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ABSTRACT

Using the conceptual frameworks of "levels of processing" and "transfer appropriate processing," the research literature on listening and notetaking was interpreted. Based on these frameworks, implications for encoding and external storage hypotheses are presented and critiqued. The report concludes that there is a potential benefit to students from the encoding function of notetaking when the lecture environment permits deep processing while taking notes and when students take the kind of notes that entail processing the information in the way they will be tested on it. The report also concludes that students can benefit from reviewing notes when the notes contain the information on which they will be tested and when students process the information in a way similar to that in which it will be used on the test. The report critiques Pauk's Cornell system for taking notes and finds that, in general, the advice given is consistent with current research. Finally, recommendations are offered for college instructors on how to give effective lectures and for students on how to take and use notes effectively. An extensive reference list is included. (SRT)

CENTER FOR THE STUDY OF READING

Technical Report No. 374

THE VALUE OF TAKING NOTES DURING LECTURES

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Abstract

The conceptual frameworks of "levels of processing" and "transfer appropriate processing" were used to interpret the research literature on listening and notetaking. Based on these frameworks, implications for the encoding and external storage hypotheses about the functions of notetaking are presented and critiqued. We conclude that there is a potential benefit to students from the encoding function when the lecture situation permits deeper processing while taking notes and when students take the kind of notes that entail processing the information in the way they will need to use it on the criterion test. Also, students can benefit from reviewing notes when the notes contain the information that will be tested and when students process the information in a way similar to how it will be used on the criterion test.

The Value of Taking Notes During Lectures

College students typically spend ten or more hours per week attending lectures. How can students make the most efficient use of that time? Is the time-honored suggestion to listen carefully and take good notes a sound one? If taking notes is helpful, how is it helpful? In 1910, educator Seward (1910) answered some of these questions in about the same way that many experts do today by proposing two functions of notetaking:

> Ask our friend, the average student, what is the use of taking notes, and he will answer without hesitation: Why, to preserve a record of what a lecturer has said, for the sake of future use, especially interviewing for examinations. (p. 1)
>
> Our notes should, indeed, be useful for purposes of review yet that usefulness is not their chief value. They should be full, yet contain only what the mind has accepted as significant. The practical value of our notes will take care of itself as a matter of secondary importance, if we devote ourselves wholly to their main purposes--to make us alert, clearheaded, and responsible as we listen to a lecture, and to serve as a ready test of the firmness of our grasp. (p. 9)

The two functions of notetaking identified by Seward approximately 75 years ago are still the hypothesized functions of notetaking. Today the hypotheses are commonly labelled "external storage" and "encoding." The "encoding" hypothesis suggests that the actual process of taking notes helps the notetaker learn and remember information; the "external storage" hypothesis postulates that the value of taking notes lies in preserving information for later use, such as review before an examination. Thus, the "encoding" and "external storage" hypotheses offer two opportunities for learning information from a lecture: once while listening and recording notes and again while reviewing or studying the notes prior to an examination.

Recent theory and research in cognitive psychology suggest <u>how</u> taking notes on a lecture might affect learning at both the listening/"encoding" and reviewing/studying stages. The purpose of this paper is to review the research on taking notes during lectures from a cognitive psychology perspective and to draw implications for college instruction.

<u>A Perspective from Cognitive Psychology</u>

We have found the conceptual frameworks of "levels of processing" (Anderson, 1970, 1972; Craik & Lockhart, 1972) and the related "transfer appropriate processing" (Morris, Bransford, & Franks, 1977) to be particularly useful in interpreting the research literature on listening and notetaking. (Bretzing & Kulhavy, 1979; and Kiewra, 1985a, have also used this framework to help conceptualize the effects of notetaking strategies.) We will first briefly describe these conceptual frameworks. Then we will discuss the implications of these ideas for the "encoding" and "external storage" hypotheses about the functions of notetaking.

According to the concept of levels of processing, information is processed in a hierarchy of stages, from an analysis of physical or sensory features to a "deeper" semantic analysis, involving the extraction of meaning. The level of analysis performed on incoming information determines what gets stored in memory. A deeper, semantic processing of information is assumed to be necessary for long-term memory.

The idea of "levels of processing" is not without its critics. For example, Eysenck (1978) claims that there are no suitable criteria available for indexing either the depth or spread of encoding. Lockhart and Craik (1978) agree that while there is some circularity in the definition of "depth" and that the hypothesis can hardly be classified as a theory, it possesses considerable heuristic value. In this paper, we build on the heuristic value of this model with no claims as to its theoretical purity.

The levels of processing framework suggest that what is learned from listening or reading is a function of three interacting factors, including:

1. The amount and type of cognitive effort given to processing the information. Different cognitive activities involve different levels of processing.

2. The nature of the input information. Many characteristics of the incoming information affect cognitive processing, including familiarity of content, concept load (number and density of ideas), and organization.

The conceptual framework of "transfer appropriate processing" (Morris, Bansford, & Franks, 1977) suggests another important factor influencing what is learned from listening or reading.

3. The learner's purposes or goals.

According to the concept of transfer-appropriate processing, the value of particular processing activities must be defined relative to particular goals and purposes of the learner. That is, particular types of processing are not inherently deep/meaningful or shallow/superficial: It depends on the learner's goals. For example, if the learner's purpose is to attend to so-called superficial aspects of text, such as number of multisyllabic words, deeper, more meaningful processing is not appropriate and may actually impede encoding of the target material. Transfer appropriate processing suggests that the learner's knowledge or expectation about what they will do with the input information will guide the way they choose to process the information (see also Anderson & Armbruster, 1984).

