models were soon abandoned. But even though multistore models are no longer utilized in memory research, it is important to realize that some of the concepts developed in these models continue to be used by memory theorists. For example, there is still general acceptance of the notion of sensory memories. Also, memory theorists continue to use the term short-term memory. However, short-term memory is no longer considered to be a separate structure with fixed and invariant characteristics. Rather, many theorists now use the term to refer to those contents of long-term memory that are currently activated and undergoing processing.

The most important contribution of the levels of processing framework was its emphasis on the dynamic aspects of memory - its emphasis on memory processes rather than structures. This emphasis turned out to be very helpful in explaining number of different memory phenomena. For example, ideas from the levels of processing approach have been applied to investigations of memory development in children (Hagen, 1979), memory declines due to the aging process (Craik, 1977a; Perlmutter, 1978), the effects of alcohol on memory (Craik, 1977b; Hartley, Birnbaum, & Parker, 1978), and the study of amnesia (Cermak, 1979). To illustrate, let us consider how the levels of processing framework has contributed to an understanding of the memory deficits observed in patients suffering from Korsakoff’s syndrome.

Korsakoff patients have severe subcortical brain damage caused by chronic alcoholism. They seem to be incapable of learning and remembering any new information, such as day-to-day events, current news, or even hospital personnel and procedures. The only information that seems to be available to these patients is that which they learned prior to the onset of their disorder. In other words, they can recall events from their childhood and early adulthood, and even public events that may have occurred 30 or 40 years ago; but, they know very little about the present. They usually do not know the year, the name of the president, nor even the name, of the hospital in which they reside.

Research on these subjects has indicated that their inability to remember is due to deficits in encoding. Laird Cermak and his colleagues (Cermak, 1979) have used the levels of processing approach to show that the severe memory problems of the Korsakoff patients may be due to the fact that they are incapable of deep levels of processing. They seem to have no problems with analyzing a verbal stimulus to a phonemic level, but they encounter many difficulties in performing semantic analyses, especially the type of analysis that involves elaboration and requires associating the meaning of the stimulus to other information stored in memory.

This example illustrates how the levels of processing approach has served to increase our theoretical understanding of an important memory phenomenon - amnesia. But the contributions of the levels of processing approach are not limited to the theoretical level. The incidental memory paradigm, used in studying levels of processing, has also had a significant impact on memory research. Prior to the levels of processing experiments, the
majority of memory research was concerned with intentional learning and memorizing. But, as you well know, intentional learning rarely occurs outside of the classroom and experimental psychology laboratories. Most of our everyday learning is incidental. The levels of processing approach led to a shift in memory research away from the almost exclusive study of intentional learning toward more studies of incidental learning. As a result of this shift, researchers are now in a better position to generalize their findings to situations outside the laboratory. In fact, this shift has led researchers to investigate factors that ordinarily are not involved in laboratory or classroom learning and memory, but that do play a role in everyday memory processing. For example, Keenan and Badley (1980) have used a levels-of-processing type of task to study how the personal significance of events influences their retention.

Despite its tremendous contributions to memory research, the levels of processing framework has not been without its critics. Although almost all researchers adhere to the basic tenets of the levels of processing framework – (1) that memory processing should be conceived of as a continuum of processing involving qualitatively different types of analysis, rather than as a series of transfers of information from one memory store to another, and (2) that the memory trace for an event is a by-product of the processes occurring during its encoding - nonetheless, many find fault with the particulars of the formulation. An article by Alan Baddeley (1978) presents the clearest articulation of the problems with the levels of processing framework.

The main problem is that there is no independent measure of processing depth. In other words, there is no way of knowing, apart from its consequences for memory performance, whether one task involves deeper processing than another. Therefore, to say that deeper processing leads to better memory, when depth is defined in terms of its effect on memory, is to render the notion of processing depth completely circular. Of course, processing depth can be defined a priori when one task involves semantic processing and another task does not, because depth refers to amount of semantic involvement. But, when both tasks involve the same types of analysis (e.g., semantic), there is no dimension on which to specify which task will involve deeper processing. The same problem occurs with the notion of encoding elaboration. It, too, is a fairly vague notion that is difficult to measure independent of its consequences for memory performance.

It is likely that it will take quite a while for memory researchers to be able to define the dimensions that determine processing depth and encoding elaboration. Perhaps you and your fellow students may be able to contribute to this enterprise through your answers to questions 6 in Levels of Processing 1 and 5 in Levels of Processing 2. Overall, however, there can be no doubt that the levels of processing framework has fulfilled an important role by providing and developing a milieu of thought that has led researchers to more fully appreciate the role of encoding processes in determining memory performance.

Levels of processing is a theory concerning the factors that determine the nature of the memory trace. As such, it tells only part of the story of what determines our ability to remember events. Remembering depends not only on what is stored in memory, but also on the processes operating at the time when we attempt to retrieve the event. The next
chapter, therefore, picks up where the levels of processing framework leaves off. It provides a set of experiments designed to examine retrieval processes and their relation to encoding processes.
References


