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ENCODING AND RETRIEVAL OF INFORMATION FROM LECTURE

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ENCODING AND RETRIEVAL OF INFORMATION

FROM LECTURE

by

Howard Kwong-Ho Yu

A Dissertation Submitted to the Faculty of the

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

In Partial Fulfillment of the Requirements
For the Degree of

DOCTOR OF PHILOSOPHY

In the Graduate College

THE UNIVERSITY OF ARIZONA

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THE UNIVERSITY OF ARIZONA
GRADUATE COLLEGE

As members of the Final Examination Committee, we certify that we have read
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and recommend that it be accepted as fulfilling the dissertation requirement
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Howard K. Yu

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ABSTRACT

Recent studies of instruction have been concerned with the cognitive processes of learners as they interact with instructional material. Researchers pursuing this line of research consider the learner to be very active, mediating between instructional stimuli and learning outcomes.

Using the mediating process paradigm to formulate research on instruction in college classroom settings, the present study investigated two specific questions:

1. What attending strategies generate effective encoding during a lecture so that comprehension is enhanced?
2. What is the influence of reviewing processes on encoding and retrieval of lecture information when review occurs immediately after a lecture and/or just before a test?

To provide empirical answers to these two specific questions, two hypotheses derived from previous research were simultaneously tested:

1. The levels of processing hypothesis, which postulates that deeper encoding of a lecture produces better retrieval of information from the lecture;
2. The external storage hypothesis, which postulates that the major function of note-taking during a lecture is to provide

an external record for later review, thus facilitating retrieval of information from the lecture.

Four different methods for attending to a college lecture were studied (listening, listening with an outline, note-taking, note-taking with an outline). Each method was designed to influence the student's level of processing and, therefore, to effect the encoding and retrieval of information from a lecture. In addition, the effects of no review or review after a lecture and no review or review before a test were also studied.

The experiment used an intentional learning paradigm, with a 4(encoding) x 2(after-lecture review) x 2(before-test review) between-subject design. Four levels of encoding (listening, listening with outline, note-taking, note-taking with outline) were factorially combined with two levels of after-lecture review (no review vs. review) and two levels of before-test review (no review vs. review). Thus, the design yielded 16 independent experimental cells, each of which ultimately contained six subjects that had been randomly assigned. Comprehension was measured by a multiple-choice recognition test of 20 questions and a short-answer recall test of 10 questions given three weeks after lecture instruction.

Statistically significant findings provide evidence that the level of processing is an important variable in learning from college lecture. Other findings, though not statistically significant, lent support to the external storage hypothesis. These data help to

explain why note-taking and/or lecture outline are advantageous in lecture learning.

Findings from the present study suggest ways to improve learning from college lecture. If lecturers were to provide outlines to students while the students listen or take notes; require a review after a lecture is given; and require a review before a test on the content of the lecture is given; learning would probably be facilitated. Further study of these recommendations is needed.

CHAPTER I

INTRODUCTION

Background and Research Questions

Both behavioristic and cognitive psychology have made contributions to the theory, practice, and study of instruction. The most recent studies of instruction, however, have more often had their roots in cognitive psychology and have focused on the cognitive processes of the learners as they interact with the instructional materials. Within this paradigm it is the learner's cognitive responses that are viewed as determining what is learned. Central to this position is the concept of mathemagenic behavior. These are behaviors, including cognitive strategies, that enable the learner to extract information (effective stimuli) during instruction (nominal stimuli), and process this information so that it is stored in memory and retrievable from memory. This is sometimes called the mediational process paradigm, and serves as a useful way of studying instruction. Using the mediational framework to formulate research on instruction, two questions about how students can learn more effectively from a lecture are explored in the research described below.

Theoretical Base of Instruction

It seems that there are no explicit theories of instruction (Gage, 1963). Apparently, even though a science of instruction is

developing (Merrill, Kowallis, and Wilson, 1981), theories of instruction continue to be based on theories of learning (e.g., Hilgard and Bower, 1975; Bigge, 1976; Klahr, 1976; Gage and Berliner, 1979; Huetsch and Pentz, 1980). From 1900 to 1955 most theories of learning were behaviorally oriented. In fact, behaviorism was the foundation upon which the practice of American education and the study of instruction was built (Strike, 1974). However, both the dominant behavioristic psychologists and the less dominant cognitive psychologists have made important contributions to the scientific study of instruction (Wittrock and Lumsdaine, 1977). For example, while the behavioral view of transfer of learning was put forth by Thorndike (1913), a cognitive view of transfer of learning was offered by Judd (1908). And, while Hull (1943) and Skinner (1938) put forth behavioral views of learning, concentrating on the role of reinforcement and the external environment in learning, Tolman (1932) was emphasizing the importance of the intervening processes between stimuli and responses.

More recently, as concerns about problem solving and meaningful learning have become more salient (Wertheimer, 1959; Bruner, 1960; Ausubel, 1968), the psychological study of instruction has shown a distinct cognitive orientation. Furthermore, contemporary research on memory (Craik and Lockhart, 1972; Cermak and Craik, 1979) is being fused with instructional theory, melding the older behavioral and newer information processing approaches (Merrill, Kowallis, and Wilson, 1981).

Trends in the Study of Instruction

Recently the study of instruction has shifted to concerns about the cognitive processes of the learners as they interact with the instructional materials (Rothkopf, 1970; Wittrock and Lumsdaine, 1977; Fleming, 1980; Resnick, 1981). It is now believed that to understand the effects of instruction upon comprehension and memory, an understanding must be obtained about how learners use their cognitive processes to attend, select, and transform the nominal stimuli provided during instruction into functional, meaningful, internal representations. In this view of instruction it is the cognitive activities or mediational activities of the learners that are of primary importance.

The Importance of Mediation in Learning

Dewey's (1933) learner-centered notion of instruction suggests the necessity of the very important concept of mediation in instruction (cf. Reese, 1976). In essence, mediation refers to the cognitive "process that intervenes between presentation of stimulus and production of response" (Reese, 1976, p. 71). The mediating process paradigm (e.g., Paivio, 1971; Rohwer, 1973; Anderson and Biddle, 1975) is used in the study of instruction to give insight into the nature of the relationship between instructional stimuli and learner response variables. The research demonstrates that the learner's cognitive responses to instructional stimuli play an active mediational role in determining "what is processed, how it is processed, and therefore, what is remembered" (Rothkopf, 1976, p. 116).

Mathemagenic Behavior Mediates Learning

Central to the learner's mediational role is the concept of mathemagenic behavior (Rothkopf, 1970, 1976). The word "mathemagenic" is derived from the Greek: mathema, that which is learned; and gignesthai, to be born. Mathemagenic behaviors are cognitive behaviors (Brown, 1975; Flavell and Wellman, 1977) that give birth to learning. The concept is related to the distinction and connection between nominal and effective stimuli in learning (Underwood, 1963). Nominal stimuli are represented by the original information given during instruction, whereas effective stimuli are represented by the information that the learner actually processes during the instruction. The selective transformation of nominal stimuli into effective stimuli occurs through the learner's mathemagenic behaviors. Mathemagenic behaviors include the information processing operations or encoding strategies (e.g., attending, translating, segmenting, integrating, elaborating, etc.) which enable the learner to extract information (effective stimuli) from instruction (nominal stimuli) and process this information for memory storage. Thus, the mathemagenic behaviors determine the nature of the effective stimuli, which, in turn, determine what is learned.

The Mediating Process Paradigm and Lecture Instruction

Although the mediating process paradigm is most often used in prose learning research (e.g., Frase, 1975; Bransford and Franks, 1976), the paradigm has application to a wide range of instructional activities. Berliner (1976) and Doyle (1977) have recommended that a

mediating process paradigm be used to formulate a wide range of research issues in instruction.

Experiments using the mediating process paradigm in studies of one common form of instruction, lecture instruction, have been reported by Berliner (1971, 1972). Berliner compared the mediational effects of inserting questions into lectures with those of instructions to students to take notes or merely pay attention. On immediate and delayed tests, the group that received questions and attempted answers during the lecture did better than groups engaged in note-taking or in paying attention. The note-taking group showed superior performance in comparison to the paying attention group.

The mediating process paradigm helps to formulate meaningful questions and to interpret answers about the effectiveness of an instructional method such as lecture. Using that paradigm to describe the learning situation during lecture, it is possible to inquire how students can learn more effectively from a lecture. For example:

1. Can certain orienting tasks before learning affect the encoding and comprehension of information during a lecture?
2. Can certain factors improve comprehension and memory by
 - a. enhancing encoding/storage after lecture; and by
 - b. facilitating retrieval before the test?

Review of the Literature

In the following section the relevant literature related to the above two questions has been organized into four topics. First, there is a review of the effectiveness and necessity of lecture instruction.

Second, there is a review of the two commonly used encoding strategies for learning from lecture. Third, the two competing hypotheses about the effectiveness of note-taking in learning from lecture are reviewed. Finally, the levels of processing hypothesis and the potential for using outlines in learning from lecture are reviewed.

The Effectiveness and Necessity of Lecture

For centuries lecture has been employed as a major instructional method in higher education. Empirical evidence has substantiated the effectiveness of lecture as a means of inducing learning. Lecture is considered an adequate instructional method by cognitive psychologists because it can induce cognitive activities on the part of students. These activities help students process the materials to be learned in ways that result in better comprehension and memory.

History and Empirical Status of Lecture. Berliner (1968) defined lecture as ". . . a verbal instructional technique in which audio or audio-visual information on some particular subject is passed from a sending person to one or more receiving persons" (p. 1). Used at least since Plato in the fifth century B.C. as a major instructional mode, lecture is still popular worldwide as an instructional method in contemporary higher education.

There has been abundant research done on lecture (McLeish, 1976). Among the most interesting of the early studies was that of Jones (1923). He conducted one of the first systematic studies of recall from lecture. He used as subjects 781 students enrolled in his

psychology course. The subjects attended thirty lectures and were tested with items from a pool of 3,000 questions about the lecture materials. On the immediate test, although individual differences were noted, the average score was 62%. This demonstrates that students do, in fact, learn substantial amounts from lectures. More importantly, he verified Ebbinghaus' (1913) findings, demonstrating that forgetting of lecture materials was of a lawful character. The curve of retention dropped from approximately 60% on a test of immediate recall to 20% on a test of delayed recall given eight weeks after learning. Thus, research on learning in lecture settings is potentially generalizable to many other learning studies concerned with the retention of meaningful or non-meaningful materials.

Criticism and Defense. The necessity of using lecture as an instructional method has been questioned ever since the invention of movable type (McLeish, 1976) and the easy availability of books (Boswell, 1953); however, its value has also been defended (e.g., Chanbarisov, cited in McLeish, 1968; Paulsen, cited in McLeish, 1968). Empirical evidence over the past fifty years, based on comparisons of lecture with other instructional methods, indicates that lecture is at least as effective as other instructional methods (Gage and Berliner, 1979). In essence, lecture is a defensible means of instruction because it can organize the materials to be learned economically (Chanbarisov, cited in McLeish, 1968), can reinforce students' attention (Gage and Berliner, 1979), and can arouse students' active interest (Paulsen, cited in McLeish, 1968). In light of modern cognitive psychology, lecture

settings are viewed as intentional and incidental learning environments (e.g., Brown, 1975) which induce cognitive activities in students that allow for the instructional materials to be meaningfully processed (Wittrock, 1974). In different students, and in the same student at different times, that processing is done at different levels, resulting in differences in comprehension and memory (Craik and Lockhart, 1972; Cermak and Craik, 1979).

Encoding Strategies for Learning from Lecture

Listening and note-taking are two encoding strategies for learning from lecture. The effectiveness of listening would appear to depend upon the attentional capacity of the learner. The effectiveness of note-taking would appear to depend upon the degree to which the process of note-taking results in better encoding of the lecture, and/or the degree to which the notes provide external storage of the information contained in the lecture, and is available for review at some later time. Generally, listening is viewed as a rather passive strategy, whereas note-taking is viewed as a rather active strategy. However, neither theoretical nor empirical data have as yet unequivocally supported these viewpoints. There have been many empirical studies of listening vs. note-taking, where each has been considered as an encoding strategy for lecture. These data have shown a consistent correlation between amount of notes taken and recall. There are no comparable correlational data between amount or depth or intensity of listening and recall. The experimental data on listening vs. note-taking are

inconsistent--sometimes the test results favor note-taking; sometimes they do not.

Listening vs. Note-taking as Encoding Strategies for Learning from Lecture. Whether "live," on film, on television, or on audio-tape the presentation of information by lecture (Hartley and Davies, 1978) is associated with two prevalent classes of activities on the part of the attendants. They are listening and note-taking (Berliner, 1968).

The listening process occurs when we receive data aurally (Weaver, 1972). In order to process information aurally, we must first give it attention. Theories of attention (Wingfield, 1979; J. Anderson, 1980) differ in their assumptions about which psychological processes (e.g., memory) are dependent upon attention. All theories agree, however, that we are limited in what kinds of and how many inputs we can attend to at any one time. Within these biological limits, there are large individual differences in the strategies that people use for paying attention to aural events in the environment. These different strategies of attending result in differences in what is encoded and what is learned while listening to lecture instruction.

Note-taking calls upon more cognitive processes than does mere listening (Hartley and Davies, 1978; Ladas, 1980). Note-taking requires that oral and written information be transcribed verbatim or in some other form. Although we are far from a useful theory of note-taking during lecture (Faw and Walker, 1976), we can conceptualize the functions of note-taking as a "process vs. product" dichotomy (Di Vesta and Gray, 1972; Faw and Walker, 1976; Carrier and Titus, 1979).

If we consider note-taking as a "process," the encoding hypothesis has some sensibility (Howe, 1970a; Di Vesta and Gray, 1972). The encoding hypothesis postulates that listening and taking notes aids the learner to process the lecture into a personally meaningful form. Peper and Mayer (1978) discuss three theoretical frameworks for viewing the encoding function of note-taking using the concept of mathemagenic activity:

1. Attention--note-taking increases the learner's attention, and thus leads to a greater concentration on the lecture to be learned (Frase, 1970);
2. Generative--note-taking facilitates the assimilation of new information from the lecture with old information by activating the learner's prior cognitive repertoire (Ausubel, 1968; Wittrock, 1974);
3. Effort--note-taking requires the learner to process the lecture at a more meaningful or deeper level (Craik and Lockhart, 1972).

If we consider note-taking from the perspective of a "product," the external storage hypothesis is sensible (Miller, Galanter, and Pribram, 1960). The external storage hypothesis postulates that when notes are taken the lecture is transformed into a product for the learner's later review and further learning. Investigators disagree, however, over which note-taking hypothesis (external storage or encoding) best accounts for its utility for learning from lecture (e.g., Howe, 1970a; Di Vesta and Gray, 1972; Fisher and Harris, 1973; Carter and Van Matre, 1975).

In sum, while both listening and note-taking are encoding strategies for encoding information from a lecture, note-taking has the advantage of providing a record of the lecture once the lecture is over. Even if the quantity of notes is low and the quality of the notes is marginal, they do comprise an external repository of information (Palkovitz and Lore, 1980; Annis, 1981) which can be conveniently retrieved and rehearsed (Craik and Lockhart, 1972; Craik and Watkins, 1973). Thus, notes alleviate excessive demands on memory.

Theoretical Consideration of the Effectiveness of Listening vs. Note-taking on Lecture Comprehension. Both listening and note-taking are commonly accepted behaviors for learning from lectures. Although listening is often considered as a rather passive strategy, a listener may covertly transform what is heard by using different cognitive strategies such as extracting, paraphrasing, elaborating, integrating, and imaging (Carrier and Titus, 1979). Generally, most learners believe that writing information down in their own words better facilitates subsequent recall (Hartley and Davies, 1978). Nevertheless, overt activity such as note-taking does not necessarily ensure comprehension and memory of lecture materials. Thus, a note-taker may simply record verbatim words or sentences (R. Anderson, 1970; Palkovitz and Lore, 1980; Bretzing and Kulhavy, 1981) without really comprehending what is being said (R. Anderson, 1970).

Some studies on level of processing (Craik and Tulving, 1975) have shown that overt manipulation of verbal materials does not necessarily ensure semantic processing. Bretzing and Kulhavy (1979)

studied the effects of summary and paraphrase as note-taking strategies to test this hypothesis. On immediate and delayed tests, note-takers who took notes by summarizing or paraphrasing recalled significantly more than note-takers who took verbatim notes. Although these data are based on note-taking from a 2,000-word text, they provide empirical evidence that note-taking that requires transformations such as in summarizing and paraphrasing may be related to deeper or better encoding of a lecture.

Correlational Evidence on the Effectiveness of Listening vs. Note-taking as Encoding Strategies for Lecture. Empirical data over the past fifty years have shown a consistent correlation between the "presence or absence of notes (and their accuracy)" and subsequent test performance (Hartley and Davies, 1978). However, "presence or absence of notes" does not mean listening and note-taking vs. listening-only in these available studies. Rather, the available correlational data show that when there are differing degrees of note-taking, higher levels of note-taking lead to enhanced performance in subsequent tests. The correlational data between listening-only and subsequent test performance are lacking.

Howe (1970b) showed that the probability of recalling an item that occurred in the learner's notes was about seven times that of items not in his notes. Aiken, Thomas, and Schennum (1975) found correlations of about .60 between note-taking and recall, and in a replication of that study they found correlations of about .50 (Thomas, Aiken, and Schennum, 1975). Crawford (1925a), in seven studies under normal class

conditions, found a median correlation of .50 (range = .36-.66) between points correct in the notes and points correct on tests after a few days and weeks. He concluded that not taking notes on a point of information greatly decreased its recall on the test, but that having the point in notes did not promise its being recalled. In related research Fisher and Harris (1973) included immediate review in their note-taking study with immediate and three-week delayed tests, and they found correlations of .28 between the quality of a subject's notes and scores on an objective test, and a .53 between the quality of a subject's notes and scores on a free recall test. In another study (Fisher and Harris, 1974a), they found correlations of .52 between the quality of a subject's notes and objective test scores and a .54 between the quality of a subject's notes and free recall scores.

Further, Nie (1978) found a correlation of .27 between the final "course marks" at the end of the academic year and the number of words in the notes of a lecture. The correlation between the final "course marks" and number of "minor points" in the notes matching the lecture content was .26. There was a high correlation (.82) between the number of words in the notes and number of "minor points." There was also a high correlation (.77) between the number of words in the notes and "main points." Norton (1981) found a correlation of .36 between the number of words in the notes of a lecture and test performance given three weeks later. Bretzing and Kulhavy (1981) found a correlational range of .74-.89 between notes and recall of "idea units." An "idea unit" not recorded in the notes had a 15 percent chance of being

recalled; however, an "idea unit" recorded in the notes had a 58 percent chance of recall.

While there are no available correlational data on the effectiveness of listening-only as an encoding strategy for lecture, correlational data about the effectiveness of listening and note-taking, combined, as an encoding strategy for lecture are consistent. However, the effectiveness of this encoding strategy when studied experimentally (rather than correlationally) is somewhat different and inconsistent (Hartley and Davies, 1978).

Experimental Evidence on the Effectiveness of Listening vs. Note-taking as Encoding Strategies for Lecture. Hartley and Davies (1978) have examined 35 experimental studies, keeping in mind the question: Does the process of note-taking itself aid recall as compared with no note-taking? Many of the studies have confounded the simple issue of "note-taking vs. listening," since, for example, no note-taking does not necessarily mean "listening" and some note-takers have been instructed on how to take notes or are given handouts. Generally, the comparative results are inconsistent. Only two studies reported significant differences in favor of listening and no note-taking; 16 studies indicated no significant differences; and 17 studies reported a significant difference in favor of note-taking. Table 1 presents the 35 experimental studies cited by Hartley and Davies (1978) examining the effectiveness of note-taking as an encoding strategy for lecture. Among those who found note-taking better than listening on both the immediate and the delayed tests were Crawford (1925a), Berliner (1971,

Table 1

A Summary of 35 Experiments on the Effectiveness
of the Process of Note-taking on Recall*

| Experiments Indicating Lack of Effectiveness (N=2) | Experiments Indicating No Significant Difference (N=16) | Experiments Indicating Effectiveness (N=17) |
|--|--|---|
| Peters, 1972 Thomas, Aiken, & Schennum, 1975 | Jones, 1923 (2 studies) Crawford, 1925b (3 studies) Freyberg, 1956 McClendon, 1958 Eisner & Rhode, 1959 Pauk, 1963 MacManaway, 1968 Howe, 1970a Fisher & Harris, 1974a Fisher & Harris, 1974b Baker, Baker, & Blount, 1974 (1 study) Aiken, Thomas, & Schennum, 1975 Carter & Van Matre, 1975 | Jones, 1923 (1 study) Crawford, 1925b (2 studies) McHenry, 1969 (4 studies) Berliner, 1971 Berliner, 1972 Peters & Harris (undated) Di Vesta & Gray (1972) Di Vesta & Gray (1973) (2 studies) Fisher & Harris, 1973 Baker, Baker, & Blount, 1974 (1 study) Fairbanks & Costello, 1977 |

*Slightly modified from Hartley and Davies, 1978, p. 200.