Implications for the "Encoding" Hypothesis

We suggest three main implications of the concepts of levels of processing and transfer appropriate processing for the "encoding" hypothesis. First, the student could theoretically take notes involving any level of processing. An example of notetaking while listening involving a very superficial level of processing is the verbatim script that a secretary makes using shorthand or the script made by a court recorder during courtroom proceedings. A somewhat deeper level of processing is involved in selectively noting information--for instance, identifying and recording main ideas that a speaker highlights. Finally, a deep, semantic level of processing would be involved in recording notes that represent some meaningful transformation of the input information--for example, notes involving paraphrases, inferences, and elaborations of points made in a lecture.

The second implication for the "encoding" hypothesis is that the level of processing will depend on characteristics of the lecture itself. Notetaking takes time and cognitive effort. Time and effort are required to process the information, with deeper processing requiring more than shallow processing. Time and effort are also required to record notes, regardless of what level of processing was involved in generating the content of the notes. Of course, there is a limit to the amount of time and effort that students can or will spend on taking notes.

Therefore, one characteristic of the lecture that affects processing is the rate of presentation. The faster the rate of the lecture, the greater the restrictions on taking notes especially when notetaking involves processing at deeper levels. Another characteristic of lectures related to presentation rate is concept load. If the incoming information is dense, students have both a heavier cognitive processing load and more notes to record, both of which take time.

The third implication for the "encoding" hypothesis is suggested by the concept of transfer appropriate processing: The students' purposes or goals will influence notetaking during a lecture. College students usually have some knowledge or expectation about what they should "bring away" from the lecture; for example, they may know what type of question is likely to appear on upcoming examinations. This knowledge or expectation establishes a purpose for taking notes and determines what students will note and what kind of cognitive processing they will engage in as they record notes.

These implications from the concepts of levels of processing and transfer appropriate processing provide a framework for interpreting the results of research related to the "encoding" hypothesis.

Research Related to the "Encoding" Hypothesis

Some of the research discussed in this section consists of experimental tests of the "encoding" function. The basic experimental procedure to determine whether or not the process of taking notes itself facilitates learning is the following: Subjects are randomly divided into at least two groups. Subjects in one group take notes while listening to a lecture, and the other subjects listen to the lecture without taking notes. After the lecture, and without the opportunity for reviewing notes, all students take the same criterion test. Presumably, if taking notes helps students process the information in the lecture, then the notetaking group should score higher on the criterion test. In addition to experimental studies, this section includes some research that does not test the "encoding" hypothesis but nonetheless has results relevant to our thesis.

Our tally shows that 10 experimental studies show support for the encoding hypothesis, while 14 fail to do so. Note that the entries in this table vary in two respects from those presented by Hartley and Davies (1978), Hartley (1983) and Kiewra (1985a). Table 1 does not include studies which investigated notetaking while reading as evidence of encoding, or those which gave students time to review (even a mental review) before taking the criterion test. Finally, we used the reported data, when available, and reanalyzed them. In a few cases, our decisions based on the reanalysis were contrary to those made by the authors or by earlier reviewers. For example, we decided that only experiment III from Crawford (1925a) supported the encoding hypothesis while experiments I and II failed to support the hypothesis. His other experiments do not fall within our guidelines for tests of the encoding hypothesis.

Insert Table 1 about here.

It is noteworthy that among the 9 studies that used live lectures, only 3 show support for the encoding hypothesis. Two of these three studies are quite dated and the more modern one failed to randomly assign individual students to treatment groups. Clearly, therefore, any effect of notetaking on encoding is rather difficult to demonstrate, especially in live classroom settings. Nonetheless, our plan is to explain and interpret the results of several studies using the depth of processing perspective.

<u>Qualitative differences</u>. Among the research related to the "encoding" hypothesis are two studies showing that students <u>do</u> engage in qualitatively different kinds of processing while taking notes than while listening only. In the first of three experiments reported by Peper and Mayer (1978), subjects listened only or listened and took notes on a 16-minute video taped lecture on the FORTRAN computer language and were then given a test consisting of "generation" items (which required subjects to write a computer program to solve a problem) and "interpretation" items (which were least similar to how the information was presented and thus required "far transfer"). Results indicated a

significant notetaking by problem type interaction: Notetakers did better on "interpretive" items and non-notetakers did better on "generative" items. The second experiment essentially replicated the results of the first experiment, except with different lecture content. In the third experiment, subjects again listened to the FORTRAN lecture. Results on a free recall test revealed an interaction of notetaking treatment and types of items recalled. The notetakers remembered more about how a computer operates and included more intrusions, while the listen-only group recalled more technical symbols. The notetakers also produced more coherently patterned recalls indicating that the learned information was structured differently. Thus, the three experiments of the Peper and Mayer study demonstrate that notetaking can involve concomitant qualitative differences in cognitive processing either during input or recall.

