

Note-Taking, Individual Differences, and Memory for Lecture Information

Gilles O. Einstein, Joy Morris, and Susan Smith
Furman University

Two experiments were performed to examine (a) the encoding function of note-taking and (b) processing differences between successful and less successful students in lecture situations. In the first experiment, subjects either took notes or listened during a lecture. Different memory patterns were found for these two groups, with note-takers recalling many more high-importance propositions than low-importance propositions and non-note-takers recalling an equal number of high- and low-importance propositions. These results suggested that note-taking enhances organizational processing of lecture information. In the second experiment, the notes and recall of successful and less successful students were compared. Successful students recalled more of the most important propositions, but these two groups of students did not differ in their recall of less important propositions. For both groups of students, recall content was closely related to the content of the notes, with successful students recording more high-importance propositions in their notes. Also, successful and less successful students were quite similar in their note-taking styles and the degree to which they benefited from reviewing their notes. Thus, the memory difference between these two groups of students was interpreted to be the result of factors occurring during note-taking, with successful students engaging in greater integrative processing.

Because the lecture method is often used in teaching, any procedures that clarify the effectiveness of note-taking are likely to have important implications for classroom learners. DiVesta and Gray (1972) distinguished between two possible functions of note-taking—storage and encoding. According to the storage function hypothesis, note-taking facilitates retention by providing students with a form of external storage that can then be used for review. Testing of the external function of note-taking requires comparisons of students who are allowed to review their notes with students who are not allowed to review their notes. Whereas some researchers (e.g., Carter & Van Matre, 1975) have claimed that external storage is the major benefit of note-taking, others have argued that note-taking

also affects how information is encoded (e.g., Peper & Mayer, 1978). The major point of the encoding function hypothesis is that note-taking leads to activities during learning that are beneficial to memory and/or transfer. Compared with merely listening to a lecture, note-taking may encourage increased attention, more elaborate processing of individual ideas, and/or greater organization of the lecture material. If note-taking serves a useful encoding function, then note-takers and non-note-takers should differ in learning outcomes, even when they are not allowed to review their notes. Despite much research on the encoding function of note-taking in recent years, the literature has not yielded consistent results. Some investigators have found that note-taking interferes with learning (Aiken, Thomas, & Shennum, 1975) in some situations, others have found that note-taking has no effect on performance (Carter & Van Matre, 1975; Fisher & Harris, 1974), and still others have found that note-taking improves memory for lecture material (DiVesta & Gray, 1972; Peper & Mayer, 1978). According to Cook and Mayer's (1983) review of the literature, it appears that note-taking hinders effective

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Requests for reprints should be sent to Gilles O. Einstein, Department of Psychology, Furman University, Greenville, South Carolina 29613.

encoding when the presentation rate is fast and the informational density high. In these cases, the act of note-taking competes with the attentional resources necessary to process the lecture. With more moderate presentation rates or self-paced presentation methods, note-taking has often been found to have a positive effect on learning.

Although note-taking appears to enhance the encoding of new material in many situations, no general agreement exists on the specific performance measures that are affected by note-taking or on the theoretical mechanisms underlying the beneficial effects of note-taking.

According to Peper and Mayer (1978), the specific theories that have been developed to account for the effects of note-taking can broadly be classified as either quantitative or qualitative theories. The major point of the quantitative views is that note-taking mainly affects *how much* information is encoded. For example, note-taking may be effective because it increases subjects' overall level of attention or effort. Within this view, note-taking should lead to increased levels of recall for all types of information, and subjects who take more notes should recall more. It is difficult to evaluate this position directly because researchers in the area have typically used a total recall score as their sole dependent measure. Despite this problem, the results of studies showing that note-taking produces higher overall levels of recall (DiVesta & Gray, 1972) and that recall is positively related to the number of ideas included in the notes (Fisher & Harris, 1974; Howe, 1970) are consistent with the quantitative view.

On the other hand, qualitative theories propose that note-taking increases recall by affecting the nature of processing. According to this view, note-taking forces students to engage in processing that is different from normal listening—such as relating the ideas to one another and/or integrating the information with one's existing knowledge. Thus, note-takers should differ from non-note-takers primarily in *what* is encoded and remembered.