1972), and Di Vesta and Gray (1972, 1973). Two more recent experiments by Barnett, Di Vesta, and Rogozinski (1981) add further data in favor of note-taking.

Carrier and Titus (1979) have also reviewed some studies on the effectiveness of note-taking on recall. While their results are consistent with Hartley and Davies (1978), they further point out that the utility of note-taking may depend on other factors, such as review. This point is also made by Norton (1981) and Barnett et al. (1981).

Review and Two Hypotheses about the Utility of Note-taking for Learning from Lecture

In this section the possibility of an interference effect from taking notes during lecture is examined. This effect appears to be negligible. The effect of reviewing notes is also examined. Generally, empirical data have substantiated that reviewing notes before a test facilitates recall over not reviewing notes. Experiments on note-taking and reviewing notes are related to the encoding and the external storage hypotheses. It is concluded, however, that the relative importance of the external storage and encoding hypotheses cannot be determined from the experimental data.

Interference Effect vs. Reviewing Effect of Note-taking on Lecture Comprehension. Some students reported that note-taking sometimes interferes with their comprehension of the lecture (Hartley and Davies, 1978). Experiments separating out the listening and the writing function of note-taking (Aikens et al., 1975; Thomas et al., 1975) indicated that distributed note-takers (taking notes between segments

of lecture) recalled better than parallel note-takers (taking notes during the lecture). Thus, from these data, a case for an interference effect can be made. Berliner (1971, 1972) also claims that there is an interference effect for people with low scores on short-time memory tests. Eisner and Rhode (1959) also investigated this issue. They compared note-taking during a 30-minute lecture with note-taking after the lecture. Results revealed no significant differences between these two strategies. The interference effect was lacking. Moreover, data from Thomas (1978) must be considered. He included a review period in his note-taking experiment and suggested that parallel note-takers could record more information than distributed note-takers and were thus able to benefit from reviewing more detailed notes.

Thus, the interference effect of note-taking appears to be negligible and the effect of review appears to be very facilitative. Note-taking, besides its apparent positive encoding effect, provides an external record that may facilitate later retrieval and deeper levels of comprehension, if the notes are reviewed.

The Facilitative Effect of Reviewing Lecture Notes on Recall.

The general belief is that reviewing lecture notes before a test facilitates recall (Carrier and Titus, 1979), and this belief has been supported by empirical data that rehearsal and additional exposure time are useful learning strategies (Travers, 1977; Wittrock and Lumsdaine, 1977). There are many studies of the facilitative effect of reviewing notes before a test on recall. Hartley and Davies (1978) located 16 studies which have examined this issue. The results are generally

consistent. Only three studies suggest no significant differences, whereas 13 studies indicated a significant difference in favor of review. Consistent data on the facilitative effect of reviewing lecture notes on recall have also been examined and cited by Carrier and Titus (1979). Additional consistent data have been reported by Barnett et al. (1981, Experiment 2) and by Friedman and Rickards (1981). Table 2 presents all of the available studies examining the facilitative effect of reviewing notes on recall.

The three typical review strategies are: (1) mental review without notes, (2) review of one's own notes, and (3) review of externally provided notes. Generally reviewing notes of any type improves recall when compared with not reviewing notes.

The Fisher and Harris Experiment of Note-taking and Reviewing as Related to the Encoding and External Storage Hypotheses. Fisher and Harris (1973) studied the effects of note-taking and reviewing on recall. Their experiment featured a live lecture with five treatment groups. They found the following group order on both immediate (after the lecture) free recall and objective tests:

1. Note-taking and reviewing own notes;
2. Listening and reviewing lecturer's notes;
3. Note-taking and reviewing lecturer's notes;
4. Note-taking and mental review;
5. Listening and mental review.

These results showed that note-taking and reviewing one's own notes yielded the highest recall scores, whereas listening and mental review

Table 2

A Summary of the Available Experiments on the Facilitative
Effects of Reviewing Notes on Recall*

| Experiments Indicating Lack of Effectiveness (N=0) | Experiments Indicating No Significant Difference (N=3) | Experiments Indicating Effectiveness (N=18) |
|--|---|--|
| | Fisher & Harris, 1974a Fisher & Harris, 1974b Peters & Harris (undated) | Crawford, 1924b (2 studies) Freyberg, 1956 Howe, 1970a Di Vesta & Gray, 1972 Fisher & Harris, 1973 Hartley & Marshall, 1974 Annis & Davis, 1975 Carter & Van Matre, 1975 Annis & Davis, 1977 Howe & Godfrey, 1977 (4 studies) Rickards & Friedman, 1978 Barnett, Di Vesta & Rogozinski (1 study) Friedman & Rickards, 1981 |

*Slightly modified from Hartley and Davies, 1978, p. 201.

yielded the lowest recall scores. Further, listening and reviewing the lecturer's notes resulted in higher performance than note-taking and mental review. However, there were no significant differences between groups on a three-week delayed retention test. Nevertheless, it was concluded that while the two functions, encoding and external storage do work, the latter may be the more important function of note-taking.

A problem with the Fisher and Harris experiment was that the reviewing was done immediately after the lecture. This feature of the design is a problem because review may interact with listening or note-taking, forming a part of the encoding process (Craik and Lockhart, 1972), and may not serve the external storage function associated with note-taking (Miller et al., 1960). Thus, the flaws in the study make interpretation difficult.

The Carter and Van Matre and Other Experiments Favoring the External Storage Hypothesis. Carter and Van Matre (1975) pointed out that "a strong test of the external storage hypothesis requires that the review come immediately before the test and that the test come after a delay. This also closely parallels common practice in classrooms" (pp. 900-901). In their experiment they found support for the external storage hypothesis on both immediate and one-week delayed free recall tests. The order combining immediate and delayed scores for their four treatment groups was: note-taking and reviewing own notes > listening and mental review = notetaking and mental review > listening and no review.

Carter and Van Matre interpreted the lack of a significant difference between "note-taking and mental review" and "listening and mental review" as implying that the encoding function associated with taking notes does not produce a consistent effect. However, it should be noted that Carter and Van Matre did not report any separate analyses for the immediate and delayed tests. These data should have been analyzed separately before making such generalizations.

Some other experiments (e.g., Fisher and Harris, 1973; Palkovitz and Lore, 1980) also provide supporting data for the "external memory device" function of notes. The record of the lecture preserves the information for later use. But the data supporting this hypothesis are not unequivocal when we look at which function may be more powerful, the external storage or the encoding function.

Experiments Favoring the Encoding Hypothesis. Howe (1970a) and Di Vesta and Gray (1972) argued that too much reliance on notes as an external memory device can result in insufficient learning if the crucial encoding stage is bypassed. Howe (1970b) asserted that in meaningful learning the acquisition process is affected by how the individual learner interprets and encodes the materials (also see Bartlett, 1932; Alport and Postman, 1947; Kay, 1955). In Howe's (1970b) experiment, he asked subjects to take notes on a prose passage that they heard. One week later they were asked to recall the passage without before-test review. Items not recorded in the subjects' notes had an approximate .05 probability of recall; however, items recorded in notes had a .34 probability of recall. These results suggest that "the notes learners

make provide a useful indication of the products of individual encoding processes in meaningful verbal learning and memory" (Howe, 1970b, p. 61). Barnett et al. (1981) found that when learners were asked questions from their own notes, they performed nearly twice as well as on any other type of questions. Their finding further supports the encoding function of note-taking.

Di Vesta and Gray (1972) maintained that any facilitative effects of note-taking should be due to the encoding function, rather than the external storage function served by notes. Encoding, they believe, reflects a transaction between the learner and the learning materials, and the learner actively links the learning materials meaningfully to his existing cognitive structure. Di Vesta and Gray found, in their experiment, that the number of ideas recalled by subjects after listening to a short passage was favorably influenced by note-taking and by immediate review. They speculated that while both note-taking and review facilitate encoding, review provides an opportunity for consolidating the information learned at a given level of transformation.

To clarify further the relative importance of the encoding hypothesis and the external storage hypothesis about the function of note-taking, Annis and Davis (1975) manipulated the note-taking and review conditions in their study. They also investigated whether the better external memory record was one externally provided or personally produced. Their experiment involved a lecture on "Behavior Modification" and was followed by a two-week delayed review and short-answer

and objective tests. The experiment included seven groups:

1. Note-taking and mental review;
2. Lecturer's notes and mental review;
3. No instructions on note-taking and no review;
4. Note-taking and reviewing own notes;
5. Note-taking and reviewing lecturer's notes;
6. Lecturer's notes and reviewing lecturer's notes;
7. Note-taking and reviewing both own notes and lecturer's notes.

Results indicated that the order of the three top groups were: note-taking and reviewing both own notes and lecturer's notes > note-taking and reviewing own notes > note-taking and reviewing lecturer's notes. Mental review groups produced the least recall.

These data indicated that as long as subjects encoded the lecture by their own note-taking, reviewing of their own notes or the lecturer's notes are similarly helpful. It made little difference whether the external memory record was externally provided by the professor or personally produced by the students. Therefore, Annis and Davis suggested that while the encoding and external storage functions of note-taking are both important, the encoding function is more important in accounting for success in recall. Bretzing and Kulhavy (1979) seem to agree and conceptualize the encoding function in terms of levels of processing as described by Craik and Lockhart (1972).

The Levels of Processing Hypothesis and Outline for Learning from Lecture

In this section the nature of encoding is discussed. Encoding can be conceptualized as a cognitive process consisting of different levels that affect the memory trace. Conceiving of the instruction in terms of levels of processing has been useful. Based on this conception of learning and memory an outline of the material to be learned from prose has been given to subjects to use while trying to learn. Use of an outline has been found to be effective for encoding and retrieval. This facilitative effect suggests that an outline helps the learners to process the material at deeper levels of comprehension. This section ends by noting that further studies of learning from lectures with the use of an outline are needed. Of particular interest would be studies that contrast the encoding hypothesis (conceptualized as depth of processing) and the external storage hypothesis.

The Levels of Processing Hypothesis. The levels of processing hypothesis (Craik and Lockhart, 1972; Cermak and Craik, 1979) postulates that the more deeply the learning materials are processed, the richer and longer are the memory traces. Depth of processing refers to an invariant sequence of processing stages ranging from the physical stage to the semantic stage to the stage of conceptual analysis. The beginning stages of processing information are related to the physical features of the material, and later stages of analysis involve the extraction of meaning from the material. The deepest levels of processing involve "conceptualizing" the learning materials by assimilating them into the individual learner's preexisting cognitive repertoire.

Processing can also be conceptualized as divided into Type I processing, which involves the maintenance of processing at any level (e.g., physical, semantic, conceptual) and Type II processing, which involves further processing of the materials at a deeper level (Craik, 1973).

The levels of processing hypothesis has attracted many researchers in memory and cognition, and abundant experimental evidence has substantiated the utility of this hypothesis (Kintsch, 1977; Cermak and Craik, 1979). In addition, there have also been some studies of the application of this hypothesis to instructional settings (Wittrock and Lumsdaine, 1977).

Bretzing and Kulhavy (1979) have studied note-taking within the framework of the levels of processing conceptualization. They studied prose learning, using college students who took notes from a 2,000-word prose passage. Their data suggest that deeper levels of note-taking, such as summary and paraphrase, may relate to more meaningful encoding of a prose passage or a lecture. In another study, Friedman and Rickards (1981) asked college students to read prose passages which contained three kinds of inserted questions: verbatim, paraphrase, and inference. These were intended to correspond to the three levels of processing described above. Some students were also asked to review the materials for ten minutes before the test. Results indicated that students in the inference condition performed better than students in the paraphrase condition who, in turn, performed better than the students in the verbatim condition. Further, students who reviewed performed better than students who did not review.

From these studies the utility of the levels of processing hypothesis is confirmed. That hypothesis can be used for conceptualizing how an outline might function in a learning situation. Glynn and Di Vesta (1977) and Staley and Wolf (1979) have studied the effect of an outline as an encoding and retrieval cue in prose learning situations. They have shown a positive effect as described below.

The "Improved" Lecture Method Using Outlines. Three means of transmitting lecture information are described by Northcraft and Jernstedt (1975): (1) traditional lecture, (2) transcript lecture, and (3) the "improved" method, using the traditional lecture and handouts. Using the "improved" method, Northcraft and Jernstedt compared four teaching methods on a lecture entitled "Theories of Reinforcement" for large classes. In their experiment, the first three groups attended the lecture and received either the lecturer's outlines, examples of the concepts in the lecture, or no supplementary materials. The fourth group did not attend the lecture but received a lecture transcript. Results on the follow-up multiple-choice tests, without immediate or delayed review, indicated the following group order: Lecturer's outlines = concept examples > attending lecture = receiving transcript.

Instead of passing the outlines to students at the beginning of the lecture, Cheong (cited in Gage and Berliner, 1979) presented the outlines to students progressively as the lecture unfolded. Cheong's experimental results suggest the value of giving students the structure of a lecture progressively by writing outlines on the board step-by-step as the lecture unfolds.

Glynn and Di Vesta (1977) found that an outline provided at encoding, but not at retrieval, facilitated recall from prose learning. Staley and Wolf (1979) asked their subjects to study a prose section with an outline available either during encoding, retrieval, both, or neither. Results on immediate and delayed recall indicated the following order for the effect of outline: retrieval > encoding > both > neither. Thus, an outline appears to facilitate learning both at encoding and when used at retrieval as an external storage mechanism.

In comparison to control conditions, the data on the effectiveness of outline during encoding and retrieval suggest that an outline helps learners to encode the material at deeper levels of comprehension. Although the effect of an outline on encoding and retrieval has been evident in prose learning (Glynn and Di Vesta, 1977; Staley and Wolfe, 1979), data about this technique in lecture learning is still scanty. Specifically, data are lacking on the issue of the relative contributions of the encoding (conceptualized as depth of processing) and the external storage functions of outline in learning from lecture.

Rationale of the Study

From the above literature review, there appears to be agreement that both encoding and external storage functions are important when studying note-taking and outlines in lecture learning situations. However, there remains some disagreement about the relative importance of the encoding and external storage hypotheses. While some researchers (e.g., Fisher and Harris, 1973; Carter and Van Matre, 1975; Palkovitz and Lore, 1980) have contended that the external storage function of

note-taking exceeds the encoding function in facilitating lecture learning, several experimental studies (e.g., Howe, 1970b; Di Vesta and Gray, 1972; Annis and Davis, 1975; Barnett et al., 1981) have shown greater facilitative effects for the encoding functions of note-taking.

Misconceptions about Encoding

The inconsistent data that relate to the encoding vs. external storage issue may be due to misconceptions about encoding. Methodological problems can occur as a function of these misconceptions. Encoding must be thought of as a complex process variable. One would ask different questions about encoding depending on which aspects of the process are of interest. For example, questions could be asked about the encoding strategy (e.g., listening or note-taking) during a lecture. But one might also raise questions about the function of a review of lecture information that occurs immediately after the lecture. After-lecture review may be conceptualized as part of the encoding process, as proposed by Fisher and Harris (1973). Thus, an after-lecture review, as distinguished from a before-test review, would be related to encoding issues and not external storage issues.

A simultaneous testing of the encoding and external storage hypothesis can be based on the paradigm proposed by Carter and Van Matre (1975). They specify the encoding phase as attending lecture and participating in immediate review. They specify the phase of instruction that is relevant to external storage as made up of a delayed review and a test. However, Carter and Van Matre did not conceptualize encoding in terms of depth of processing (Craik and Lockhart,

1972), and it appears fruitful to do so. Furthermore, because of the way they analyzed their data, they were unable to report statistically significant differences between the delayed test scores of a note-taking group and its control. This kind of difference is a necessary condition to provide support for the external storage hypothesis (Miller et al., 1960). While still using the distinctions of Carter and Van Matre, improvements in design and analysis can be made to study the encoding and external storage hypothesis in learning from lecture.

Redefinition of Research Questions Relating to Encoding and Retrieval of Information from Lecture

Since the goal of a college lecture is student learning, it is desirable to study how college students can learn more effectively from a lecture. From the literature reviewed, the two questions which were raised earlier (p. 5) can now be revised, as follows:

1. What attending strategies generate effective encoding during a lecture so that comprehension is enhanced?
2. What is the influence of review processes on encoding and retrieval of lecture information when review occurs immediately after a lecture and/or just before a test?

Previous studies have not yet provided satisfactory answers to these two questions.

The Present Experiment, Hypotheses,
and Predictions

The present experiment was specifically designed to provide empirical answers to the above two questions by examining the effects of the following three variables on learning from lecture: (1) encoding, (2) after-lecture review, and (3) before-test review. These three variables were operationalized in light of the encoding hypothesis and the external storage hypothesis.

The Encoding Hypothesis and Prediction

There is evidence that outline facilitates encoding and retrieval in prose learning (Glynn and Di Vesta, 1977; Staley and Wolf, 1979) and lecture learning (Cheong, cited in Gage and Berliner, 1979; Northcraft and Jernstedt, 1975). In the present experiment an outline was used to facilitate encoding of the lecture and to augment the usual listening and note-taking treatments in experiments of learning in lecture. The encoding variable was operationalized into the following four levels: listening < listening with lecturer's outline < note-taking < note-taking with lecturer's outline. This is hypothesized to be a continuum based on an analysis of the potential depth of processing that each level produces. To further explore the process of encoding, an after-lecture review variable with no review and review levels was incorporated in the design of this experiment. After-lecture review requires further processing of the information to be learned and is hypothesized to induce a deeper level of processing.

Thus, the concern for the levels of processing hypothesis (Craik and Lockhart, 1972) was incorporated into the design of the present experiment not only in terms of the encoding variable with its four levels (listening, listening with outline, note-taking, note-taking with outline) but also in terms of the after-lecture review variable with its two levels (no review vs. review). From another viewpoint (Craik, 1973), the levels of processing hypothesis might be conceptualized as having been operationalized in the present experiment as follows: the encoding variables involved the processing of information at a given level of analysis (Type I processing), and the after-lecture review variable involved further processing of the material to a deeper level (Type II processing).

Statistical significance on the encoding variable, the after-lecture review variable, and their (possible) interaction were predicted. The four levels used for encoding the lecture were hypothesized to be ordered by the levels of processing required for learning and were, therefore, predicted to order in this manner on the learning measure. The analysis of the order of these levels was to be determined by post hoc statistical tests. It was also hypothesized that the scores of subjects in the review condition would exceed the scores of subjects in the no review condition for the after-lecture review variable.

The External Storage Hypothesis and Prediction

A before-test review variable with no review and review levels was also incorporated in the design of this experiment. The before-test review variable was designed to obtain data to test the external storage hypothesis (Miller et al., 1960).

Statistical significance on the before-test review variable was predicted, with review hypothesized to exceed no review. Specifically, a statistically significant (encoding) x (before-test review) interaction involving the note-taking and note-taking with outline treatments of the encoding variable would provide strong support for the external storage hypothesis.

CHAPTER II

METHOD

Design

This experiment featured a 4(encoding) x 2 (after-lecture review) x 2(before-test review) between-subject design (Winer, 1971). Four levels of encoding (listening, listening with outline, note-taking, note-taking with outline) were factorially combined with two levels of after-lecture review (no review vs. review) and two levels of before-test review (no review vs. review). Thus, the design yielded 16 independent experimental cells (Figure 1), each of which ultimately contained six subjects that had been randomly assigned.

Subjects

Subjects were undergraduate volunteers from two educational psychology and two introductory psychology classes at The University of Arizona. They were asked to participate in both the learning and testing phase of the experiment (Appendix A). There were 225 subjects who participated in the learning phase. Of these, 134 subjects returned three weeks later for the testing session. The majority of them (approximately 85%) received extra credit in their courses for participating in the experiment.