A study reported by Howe (1976) provides additional evidence that notetaking entails different cognitive processing than listening only. In this study, subjects were asked to take notes as they listened to an audio taped excerpt from a novel. They then relinquished their notes for analysis. Results on a free recall test given 1 week later showed that noted items had a 0.34 probability of being recalled, while items not noted were recalled with a probability of only 0.05. In other words, subjects were almost 7 times more likely to recall information that appeared in their notes than information not recorded. Howe also developed the notion of "efficient" notetaking--the ratio of the number of meaningful ideas to the number of words used to record those ideas. The correlation between the efficient note index and the number of meaningful units recalled on the test was positive and significant (0.53), thus indicating that what students chose to note was processed differently than other information.

A result similar to Howe's finding on "efficient notetaking" is reported by Maqsud (1980). In two experiments, college subjects classified as either "short" or "long" notetakers listened only or listened and took notes on a 2200 word audio taped lecture presented at 110 words/minute. Subjects who took brief notes recalled more information units than subjects who took detailed notes. Perhaps Maqsud's "short" notetakers are similar to Howe's "efficient" notetakers, with short, efficient notes reflecting deeper cognitive processing of the information. Short notetakers may parse and summarize a segment of lecture information, then search memory to see if they already have a word or word phase not represent that summary. If they do have such a label, it is recorded. On the other hand, long notetakers might be less likely to summarize and search memory. Instead, they record a more literal representation of the information segment.

Care must be exercised in interpreting Maqsud's (1980) results since the students were categorized into treatment groups based on their notetaking history in his course. This technique can confound important independent variables. For example, short notetakers may also be more motivated and intelligent than long notetakers. Without random assignment to treatment groups one cannot be sure which variables, if any, are confounded, consequently affecting the criterion measure.

Lecture effects. Other research related to the "encoding" hypothesis provides evidence that cognitive processing is affected by characteristics of the lecture itself, particularly presentation rate and information density.

We found some data on lecture presentation rate in "typical" college courses. Maddox and Hoole (1975) report the highest lecturing rate of 114 words per minute while Fisher and Harris (1973) report the lowest rate at 44 words per minute. Nye (1978) refers to an in-between index of 84 words per minute. Obviously, the rate of presentation varies widely, depending on how often and how long the lecturer pauses to entertain questions or discussion, write on the chalkboard, or engage in activities that interrupt the presentation of the lecture material.

Evidence for the influence of presentation rate on the ability to process information from a lecture is found in a study by Aiken, Thomas, and Shennum (1975). Subjects listened to audio taped four-part lectures that were presented either once at rates of 120 or 240 words/minute or twice at 240 words/minute, and either took notes or listened only. The speeded speech of 240 words/minute impeded recall, suggesting that a fast rate interferred with deeper cognitive processing. The Aiken, Thomas, and Shennum study also provides evidence about the effect of information density. In addition to speed, the lectures in the study varied with respect not density of information. Subjects listened to either a low density lecture (106 "information units"/2000 words) or a high density lecture (206 "information units"/2000 words). Subjects who listened to the low density lecture recalled more information units, or facts, than subjects who listened to the high density lecture, suggesting that the dense content overloaded the cognitive processing capabilities of the subjects.

The Aiken, Thomas and Shennum study provides further evidence about the effects of lecture characteristics on cognitive processing while taking notes. In the study, subjects who took notes either took them during the four lecture segments ("parallel" notetaking) or during breaks between lecture segments ("spaced" notetaking). Spaced notetakers recalled more information units than parallel notetakers. We suggest that characteristics of the lecture precluded deeper processing by parallel notetakers. Recall that the slowest presentation rate in this study was 120 words/minute, well above the "typical" presentation rates reported by other researchers. Also, the density of information was quite high for some parallel notetakers. The requirement to take notes while listening to dense, rapidly presented information could well have impeded deep cognitive processing of the information because the combination of listening and noting activities exceeded the students' cognitive capacity.

In studies by DiVesta and Gray (1972, 1973), one explanation for this positive results for the "encoding" hypothesis of notetaking may be that certain characteristics of the lecture were amenable to deeper processing by notetakers. In the DiVesta and Gray (1972, 1973) studies, subjects listened to 5-minute audio taped lectures presented at 100 words/minute. We argue this was probably little enough information at slow enough speeds to enable deeper processing while recording notes.

In contrast to studies supporting the "encoding" hypothesis, nonsupportive studies contained lecture conditions that were not conducive to deeper cognitive processing by notetakers. For example, in a study by Ash and Carlton (1953), college subjects viewed two 20-minute informational films. Some subjects took notes while viewing the films; others did not. Multiple-choice and objective item tests were administered immediately after the films. For one film, there were no statistically significant differences between test scores of subjects who took notes and those who did not, while for the other film, the notetakers scored significantly lower than the non-notetakers. We do not find these results surprising. Since films are characterized by a stream of concomitant verbal, graphical and pictorial information, they often have a very heavy information load. Therefore, it is quite likely that the requirements to take notes while attending to a variety of information sources interfered with the subjects' cognitive processing of the information in the film.

In a study by Peters (1972), college subjects either listened only or listened and took notes on an audio taped lecture presented at two rates, 146 and 202 words/minute. On a 25-item multiple-choice test (with a suspiciously low internal consistency reliability), subjects who did not take notes scored significantly higher than subjects who took notes. Once again, we are not surprised at the results. The presentation rates of 146 and 202 words/minute are among the highest of any study we reviewed. Also, the lecture, which was on the topic of steel as an alloy, probably contained a high density of unfamiliar, difficult information. Given these factors, the additional requirement to take notes is likely to have interfered with the cognitive processing of the notetakers.