Peper & Mayer (1978) provided support for this position. They had subjects either take notes or listen to a short videotaped

lecture on computer programming and found that note-taking led to an increase in recall of ideas concerning the format of FORTRAN statements and ideas related to the structure of computers. Note-takers and non-note-takers did not differ in their recall of technical details. Note-takers also performed better than did non-note-takers on far transfer problems, which required general conceptual information to solve. According to Peper and Mayer (1978), note-taking primarily encourages deeper comprehension and organization of incoming information, not the more complete encoding of all types of propositions in the lecture.

One purpose of the present studies was to test directly the quantitative and qualitative views described above by examining the effects of note-taking on the recall of propositions varying in their importance to the lecture. According to the quantitative hypothesis, note-taking should enhance memory for all types of propositions, regardless of their importance to the theme of the lecture. By contrast, if note-taking encourages subjects to increase their organization or structuring of a lecture (qualitative view), then it should primarily increase recall for the most important propositions in the lecture (Cook & Mayer, 1983; Peper & Mayer, 1978). This latter prediction is based on research showing that a strong levels effect (better recall of high-importance compared with low-importance propositions) is observed under conditions that maximize subjects' opportunities to organize learning material (e.g., Einstein, McDaniel, Bowers, & Stevens, 1984).

We were particularly interested in assessing memory of the lecture because recently it has been suggested that note-taking "may have facilitative effects only on transfer items, not on retention" (Barnett, DiVesta, & Rogozinski, 1981, p. 192). Few experiments, however, have used anything other than overall recall, cued recall, or recognition scores to evaluate the effectiveness of note-taking. As Cook and Mayer (1983) pointed out, more research is needed on dependent measures that are sensitive to note-taking strategies. Also, research with other mathemagenic activities, such as generating questions, has shown that these ac-

tivities may have selective effects on retention (Frase, 1975).

Another goal of the present experiments was to examine the content of subjects' notes and the relation between this content and recall. Although several studies have shown that subjects tend to recall what they put in their notes (Aiken et al., 1975; Bretzing & Kulhavy, 1981), little research exists on the type of information that is recorded in the notes.

Experiment 1

The first experiment was performed to investigate whether note-taking influences the type of information recalled from a lecture. Subjects either took notes or listened during the presentation of a videotaped lecture and later were asked to recall the lecture. Because subjects were not given the opportunity to review their notes, this study examined only the encoding function of note-taking. A major feature of the present study was that the propositions in the lecture were rated for their importance to the lecture. Thus, the predictions of the quantitative and qualitative theories could be directly compared.

Method

Subjects and Design

Twenty-four subjects were randomly assigned to each of two groups that differed in terms of whether they were asked to take notes or listen during the presentation of the lecture. Subjects participated in the experiment to fulfill a requirement of their introductory psychology course.

Materials

All students were presented with the same 10-min videotaped lecture on the history of individual differences. The lecture contained many statements about the lives of particular people (Darwin, Galton, Cattell, Binet), their involvement in important events, the causes and consequences of these events, and the effects of these developments on the history of individual differences. The lecture was excerpted from one that is used in an upper-level course, and our assumption was that it was unfamiliar to all of the subjects. To simulate a typical classroom lecture, the information was presented in the lecturer's normal teaching style.

Procedure

All subjects participated in a single session lasting approximately 45 min and were tested in small groups ranging from three to four. All subjects were told they were participating in an experiment concerning the effectiveness of various strategies on lecture comprehension and that they would be asked to rate the lecture for difficulty of comprehension. They were then read instructions appropriate to their experimental treatment. Subjects were not told about the memory test. Subjects in the note-taking condition were given several sheets of paper and were instructed to take notes in their normal style during the lecture. Subjects in the listening-only condition were instructed not to take notes but to listen carefully to the lecture. Both groups were told to pay close attention to the lecture and to try to comprehend it.

Following the lecture, all subjects were instructed to rate their comprehension of the lecture on a 7-point scale ranging from *very easy to comprehend* (1) to *very difficult to comprehend* (7). Subjects were then given 10 min to write down everything that they could remember from the lecture.

Results and Discussion

Unless otherwise indicated, the rejection level for all analyses was set at .05. The analysis of comprehension ratings revealed that both groups thought the lecture was fairly easy to comprehend, and there was no reliable difference between the ratings of the note-taking, ($M = 2.29$) and listening-only ($M = 2.46$) conditions, $F < 1$.