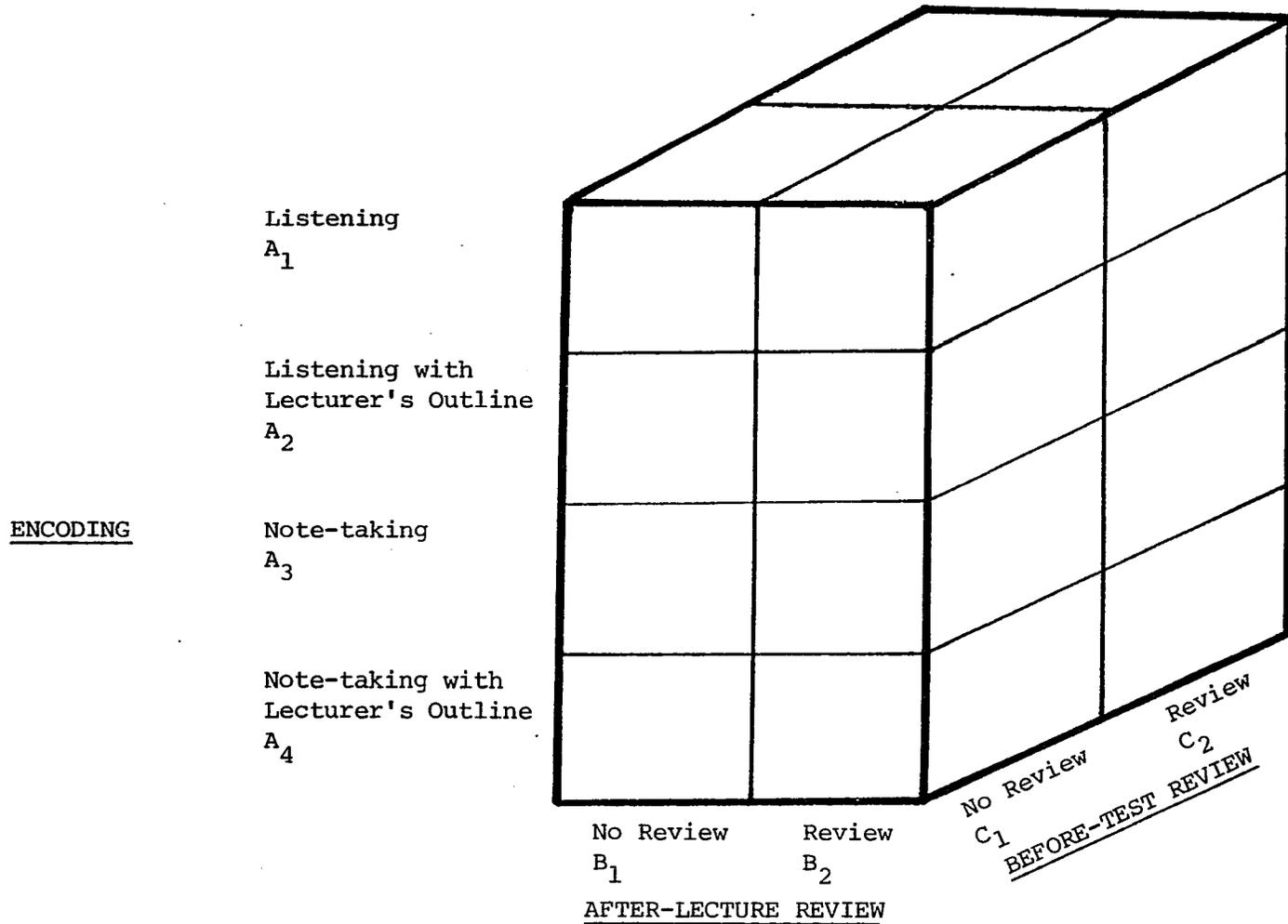


Figure 1

A Schematic Representation of the Design of the Experiment

Materials

The materials for this experiment consisted of a lecture, accompanying instructional materials, pretest instructions, and accompanying test instruments.

Lecture

The lecture was delivered live, following a well-prepared and organized set of notes (Appendix B) on the topic of "Concept Learning" (adapted from Ellis, 1978) specifically designed for this experiment. Before the experiment the lecturer rehearsed delivering the lecture from notes several times. The experimenter provided feedback on the lecturer's performance.

The lecturer's notes were initially written by the experimenter and further revised by both the experimenter and the lecturer according to the lecturing method of Gage and Berliner (1979). The lecture consisted of three parts:

1. the introduction, in which an overview of concept learning was presented using advance organizers;
2. the body, in which the content about concept learning was presented in a logical organization;
3. the conclusion, in which the issues in concept learning were drawn together and some practical principles of how to teach concepts effectively were provided.

In addition, the body of the lecture was accompanied by eight visual displays (Appendix B). These displays were transparencies and were

specifically designed to illustrate and clarify some topics of the lecture.

Instructional Materials

Subjects attended to the lecture according to the instructions they were given. There were four different sets of instructions designed to affect encoding:

1. Listen to the lecture and give it your full attention;
2. Listen to the lecture. Give it your full attention and follow the lecture using the outline you have been given;
3. Listen to the lecture. Give it your full attention and take notes the way you usually do;
4. Listen to the lecture. Give it your full attention and take notes the way you usually do, but use the outline to help you follow the lecture and organize your notes.

The outlines for encoding treatment 2 (listening with outline) and encoding treatment 4 (note-taking with outline) were identical. The outlines are presented in Appendix E or F (treatment 2) and Appendix I or J (treatment 4). For treatment 4 (note-taking with outline) there was a space provided under each topic in the outline for taking notes.

Immediately after the lecture, one-half of the subjects in each of the four encoding treatments were given an assignment to prevent review. The other half of the subjects in each of the four encoding treatments were given instructions to review the information they

obtained in the lecture. These subjects read instructions requesting that they review the lecture mentally (encoding treatment 1); mentally with the outline used during the lecture (encoding treatment 2); or that they review the lecture with their notes (encoding treatments 3 and 4).

In summary, the four different encoding instructional conditions and the two review conditions yielded eight different lecture encoding treatments. Accordingly, there were eight different types of encoding booklets (Appendices C through J). Subjects in each of the eight treatment groups received their respective encoding booklets informing them what to do before, during, and after the lecture. Each encoding booklet consisted of:

1. The front page informing subjects what to do before the lecture;
2. Part A informing subjects what to do during the lecture;
3. Part B informing subjects what to do after the lecture.

Instructions Prior to Testing

Printed instructions for a no-review and a review group constitute the materials given to subjects prior to their being tested. The pretest instructions for the no-review group (Appendix M) explained to the subjects that the comprehension test consisted of two parts. Subjects were also assured that results of their comprehension test would be confidential.

The pretest instructions for the review group involved three different before-test review instructions (Appendices N through P) and

the after-review instructions (Appendix Q). The before-test review instructions were the same as the after-lecture review instructions. Subjects were requested to review the lecture mentally (Appendix N); review the lecture mentally with the outline used during the lecture (Appendix O); or review the lecture with their notes (Appendix P). Subjects were asked to spend at least five and up to ten minutes reviewing the lecture. When they had completed their review, subjects were requested to ask for their comprehension test. The after-review instructions of the review group (Appendix Q) were the same as the pretest instructions of the no-review group (Appendix M).

Test Instruments

Comprehension of the lecture was measured by means of a 20-question multiple-choice recognition test and a short-answer recall test consisting of 10 questions (Appendix R). These two tests were specifically designed for this experiment.

Test Construction. The multiple-choice test was composed of mostly knowledge level questions, each of which consisted of four choices. The short-answer test was composed of approximately half knowledge level and half application level questions. All the test items for both tests were written by the experimenter according to the method for writing test items suggested by Wesman (1971). The lecturer's notes and the outline were used as guides to write all the test items. Items on both tests were drawn evenly from all parts of the lecture.

Content Validity. In order to have adequate content validity, the experimenter developed items that could be classified as knowledge and application levels from all parts of the lecture in proportion to the emphasis a particular part of the lecture had received. In order to obtain an external evaluation of the content validity, the experimenter asked two graduate students in educational psychology to examine the test content systematically and evaluate critically its relationship to the lecturer's notes. They agreed with the experimenter that the test items represented the content domain adequately.

Pilot Study. To receive feedback on how both tests were perceived, a pilot study involving 16 subjects was conducted, with each subject randomly assigned to one of the 16 independent cells of the experiment (Figure 1). Data for the pilot study were collected on three occasions. The number of subjects for the three occasions were six, five, and five respectively. The interval between the learning and the testing phase was three weeks as it was for the actual experiment. The procedures used during each of the three learning and testing sessions were similar to those used in the actual experiment. The lecture for the pilot study was delivered by an audio-tape that had been made during the lecturer's rehearsal. The visual displays that accompanied the lecture were presented by the experimenter.

Feedback about the multiple-choice recognition test and the short-answer recall test was collected through an interview between the experimenter and every pilot subject. Feedback from all subjects indicated that the test questions were clearly written and that they

represented very well the lecture material. These subjects further commented that both the recognition test and the recall test were about at their respective average level of difficulty, and "the recall test was indeed more difficult than the recognition test." Both the multiple-choice recognition test and the short-answer recall test were further revised on the basis of the feedback from the pilot study.

Procedure

The lecture, which constituted the stimulus material in this experiment, was conducted in a lecture hall where classes usually met. Two lecture occasions were needed to process all the subjects. All subjects arrived at the lecture hall during the first five minutes of the class hour. At the entrance of the lecture hall, each subject was given one of the eight different types of encoding booklets (Appendices C through J) by random alternation. These booklets had been arranged by decks, each of which consisted of the eight different types of encoding booklets in random order. This method of subject assignment to treatment allowed for almost an equal number of each of the eight different types of encoding booklets to be distributed to subjects. Further, subjects who were friends, coming in together and sitting next to each other, would not have the same types of encoding booklets. Each booklet was sealed but was separated into Part A and Part B. The front cover of the booklet had instructions that informed subjects not to open the booklet until asked to do so.

At 10 minutes past the hour, the experimenter announced that there was a special lecture on "Concept Learning" by a guest speaker.

Subjects were informed that they would be given a comprehension test three weeks later to see how well they understood the lecture. All subjects were then requested to open Part A of the encoding booklet and attend to the lecture only according to the method described in their booklet. Subjects who were to take notes (encoding treatments 3 and 4) wrote in their encoding booklets.

The lecture, which lasted for about 35 minutes, was delivered by a female graduate student skilled in educational psychology and communications. She lectured from notes (Appendix B), and presented the visual displays (Appendix B) by means of an overhead projector. Thus, the subjects were in an experiment designed to be similar to their usual class meeting where they are exposed to the delivery of a live lecture. The experiment conformed to an intentional learning paradigm since subjects were aware during the lecture that a memory test would be administered later (Wickelgren, 1978) and because of the explicit instructions for encoding the lecture (McLaughlin, 1965).

Immediately after the lecture, the experimenter asked all subjects to open Part B of their encoding booklets. Part B presented two different review instructions. One-half of each of the four encoding instructional groups (Appendices C, E, G, and I) were asked to complete a rating assignment on four abstracts of research articles selected from the Journal of Educational Psychology. The other half of the subjects of each of the four encoding instructional groups (Appendices D, F, H, and J) were requested to review the lecture mentally (encoding treatment 1); mentally with the outline used during the

lecture (encoding treatment 2); or by using their notes (encoding treatments 3 and 4). Subjects in the review condition were asked in their encoding booklets to spend at least 5 minutes, but were allowed 10 minutes to complete their respective assignments.

The written instructions for all subjects requested that they write their names on the encoding booklets and return the encoding booklets when they had completed their respective assignments. Further, subjects were then asked not to discuss the lecture with one another, and all were reminded to come back in three weeks to take the comprehension test. When subjects had returned their encoding booklets, they were given a note informing them of the date, time, and place for the comprehension test (Appendix K).

Prior to the testing day, all subjects were contacted by mail to return for the comprehension test (Appendix L). During the testing day, all subjects that came back for testing were assigned, by random alternation, to either the no-review or the review condition, respectively, before the test.

Subjects in the no-review condition were given written instructions (Appendix M) to take the multiple-choice recognition test immediately. In addition, the instructions assured the subjects that results of the comprehension test would be completely confidential. Subjects in the review condition that did not take notes (encoding treatments 1 and 2) did not receive their encoding booklets. They were given written instructions to review the lecture mentally (encoding treatment 1) or mentally with the aid of the outline used during lecture (encoding

treatment 2) for at least 5 and up to 10 minutes before the test (Appendix N or O). Subjects in the review condition who took notes (encoding treatments 3 and 4) received their encoding booklets (Appendices G through J) and they were given written instructions (Appendix P) requesting that they review their notes for at least 5 and up to 10 minutes before the test. All subjects in the review condition were given written instructions (Appendix Q) to take the multiple-choice recognition test after they had finished their respective reviews. The instructions further assured that the results of the comprehension test would be completely confidential.

All subjects in the no-review and review conditions were given the short-answer recall test after they had finished the multiple-choice recognition test. Both tests (Appendix R) were untimed. Most subjects took about 30 minutes to complete the two tests. At the end of the testing, subjects who participated in the experiment for extra credit were given a receipt acknowledging their participation in the study.

As mentioned above, the lecture was given twice, to approximately 60% and 40% of the subjects each time. The lectures were separated by five days. Thus, the testing sessions for these subjects were also separated by five days. The procedures used during each of the two learning and testing sessions were identical. There were no questions from students during either lecture.

CHAPTER III

RESULTS

Subject Mortality

The number of subjects in the two sessions were: 130 and 95, respectively, for the learning phases; and 59 and 75, respectively, for the testing phase. In total there were 225 subjects who participated in the learning phase. Since only 134 subjects returned three weeks later for the testing session, the numbers of subjects in the 16 cells of the experiment were unequal, ranging from 6-11. As a result, the internal validity of the experiment might have been threatened due to "differential mortality," a problem identified by Campbell and Stanley (1966). Therefore, the four encoding and the two after-lecture review conditions were examined to inquire if mortality was systematic or random. Using a two-way chi-square (4 encoding treatments x 2 after-lecture review treatments), it was found that the frequency of missing subjects in any of the cells in the design was not greater than could be expected by chance ($\chi^2(3) = 1.13, p = .75$).

Scoring

The multiple-choice recognition tests and the short-answer recall tests of all subjects were scored by the experimenter using a list of correct answers (Appendix S) that were derived from the lecturer's notes and the lecture outline. Further, the two graduate

students who were asked earlier to evaluate the content validity for both tests were asked again to examine the correct answers for both tests. They agreed with the experimenter that all the answers used for scoring both tests were correct.

There were 20 questions making up the multiple-choice recognition test. One point was assigned to each correct answer. The maximum score was, therefore, 20. Subjects obtained a range of scores from 2-16. For the short-answer recall test the highest possible score was also 20. The test consisted of 10 questions for which each correct answer could receive up to two points. The range of scores was from 0-16.

Reliability

The reliability of the two tests was computed by means of coefficient alpha (Cronbach, 1951) using all the 134 subjects who took the comprehension tests. The reliability coefficients were rather low for both tests: they were .48 and .70 respectively for the multiple-choice recognition test and the short-answer recall test. The reliability coefficients for both tests were slightly different when computed using only the 96 subjects who actually were used in the final analyses. These coefficients were .46 and .69, respectively, for the recognition and recall tests.

Numbers of Subjects and Descriptive Data

Of the 134 subjects who took the comprehension tests, four were eliminated because they failed to respond to the short-answer recall

test and, therefore, received a score of zero. Additional subjects were randomly eliminated, until all cells contained six subjects. This was done to have equal numbers of subjects per cell, a desirable condition for analysis of variance (Linton and Gallo, 1975). Table 3 presents the means and standard deviations for the 96 subjects who made up the sample used in the analyses which follow. In Table 4 the means and standard deviations are presented for the subjects' scores on the multiple-choice recognition and short-answer recall tests, grouped according to the three factors that are of interest in the study--encoding, after-lecture review, and before-test review.

Analysis of Variance

Using the data from 96 subjects, a 4 (encoding) x 2 (after-lecture review) x 2 (before-test review) between-subject fixed effect model analysis of variance (ANOVA) was conducted with both the recognition and the recall tests scores. Table 5 presents the ANOVA results for recognition and recall performance.¹

Recognition

The analysis of variance for recognition test scores (Table 5) yielded three statistically significant effects: A main effect for the encoding variable, $F(3,80) = 4.29, p = .007$; a main effect for the before-test review variable, $F(1,80) = 12.32, p = .001$; and an

1. Using all the 134 scores, an ANOVA with unequal numbers of scores per cell was also conducted with the recognition and recall test scores. The ANOVA results with unequal sample sizes are presented in Appendix T for the interested reader, but are not discussed further.

Table 3

Means and Standard Deviations on the Recognition and Recall Test Scores for the 16 Groups of Subjects

| Encoding | After-Lecture Review | Before-Test Review | N | Recognition | | Recall | |
|--------------------------|-------------------------|-----------------------|---|-------------|------|-----------|------|
| | | | | \bar{X} | S | \bar{X} | S |
| Listening | No | No | 6 | 9.00 | 2.76 | 3.17 | 1.84 |
| | | Yes | 6 | 7.00 | 2.10 | 4.50 | 3.83 |
| | Yes | No | 6 | 7.00 | 1.28 | 3.33 | 1.03 |
| | | Yes | 6 | 9.50 | 2.07 | 4.33 | 1.37 |
| Listening & Outline | No | No | 6 | 9.17 | 2.32 | 3.67 | 2.16 |
| | | Yes | 6 | 9.67 | 1.03 | 5.33 | 1.75 |
| | Yes | No | 6 | 7.17 | 1.15 | 3.00 | 2.10 |
| | | Yes | 6 | 12.17 | 2.64 | 6.50 | 1.64 |
| Note-taking | No | No | 6 | 7.67 | 2.58 | 3.17 | 1.94 |
| | | Yes | 6 | 10.33 | 2.34 | 5.00 | 1.90 |
| | Yes | No | 6 | 7.83 | .98 | 3.33 | 2.50 |
| | | Yes | 6 | 9.33 | 3.39 | 7.33 | 4.72 |
| Note-taking & Outline | No | No | 6 | 9.00 | 2.37 | 4.17 | 1.47 |
| | | Yes | 6 | 10.50 | 3.15 | 6.50 | 2.07 |
| | Yes | No | 6 | 10.17 | 3.60 | 6.67 | 3.01 |
| | | Yes | 6 | 12.33 | 2.88 | 10.50 | 2.81 |

Table 4

Mean and Standard Deviations on the Recognition
and Recall Test Scores for the Levels
of Encoding, After-Lecture Review,
and Before-Test Review

| Treatments | N | Recognition | | Recall | |
|----------------------|----|-------------|------|-----------|------|
| | | \bar{X} | S | \bar{X} | S |
| Encoding | | | | | |
| Listening | 24 | 8.13 | 2.29 | 3.83 | 2.95 |
| Listening & Outline | 24 | 9.54 | 2.55 | 4.63 | 2.28 |
| Notetaking | 24 | 8.79 | 2.57 | 4.71 | 3.28 |
| Notetaking & Outline | 24 | 10.50 | 3.05 | 6.96 | 3.24 |
| After-Lecture Review | | | | | |
| No Review | 48 | 9.04 | 2.48 | 4.44 | 2.32 |
| Review | 48 | 9.44 | 2.99 | 5.63 | 3.46 |
| Before-Test Review | | | | | |
| No Review | 48 | 8.38 | 2.35 | 3.81 | 2.34 |
| Review | 48 | 10.10 | 2.88 | 6.25 | 3.37 |

Table 5

ANOVA for Recognition and Recall Test Scores

| Effects | Recognition | | | Recall | | |
|-------------------------------|-------------|--------|------|--------|--------|------|
| | F | df | P | F | df | P |
| Encoding (E) | 4.29 | (3,80) | .007 | 7.29 | (3,80) | .001 |
| After-Lecture Review (ALR) | .65 | (1,80) | NS | 5.69 | (1,80) | .019 |
| Before-Test Review (BTR) | 12.32 | (1,80) | .001 | 23.97 | (1,80) | .001 |
| E X ALR | .66 | (3,80) | NS | 2.20 | (3,80) | NS |
| E X BTR | 1.16 | (3,80) | NS | .77 | (3,80) | NS |
| ALR X BTR | 4.65 | (1,80) | .034 | 1.68 | (1,80) | NS |
| E X ALR X BTR | 2.08 | (3,80) | NS | .32 | (3,80) | NS |

NS means Not Significant (alpha = .05)

interaction effect between (after-lecture review) x (before-test review), $F(1,80) = 4.65, p = .034$.

Since the encoding variable was found to be statistically significant and was not involved in the significant interaction with other variables, the means of the four encoding groups (Table 4) were analyzed by the Newman-Keuls test with alpha set at the .05 level. Table 6 presents the Newman-Keuls results for the four encoding groups on the recognition scores. Results indicated three statistically different differences: Listening ($\bar{X} = 8.13$) < note-taking and outline ($\bar{X} = 10.50$); listening ($\bar{X} = 8.13$) < listening and outline ($\bar{X} = 9.54$); and note-taking ($\bar{X} = 8.79$) < note-taking and outline ($\bar{X} = 10.50$). Figure 2 depicts the trend of the four encoding group means on the recognition test.