Students' purposes. In addition to characteristics of the lecture itself, students' purposes or goals can influence how they take notes during a lecture. In the absence of specific information to the contrary, most college students probably assume that they will be tested on "main ideas" or important points and, therefore, try to record main ideas in their notes. Research provides some evidence that this is so. Several researchers have analyzed student notes and compared the overlap with the lecture script and/or a set of "ideal" notes. (Ideal notes were compiled by the lecturer and/or teaching assistant and were based on the lecturer's notes or script.) Such analyses show that, on the average, students note a little more than one-half of the ideas from the lecture: 60% of ideal notes (Locke, 1977), 53% of relevant material (Crawford, 1925b), 52% of ideal notes (Maddox & Hoole, 1975) and 50% of ideal notes (Hartley & Cameron, 1967). Since it is difficult to determine from these studies how many of the "ideal" notes might be considered main points, we are not sure how many main points students are recording. Nye (1978) analyzed students' notes differently and showed that 70% of the main points and 38% of minor points were recorded by the students. Fifty percent of all lecture points were recorded--a value very consistent with those reported above. Thus, it appears that students typically record between 50% and 70% of the main ideas from a lecture.

Research also shows that certain conditions of the lecture situation can influence what students note. Maddox and Hoole (1975) report that from 70 to 96% of students were likely to note ideas when they were: (a) written on a chalkboard by the lecturer (a finding also reported by Locke, 1977), (b) dictated in the form of headings or subheadings, (c) read aloud as numbered points, (d) given strong signaling, and (e) repeated or restated. Maddox and Hoole (1975) also report that students are not very likely to note ideas when the lecturer: (a) was standing away from the lecture notes, (b) used ideas in a joke, and (c) used visual aids (an observation also made by Hartley & Cameron, 1967). Students were also unlikely to take notes when another student asked a question of the lecturer. Apparently, the students in the research studies cited above had learned that certain lecture conditions served as cues for what was likely or unlikely to appear on examinations; this expectation shaped their notetaking behavior.

One condition of the lecture situation that influences students' goals, and therefore their notetaking behavior, is specific directions about what to note or how to note it. One relevant study is reported by Barnett, DiVesta, and Rogozinski (1981). In this study, college students were told that they were in an experiment and would be tested later. Then they listened to an 1800 word lecture on "The History of Roads in America" presented at 120 words/minute in one of three conditions: (a) listen only, (b) listen and take notes, and (c) listen and were provided with notes. Subjects who took notes were told to listen carefully, identify key ideas, and place them in outline form. Subjects provided with notes were given notes containing most of the important ideas from the lecture in outline form; they were told not to take additional notes. Immediately after the lecture, some subjects engaged in a 20-minute "filler task" which required them to mentally manipulate objects in space. (Other students engaged in more relevant types of review activities, which are discussed later in this chapter, but here we are concerned only with the filler tasks, no-review group.) Results on a 20-item cued response test showed that the listening-only group obtained a mean score of 3.2 items correct compared to the take-notes group mean of 8.2, a statistically significant difference. The 256% margin of superiority for notetakers over non-notetakers is clear evidence that notetaking can facilitate cognitive processing. We think that notetaking was particularly effective in this study because the subjects were encouraged to take notes in a way that entailed a relatively deep cognitive processing of the information. This is, subjects could hardly take notes on main ideas organized into an outline without processing the information at a fairly deep level.

Finally, in a study by Kiewra and Fletcher (1984) undergraduate students were instructed to take factual, conceptual or relational notes while listening to a taped lecture. Factual notes were described as factual information or details. Conceptual notes were those that summarize only main ideas while relational notes relate the main ideas to new situations. An analysis of their notes indicates that most students took conceptual (main idea) notes irrespective of the instructions given. The group that was instructed to take only factual notes took more total notes (factual plus conceptual and relational) than the other three groups. Kiewra and Fletcher concluded that notetaking behavior was only moderately manipulated. To only moderately manipulate notetaking behavior seems like a reasonable outcome since these students had no notetaking training to change their "natural" inclinations of recording mostly main ideas (Nye, 1978).

From our review of the research testing the "encoding" hypothesis, we conclude that students can remember more about main points if they take notes on them than if they listen without taking notes. We suspect this is true only under certain conditions: (a) when the lecture situation (such as speed of presentation and density of ideas) is such that taking notes does not interfere with cognitive processing, and (b) when they are able to take the kind of notes that entail deep processing of the input information, or at least processing appropriate to the criterion test. We next consider the second hypothesized value of notetaking--that notes provide an "external storage" device.

Implications for the "External Storage" Hypothesis

The concepts of levels of processing and transfer appropriate processing also have implications for the hypothesized "external storage" function of notetaking. First, as with the "encoding" state, any level of processing could be taking place as students review notes prior to an examination. Students could do anything from skimming their notes, accompanied by shallow processing, to meaningfully transforming their notes by outlining or elaborating them, accompanied by deep processing.

A second implication for the "external storage" hypothesis is that the level of processing while studying notes is heavily influenced by characteristics of the notes. As the concept of transfer appropriate processing suggests, among the important characteristics of the notes is their ability to cue recall or reconstruction of information needed for the criterion test. In most cases, the ability to cue recall or reconstruction is probably a function of the degree of correspondence between the notes and the original lecture. The influence of the notes also varies as a function of the time between taking and studying them: The greater the time between taking and studying notes, the greater the influence of the notes themselves on learning outcomes. This relationship holds because information processed while taking notes is more likely to have been forgotten than information processed closer to the time of testing.

A third implication for the "external storage" hypothesis is that the students' purposes or goals will influence how they choose to process their notes during review. Presumably, motivated college students will try to process deeply the information they know or expect to be on the upcoming examination. Their ability to do so will be constrained by the contents of their notes, as discussed above, and the time available for study.

These implications from the concepts of levels of processing and transfer appropriate processing provide a framework for interpreting the results of research related to the "external storage" hypothesis.

Research Related to the "External Storage" Hypothesis

This section will discuss both correlational and experimental studies. The correlational studies were not specifically designed to test the "external storage" hypothesis, but rather investigated the general relationship between notetaking and some criterion measure without regard to whether learning occurred during listening or during review. In these "naturalistic" studies (Collingwood & Hughes, 1978; Crawford, 1925b; Locke, 1977), students took notes during a lecture and were tested later. The researchers did not determine whether students actually reviewed their notes; however, since the criterion tests were regular course examinations, it is likely that students did review their notes. Also, the delay between taking notes and the criterion test in these studies makes the "external storage" function more plausible as an explanation of the results. The longer the delay between listening and testing, the less the effect of initial processing during the "encoding" stage because of the forgetting that would have occurred in the interim.

Researchers interested in experimentally testing the "external storage" hypothesis have usually tested it in conjunction with the "encoding" hypothesis. Therefore, a typical design includes groups that (a) listen only and review provided notes, (b) take notes and review own notes or provided notes, and (c) take notes but do not review notes prior to the criterion test. Ideally, there should be a delay between the time of listening and the review (to decrease the effect of initial processing during the "encoding" stage), and the criterion test should immediately follow the review. Presumably, if the only or primary function or notetaking is "external storage," the group that listens and reviews provided notes will outperform the other two groups on the criterion test.

Of the 14 studies we discuss in this section, all of them provide some support for the external storage hypothesis. Obviously, researchers have found it easier to demonstrate the external storage hypothesis than the encoding hypothesis.

Congruence between notes and tests. Several correlational studies we reviewed investigated the influence of characteristics of notes and learning outcomes. In general, these studies suggest that the greater the congruence between the information in the notes available for review and the information required on the criterion test, the greater the learning outcomes.

Crawford (1925b) lectured to 211 students in seven classes, who took notes in their usual manner. Between 2 and 35 days after the lectures, the students took announced quizzes over the lecture material. Most of the quizzes were essentially free recall tests of the lectures. After the quizzes, the students' notes were collected and analyzed. The points covered in the lectures were compared with those recorded in the notes and the quizzes. Crawford found a significant positive correlation between the number of points recorded in the notes and the number recalled on the quiz. Furthermore, points noted "right" correlated 0.50 with "right" quiz points. "Vague" noted points tended to have a near zero or negative correlation with "right" quiz points. Points "omitted" from the notes had a probability of only 0.14 of being answered correctly on the quiz.

In a naturalistic study completed more recently, Locke (1977) analyzed the notes taken during lectures and course grades earned by 161 students in 12 different courses. He found a significant, positive correlation between completeness of lecture notes and courses grades (although this relationship held only for the material not written on the chalkboard by the lecturer).

Kiewra (1985a) cites a naturalistic study in which the number of lecture notes taken over a four-week period correlated 0.61 with performance on the course exam covering both lecture and reading material, and 0.78 with performance on items derived from the lecture only.

Other studies have compared the effectiveness of students reviewing their own notes with reviewing supplied notes. In a naturalistic study by Collingwood and Hughes (1978), college students listened to three consecutive live lectures in their regular course in each of three notetaking conditions: (a) took own notes, (b) received full notes (a complete typed copy of the lecturer's notes, including diagrams), and (c) received partial notes (an edited copy of the lecturer's notes, including headings, key points, unlabeled diagram outlines, tables, and references). Four weeks after the last lecture, students completed a midterm exam including multiple-choice items over the lecture content. Results included a significant main effect for the notetaking condition. Subjects performed best when they had full notes and worst when they took their own notes. The results suggest that the more complete the notes, the higher the performance.

A naturalistic study by Powers and Powers (1978) also presents some evidence in favor of the effectiveness of instructor-prepared notes. In this study, college students were assigned to the following conditions. During the first half of the term, one experimental group received instructor-prepared notes while the second experimental group served as a control. During the second half of the term, the roles were reversed. The instructor-prepared notes elaborated content presented in the text. Multiple-choice tests administered throughout the term "sampled these 'elaborated' principles from the text" (p. 39). During the first half of the term, there was no significant difference between subjects who received notes and those who did not. During the second half of the term, however, subjects who received notes outperformed subjects who did not receive notes.

(Unfortunately, the authors did not provide enough information to permit speculation about why the provided notes were only effective for the second half of the term. The difference could have been due to differences in course content, tests, instructor-prepared notes, or student attention).

In an experimental study by Annis and Davis (1978), college students were assigned to one of several notetaking and review conditions. Two weeks after listening to a 40-minute lecture on behavior modification, subjects were given a ten-minute lecture review session followed by an examination consisting of objective and short-answer questions. A single factor analysis of variance revealed significant overall differences. Although post hoc multiple comparisons were not performed, the lowest means were obtained by groups in which subjects reviewed "mentally" or not at all, and the highest means by groups in which subjects reviewed notes. These results support the value of notes as an external storage device. Furthermore, the fact that the very highest mean was obtained by subjects who reviewed their own <u>and</u> the lecturer's notes suggests that the more complete the notes, the greater the potential learning during review session.