The Newman-Keuls test was also used to analyze the significant (after-lecture review) x (before-test review) interaction. Table 7 represents the Newman-Keuls results for the significant (after-lecture review) x (before-test review) interaction on the recognition scores. Results indicated two statistically significant differences: No review after-lecture and no review before-test ($\bar{X} = 8.71$) < review after-lecture and review before-lecture ($\bar{X} = 10.83$); review after-lecture and no review before-test ($\bar{X} = 8.04$) < review after-lecture and review before-test ($\bar{X} = 10.83$).

Figure 3 depicts the significant (after-lecture review) x (before-test review) interaction that occurred when the recognition test scores were analyzed. The two-by-two matrix presented with

Table 6

Newman-Keuls Results with Means, Mean Differences, and
Critical Values on the Recognition Test Scores

| | Listening $\bar{X} = 8.13$ | Listening & Outline $\bar{X} = 9.54$ | Note-taking $\bar{X} = 8.79$ | Note-taking & Outline $\bar{X} = 10.50$ | Critical Value |
|---|-------------------------------|--|---------------------------------|---|-------------------|
| Listening $\bar{X} = 8.13$ | -- | 1.41* | .66 | 2.37* | 1.81 |
| Listening & Outline $\bar{X} = 9.54$ | | -- | .75 | .96 | 1.61 |
| Note-taking $\bar{X} = 8.79$ | | | -- | 1.71* | 1.37 |
| Note-taking & Outline $\bar{X} = 10.50$ | | | | -- | |

*p < .05

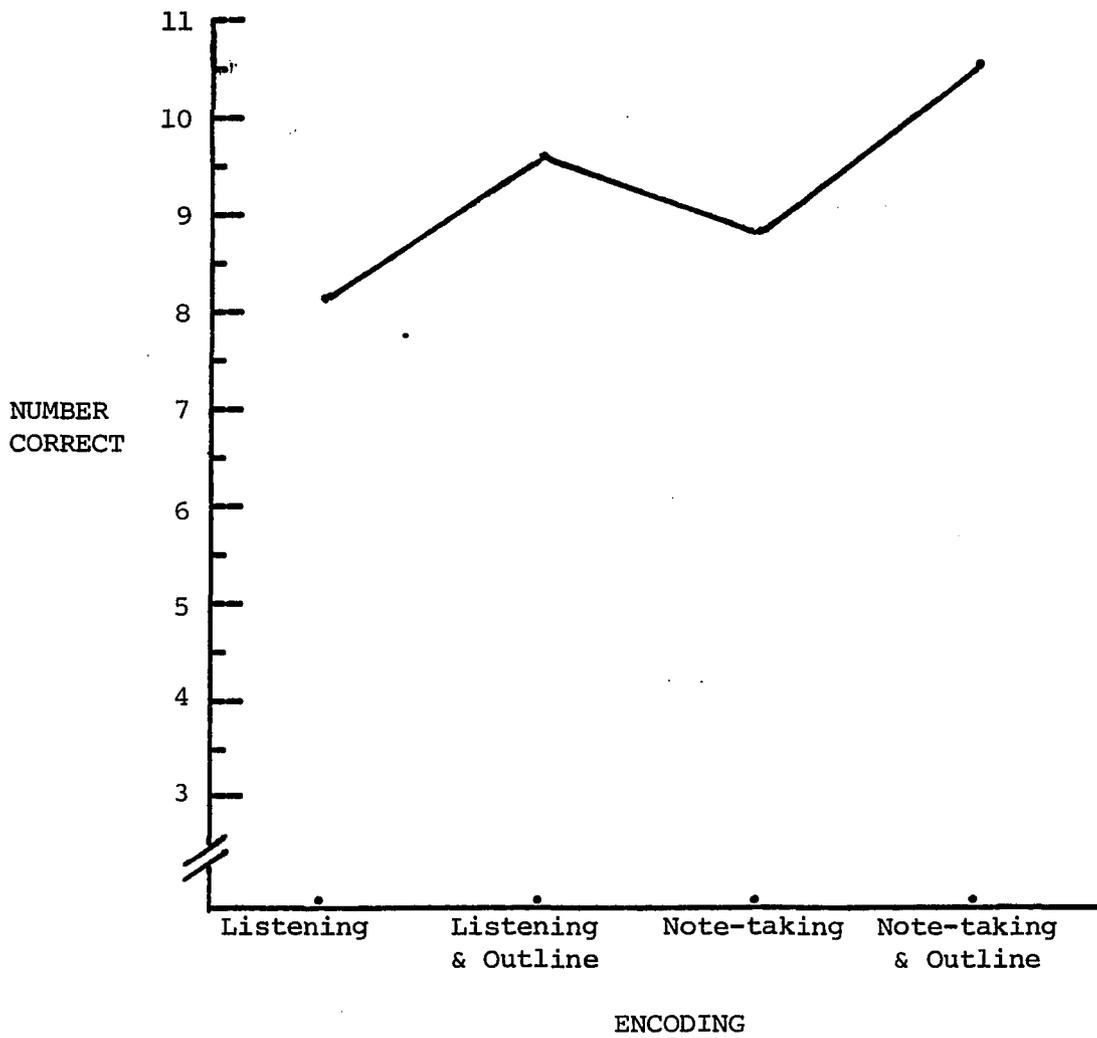


Figure 2

Trend of the Mean Scores on the Recognition Test for the Four Encoding Groups

Table 7

Newman-Keuls Test Results with Means, Mean Differences, and Critical Values
for the Significant (After-Lecture Review) x (Before-Test Review)
Interaction on the Recognition Test Scores

| | No Review after Lecture and No Review Before Test $\bar{X} = 8.71$ | No Review after Lecture and Review Before Test $\bar{X} = 9.38$ | Review After Lecture and No Review Before Test $\bar{X} = 8.04$ | Review after Lecture and Review Before Test $\bar{X} = 10.83$ | Critical Values |
|--|--|---|---|---|--------------------|
| No Review after Lecture and No Review before Test, $\bar{X} = 8.71$ | -- | .67 | .67 | 2.12* | 1.81 |
| No Review after Lecture and Re- view before Test, $\bar{X} = 9.38$ | | -- | 1.34 | 1.45 | 1.65 |
| Review after Lecture and No Review before Text, $\bar{X} = 8.04$ | | | -- | 2.79* | 1.37 |
| Review after Lecture and Re- view before Test, $\bar{X} = 10.83$ | | | | -- | |

*p < .05.

| | | |
|----------------|----------------|----------------|
| | B ₁ | B ₂ |
| C ₁ | 8.71 | 8.04 |
| C ₂ | 9.38 | 10.83 |

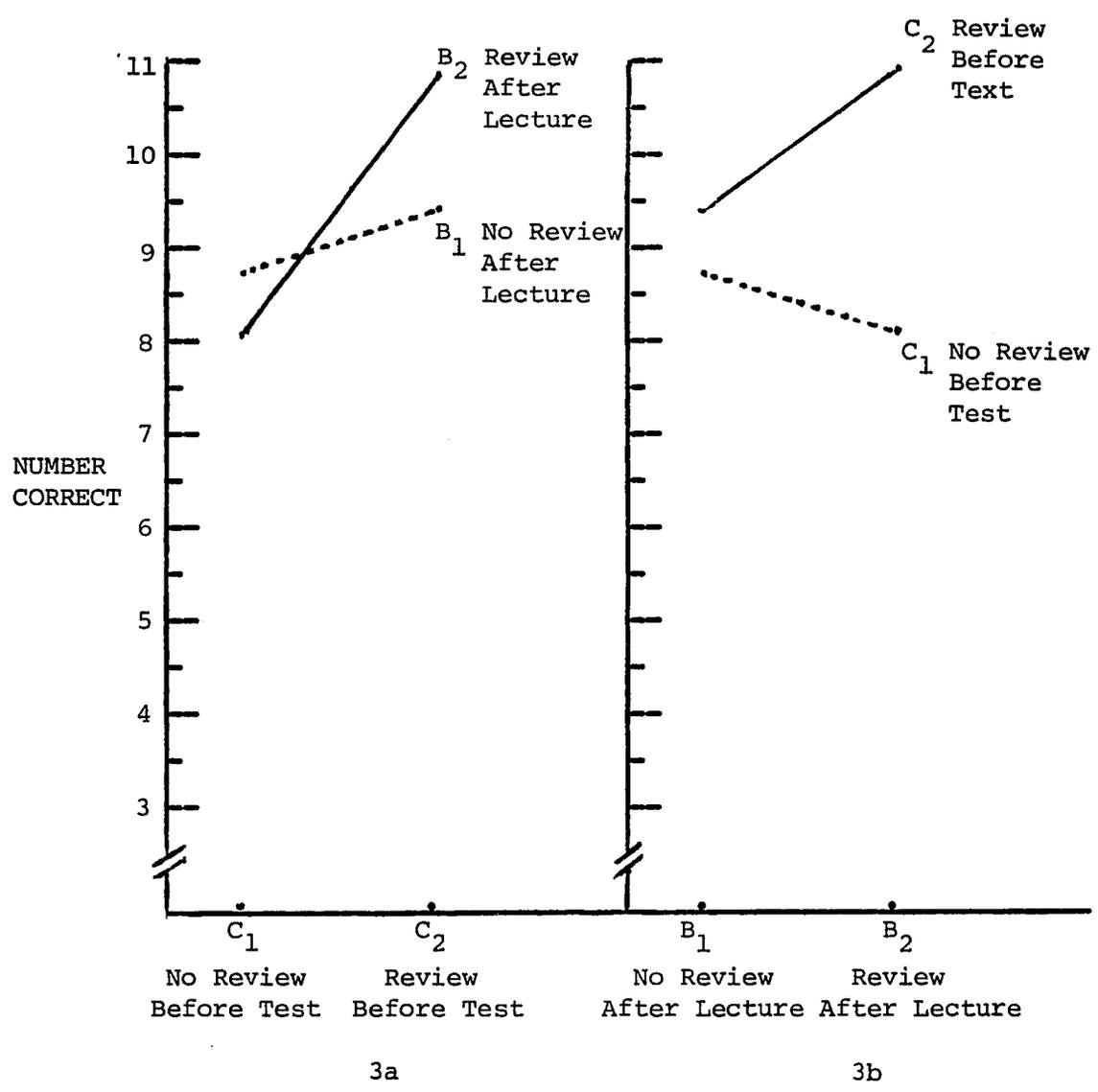


Figure 3

Significant Interaction of (After-Lecture Review)
 x (Before-Test Review) for Recognition
 Test Scores (Plotted Two Ways)

Figure 3 contains the data on which the interaction is based. Figure 3a and Figure 3b, based on that data, are two plots of the same interaction. Figure 3a depicts a disordinal pattern of interaction, whereas Figure 3b depicts the interaction effects as ordinal.

Recall

The recall test scores also yielded statistically significant findings. The analysis of variance for recall scores (Table 5) yielded three statistically significant main effects: Encoding, $F(3,80) = 7.29$, $p = .001$; after-lecture review, $F(1,80) = 5.69$, $p = .019$; and before-test review, $F(1,80) = 23.97$, $p = .001$. In addition, the (encoding) x (after-lecture review) interaction, $F(3,80) = 2.20$, approached but did not attain conventional significance levels ($p = .094$).

Since the encoding variable was found to be statistically significant and was not involved in the significant interaction with other variables, the means of the four encoding groups (Table 4) were analyzed using the Newman-Keuls test with alpha set at the .05 level. Table 8 presents the Newman-Keuls results for the four encoding groups with the recall test scores. Results indicated three statistically significant differences: Listening ($\bar{X} = 3.83$) < note-taking and outline ($\bar{X} = 6.96$); listening and outline ($\bar{X} = 4.64$) < note-taking and outline ($\bar{X} = 6.96$); and note-taking ($\bar{X} = 4.71$) < note-taking and outline ($\bar{X} = 6.96$). Figure 4 depicts the trend of the four encoding group means on the recall test.

The interaction between (after-lecture review) x (before-test review) on the recall test was not statistically significant ($p = .20$),

Table 8

Newman-Keuls Results with Means, Mean Differences,
and Critical Values on the Recall Test Scores

| | Listening $\bar{X} = 3.83$ | Listening & Outline $\bar{X} = 4.64$ | Note-taking $\bar{X} = 4.71$ | Note-taking & Outline $\bar{X} = 6.96$ | Critical Values |
|--|-------------------------------|--|---------------------------------|--|--------------------|
| Listening $\bar{X} = 3.83$ | -- | .81 | .88 | 3.13* | 1.81 |
| Listening & Outline $\bar{X} = 4.64$ | | -- | .07 | 2.50* | 1.65 |
| Note-taking $\bar{X} = 4.71$ | | | -- | 2.25* | 1.37 |
| Note-taking & Outline $\bar{X} = 6.96$ | | | | | -- |

*p < .05.

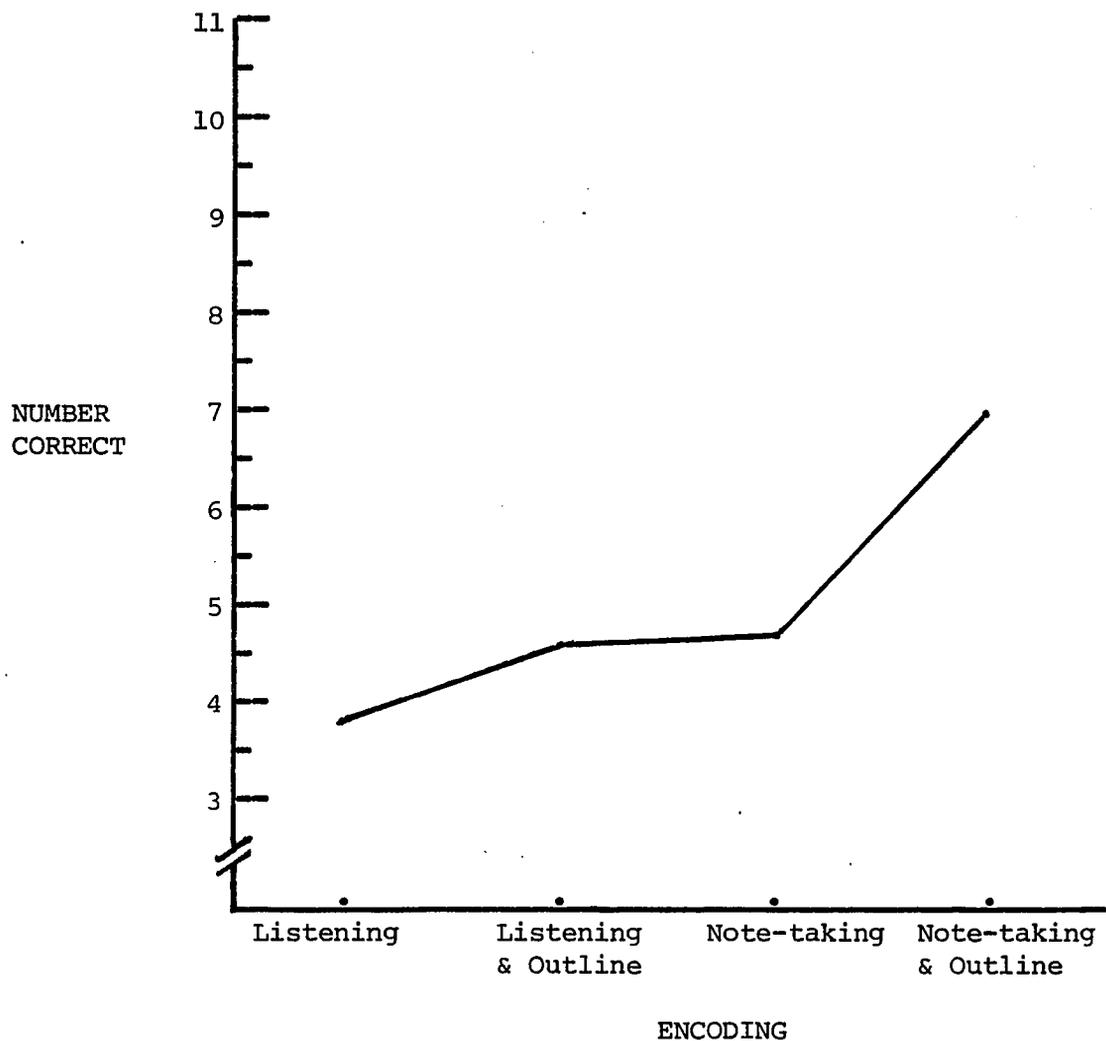


Figure 4

Trend of the Mean Scores on the Recall
Test for the Four Encoding Groups

as it was with the recognition test. Nevertheless, the Newman-Keuls test was also used to analyze the nonsignificant (after-lecture review) x (before-test review) interaction on the recall test, to see if the trends of mean differences were similar to those found with the recognition test. Table 9 presents the Newman-Keuls test results for the nonsignificant (after-lecture review) x (before-test review) interaction on the recall test. Results indicated four statistically significant differences: no review after-lecture and no-review before-test ($\bar{X} = 3.54$) < no review after-lecture and review before-test ($\bar{X} = 5.33$); no review after-lecture and no review before-test ($\bar{X} = 5.33$) < review after-lecture and review before-test ($\bar{X} = 7.17$); no review after-lecture and review before-test ($\bar{X} = 5.33$) < review after-lecture and review before test ($\bar{X} = 7.17$); and review after-lecture and no review before-test ($\bar{X} = 4.08$) < review after-lecture and review before-test ($\bar{X} = 7.17$).

Figure 5 depicts the nonsignificant (after-lecture review) x (before-test review) interaction that occurred when the recall scores were analyzed. The two-by-two matrix presented with Figure 5 contains the data on which the interaction is based. Figure 5a and Figure 5b, based on that data, are two plots of the same interaction. Figure 5a and Figure 5b both depict an ordinal pattern of interaction. Inspection of Figures 3a and 5a simultaneously shows that there is a similarity in the trends of the (after-lecture review) x (before-test review) interaction for both recognition and recall. The similarity in trends is noted in the very steep slope for the review after-lecture condition,

Table 9

Newman-Keuls Test Results with Means, Mean Differences, and Critical Values for the Nonsignificant (After-Lecture Review) x (Before-Test Review) Interaction on the Recall Test Scores

| | No Review after Lecture and No Review Before Test $\bar{X} = 3.54$ | No Review after Lecture and Review Before Test $\bar{X} = 5.33$ | Review after Lecture and No Review Before Test $\bar{X} = 4.08$ | Review after Lecture and Review before Test $\bar{X} = 7.17$ | Critical Values |
|---|---|--|--|---|-----------------|
| No Review after Lecture and No Review before Test, $\bar{X} = 3.54$ | -- | 1.79* | .54 | 3.36* | 1.81 |
| No Review after Lecture and Review before Test, $\bar{X} = 5.33$ | | -- | 1.25 | 1.84* | 1.65 |
| Review after Lecture and No Review before Test, $\bar{X} = 4.08$ | | | -- | 3.09* | 1.37 |
| Review after Lecture and Review before Test, $\bar{X} = 7.17$ | | | | -- | |

*p < .05.

| | | |
|----------------|----------------|----------------|
| | B ₁ | B ₂ |
| C ₁ | 3.54 | 4.08 |
| C ₂ | 5.33 | 7.17 |

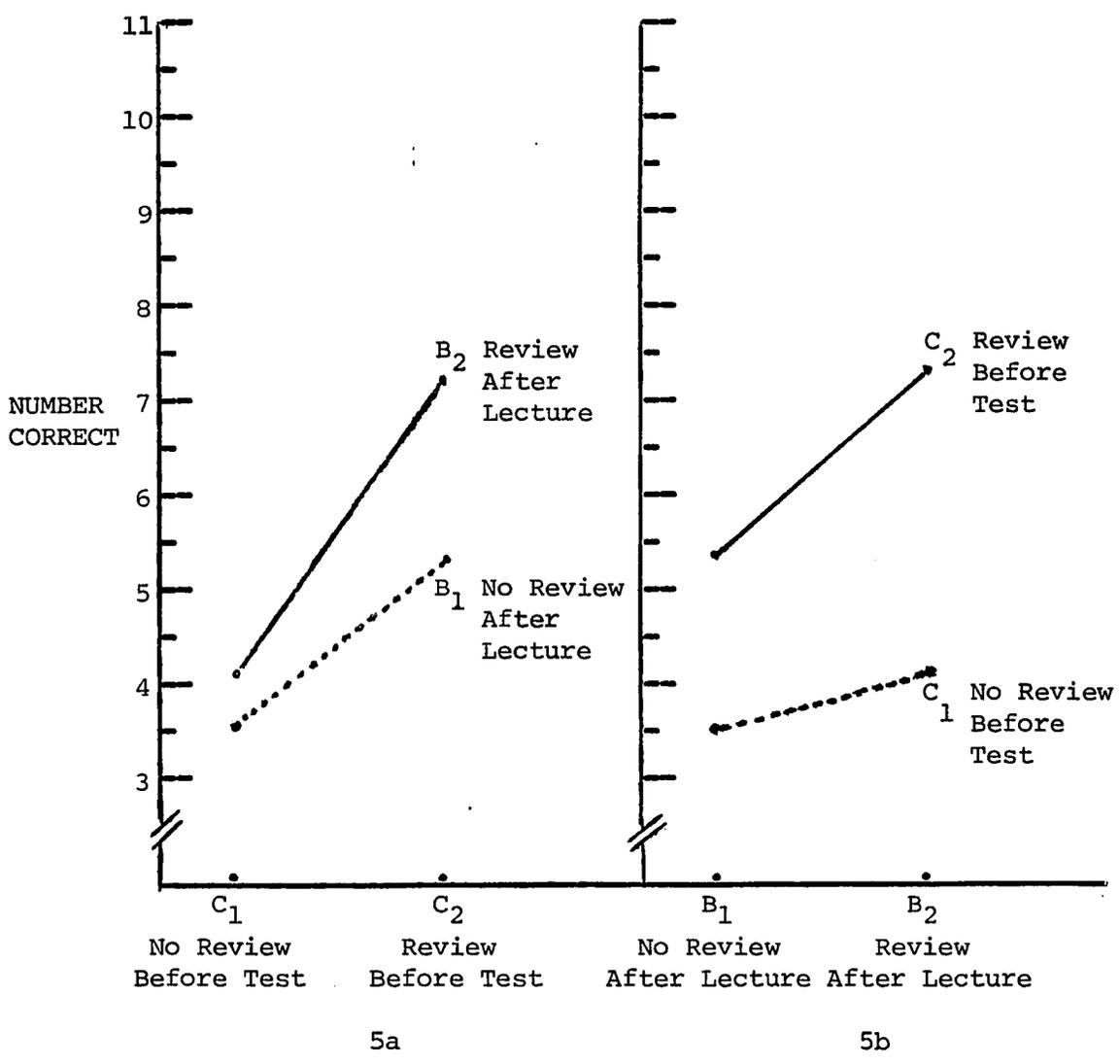


Figure 5

Nonsignificant Interaction of (After-Lecture Review)
 x (Before-Test Review) for Recall Test
 Scores (Plotted Two Ways)

and the much less steep slope for the no review after-lecture condition. Inspection of Figures 3b and 5b also show some similarity in that the review before-test condition shows a very steep slope, while the no review before-test condition shows a shallow or negative slope.

CHAPTER IV

DISCUSSION

Recognition vs. Recall

There has been a proposal (e.g., James, 1890; Kintsch, 1970) that there are important qualitative differences between recognition and recall. A contemporary conception is that recall involves a search process and a decision process which adjudicates on the appropriateness of what has been retrieved, whereas recognition primarily involves only the decision process (Kintsch, 1970). This conception of the information processing requirements of the two types of activity suggests that recall tests might be more difficult than recognition tests. The present findings (Tables 1 and 2) seem to support that interpretation because recognition scores were generally higher than recall scores.

However, three concerns should be considered: First, the recognition test might have served as further learning (or another review) thus leading to deeper encoding of the material. If this explanation of the phenomenon was true, it would produce higher recall scores than might otherwise be the case. Second, there is a belief that guessing on a multiple-choice test yields higher scores than if no guessing were permitted. Since there were four choices for each of the 20 items of the recognition test, it could be assumed that subjects' scores on the recognition test might be five points higher just by guessing. Subtracting five points from the subjects' recognition test scores would

show that the recognition test scores are similar to (or only slightly higher than) the recall scores (Table 4). Third, there was no empirical confirmation that the two tests were parallel, although both the experimenter and the two content validity consultants agreed that both tests had a very high content validity. However, feedback from most subjects was that "the recall test was indeed more difficult than the recognition test."

There might well be qualitative differences between recognition and recall tests, as supported by Kintsch (1970) and James (1890). However, whether this recall test was more difficult than this recognition test was not answered by the present experiment.

Encoding

The present findings produced strong evidence (Tables 5, 6, and 8) for the levels of process hypothesis (Craik and Lockhart, 1972; Cermak and Craik, 1979). The encoding factor was statistically significant with both the recognition and recall tests (Table 5). For recognition (Table 6 and Figure 2), note-taking with outline yielded the highest scores, from which we infer that this encoding condition produced a deeper level of encoding as compared to the other two methods (listening, note-taking) of attending to the lecture. Further, it is inferred that listening with outline produced deeper encoding than listening. For recall (Table 8 and Figure 4) note-taking with outline again yielded the highest scores, from which we infer that the encoding condition produced a deeper level of encoding as compared to the other

three methods (listening, listening with outline, note-taking) of attending to the lecture.

Interestingly, the data suggest that when recognition tests are used as a criterion for learning, the listening with outline treatment is superior to the note-taking treatment, indicating a deeper level of encoding (Table 6 and Figure 2). On the recall test listening with an outline is almost equal to the effects of the note-taking treatment (Table 8 and Figure 4). The trend (Figures 2 and 4) suggested from these data is that with improved outlines and training in using outlines it is likely that listening to a lecture and following an outline is superior to the treatment of note-taking as an effective encoding method while attending a lecture.

The after-lecture review factor showed statistical significance when the recall scores were analyzed. Thus, it is believed that after-lecture review involved further encoding of the lecture information inducing processing at a deeper level (Craik and Lockhart, 1972; Cermak and Craik, 1979). The belief that encoding of the lecture information took place at a deeper level was further supported by an (encoding) x (after-lecture review) interaction from the recall test. This interaction was not quite significant at conventional levels, $p = .094$.

The data on encoding and after-lecture review, discussed above, apparently support the levels of processing hypothesis in lecture learning as it would be conceptualized by Craik and Lockhart (1972). An alternative interpretation of the data, also in line with the levels of processing hypothesis, might be in terms of the Type I and Type II

processing levels proposed by Craik (1973). Type I processing involved the maintenance of processing, at any given level, while listening, listening with outline, note-taking, or note-taking with outline. Type II processing involved further processing of the materials at a deeper level such as by means of an after-lecture review. It should be pointed out, however, that "depth of processing," as inferred from different scores on different tests in different treatments, is a difficult construct to defend. One reason is that differences in test scores might be due to other factors (e.g., motivation), rather than the depth of processing during learning.

It should be noted that there were no significant differences between note-taking and listening on both the recognition and recall tests (Tables 6 and 8). Therefore, the present findings were in conflict with many previous experimental results (Hartley and Davies, 1978; Carrier and Titus, 1979) and the more recent work by Barnett et al. (1981) and Bretzing and Kulhavy (1981), which make arguments for the importance of the encoding function of note-taking. However, the note-taking with outline group exceeded the listening group on both the recognition and recall tests (Tables 6 and 8). The present study, then, produced evidence which suggests a strong facilitative encoding effect when note-taking with outline, as compared to listening. Further research of this phenomenon would add to our understanding of how to best insure learning during lecture.

The Effects of Review and the Encoding
Variability Hypothesis

The interaction between after-lecture review and before-test review on the recall scores was not statistically significant as it was with the recognition scores. Interestingly, inspection of Figures 3a and 5a, simultaneously, shows that there is a similarity in the trends of the (after-lecture review) x (before-test review) interaction. Figures 3b and 5b which show the same data, plotted differently, clearly illustrate the nature of the interaction for the two review factors. There is a review effect, such that either a review after a lecture, or a review before a test, yields superior performance on tests of recognition or recall, in comparison to no review. But there is an additional effect produced by two reviews, the after-lecture and before-test review, that results in test performance that is far superior to any of the other conditions. It would appear that maximum performance on recall and recognition tests is achieved when both reviews take place.

It is not clear that the superior recognition and recall test performance is, in fact, due to review of notes and outlines (i.e., the physical record of the lecture) at both after-test or after-lecture. That is, there is no statistically significant (encoding) x (after-lecture review) x (before-test review) three-way interaction involving the outline and the note-taking conditions. Nevertheless, examination of Table 3 reveals that reviewing at both after-lecture and before-test, involving the listening with the outline condition and the note-taking with outline condition yields superior test performance in comparison

to the other treatments. It is interesting to note, also, that listening with review both after-lecture and before-test results in better test performance than note-taking and no review either after-lecture or before-test. This demonstrates the power of the review procedure.

The phenomenon that reviewing both after-lecture and before-test results in superior test performance might be explained by using the encoding variability hypothesis (Madigan, 1969). In essence, the encoding variability hypothesis postulates that memory improves with the "space effect," or the increase in lag between two study occasions. The hypothesis predicts that superior test performance depends in part on how well a study context matches a test context. The more difference there is between the two study contexts, the higher the chance that one of the contexts will match with the test context. With short lags, the two study contexts might be similar to each other and therefore the chance of either study context matching the test context might not be much greater than the chance of one study context. On the other hand, with long lags, it is likely that the two study contexts might be quite different from each other, and therefore the chance for either study context matching the test context might be higher.

In the present study, the three-week interval between the after-lecture review and the before-test review was a long lag which would have made the contexts of the two review episodes quite different from each other. Accordingly, one of the review contexts might well match the test context and therefore result in superior performance. The utility of the "spacing effect" has been demonstrated not only in

sentences (e.g., D'Agosteno and DeRemer, 1973), but also in text materials (see J. Anderson, 1980).

External Storage

The present findings did not produce unequivocal evidence (Table 3) for the external storage hypothesis (Miller et al., 1960). Although the before-test review factor showed statistical significance on both the recognition and recall scores, there was no statistically significant (encoding) x (before-test review) interaction found. Overall, the review before-test condition yielded superior performance on the recognition and recall tests in comparison to the no-review before-test condition (Table 2). But it is not clear that the superior performance on recognition and recall tests was, in fact, due to the effect of reviewing notes. Even mental review for the listening-only treatments seemed somewhat successful. Thus, a case can be made that it is just a before-test review that is helpful, rather than a before-test review with notes, thus weakening the external storage argument.

However, as Figures 2 and 4 indicate, note-taking with an outline yielded the highest scores on both the recognition and recall. Moreover, listening with an outline was a superior treatment to just listening (Tables 2 and 4). These data concerning reviews with notes and outlines and their effects on test performance do provide some further evidence for the external storage hypothesis.

Implications

Using the mediating process paradigm as Berliner (1971, 1972, 1976) did to formulate research on lecture learning, the present study simultaneously tested the encoding hypothesis and the external storage hypothesis using the paradigm of Carter and Van Matre (1975). Statistically significant data provide (1) confirmatory evidence for the levels of processing hypothesis, and (2) partial evidence for the external storage hypothesis.

What is the meaning of these results? First, and most important, we have learned that we can process lecture information at a deeper level of cognition by use of a strategy combining two encoding methods, namely, listening with outline or note-taking with outline during the lecture and reviewing immediately after a lecture. Second, a (delayed) before-test review facilitates retrieval, perhaps by inducing further learning. The data associated with the (delayed) before-test review allow the inference to be made that a deeper level of processing of the lecture information has occurred. Third, review at both after-lecture and before-test with the same outline (cues) facilitates retrieval. This seems similar to the encoding specificity principle (Tulving and Thompson, 1973) that hypothesizes that cues (outline) that are present at the encoding and also presented at retrieval facilitate retrieval. Previous studies (e.g., Glynn and Di Vesta, 1977; Staley and Wolfe, 1979) on the application of the encoding specificity principle on prose learning have not seemed to successfully demonstrate its utility. Further research with the encoding specificity

principle may well result in knowledge of how to increase lecture learning.

Generalizability of research findings is an important and a practical question. Having completed the present study with satisfactory internal validity (Campbell and Stanley, 1966), to what other situations might the results apply (Bracht and Glass, 1968)? Our target population was college students in general, and our accessible population consisted of two educational psychology and two introductory psychology classes at The University of Arizona. The accessible population represents undergraduate volunteers majoring in the areas of education, liberal arts, science, engineering, etc. Thus, findings from the sample should be generalizable to the accessible population. Generalizing from the accessible population to the target population involves some limitations. However, there are some similarities between the accessible population and the target population: subjects in the accessible population came from all over the country and are quite heterogeneous with regard to background, as are students studying in most other colleges and universities. Therefore, the present findings can be cautiously generalized to the target population consisting of college students in general, who try to learn from well-prepared lectures.

If the potential for generalizability is accepted, then the data in this study suggests ways to improve learning from college lectures. If lecturers were to use outlines and require after-lecture as well as before-test reviews, learning would be facilitated. We should

learn to design materials and procedures that help learners to mediate in instructional situations. Much of current instructional research is concerned about these issues (Klahr, 1976; Anderson, Spiro, and Montague, 1977; Snow, Federico, and Montague, 1980; Glaser, 1981; Resnick, 1981).

Further use of the mediating process paradigm, as recommended by Berliner (1976) and Doyle (1977), to formulate research on lecture learning along the lines of the present study, will make fruitful empirical as well as theoretical contributions to instructional psychology. "Instructional psychology is no longer basic psychology applied to education. It is fundamental research on the processes of instruction and learning" (Resnick, 1981, p. 660).

APPENDIX A

LETTER AND CONSENT FORM TO ALL SUBJECTS

WHO PARTICIPATED IN THE STUDY

(BOTH SESSIONS)



THE UNIVERSITY OF ARIZONA

TUCSON, ARIZONA 85721

COLLEGE OF EDUCATION
Department of Educational Psychology

November 4, 1980

Dear Students:

You are being asked to participate in a study entitled Encoding and Retrieval of Information from Lecture. We are conducting a study that examines different ways of attending a lecture and reviewing material from a lecture. Comprehension of the lecture will also be studied. The first part of the research has been scheduled on November 12 (Wednesday) at 8:00 A.M. during your regular class period. Your participation in this study begins by coming to the class as usual. A guest speaker will lecture on an interesting topic in educational psychology during the regular class period.

Your further participation in this study is very important to us. We need a few minutes of your time, three weeks later, in order to have you take a test on the material presented in the lecture. A room will be available for you all day and evening (8:00 A.M. - 10:00 P.M.) on December 3 (Wednesday) for you to take the test. Naturally, the data from this study will be coded so your responses will be completely confidential. The data we obtain will not be released to anyone and will not affect your grades in any course. Please help us in this research.

We believe the study will yield very valuable information to educational psychology. Will you please indicate your agreement to participate in the lecture and the testing phase of this study by signing your name at the bottom of this letter, and return the letter to us.

Thank you very much for your participation in this study.

Sincerely,

Howard K. Yu, M.A.
Advanced Graduate Student

.....
I _____ agree to participate in both the lecture and the testing phase of this study. I have read the above letter and I understand the nature of the study. I understand that I may ask questions and that I am free to withdraw from the project at any time without incurring ill will or jeopardizing my class standing. I also understand that this consent form will be filed in an area designated by the Human Subjects Committee with access restricted to Howard K. Yu and David C. Berliner, or authorized representatives of the Educational Psychology Department. A copy of this consent form is available upon request. Please leave us your local address (print) so that we can remind you to come to both the lecture and the testing phase of this study. Thank you!

NAME _____

ADDRESS _____



THE UNIVERSITY OF ARIZONA
TUCSON, ARIZONA 85721

COLLEGE OF EDUCATION
Department of Educational Psychology

November 4, 1980

Dear Students:

You are being asked to participate in a study entitled Encoding and Retrieval of Information from Lecture. We are conducting a study that examines different ways of attending a lecture and reviewing material from the lecture. Comprehension of the lecture will also be studied. The first part of the research has been scheduled on November 17 (Monday) evening during the second portion of your regular class period. Your participation in this study begins by coming to the class as usual. A guest speaker will lecture on an interesting topic in educational psychology during the second portion of your regular class period.

Your further participation in this study is very important to us. We need you to take a test on the material presented in the lecture, three weeks later, on December 8 (Monday) evening during the first portion of your regular class period. Naturally, the data from this study will be coded so your responses will be completely confidential. The data we obtain will not be released to anyone and will not affect your grades in any course. Please help us in this research.

We believe the study will yield very valuable information in educational psychology. Will you please indicate your agreement to participate in the lecture and the testing phase of this study by signing your name at the bottom of this letter, and return this letter to me.

Thank you very much for your participation in this study.

Sincerely,

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NAME _____

ADDRESS _____

APPENDIX B

LECTURER'S NOTES ON CONCEPT LEARNING

Introduction

Concept and Our Learning Experience

Have you ever imagined how complex and burdensome our learning experience would be if we had to learn a particular response for each and every situation we encounter in life? Fortunately, we are not overwhelmed by the prospect of having to learn a response for every situation because we have the ability to generalize from one situation to another. Our ability to generalize enables us to learn concepts. The whole process of concept learning is what I would like to talk about today.

Overview of the Lecture

I would like to give you a brief overview of some of the topics which we are going to cover in the lecture. We are going to define a concept and talk about theories of how we form concepts. Then we will be looking at specific aspects of concepts such as attributes and rules. We will continue the lecture by discussing types of concept learning and factors influencing concept learning. In conclusion, I will give you some practical principles that you as teachers can use to help your students to learn concepts.

Some Examples of Concepts

The first thing I would like to do is to give you some examples for concept learning. Concepts allow us to classify a variety of specific instances as members of a set. In learning the concept of

"dog," young children learn to classify a variety of specific instances such as poodles, collies, boxers, and laboradors as members of the set "dog." We can group together specific instances like football, baseball, and tennis into the set "sport." In our case, despite the differences in sex, age, and background we are all instances of the set "college student." Therefore, the fact that we can classify instances in a consistent fashion is taken as evidence of concept learning. However, once when we have learned a concept, we can still revise and refine it with our new knowledge and experience. This is a very important characteristic of concept learning.

Benefits of Concepts

Being able to learn concepts can benefit us in many ways. Three of the most important benefits are that: (1) Concepts decrease the necessity of learning an appropriate response all over again for each situation we encounter; (2) concepts reduce the complexity of our environment; (3) Concepts provide us with tools for thinking and learning principles.

Definition of Concept

General Definition

Knowing the benefits of concepts, we may ask: What is the definition of concept? A concept is the cognitive basis for assigning a category name to specific instances of a set.

This is a rather general (or tentative) definition of concept. As we progress in our lecture, we will learn a more technical definition of concept. There are different theories about how we learn concepts. Two important theories are:

1. the stimulus-response association approach,
2. the stimulus-response mediation approach.

First, we will look at the stimulus-response approach to concept learning.

The Stimulus-Response Association Approach

The stimulus-response association approach views concept learning involving learning a single response for one or more stimuli. For example (present Display 1, see page 79), if we were given the following five stimuli: Carter, Ford, Nixon, Johnson, and Kennedy, we would make only one response to these stimuli. We would respond that these stimuli are all instances of the concept "President."

Discrimination between Classes and Generalization within Classes. The stimulus-response association approach further views concept learning as a combination of discriminating between classes of instances and generalizing within classes of instances. For example (present Display 2, see page 80), if our task is to learn the concept "triangle," we must focus on the concept of "triangle." That is, we discriminate the concept "triangle" from the concepts of "square" and "circle." Then, we generalize the concept of "triangle" to other instances despite their color and size. Therefore, we have learned the concept "triangle" with different color and size. If we have to

DISPLAY 1

THE STIMULUS - RESPONSE
ASSOCIATION APPROACHSTIMULIRESPONSE

CARTER

FORD

NIXON

JOHNSON

KENNEDY

THE

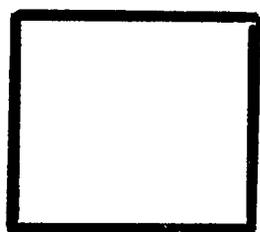
CONCEPT

"PRESIDENT"

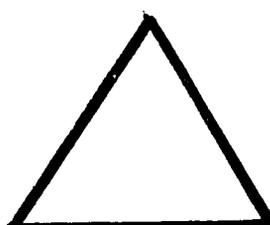
DISPLAY 2

THE CONCEPT OF "TRIANGLE"

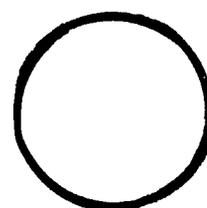
"triangle"



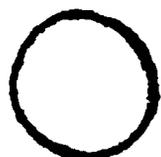
white



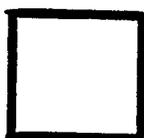
yellow



red



yellow



red



white



red



white



yellow

learn the concept "red," we must first discriminate the concept of "red" from the concepts of "white" and "yellow" (present Display 3, see page 82). Then, we generalize the concept "red" when it appears in different shapes with different sizes.