In the second of two experiments by Maqsud (1980), college students were assigned to one of four review conditions one week after listening to a taped lecture: (a) review personal lecture notes, (b) review a teacher-prepared handout described as "detailed but simplified and organized" (p. 292), (c) review both personal notes and teacher-prepared handout, or (d) mental review (no notes). Three hours after review, subjects were asked to recall as much as they could of the lecture. Reviewing personal notes plus the teacher-prepared handout resulted in the most recall, followed by teacher's handout, then personal notes, and finally mental review. The results support the value of reviewing notes over mental review and again suggest that the more information subjects have available at the time of review, the more they are likely to recall.

In three similar studies reported by Kiewra and his colleagues (Kiewra, 1985b; Kiewra, 1985c; Kiewra & Benton, 1985), college students listened to a 20-minute video taped lecture with or without taking notes. (In the Kiewra, 1985b study, a third condition included subjects who did not attend the lecture.) Two days after the lecture, notetakers reviewed their own notes while listeners (and nonattenders) reviewed notes provided by the instructor. The provided notes consisted of all of the "critical points" of the lecture, including main ideas, supporting details, and examples. In all three studies, subjects who reviewed the instructor's notes scored significantly higher than subjects who reviewed their own notes on factual multiple-choice items. Kiewra attributes the effect to the nature of the review materials, reporting that the instructor's notes were far more complete, detailed, and organized than were the students' notes.

A study by Fisher and Harris (1973), while generally supporting the importance of the "external storage" function of notes, presents some ambiguous results with respect to the idea that the more notes, the better. In this study, college students listened to a live lecture presented at a rate of about 44 words/minute in 1 of 5 notetaking and review conditions. Immediately following the lecture, subjects reviewed their notes or engaged in mental review for 10 minutes before completing a free recall test and an objective test. (Note that this situation does not represent an ideal test of the external storage hypothesis.) Three weeks later, subjects took another objective test without review. While subjects who were allowed to review notes generally scored higher on all measures than subjects who mentally reviewed, those who reviewed their own notes outperformed those who reviewed the lecturer's notes. Unfortunately, the authors do not describe the lecturer's notes; they may have consisted of anything from a full transcript to a very sketchy outline. Also, since the lecture was presented at a very slow rate, students could have made quite complete notes on their own. It is possible that the students' own notes were more complete than the lecturer's notes, thus providing support for the importance of congruence between the content of notes and the requirements of the criterion test. Finally, even if the lecturer's notes were more complete than their own notes, students may not have had time to review them adequately during the short review period.

Annis (1981) also reports results that seem to contradict the idea that the more notes, the better. In this study, college students listened to a live lecture within the regular classroom context in one of three groups: (a) received a full lecture transcript and were told not to take notes, (b) received partial notes consisting of headings and key points with space left for taking notes, and (c) were given blank paper for taking their own notes. The criterion test consisted of multiple-choice and short answer items on the regular midterm 2 weeks after the lecture. Students who took their own notes or received partial notes scored significantly higher than those who received full notes. We offer an explanation for this apparent contradictory finding on the basis that the most impressive significant difference on the criterion test was performance on the short-answer items. Clearly, those students who wrote their own notes, or filled in the partial notes were processing in a more "transfer appropriate" way. The effect of this generally masked the effects of "the more notes, the better" principle. The Annis (1981) study thus provides a transition to the text topic: the extent to which the review of notes is appropriate for the demands of the criterion test.

<u>Transfer appropriateness of notes</u>. The congruence between notes and test is only part of the answer to the value of review.

In addition to having the "right" information available, students must also process it in a "transfer appropriate" way, that is, the way they will need to use the information on the criterion test. A study by Carter & Van Matre (1975) suggests that opportunity for review is particularly helpful if subjects know what and how to review. Carter and Van Matre had college students listen to a 17-minute taped lecture in 1 of 4 studying conditions: (a) took notes and reviewed notes, (b) took notes and reviewed mentally, (c) listened only and reviewed mentally, and (d) listened only and engaged in a filler task. Free recall tests and alternate forms of a completion test consisting of verbatim and paraphrase items were administered immediately and after 1 week. Half of the subjects reviewed prior to the delayed test and half did not.

The fact that the notes/notes review group scored significantly higher than the notes/mental review groups on all tests provides support for the "external storage" function of notes. In addition, the notes/notes review group scored higher on verbatim than paraphrase items on the delayed test, while the other conditions did not perform differently for the two types of items. Carter and Van Matre offer the explanation that over time, differences between verbatim and paraphrase performance tend to diminish, probably as a result of forgetting the superficially processed (verbatim) information. However, the group that was allowed to review their notes prior to the delayed test had a second opportunity to process the information. We know that subjects had the opportunity to review verbatim information, since the authors report that subjects' notes consisted largely of verbatim excerpts from the lecture. We suggest, too, that subjects probably expected a test similar to the one they had already had, and thus had a reason to process the information in a way appropriate for answering verbatim questions. These explanations are also supported by the fact that there were no significant differences between verbatim and paraphrase performance for subjects who were <u>not</u> permitted to review notes prior to the delayed test.

Hartley and Marshall (1974) provide additional evidence that review is particularly helpful if subjects have the "right" information as well as some knowledge of how they will need to use it on the criterion test. In this naturalistic study, college students heard a lecture in the regular classroom context. Subjects took an immediate recall test, then were given 10 minutes to "revise" their notes, and finally took the same test again. The subjects were divided into "good" and "poor" notetakers on the basis of their relinquished notes. Although there was no difference between good and poor notetakers on the immediate test, the good notetakers improved more than the poor notetakers on the second test. One possible explanation is that although all students had the same knowledge of the criterion test at the time review, good notetakers were better able to use this knowledge during review because they had better information available in their notes.

Barnett, DiVesta, and Rogozinski (1981) report an experiment designed to test the effect of different types of processing during review. In the earlier experiment already discussed in this chapter, the authors had observed that "elaborating" notes during review (i.e., relating notes to prior knowledge) failed to facilitate test performance and in some cases even interfered with performance. They designed an experiment to test the hypothesis that subjects who elaborate their notes learn qualitatively different kinds of information than subjects who just review their notes. In this experiment, subjects either took notes or were provided with notes. During the review session, they either reviewed by writing key ideas and details from the lecture or elaborated their notes. Eight days later, subjects completed and individualized test containing four types of completion items: items from the lecture itself that were common to all subjects, items from the reviews or elaborations created by the individual, items randomly selected from a pool of items created for subjects who reviewed, and items randomly selected from a pool of items created for subjects who elaborated. The following results were found: (a) On the common items, subjects who reviewed scored higher than those who elaborated, (b) On the average, subjects scored about twice as high on items taken from their own protocols than on items taken from the protocols of other subjects.

Barnett, DiVesta, and Rogozinski refer to transfer appropriate processing in discussing their findings. Elaboration during review interfered with performance on items requiring accurate recall because subjects were not processing the information in a manner consistent with the way they needed to use the information on the test. Subjects did best when they were given test items congruent with the way they had processed the information during review.

In the Kiewra and Benton (1985) study discussed previously, the authors also investigated the effect of different types of processing during review. In this study, college students either took notes on or listened only to a 20-minute video taped lecture. Notes were collected after the lecture. Two days later, notetakers received their own notes while listeners received the instructor's notes. Both groups also received practice questions designed to tap higher-order knowledge (application, analysis, synthesis, and problem-solving). Half of the subjects were given an answer key (feedback) for the questions. Subjects were given 25 minutes to study the notes and answer the questions prior to taking a multiple-choice test consisting of factual and higher-order items. Results included the fact that when feedback accompanied the practice questions, performance on the factual items was facilitated. The authors speculate that the learning resulting from completing the practice questions and receiving feedback provided an effective framework for organizing and for recalling associated factual information. In other words, the activity that this experimental group engaged in during review was appropriate the demands of the criterion task.

From our review of the research testing the "external storage" hypothesis, we conclude that an important function of notes is their availability for use for later review or study. The bulk of the evidence shows that reviewing notes prior to a criterion test is likely to facilitate performance. Notes are helpful to the extent that they contain the information that will be tested. In most cases, this probably translates as: the more information, the better. But what students do with their notes is also important. Students who engage in transfer appropriate processing (i.e., who cognitively process the information in their notes i the same way they will need to use it on the criterion test) will fare the best.

A Notetaking System

We next take a critical look at advice about taking notes from lectures given by Pauk (1984) in his popular book, How to Study in College. Pauk claims to have integrated 30 years of experience at the Cornell University Reading Research Center into the "Cornell System for Taking Notes." The critical features of this system are presented and discussed below.

Before the lecture:

1. Take a few minutes to look over your notes on the previous lecture, to provide continuity with the lecture you are about to hear.

During the lecture:

2. Record your notes completely and clearly enough so they will still have meaning for you long after you have take them.
3. Strive to capture general ideas rather than illustrative details.

After the lecture:

4. Consolidate your notes during your first free time after class by reading through them to clarify handwriting and meaning. Also underline or box in the words containing the main ideas.
5. Restructure the notes by reading them and then jotting down key words and key phrases that represent your reflections of them.
6. Use the jottings as cues to help you recall and recite aloud the facts and ideas of the lecture as fully as you can in your own words.

Pauk (1984) appears to be advocating the use of notetaking primarily as an external storage device. "Remember that your purpose is to record the lecturer's ideas for later study" (p. 122). We suspect, however, that he does not deny the potential benefits of encoding: "Notetaking does not interfere with listening and comprehension; in fact, it helps you listen" (p. 122). We disagree with Pauk in one aspect of this advice in that research shows that there are some conditions in which notetaking can interfere with comprehension. Under those conditions where one seemingly has to either sacrifice comprehension or notetaking, Pauk appears to recommend sacrificing comprehension. "Don't stop to ponder the ideas presented. By the time you have finished reflecting on idea number one, the lecturer will probably be on ideas number four or five" (p. 123). We suspect that in many lecture courses, however, it would be wise for the student to forego notetaking when confused and ask a clarification question of the lecturer rather than faithfully perservering with the notetaking process. A successful clarification might help smooth out the encoding and notetaking processes for the remainder of the lecture.