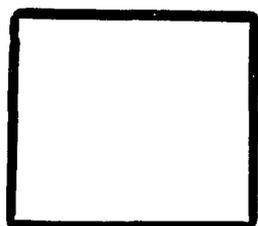
The Stimulus-Response Mediation Approach

Passive vs. Active Role. The stimulus response association approach to concept learning also assumes a passive role on the part of the learner since the learner simply learns concepts passively by responding to stimuli given. On the other hand, the stimulus-response mediation approach to concept learning assumes a more active role on the part of the learner. Let us look at the stimulus-response mediation approach, the second theory of how we learn concepts.

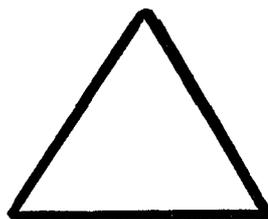
Intervening Process. According to the stimulus-response approach, concept learning develops as the result of an intervening process occurring between the stimuli and the response. For example (present Display 4, see page 83), if we were given the six stimuli: mountain, tacos, ice cream, steak, cottage cheese, and pencil, we would go through an intervening process before we get to the response of "food," which is the concept. During the intervening process we would do two things. First, we group together tacos, ice cream, steak, and cottage cheese, then we eliminate mountain and pencil. Tacos, ice cream, steak and cottage cheese are four stimuli which share the common attributes of edibility and nutrition. As we can see, the mediation approach views concept learning as the learner actively links the stimuli together through an intervening process.

DISPLAY 3

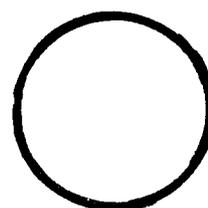
ATTRIBUTES AND DIMENSIONS



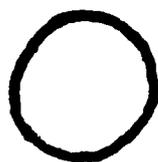
white



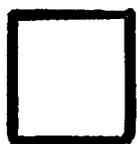
yellow



red



white



red



yellow



red



white



yellow

DISPLAY 4

THE STIMULUS - RESPONSE
MEDIATION APPROACH

STIMULI

TACOS

ICE CREAM

STEAK

COTTAGE CHEESE

INTERVENING

EDIBILITY

AND

NUTRITION

RESPONSE

THE

CONCEPT

"FOOD"

Technical Definition

Whether we consider the stimulus-response association approach or the stimulus-response mediation approach, concept learning is any activity in which we classify instances (or events) into a specific set. Specifically, concept learning requires that we come to respond to the relevant attributes of a set of stimuli but to ignore other relevant attributes. Accordingly, the refined definition of concept refers to a set of stimuli sharing one or more attributes which are connected by a rule.

Attributes and Rules

The Two Features: Attributes and Rules

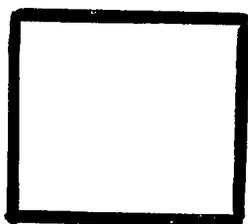
Now, we know that a concept has two important aspects; namely, attribute(s) and rule. Let us continue our discussion further with attribute and rule in order to gain more understanding of concept learning.

Attributes. Attributes are characteristics of the stimuli that are relevant to the concept. For example, the relevant attribute of the concept "college student" is enrollment in college and the irrelevant attributes are sex, age, major, background, etc. These irrelevant attributes are not important to the concept "college student."

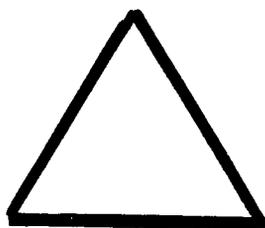
Attributes and Dimensions. Further, we should understand that attributes may have more than one dimension. For example (present Display 5, see page 85), these stimuli have shape, color and size as attributes. Each attribute has two dimensions. The attribute shape

DISPLAY 5

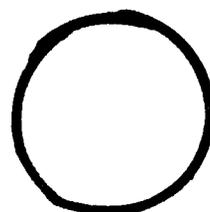
THE CONCEPT OF "RED"



white



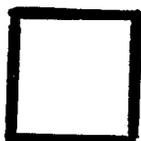
yellow



red



yellow



red



white



red



white



yellow

has two attributes: square and triangle; the attribute color has two dimensions: white and yellow; and the attribute size has two dimensions: small and large. Another example of attribute and dimension is the attribute college major which has many dimensions.

Conceptual Rules. In describing a concept we must refer to its attribute(s) and dimensions and how the attributes are combined. The specific way that attributes are combined to form a concept is referred to as a conceptual rule. It should be noted that conceptual rules do not describe how we learn concepts; rather, they are logical rules which describe the relationships among attributes. There are many conceptual rules. However, three basic ones are: affirmative, conjunctive, and disjunctive. We will look at these three rules one by one.

Affirmative Rule

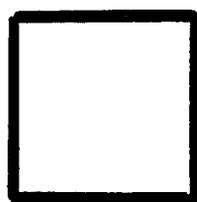
The affirmative rule is the simplest rule which defines a concept by a single attribute. For example (present Display 6, see page 87), if the concept is "yellow," then all stimuli regardless of shape and size which are yellow are classified as positive instances of the concept "yellow." Other instances which do not possess the attribute yellow are negative instances of the concept "yellow." Therefore, if A represents the attribute of a concept, the affirmative rule can be summarized as "All A."

Conjunctive Rule

The conjunctive rule is a more complex rule which defines a concept by the joint presence of two attributes. For example (present

DISPLAY 6

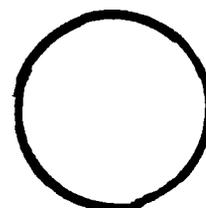
AFFIRMATIVE RULE = ALL "A"

THE POSITIVE AND NEGATIVE
INSTANCES OF THE CONCEPT "YELLOW"POSITIVE
INSTANCES
OF THE
CONCEPT
"YELLOW"

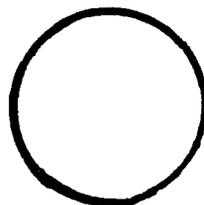
yellow



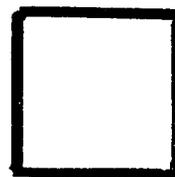
yellow



yellow

NEGATIVE
INSTANCES
OF THE
CONCEPT
"YELLOW"

red



red



red

Display 7, see page 89), if the concept is "white square," then all the stimuli which share the attributes of white and square regardless of size are positive instances of the concept "white square." Other instances which only have either the white or the square attribute, or neither of these attributes, are negative instances of the concept "white square." Therefore, if A and B represent the joint attributes of a concept, then the affirmative rule can be summarized as "A and B."

Disjunctive Rule

The disjunctive rule is the most complicated rule. Given that the correct attributes are A and B, the disjunctive rule can be summarized as "A and/or B." One practical example may illustrate the disjunctive rule. Assuming that I am going to give you a take-home exam, that means it is an open book and/or open person exam. It is totally legitimate for you to get information from any book(s) you want to use and/or from any person(s) you want to ask. Therefore, using a person, or using a book, or both are acceptable for a take-home exam. Other exams which do not at least possess one of the two attributes of open book and open person are negative instances of the concept "take-home exam."

Disjunctive vs. Conjunctive Rule

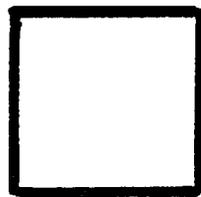
We can distinguish the conjunctive rule and the disjunctive rule by the following two examples. A yellow truck is an object which is both yellow and a truck; hence, a yellow truck is an instance of a conjunctive concept. An eligible voter might be legally defined as

DISPLAY 7

CONJUNCTIVE RULE = "A AND B"

POSITIVE AND NEGATIVE INSTANCES
OF THE CONCEPT "WHITE SQUARE"

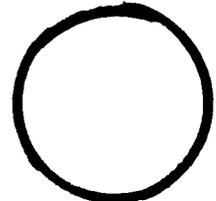
POSITIVE
INSTANCES
OF THE
CONCEPT
"WHITE SQUARE"



white



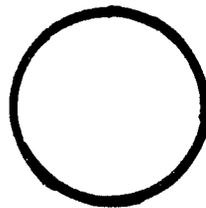
white



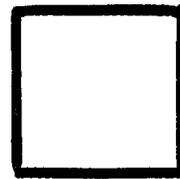
white

NEGATIVE
INSTANCES
OF THE
CONCEPT

"WHITE SQUARE"



white



yellow



red

anyone who is a resident and/or a property owner; hence, an eligible voter is an instance of disjunctive concept.

Types of Concept Learning

Let us remember that concept learning requires us both to select the appropriate instances and to reject the inappropriate instances. Further, concept learning can be divided into concept identification and concept formation.

Concept Identification

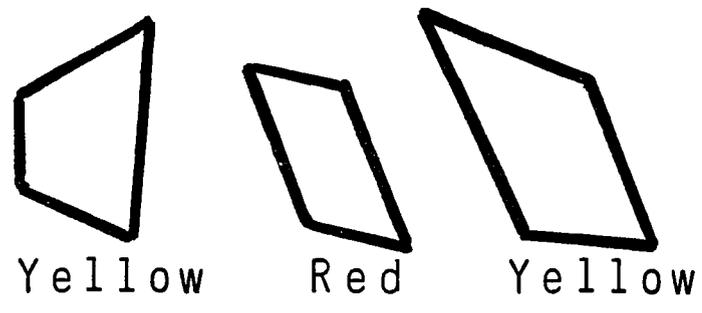
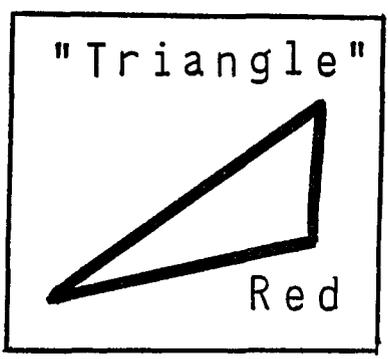
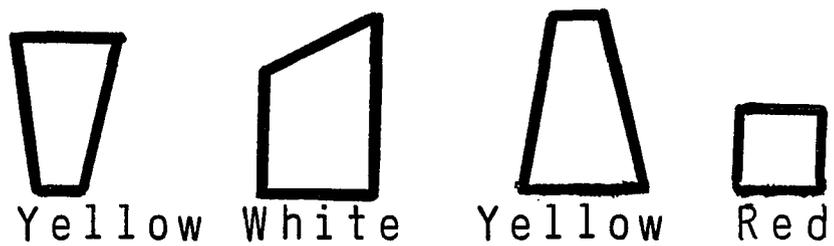
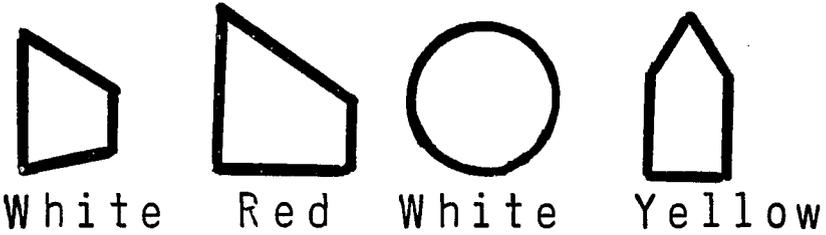
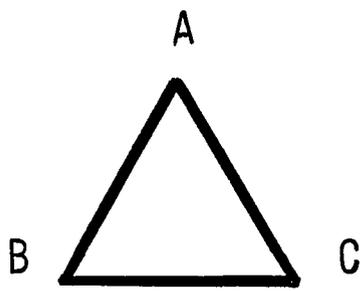
Concept identification refers to the situation which requires us to learn a new response to a concept that we have already learned. For example (present Display 8, see page 91), having learned the concept "triangle" which has the attributes of three sides and three angles, we make a new response to recognize a triangle among other instances. We are going through a process of concept identification as the concept "triangle" occurs in a new situation.

Concept Formation

On the other hand, concept formation refers to the situation which requires us to learn the meaning of a new concept. Think back about the first time you learned about the meaning of the concept "mineral" or the meaning of some rather abstract concepts such as "freedom," "happiness," "intelligence," etc. When you were doing that you were going through a process of concept formation. The emphasis was on forming the actual concept itself.

DISPLAY 8

CONCEPT IDENTIFICATION



Concept Identification vs. Concept Formation

Both concept identification and concept formation require analyzing the stimuli and finding the common attributes and rule that define the concept. However, research evidence suggests that concept identification is easier than concept formation. The reason is that while both situations apparently begin with trying out old concepts, concept formation does not begin until the old concepts have been tried and found inappropriate.

Factors Influencing Concept Learning

Now let us turn our attention to some important factors which influence concept learning. In general, these factors can be classified into two categories; (1) task variable, and (2) learner variable. The three task variables which we will discuss first are: (1) positive and negative instances, (2) relevant and irrelevant attributes, and (3) concreteness vs. abstractness. The two learner variables which we will discuss next are: (1) memory, and (2) intelligence.

Task Variables

Positive and Negative Instances. The first task variable is positive and negative instances. We learn concepts faster from positive than from negative instances because we are less accustomed to dealing with negative instances in our society. In our everyday experiences we are much more likely to use positive instances. The reason is that the number of negative instances is much larger than

the number of positive instances, and therefore negative instances are less useful in conveying information.

Relevant and Irrelevant Attributes. The second task variable is relevant and irrelevant attributes. The larger the number of relevant attributes, the easier is concept learning. This principle is easy to understand because by increasing the number of relevant attributes the likelihood that we will discover one or more of the relevant attributes is increasing. On the contrary, the larger the number of irrelevant attributes in a conceptual task, the more difficult is the task. This principle is not hard to understand because the more irrelevant attributes that we must learn to ignore, the longer it will take to find the relevant attributes.

Concreteness vs. Abstractness. The third task variable is concreteness vs. abstractness. It seems that it is easy to learn concrete concepts such as "building" and "tree" probably because we can see the relevant attributes. On the other hand, it may be difficult for us to learn abstract concepts such as "democracy" and "honesty" because the relevant attributes are not visible. Therefore, the distinctiveness of relevant attributes tends to make concrete concepts easier than abstract concepts to learn. Since abstract concepts are usually ambiguous and confusing, the relevant attributes tend to be similar and thus make abstract concepts difficult to learn.

Learner Variables

Concept learning not only relates to the characteristics of the task but also to the learner as well. Next we will examine the two learner variables: memory and intelligence.

Memory. In order to attain a particular concept, the learner must memorize information over trials since information from a single trial is not sufficient for learning the concept. Therefore, memory for specific instances facilitates concept learning.

Intelligence. In a similar vein, more intelligent individuals learn concepts faster than less intelligent individuals because intelligence is related to the skills necessary for making intervening mediation between instances and response.

Practical Principles

Knowing so much about concept learning, you may wonder how you as teachers can help your students to learn concepts more easily. In concluding this lecture on concept learning, I would like to give you four useful principles that will help you to teach concepts more effectively, regardless of what field you are in and which grade you teach.

Think of New Examples of the Concept

The first principle is to have your students think of new examples of the concept. In order that a concept be fully grasped and understood, it is important that your students think of their own examples beyond the ones you presented. Besides, thinking of new

examples helps your students to sharpen, refine and enrich the concept they have learned.

Use a Variety of Examples

The second principle is to use a variety of examples. Since concepts vary in complexity and difficulty, there is no simple answer to the question: "How many examples should we use?" By sampling examples along some range you may not include all representative ones. Perhaps the best way is to select examples so that they encompass the whole range of the concept.

Use Both Positive and Negative Instances

The third principle is to use both positive and negative instances. The precision and sharpness of a concept develops as your students process both positive and negative instances of a concept. If all of your examples are positive instances of the concept, then your students would have minimal opportunity to compare positive instances with negative instances. With only positive instances, your students fail to respond to the relevant attributes of the concept and instead respond to some superficial or irrelevant attributes.

Highlight Relevant Attributes

The fourth principle is to highlight relevant attributes. The advantage of highlighting relevant attributes is to make the relevant attributes more distinctive than the irrelevant attributes. You can make concepts more distinctive by the simultaneous presentation of both positive and negative instances.

For example, when you teach the concept "lake," you may show pictures of a lake, a stream, a river, and an ocean at the same time. Leaving all of the pictures in view helps your students better able to discriminate between relevant and irrelevant attributes of a lake. You might call attention to the relevant attribute size of a lake and compare it with other bodies of water. You might call attention to the relevant attribute static state of a lake and compare it with the irrelevant attribute flowing state of other bodies of water.

APPENDIX C

ENCODING BOOKLET A B₁

LISTENING AND NO REVIEW AFTER LECTURE

INSTRUCTIONS

Thank you for participating in our study. We are going to have a guest speaker lecturing on a topic that is usually discussed in courses of educational psychology.

Before the lecture starts, please find a seat where you will be comfortable. Do not open this booklet until you receive instruction to do so. Please PRINT your name in the space below.

NAME _____

PART A

Please do not open until you receive instruction

Now open here

Instruction: During this lecture we ask that you pay full attention to the presentation. That is all that is required of you. Other students, chosen randomly, have other instructions. Please do not pay any attention to what they do during the lecture. All you are asked to do is to learn the content of the lecture while paying attention.

PART B

Please do not open until you receive instruction

Now open here

Introduction

The following are four abstracts of recent research in educational psychology selected from the Journal of Educational Psychology. Please read these abstracts and rate each one for comprehensibility to you. A rating scale is provided under each abstract.

ABSTRACT A

The purpose of this study was to evaluate the teaching effectiveness of different aspects of the SCHOLAR computer-assisted instruction system. The experiment compared how well students learn using SCHOLAR with (a) the interactive map display of map-SCHOLAR, (b) a static labeled map, and (c) an unlabeled map. The results of the experiment showed that the students learned significantly more with the interactive map display than with either the labeled map or the unlabeled map. A new method called backtrace analysis was used to assess the effectiveness of specific aspects of the tutoring strategy and the map system used in the experiment.

RATING ON COMPREHENSIBILITY:

Very Low Low Medium High Very High

ABSTRACT B

This experiment investigated the causal interplay of teachers' expectation and children's academic performance. In a 4-year longitudinal study of 4,300 British beginning elementary children, a series of cross-lagged panel correlational analyses indicated that the preponderant cause in the achievement-expectancy relationship was that of the teachers' expectations causing children's achievements to an extent appreciably exceeding that to which children's performance impinged on teachers' attitudes. Teacher's evaluations of children's social performance affected later achievement to an extent exceeding that attributable to academic expectations. The methodological and substantive implications of these findings are discussed.

RATING ON COMPREHENSIBILITY:

Very Low Low Medium High Very High

ABSTRACT C

The focus of this study was the relationship between the science career commitment and the science teacher models of 141 female and 129 male high school students. On the basis of the earlier findings, it was predicted that students with same-sex teacher models would indicate a higher science career commitment. Furthermore, it was predicted that perceived teacher attractiveness and amount of science-related contact would affect the influence of same-sex teacher models more than that of opposite-sex teacher models. The results supported the hypotheses. Implications of the results for female participation in science are considered.

RATING IN COMPREHENSIBILITY:

Very Low Low Medium High Very High

ABSTRACT D

Children's metacognitive awareness of variables that influence reading was assessed in an interview study. Eight- and 12-year old children answered questions about the effects of personal abilities, task parameters and cognitive strategies involved in reading. Although young children were aware of the influence of some reading dimensions such as interest, familiarity and length, they were less sensitive to the semantic structure of the paragraph, goals of reading, and strategies for resolving comprehension failure than sixth-grade children. Age-related differences in metacognitive knowledge may be correlated with the acquisition of efficient memory, problem-solving and reading skills.

RATING IN COMPREHENSIBILITY:

Very Low Low Medium High Very High

Now that you have read these abstracts, please rank the order of the abstracts' research in terms of your opinion about their relevance to teachers.

| | RANK | LETTER OF ABSTRACT (A, B, D or D) |
|------------------|------|-----------------------------------|
| (Most Relevant) | 1 | _____ |
| | 2 | _____ |
| | 3 | _____ |
| (Least Relevant) | 4 | _____ |

Thank you for completing the above assignment. You will be asked to return in three weeks to take a comprehension test on the lecture information. Do not discuss the lecture information with one another. Please return the booklet and check that you have printed your name on the front page of the booklet.

APPENDIX D

ENCODING BOOKLET A₁B₂

LISTENING AND REVIEW AFTER LECTURE

INSTRUCTIONS

Thank you for participating in our study. We are going to have a guest speaker lecturing on a topic that is usually discussed in courses of educational psychology.