We are not certain about the detail of notes that Pauk advocates. For example, in one place he suggests that students "strive to capture general ideas rather than illustrative details" (p. 128), while in another place his advice is to "make notes on main ideas and on sub-ideas, examples, and details" (p. 122). Perhaps the generic advice from Pauk is "make your notes complete and clear enough so that they will have meaning for you weeks and months later" (p. 125). In general we think Pauk's advice is consistent with our analysis of the research findings.

Conclusions

We raised a question at the beginning of this paper--Is the time-honored suggestion to listen carefully and take good notes a sound one? From our review of the research, we conclude that the answer is "yes," providing the information in the notes is consistent with that being tested on the criterion test and there is enough time for a review of that information.

Another question we raised was "If taking notes is helpful, how is it helpful?" In general, the research supports the two functions of notetaking proposed by Seward three-quarters of a century ago--the so-called "encoding" and "external storage" functions. That is, the actual process of taking notes can help the notetaker learn and remember information, and the notes can preserve information for later use.

Drawing from cognitive psychology, particularly the concepts of "levels of processing" and "transfer-appropriate processing," we were able to gain some insight into conditions of effective notetaking. From our review of the research, we concluded that there is a potential benefit to students from the "encoding" function when the lecture situation permits deeper processing while taking notes and when students take the kind of notes that entail processing the information in the way they will need to use it on the criterion test. (We emphasize the potential benefit since most of the live lecture research is not very convincing.) Also, students can benefit from reviewing notes when the notes contain the information that will be tested and when students process the information in a way similar to how it will be used on the criterion test.

Based on these conclusions, we offer the following recommendations for college instructors and students:

Instructors:

1. Lecture in a way that encourages processing the right information by presenting the material at a reasonable rate and by signaling important content (for example, by writing it on the chalkboard).
2. Design valid, reliable tests that assess students' understanding of important, relevant information. Then give students enough information about the tests so that they will know how to take good notes and how to study them.
3. Encourage students to take notes in a way that entails deep processing and allow time for them to take notes in this way. When lecturing over new and difficult topics, pause and direct students to write and think about what you are saying. Remember, cognition is a time dependent process.
4. Since students' notes typically include only about one-half of the lecturer's ideas, distribute lecture notes if it is important for students to know a comprehensive set of ideas.

5. Early in a course, collect students notes after a lecture and review them. Use this exercise to determine (a) how well your lectures are being understood and (b) which students need assistance in notetaking skills. Give these students advice, refer them to a general source on how to develop notetaking skills (for example, Pauk, 1984), or refer them to a study skills center directed by the university or various private companies.

Students:

1. Take rather complete notes as long as it does not interfere with listening and comprehending the information in the lecture.
2. If lectures go too fast and you are unable to record what you consider to be the most important ideas, note the names of the key concepts that "pass by" and later supplement your notes with information from the textbook, or from notes that might be provided by the lecturer or other students.
3. Try to take notes in a way that entails deep processing, or revise after lecture in such a way.
4. Find out as much as possible about the tests, and use this as a guide for taking and studying notes.
5. Study notes prior to test in a "transfer appropriate" manner. If you anticipate multiple-choice or short answer questions, practice asking and answering

questions with a friend. If you anticipate an essay test, organize your notes around the major topics and commit that organization to memory. Try talking through the ideas from the organization with a friend.

Questions

Finally, we conclude with some lingering questions that beg for additional research on the notetaking topic:

1. Under what conditions and how effective is the Cornell or any other well publicized notetaking system? How should it be modified to accommodate various content areas, study guides, examinations and textbooks?
2. How and when should students be taught to take good notes? Is early elementary school too early? Is college too late?
3. Since taking notes is most effective when they are used as an external storage of ideas, what are the effects of "note providing" services that are now prevalent on college campuses? Are there any advantages of using conferencing, or group notes, that can be generated on a network of computers?
4. How does a good, relevant textbook differ from a set of good, relevant notes? Is the students' notetaking objective simply to create a personalized adjunct textbook?

5. What are the effective ways to study or review a set of comprehensive notes? Is reciting notes a reasonable way to study for a test? Is generating questions from notes an effective strategy for test review?
6. Are findings in the recent novice-expert literature, e.g., writing (Scardamalia & Bereiter, 1985), relevant to research on notetaking and studying? Do we gain any explanatory advantages by thinking about notetaking as just one strategy in a larger problem-solving space where the problem is to "learn the material and do well on the test?" rather than as a necessary procedure for improving comprehension?

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Table 1

Studies Testing the Encoding Hypothesis

Support for Encoding	No Support for Encoding
Taped Lectures	
Barnett, DiVesta and Rogozinski (1981) (audio)	Aiken, Thomas and Shennum (1975) (audio)
Berliner (1969) (video)	Ash and Carlton (1953) (film)
DiVesta and Gray (1972) (audio)	Carter and Van Matre (1975) (audio)
DiVesta and Gray (1973) (2 studies) (audio)	Howe (1970) (audio)
Maqsud (1980) (audio)	McClendon (1958) (audio)
Peper and Mayer (1978) (1 study) (video)	Peper and Mayer (1978) (2 studies) (video)
	Riley and Dyer (1979) (audio)
Live Lectures	
Crawford (1925a) (Exp. III)	Annis and Davis (1975)
Jones (1923)	Crawford (1925a) (Exps. I and II)
Weiland and Kingsbury (1979)	Gilbert (1975)
	Jones (1923) (2 studies)