Before the lecture starts, please find a seat where you will be comfortable. Do not open this booklet until you receive instruction to do so. Please PRINT your name in the space below.

NAME _____

PART A

Please do not open until you receive instruction

Now open here

Instruction: During this lecture we ask that you pay full attention to the presentation. That is all that is required of you. Other students, chosen randomly, have other instructions. Please do not pay any attention to what they do during the lecture. All you are asked to do is to learn the content of the lecture while paying attention.

PART B

Please do not open until you receive instruction

Now open here

Instruction

Take several minutes to review the information presented during the lecture by going over in your mind as much of the material as possible. Try to review the material for at least 5 minutes. You can have up to 10 minutes if you want.

You will be asked to return in three weeks to take a comprehension test on the lecture information. Do not discuss the lecture information with one another. Please return the booklet when you have completed your review. Before leaving, check that you have printed your name on the front page of the booklet. Thank you!

APPENDIX E

ENCODING BOOKLET A_2B_1

LISTENING WITH OUTLINE AND NO REVIEW AFTER LECTURE

INSTRUCTIONS

Thank you for participating in our study. We are going to have a guest speaker lecturing on a topic that is usually discussed in courses of educational psychology.

Before the lecture starts, please find a seat where you will be comfortable. Do not open this booklet until you receive instruction to do so. Please PRINT your name in the space below.

NAME _____

PART A

Please do not open until you receive instruction

Now open here

Instruction: During this lecture we ask that you pay full attention to the presentation. As you listen, use the lecture outline provided on the following page to assist you in learning the content of the lecture. That is all that is required of you. Other students, chosen randomly, have other instructions. Please do not pay attention to what they do during the lecture.

LECTURE OUTLINE FOR LISTENING

INTRODUCTION

- Concept and our learning experience
- Overview of the lecture
- Some examples of concepts
- Benefits of concepts

DEFINITION OF CONCEPT

- General definition
- The stimulus-response association approach
 - Discrimination between classes and generalization within classes
- The stimulus-response mediation approach
 - Passive vs. active role
 - Intervening process
- Technical definition

ATTRIBUTES AND RULES

- The two features: attributes and rules
 - Attributes
 - Attributes and dimensions
 - Conceptual rules
 - Affirmative rule
 - Conjunctive rule
 - Disjunctive rule
 - Conjunctive vs. disjunctive rule

TYPES OF CONCEPT LEARNING

- Concept identification
- Concept formation
- Concept identification vs. concept formation

FACTORS INFLUENCING CONCEPT LEARNING

- Task variables
 - Positive and negative instances
 - Relevant and irrelevant attributes
 - Concreteness vs. abstractness
- Learner variables
 - Memory
 - Intelligence

PRACTICAL PRINCIPLES

- Think of new examples of the concept
- Use a variety of examples
- Use both positive and negative instances
- Highlight relevant attributes

PART B

Please do not open until you receive instruction

Now open here

Introduction

The following are four abstracts of recent research in educational psychology selected from the Journal of Educational Psychology. Please read these abstracts and rate each one for comprehensibility to you. A rating scale is provided under each abstract.

ABSTRACT A

The purpose of this study was to evaluate the teaching effectiveness of different aspects of the SCHOLAR computer-assisted instruction system. The experiment compared how well students learn using SCHOLAR with (a) the interactive map display of map-SCHOLAR, (b) a static labeled map, and (c) an unlabeled map. The results of the experiment showed that the students learned significantly more with the interactive map display than with either the labeled map or the unlabeled map. A new method called backtrace analysis was used to assess the effectiveness of specific aspects of the tutoring strategy and the map system used in the experiment.

RATING ON COMPREHENSIBILITY:

Very Low Low Medium High Very High

ABSTRACT B

This experiment investigated the causal interplay of teachers' expectation and children's academic performance. In a 4-year longitudinal study of 4,300 British beginning elementary children, a series of cross-lagged panel correlational analyses indicated that the preponderant cause in the achievement-expectancy relationship was that of the teachers' expectations causing children's achievements to an extent appreciably exceeding that to which children's performance impinged on teachers' attitudes. Teacher's evaluations of children's social performance affected later achievement to an extent exceeding that attributable to academic expectations. The methodological and substantive implications of these findings are discussed.

RATING ON COMPREHENSIBILITY:

Very Low Low Medium High Very High

ABSTRACT C

The focus of this study was the relationship between the science career commitment and the science teacher models of 141 female and 129 male high school students. On the basis of the earlier findings, it was predicted that students with same-sex teacher models would indicate a higher science career commitment. Furthermore, it was predicted that perceived teacher attractiveness and amount of science-related contact would affect the influence of same-sex teacher models more than that of opposite-sex teacher models. The results supported the hypotheses. Implications of the results for female participation in science are considered.

RATING IN COMPREHENSIBILITY:

_____ Very Low Low Medium High Very High

ABSTRACT D

Children's metacognitive awareness of variables that influence reading was assessed in an interview study. Eight- and 12-year old children answered questions about the effects of personal abilities, task parameters and cognitive strategies involved in reading. Although young children were aware of the influence of some reading dimensions such as interest, familiarity and length, they were less sensitive to the semantic structure of the paragraph, goals of reading, and strategies for resolving comprehension failure than sixth-grade children. Age-related differences in metacognitive knowledge may be correlated with the acquisition of efficient memory, problem-solving and reading skills.

RATING IN COMPREHENSIBILITY:

_____ Very Low Low Medium High Very High

Now that you have read these abstracts, please rank the order of the abstracts' research in terms of your opinion about their relevance

| to teachers. | RANK | LETTER OF ABSTRACT (A, B, D or D) |
|------------------|------|-----------------------------------|
| (Most Relevant) | 1 | _____ |
| | 2 | _____ |
| | 3 | _____ |
| (Least Relevant) | 4 | _____ |

Thank you for completing the above assignment. You will be asked to return in three weeks to take a comprehension test on the lecture information. Do not discuss the lecture information with one another. Please return the booklet and check that you have printed your name on the front page of the booklet.

APPENDIX F

ENCODING BOOKLET A_2B_2

LISTENING WITH OUTLINE AND REVIEW AFTER LECTURE

INSTRUCTIONS

Thank you for participating in our study. We are going to have a guest speaker lecturing on a topic that is usually discussed in courses of educational psychology.

Before the lecture starts, please find a seat where you will be comfortable. Do not open this booklet until you receive instruction to do so. Please PRINT your name in the space below.

NAME _____

PART A

Please do not open until you receive instruction

Now open here

Instruction: During this lecture we ask that you pay full attention to the presentation. As you listen, use the lecture outline provided on the following page to assist you in learning the content of the lecture. That is all that is required of you. Other students, chosen randomly, have other instructions. Please do not pay attention to what they do during the lecture.

LECTURE OUTLINE FOR LISTENING

INTRODUCTION

- Concept and our learning experience
- Overview of the lecture
- Some examples of concepts
- Benefits of concepts

DEFINITION OF CONCEPT

- General definition
 - The stimulus-response association approach
 - Discrimination between classes and generalization within classes
 - The stimulus-response mediation approach
 - Passive vs. active role
 - Intervening process
- Technical definition

ATTRIBUTES AND RULES

- The two features: attributes and rules
 - Attributes
 - Attributes and dimensions
 - Conceptual rules
 - Affirmative rule
 - Conjunctive rule
 - Disjunctive rule
 - Conjunctive vs. disjunctive rule

TYPES OF CONCEPT LEARNING

- Concept identification
- Concept formation
- Concept identification vs. concept formation

FACTORS INFLUENCING CONCEPT LEARNING

- Task variables
 - Positive and negative instances
 - Relevant and irrelevant attributes
 - Concreteness vs. abstractness
- Learner variables
 - Memory
 - Intelligence

PRACTICAL PRINCIPLES

- Think of new examples of the concept
- Use a variety of examples
- Use both positive and negative instances
- Highlight relevant attributes

PART B

Please do not open until you receive instruction

Now open here

Instruction

Take several minutes to review the information presented during the lecture by going over in your mind as much of the material as possible. Use the lecture outline that you followed when attending to the lecture. Go back to that outline and use it to help you in your review. Try to review the material for at least five minutes. You can have up to 10 minutes if you want.

You will be asked to return in three weeks to take a comprehension test on the lecture information. Do not discuss the lecture information with one another. Please return the booklet when you have completed your review. Before leaving, check that you have printed your name on the front page of the booklet. Thank you!

APPENDIX G

ENCODING BOOKLET A_3B_1

NOTE-TAKING AND NO REVIEW AFTER LECTURE

INSTRUCTIONS

Thank you for participating in our study. We are going to have a guest speaker lecturing on a topic that is usually discussed in courses of educational psychology.

Before the lecture starts, please find a seat where you will be comfortable. Do not open this booklet until you receive instruction to do so. Please PRINT your name in the space below.

NAME _____

PART A

Please do not open until you receive instruction

Now open here

Instruction: During this lecture we ask that you pay full attention to the presentation. As you listen and try to learn the content of the lecture, take notes just as you usually do when attending a lecture. That is all that is required of you. Other students, chosen randomly, have other instructions. Please do not pay attention to what they do during the lecture.

PART B

Please do not open until you receive instruction

Now open here

Introduction

The following are four abstracts of recent research in educational psychology selected from the Journal of Educational Psychology. Please read these abstracts and rate each one for comprehensibility to you. A rating scale is provided under each abstract.

ABSTRACT A

The purpose of this study was to evaluate the teaching effectiveness of different aspects of the SCHOLAR computer-assisted instruction system. The experiment compared how well students learn using SCHOLAR with (a) the interactive map display of map-SCHOLAR, (b) a static labeled map, and (c) an unlabeled map. The results of the experiment showed that the students learned significantly more with the interactive map display than with either the labeled map or the unlabeled map. A new method called backtrace analysis was used to assess the effectiveness of specific aspects of the tutoring strategy and the map system used in the experiment.

RATING ON COMPREHENSIBILITY:

Very Low Low Medium High Very High

ABSTRACT B

This experiment investigated the causal interplay of teachers' expectation and children's academic performance. In a 4-year longitudinal study of 4,300 British beginning elementary children, a series of cross-lagged panel correlational analyses indicated that the preponderant cause in the achievement-expectancy relationship was that of the teachers' expectations causing children's achievements to an extent appreciably exceeding that to which children's performance impinged on teachers' attitudes. Teacher's evaluations of children's social performance affected later achievement to an extent exceeding that attributable to academic expectations. The methodological and substantive implications of these findings are discussed.

RATING ON COMPREHENSIBILITY:

Very Low Low Medium High Very High

ABSTRACT C

The focus of this study was the relationship between the science career commitment and the science teacher models of 141 female and 129 male high school students. On the basis of the earlier findings, it was predicted that students with same-sex teacher models would indicate a higher science career commitment. Furthermore, it was predicted that perceived teacher attractiveness and amount of science-related contact would affect the influence of same-sex teacher models more than that of opposite-sex teacher models. The results supported the hypotheses. Implications of the results for female participation in science are considered.

RATING IN COMPREHENSIBILITY:

_____ Very Low _____ Low _____ Medium _____ High _____ Very High

ABSTRACT D

Children's metacognitive awareness of variables that influence reading was assessed in an interview study. Eight- and 12-year old children answered questions about the effects of personal abilities, task parameters and cognitive strategies involved in reading. Although young children were aware of the influence of some reading dimensions such as interest, familiarity and length, they were less sensitive to the semantic structure of the paragraph, goals of reading, and strategies for resolving comprehension failure than sixth-grade children. Age-related differences in metacognitive knowledge may be correlated with the acquisition of efficient memory, problem-solving and reading skills.

RATING IN COMPREHENSIBILITY:

_____ Very Low _____ Low _____ Medium _____ High _____ Very High

Now that you have read these abstracts, please rank the order of the abstracts' research in terms of your opinion about their relevance to teachers.

| | RANK | LETTER OF ABSTRACT (A, B, D or D) |
|------------------|------|-----------------------------------|
| (Most Relevant) | 1 | _____ |
| | 2 | _____ |
| | 3 | _____ |
| (Least Relevant) | 4 | _____ |

Thank you for completing the above assignment. You will be asked to return in three weeks to take a comprehension test on the lecture information. Do not discuss the lecture information with one another. Please return the booklet and check that you have printed your name on the front page of the booklet.

APPENDIX H

ENCODING BOOKLET A_3B_2

NOTE-TAKING AND REVIEW AFTER LECTURE

INSTRUCTIONS

Thank you for participating in our study. We are going to have a guest speaker lecturing on a topic that is usually discussed in courses of educational psychology.

Before the lecture starts, please find a seat where you will be comfortable. Do not open this booklet until you receive instruction to do so. Please PRINT your name in the space below.

NAME _____

PART A

Please do not open until you receive instruction

Now open here

Instruction: During this lecture we ask that you pay full attention to the presentation. As you listen and try to learn the content of the lecture, take notes just as you usually do when attending a lecture. That is all that is required of you. Other students, chosen randomly, have other instructions. Please do not pay attention to what they do during the lecture.

PART B

Please do not open until you receive instruction

Now open here

Instruction

Take several minutes to review the information presenting during the lecture by carefully studying the notes you took during the lecture. Go back to those notes and use them to help you in your review. Try to review the material for at least 5 minutes. You can have up to 10 minutes if you want.

You will be asked to return in three weeks to take a comprehension test on the lecture information. Do not discuss the lecture information with one another. Please return the booklet when you have completed your review. Before leaving, check that you have printed your name on the front page of the booklet. Thank you!

APPENDIX I

ENCODING BOOKLET A_4B_1

NOTE-TAKING WITH OUTLINE AND NO REVIEW AFTER LECTURE

INSTRUCTIONS

Thank you for participating in our study. We are going to have a guest speaker lecturing on a topic that is usually discussed in courses of educational psychology.

Before the lecture starts, please find a seat where you will be comfortable. Do not open this booklet until you receive instruction to do so. Please PRINT your name in the space below.

NAME _____

PART A

Please do not open until you receive instruction

Now open here

Instruction: During this lecture we ask that you pay full attention to the presentation. As you listen and try to learn the content of the lecture, take notes just as you usually do when attending a lecture. We have provided an outline of the lecture to help you take your notes. The outline and the lecture follow the same sequence. You should take your notes within the space provided under each topic in the outline. That is all that is required of you. Other students, chosen randomly, have other instructions. Please do not pay attention to what they do during the lecture.

LECTURE OUTLINE FOR NOTE-TAKING

INTRODUCTION

Concepts and our learning experience

Overview

Examples of concepts

Benefits of concepts

DEFINITION OF CONCEPT

General definition

The stimulus-response association approach

Discrimination between classes and generalization within classes

The stimulus-response mediation approach

Passive vs. active role

Intervening process

Technical definition

ATTRIBUTES AND RULES

The two features: attributes and rules

Attributes

Attributes and dimensions

Conceptual rules

Affirmative rule

Conjunctive rule

Disjunctive rule

Conjunctive vs. disjunctive rule

TYPES OF CONCEPT LEARNING

Concept identification

Concept formation

Concept formation vs. concept identification

FACTORS INFLUENCING CONCEPT LEARNING

Task variables

Positive and negative instances

Relevant vs. irrelevant attributes

Concrete vs. abstractness

Learner variables

Memory

Intelligence

PRACTICAL PRINCIPLES

Think of new examples of the concept

Use a variety of examples

Use both positive and negative instances

Highlight relevant attributes

PART B

Please do not open until you receive instruction

Now open here

Introduction

The following are four abstracts of recent research in educational psychology selected from the Journal of Educational Psychology. Please read these abstracts and rate each one for comprehensibility to you. A rating scale is provided under each abstract.

ABSTRACT A

The purpose of this study was to evaluate the teaching effectiveness of different aspects of the SCHOLAR computer-assisted instruction system. The experiment compared how well students learn using SCHOLAR with (a) the interactive map display of map-SCHOLAR, (b) a static labeled map, and (c) an unlabeled map. The results of the experiment showed that the students learned significantly more with the interactive map display than with either the labeled map or the unlabeled map. A new method called backtrace analysis was used to assess the effectiveness of specific aspects of the tutoring strategy and the map system used in the experiment.

RATING ON COMPREHENSIBILITY:

Very Low Low Medium High Very High

ABSTRACT B

This experiment investigated the causal interplay of teachers' expectation and children's academic performance. In a 4-year longitudinal study of 4,300 British beginning elementary children, a series of cross-lagged panel correlational analyses indicated that the preponderant cause in the achievement-expectancy relationship was that of the teachers' expectations causing children's achievements to an extent appreciably exceeding that to which children's performance impinged on teachers' attitudes. Teacher's evaluations of children's social performance affected later achievement to an extent exceeding that attributable to academic expectations. The methodological and substantive implications of these findings are discussed.

RATING ON COMPREHENSIBILITY:

Very Low Low Medium High Very High

ABSTRACT C

The focus of this study was the relationship between the science career commitment and the science teacher models of 141 female and 129 male high school students. On the basis of the earlier findings, it was predicted that students with same-sex teacher models would indicate a higher science career commitment. Furthermore, it was predicted that perceived teacher attractiveness and amount of science-related contact would affect the influence of same-sex teacher models more than that of opposite-sex teacher models. The results supported the hypotheses. Implications of the results for female participation in science are considered.

RATING IN COMPREHENSIBILITY:

Very Low Low Medium High Very High

ABSTRACT D

Children's metacognitive awareness of variables that influence reading was assessed in an interview study. Eight- and 12-year old children answered questions about the effects of personal abilities, task parameters and cognitive strategies involved in reading. Although young children were aware of the influence of some reading dimensions such as interest, familiarity and length, they were less sensitive to the semantic structure of the paragraph, goals of reading, and strategies for resolving comprehension failure than sixth-grade children. Age-related differences in metacognitive knowledge may be correlated with the acquisition of efficient memory, problem-solving and reading skills.

RATING IN COMPREHENSIBILITY:

Very Low Low Medium High Very High

Now that you have read these abstracts, please rank the order of the abstracts' research in terms of your opinion about their relevance to teachers.

| | RANK | LETTER OF ABSTRACT (A, B, D or D) |
|------------------|------|-----------------------------------|
| (Most Relevant) | 1 | _____ |
| | 2 | _____ |
| | 3 | _____ |
| (Least Relevant) | 4 | _____ |

Thank you for completing the above assignment. You will be asked to return in three weeks to take a comprehension test on the lecture information. Do not discuss the lecture information with one another. Please return the booklet and check that you have printed your name on the front page of the booklet.

APPENDIX J

ENCODING BOOKLET A_4B_2

NOTE-TAKING WITH OUTLINE AND REVIEW AFTER LECTURE

INSTRUCTIONS

Thank you for participating in our study. We are going to have a guest speaker lecturing on a topic that is usually discussed in courses of educational psychology.

Before the lecture starts, please find a seat where you will be comfortable. Do not open this booklet until you receive instruction to do so. Please PRINT your name in the space below.

NAME _____

PART A

Please do not open until you receive instruction

Now open here

Instruction: During this lecture we ask that you pay full attention to the presentation. As you listen and try to learn the content of the lecture, take notes just as you usually do when attending a lecture. We have provided an outline of the lecture to help you take your notes. The outline and the lecture follow the same sequence. You should take your notes within the space provided under each topic in the outline. That is all that is required of you. Other students, chosen randomly, have other instructions. Please do not pay attention to what they do during the lecture.

LECTURE OUTLINE FOR NOTE-TAKING

INTRODUCTION

Concepts and our learning experience

Overview

Examples of concepts

Benefits of concepts

DEFINITION OF CONCEPT

General definition

The stimulus-response association approach

Discrimination between classes and generalization within classes

The stimulus-response mediation approach

Passive vs. active role

Intervening process

Technical definition

ATTRIBUTES AND RULES

The two features: attributes and rules

Attributes

Attribute and dimensions

Conceptual rules

Affirmative rule

Conjunctive rule

Disjunctive rule

Conjunctive vs. disjunctive rule

TYPES OF CONCEPT LEARNING

Concept identification

Concept formation

Concept formation vs. concept identification

FACTORS INFLUENCING CONCEPT LEARNING

Task variables

Positive and negative instances

Relevant vs. irrelevant attributes

Concrete vs. abstractness

Learner variables

Memory

Intelligence

PRACTICAL PRINCIPLES

Think of new examples of the concept

Use a variety of examples

Use both positive and negative instances

Highlight relevant attributes

PART B

Please do not open until you receive instruction

Now open here

Instruction

Take several minutes to review the information presenting during the lecture by carefully studying the notes you took during the lecture. Go back to those notes and use them to help you in your review. Try to review the material for at least 5 minutes. You can have up to 10 minutes if you want.

You will be asked to return in three weeks to take a comprehension test on the lecture information. Do not discuss the lecture information with one another. Please return the booklet when you have completed your review. Before leaving, check that you have printed your name on the front page of the booklet. Thank you!

APPENDIX K

REMINDING NOTE GIVEN TO ALL SUBJECTS AT THE END OF
THE FIRST PHASE OF THE STUDY TO COME BACK IN
THREE WEEKS FOR THE COMPREHENSION TEST
(BOTH SESSIONS)

PLEASE DO NOT FORGET TO COME BACK IN THREE WEEKS FOR THE COMPREHENSION
TEST ON THE LECTURE.

DATE: DECEMBER 3 (WEDNESDAY)

TIME: AT YOUR CONVENIENCE BETWEEN 8:00 A.M. - 10:00 P.M.

PLACE: ROOM A314 (ON THE THIRD FLOOR) OF THE MAIN LIBRARY

THANK YOU FOR YOUR PARTICIPATION IN OUR STUDY.

PLEASE DO NOT FORGET TO COME BACK IN THREE WEEKS FOR THE COMPREHENSION
TEST ON THE LECTURE.

DATE: DECEMBER 8 (MONDAY)

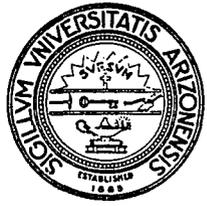
TIME: 7:00 P.M.

PLACE: 211 EDUCATION

THANK YOU FOR YOUR PARTICIPATION IN OUR STUDY.

APPENDIX L

LETTER TO ASK ALL SUBJECTS TO COME BACK
FOR THE COMPREHENSION TEST
(BOTH SESSIONS)



THE UNIVERSITY OF ARIZONA
TUCSON, ARIZONA 85721

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COLLEGE OF EDUCATION
Department of Educational Psychology

Dear Students:

Once again I want to thank you very much for your participation in our study, Encoding and Retrieval of Information from Lecture, about three weeks ago. Your further participation in this study is very important to us. We really need you to come back to take a comprehension test on the lecture. We will not be able to analyze our data without your further participation. Of course, the results of the comprehension test will be confidential.

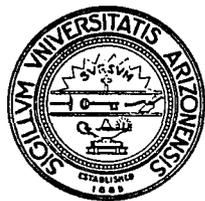
DATE: December 3, 1980 (Wednesday)

TIME: 8:00 a.m. - 10:00 p.m.

PLACE: A314 (on the third floor) of the Main Library

Sincerely,

Howard K. Yu, M.A.
Advanced Graduate Student
Department of Educational Psychology



THE UNIVERSITY OF ARIZONA

TUCSON, ARIZONA 85721

192

COLLEGE OF EDUCATION
Department of Educational Psychology

Dear Students:

Once again I want to thank you very much for your participation in our study, Encoding and Retrieval of Information from Lecture, about three weeks ago. Your further participation in this study is very important to us. We really need you to come back to take a comprehension test on the lecture. We will not be able to analyze our data without your further participation. Of course, the results of the comprehension test will be confidential.

DATE: December 8, 1980 (Monday)

TIME: 7:00 p.m.

PLACE: 211 Education

Sincerely,

Howard K. Yu, M.A.
Advanced Graduate Student
Department of Educational Psychology

APPENDIX M

INSTRUCTIONS PRIOR TO TESTING FOR ALL
SUBJECTS WHO DID NOT REVIEW BEFORE TESTING

Instruction

Thank you for coming back to take the comprehension test for the lecture on Concept Learning which you attended three weeks ago. The comprehension test consists of two parts. You are first asked to take Part I, and then Part II. Naturally, the results of your comprehension test will be coded so your responses will be completely confidential.

APPENDIX N

REVIEW INSTRUCTIONS PRIOR TO TESTING FOR ALL
LISTENING SUBJECTS WHO EITHER REVIEWED OR
DID NOT REVIEW AFTER LECTURE

Instruction

Take several minutes to review the information presented during the lecture by going over in your mind as much of the material as possible. Try to review the material for at least 5 minutes. You can have up to 10 minutes if you want.

You will be asked to return in three weeks to take a comprehension test on the lecture information. Do not discuss the lecture information with one another. Please return the booklet when you have completed your review. Before leaving, check that you have printed your name on the front page of the booklet. Thank you!

APPENDIX O

REVIEW INSTRUCTIONS FOR ALL LISTENING WITH
OUTLINE SUBJECTS WHO EITHER REVIEWED
OR DID NOT REVIEW AFTER LECTURE

Instruction

Thank you for coming back to take the comprehension test for the lecture on Concept Learning which you attended three weeks ago.

Before taking the comprehension test, please take several minutes to review the information presented during the lecture by going over as much of the material as possible. Use the lecture outline that you followed when attending to the lecture to help your review. That outline is provided on the following page. Try to review the material for at least 5 minutes. You can have up to 10 minutes if you want.

Please ask for your comprehension test when you have completed your review.

APPENDIX P

REVIEW INSTRUCTIONS FOR ALL NOTE-TAKING AND NOTE-TAKING
WITH OUTLINE SUBJECTS WHO EITHER REVIEWED
OR DID NOT REVIEW AFTER LECTURE

Instruction

Thank you for coming back to take the comprehension test for the lecture on Concept Learning which you attended three weeks ago.

Before taking the comprehension test, please take several minutes to review the information presented during the lecture. Go back to your notes and use them to help your review. Your notes are attached to this sheet. Try to review the material for at least 5 minutes. You can have up to 10 minutes if you want.

Please ask for your comprehension test when you have completed your review.

APPENDIX Q

INSTRUCTIONS PRIOR TO TESTING FOR
ALL SUBJECTS WHO REVIEWED BEFORE TEST

Instruction

Thank you for completing your pretest review. Now you are ready to take the comprehension test which consists of two parts. You are first asked to take Part I, and then Part II. Naturally, the results of your comprehension test will be coded so your response will be completely confidential.

APPENDIX R

PART I AND PART II OF THE
COMPREHENSION TEST

COMPREHENSION TEST: CONCEPT LEARNING

Part I

Instruction: Part I of the comprehension test consists of 20 multiple choice questions. Please take your time and do your best to complete Part I. When you have finished Part I, you will be given Part II. Before proceeding please make sure to put your name (IN PRINT) in the space provided below. Thank you.

NAME _____

For each of the following items, select the choice that best completes the statement. Please place your answer in the blank space at the left of each item.

1. The conceptual rule which classifies people as both male and female is a(n) _____ rule.
 - a. affirmative
 - b. conditional
 - c. conjunctive
 - d. disjunctive

2. Concepts can be
 - a. revised and amended with new knowledge and experience.
 - b. forgotten easily without appropriate rehearsal.
 - c. changed rarely once they are learned.
 - d. a and b.

3. Concept identification
 - a. is easier than concept formation.
 - b. is as difficult as concept formation.
 - c. refers to the situation which requires learning the meaning of a new concept.
 - d. refers to the situation which requires learning a new response to a concept that we do not know.

4. The concept of "small blue triangle" has
 - a. two attributes and the attributes are combined by conjunctive rule.
 - b. five attributes and the attributes are combined by disjunctive rule.
 - c. three attributes and the attributes are combined by affirmative rule.
 - d. three attributes and the attributes are combined by conjunctive rule.

5. The evidence of the development of a concept is based on one's
 - a. memory of a learned concept.
 - b. mastery of the conceptual rule(s).
 - c. understanding of the similarity and difference of attributes.
 - d. learning to classify events (or instances) in a consistent fashion.

6. Concept A has five irrelevant attributes, whereas concept B has seven irrelevant attributes. ____ is _____ to learn because it has fewer irrelevant attributes.
 - a. A, easier
 - b. A, harder
 - c. B, easier
 - d. B, harder

7. The stimuli of a concept
 - a. consist of positive and negative instances.
 - b. may vary in several dimensions.
 - c. have more than one attribute.
 - d. all of the above.

8. The stimulus-response association approach to concept learning features
 - a. both the positive and negative roles of the learner depending on the situation.
 - b. discrimination and generalization.
 - c. the passive role of the learner.
 - d. b and c.

9. A concept rule
 - a. defines the features of the stimuli that are relevant to the concept.
 - b. is defined by combining attributes in several different ways.
 - c. describes how we learn concepts.
 - d. none of the above.

10. We can learn concepts because we
 - a. know the conceptual rule(s).
 - b. can differentiate attributes.
 - c. have the capacity to generalize from particular situations.
 - d. can make distinctions between positive and negative instances.

11. The concept of "student" is an example of a(n) _____ rule.
 - a. affirmative
 - b. conditional
 - c. conjunctive
 - d. disjunctive

12. A concept is
 - a. a label we assign to objects and events.
 - b. a cognitive basis for assigning or classifying things.
 - c. an association between one stimulus and many responses.
 - d. an association between many stimuli and many responses.

13. The learner variable memory
 - a. helps the understanding of conceptual rule.
 - b. is related to trials and specific instances.
 - c. is related to the use of mediational responses.
 - d. is crucial in the sorting out of irrelevant attributes.

14. The degree of similarity among relevant attributes
 - a. facilitates concept learning.
 - b. relates to memory in concept learning.
 - c. relates to the difficulty of learning the concept.
 - d. hinders the discovery of conceptual rule(s) in concept learning.

15. Concepts have two important aspects:
 - a. rules and knowledge.
 - b. thoughts and knowledge.
 - c. attributes and rules.
 - d. attributes and knowledge.

16. The stimulus-response mediation approach to conceptual learning emphasizes the
 - a. magnitude of the stimulus.
 - b. active role of the learner.
 - c. importance of the response.
 - d. association between stimulus and response.

17. The learner variable intelligence facilitates
 - a. concept learning.
 - b. the use of conceptual rules.
 - c. the generalization of attributes.
 - d. the discovery of conceptual rules.

18. Concept learning requires the learner to
 - a. respond to both the relevant and irrelevant attributes.
 - b. ignore some relevant attributes as well as some irrelevant attributes.
 - c. respond to the relevant attributes and to ignore the irrelevant attributes.
 - d. respond to some irrelevant attributes and to ignore some relevant attributes.

19. Learning abstract concepts tends to be harder than learning concrete concepts because
 - a. abstract concepts have more similarity in attributes than concrete concepts.
 - b. abstract concepts contain more irrelevant attributes than concrete concepts.
 - c. more memory and mediation are required for abstract concepts than for concrete concepts.
 - d. the conceptual rules for abstract concepts are more confusing than for concrete concepts.

20. We learn concepts faster from being given
- a. negative rather than positive instances.
 - b. positive rather than negative instances.
 - c. many negative with few positive instances.
 - d. many positive with few negative instances.

COMPREHENSION TEST: CONCEPT LEARNING

Part II

Instruction: Part II of the comprehension test consists of 10 short essay questions. Please take your time and do your best to complete Part II. Do not discuss both Part I and Part II of the comprehension test with one another since other students have not yet taken this comprehension test. Before proceeding please make sure to put your name (IN PRINT) in the space provided below. Thank you.

NAME _____

6. Given a group of stimuli with different shapes (circles, squares and triangles) and each stimulus with different color (green, red and yellow), describe how discrimination and generalization are applied to learning the concept "red."

7. Explain whether a large number of relevant attributes would make concept learning easier or harder. How about that number of irrelevant attributes?
 Relevant attributes:

 Irrelevant attributes:

8. How would you teach the concept "white" and determine whether your students have indeed learned the concept?

9. How would you teach the concept "mineral" and determine whether your students have indeed learned the concept?

10. Explain two differences between teaching a concrete concept (e.g., house) and an abstract concept (e.g., democracy).

 (1)

 (2)

APPENDIX S

CORRECT ANSWERS OF THE COMPREHENSION

TEST USED FOR SCORING

COMPREHENSION TEST: CONCEPT LEARNING

Part I

Instruction: Part I of the comprehension test consists of 20 multiple choice questions. Please take your time and do your best to complete Part I. When you have finished Part I, you will be given Part II. Before proceeding please make sure to put your name (IN PRINT) in the space provided below. Thank you.

NAME _____

For each of the following items, select the choice that best completes the statement. Please place your answer in the blank space at the left of each item.

1. The conceptual rule which classifies people as both male and female is a(n) _____ rule.
a. affirmative
c. conjunctive
b. conditional
d. disjunctive
2. Concepts can be
a. revised and amended with new knowledge and experience.
b. forgotten easily without appropriate rehearsal.
A. c. changed rarely once they are learned.
d. a and b.
3. Concept identification
a. is easier than concept formation.
b. is as difficult as concept formation.
A. c. refers to the situation which requires learning the meaning of a new concept.
d. refers to the situation which requires learning a new response to a concept that we do not know.
4. The concept of "small blue triangle" has
a. two attributes and the attributes are combined by conjunctive rule.
b. five attributes and the attributes are combined by disjunctive rule.
D. c. three attributes and the attributes are combined by affirmative rule.
d. three attributes and the attributes are combined by conjunctive rule.
5. The evidence of the development of a concept is based on one's
a. memory of a learned concept.
b. mastery of the conceptual rule(s).
D. c. understanding of the similarity and difference of attributes.
d. learning to classify events (or instances) in a consistent fashion.
6. Concept A has five irrelevant attributes, whereas concept B has seven irrelevant attributes. _____ is _____ to learn because it has fewer irrelevant attributes.
a. A, easier
A. b. A, harder
c. B, easier
d. B, harder

7. The stimuli of a concept
- a. consist of positive and negative instances.
 - D** b. may vary in several dimensions.
 - c. have more than one attribute.
 - d. all of the above.
8. The stimulus-response association approach to concept learning features
- a. both the positive and negative roles of the learner depending on the situation.
 - D** b. discrimination and generalization.
 - c. the passive role of the learner.
 - d. b and c.
9. A concept rule
- a. defines the features of the stimuli that are relevant to the concept.
 - B** b. is defined by combining attributes in several different ways.
 - c. describes how we learn concepts.
 - d. none of the above.
10. We can learn concepts because we
- a. know the conceptual rule(s).
 - b. can differentiate attributes.
 - C** c. have the capacity to generalize from particular situations.
 - d. can make distinctions between positive and negative instances.
11. The concept of "student" is an example of a(n) _____ rule.
- a. affirmative
 - b. conditional
 - A** c. conjunctive
 - d. disjunctive
12. A concept is
- a. a label we assign to objects and events.
 - b. a cognitive basis for assigning or classifying things.
 - B** c. an association between one stimulus and many responses.
 - d. an association between many stimuli and many responses.
13. The learner variable memory
- a. helps the understanding of conceptual rule.
 - b. is related to trials and specific instances.
 - B** c. is related to the use of mediational responses.
 - d. is crucial in the sorting out of irrelevant attributes.

14. The degree of similarity among relevant attributes
- a. facilitates concept learning.
 - b. relates to memory in concept learning.
 - C** c. relates to the difficulty of learning the concept.
 - d. hinders the discovery of conceptual rule(s) in concept learning.
15. Concepts have two important aspects:
- a. rules and knowledge.
 - C** b. thoughts and knowledge.
 - c. attributes and rules.
 - d. attributes and knowledge.
16. The stimulus-response mediation approach to conceptual learning emphasizes the
- a. magnitude of the stimulus.
 - b. active role of the learner.
 - B** c. importance of the response.
 - d. association between stimulus and response.
17. The learner variable intelligence facilitates
- a. concept learning.
 - A** b. the use of conceptual rules.
 - c. the generalization of attributes.
 - d. the discovery of conceptual rules.
18. Concept learning requires the learner to
- a. respond to both the relevant and irrelevant attributes.
 - b. ignore some relevant attributes as well as some irrelevant attributes.
 - C** c. respond to the relevant attributes and to ignore the irrelevant attributes.
 - d. respond to some irrelevant attributes and to ignore some relevant attributes.
19. Learning abstract concepts tends to be harder than learning concrete concepts because
- a. abstract concepts have more similarity in attributes than concrete concepts.
 - A** b. abstract concepts contain more irrelevant attributes than concrete concepts.
 - c. more memory and mediation are required for abstract concepts than for concrete concepts.
 - d. the conceptual rules for abstract concepts are more confusing than for concrete concepts.

20. We learn concepts faster from being given
- A a. negative rather than positive instances.
 - b. positive rather than negative instances.
 - D c. many negative with few positive instances.
 - d. many positive with few negative instances.

COMPREHENSION TEST: CONCEPT LEARNING

Part II

Instruction: Part II of the comprehension test consists of 10 short essay questions. Please take your time and do your best to complete Part II. Do not discuss both Part I and Part II of the comprehension test with one another since other students have not yet taken this comprehension test. Before proceeding please make sure to put your name (IN PRINT) in the space provided below. Thank you.

NAME _____

Answer each of the following questions according to the best of your understanding of concept learning.

1. Define a concept.

A concept is the cognitive basis for assigning a category name to specific instances of a set; or a concept refers to a set of stimuli sharing one or more attributes that are connected by a rule.

2. State two purposes of concept learning.

Any two of the following three purposes:

- (1) Concepts decrease the necessity of having an appropriate response all over again for each situation or encounter.*
- (2) Concepts reduce the complexity of our environment.*
- (3) Concepts provide us with tools for thinking and learning principles.*

3. State two practical principles of concept learning.

Any two of the following four principles:

- (1) Thinking of new examples of the concept.*
- (2) Using a variety of examples.*
- (3) Using positive and negative instances.*
- (4) Highlighting relevant attributes.*

4. Give your own examples of disjunctive rule (do not use an example mentioned in the lecture).

Any example with A and/or B not mentioned in the lecture.

5. Explain the difference between stimulus-response association approach and stimulus-response mediation approach to concept learning by giving two reasons.

- (1) In learning concepts the stimulus-response association approach assumed a passive role of the learner whereas the stimulus-response mediation approach assumes an active role of the learner.*
- (2) The stimulus-response mediation approach assumes that concept learning develops as a result of an intervening process occurring between the stimuli and the response, whereas the stimulus-response association approach assumes concept learning occurs when a response is made to a set of stimuli.*

6. Given a group of stimuli with different shapes (circles, squares and triangles) and each stimulus with different color (green, red and yellow), describe how discrimination and generalization are applied to learning the concept "red."

We learn the concept "red" by discriminating "red" from yellow and green and then generalizing "red" when it occurs with different stimuli (circle, square and triangle).

7. Explain whether a large number of relevant attributes would make concept learning easier or harder. How about that number of irrelevant attributes?

Relevant attributes: Easier, because increasing the number of relevant attributes also increases the likelihood of discovering one or more relevant attributes.

Irrelevant attributes: Harder, because the more irrelevant attributes there are to learn to ignore, the longer it takes to find the relevant attributes.

8. How would you teach the concept "white" and determine whether your students have indeed learned the concept?

Students learn the concept "white" by being able to discriminate "white" from other colors and generalize "white" when it occurs with whatever stimuli.

9. How would you teach the concept "mineral" and determine whether your students have indeed learned the concept?

First, I present the attributes and rule for the concept "mineral" to students. Then I use a variety of examples with both positive and negative instances to help the students in learning how to attend the relevant attributes and ignore the irrelevant attributes of the concept "mineral."

10. Explain two differences between teaching a concrete concept (e.g., house) and an abstract concept (e.g., democracy).

(1) In comparing the similarity of attributes between concrete and abstract concepts. A concrete concept has more similarity in attributes and therefore decreases its distinctiveness.

(2) It is difficult to find appropriate instances for abstract concepts as compared to concrete concepts.

APPENDIX T

ANOVA WITH UNEQUAL SAMPLE SIZES ON
RECOGNITION AND RECALL TEST SCORES

Anova with Unequal Sample Sizes on Recognition and Recall Test Scores

| Effects | Recognition | | | Recall | | |
|-------------------------------|-------------|----------|-----|--------|----------|------|
| | F | df | p | F | df | p |
| Encoding (E) | 3.09 | (3, 118) | .03 | 5.07 | (3, 118) | .002 |
| After-Lecture Review (ALR) | .07 | (1, 118) | NS | .06 | (1, 118) | NS |
| Before-Test Review (BTR) | .58 | (1, 118) | NS | 7.54 | (1, 118) | .007 |
| E X ALR | .80 | (3, 118) | NS | 1.28 | (3, 118) | NS |
| E X BTR | .91 | (3, 118) | NS | .72 | (3, 118) | NS |
| ALR X BTR | .70 | (1, 118) | NS | .19 | (1, 118) | NS |
| E X ALR X BTR | 1.65 | (3, 118) | NS | .28 | (3, 118) | NS |

NS means Not Significant (alpha = .05)

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