Recall

To examine recall, the lecture was analyzed into 126 propositions using a method approximating Kintsch's (1974) analysis of text meaning. Thirty-two recall protocols were randomly selected and initially scored by two reviewers for the number of propositions recalled. The scores produced by these two individuals were highly correlated ($r = .88$), so the rest of the protocols were scored by one of the reviewers. An initial analysis was performed on total recall. Although the note-taking group ($M = 18.71$) recalled more propositions than did the listening-only group ($M = 15.67$), this difference was not reliable, $F(1, 46) = 2.63$, $MS_e = 42.26$.

To determine the effects of note-taking on the encoding of the structure of the lecture, a separate group of 20 subjects was asked to rate the importance of each propo-

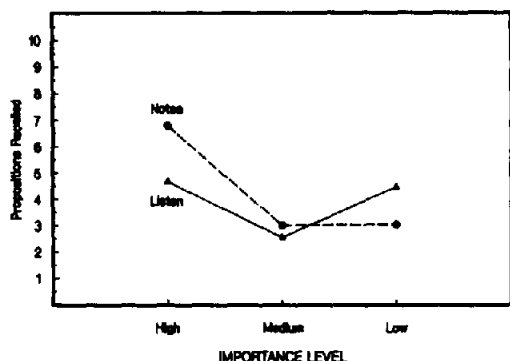


Figure 1. Mean number of high-, medium-, and low-importance propositions recalled by subjects in the note-taking and listening-only conditions.

sition to the lecture. These subjects were given typed versions of the lecture, told to read it until they fully understood it, and then to rate the importance of each proposition on a 5-point scale ranging from *highly important* (1) to *unimportant* (5). From these ratings, three importance levels were established: high, medium, and low. The high-importance propositions were the 28 with the highest mean ratings, medium-importance propositions were the 28 with mean ratings closest to the median, and the low-importance propositions were the 28 with the lowest mean ratings. Recall was evaluated as a function of these categories, and the results are present in Figure 1.

An analysis of these data indicated that there was no significant difference between the listening-only and note-taking groups on overall recall, $F < 1$. There was, however, a significant effect for the importance level variable, $F(2, 92) = 23.66$, $MS_e = 4.61$, and a reliable interaction between the treatment conditions and the importance level variable, $F(2, 92) = 8.18$, $MS_e = 4.61$. A Newman-Keuls analysis was performed to determine at which levels of importance the note-taking and listening-only groups differed. This analysis revealed that note-takers recalled more high-importance propositions than did listening-only subjects but that the two groups did not differ reliably in their recall of medium- and low-importance propositions. Although recall of all types of propositions was quite low (between 11% and 24%), floor effects probably did not hinder the detection of impor-

tant recall differences because the analysis was sensitive enough to detect the main effect of importance level and the interaction effect. In fact, recall of low-importance propositions was marginally higher ($.05 < p < .10$) for non-note-takers. For each group, a linear trend analysis was performed to determine the degree to which subjects recalled the high-importance propositions more than the low-importance propositions (levels effect). As evident in Figure 1, there was a reliable linear trend in the note-taking condition, $F(1, 92) = 36.62$, $MS_e = 4.611$, but there was no linear trend in the listening-only condition, $F < 1$.

Thus it appears that note-taking does not improve the recall of all propositions but only of the high-importance propositions. Further, recall was clearly related to the importance level of the propositions in the note-taking condition and was relatively independent of the importance level of the propositions in the listening-only condition. The different recall patterns exhibited by note-takers and non-note-takers indicate that note-taking serves an important encoding function, and the results are consistent with the predictions of the qualitative theory of note-taking.

Note Content and Relation to Recall

To explore the effects of note-taking on memory, the number and types of propositions in the notes of the 24 subjects in the note-taking group were tabulated. As in recall, the importance of the propositions strongly predicted their inclusion in the notes, $F(2, 46) = 135.66$, $MS_e = 4.68$. A Newman-Keuls analysis revealed that subjects recorded more high-importance propositions ($M = 12.29$) than medium-importance propositions ($M = 5.83$) in their notes and more medium-importance propositions than low-importance propositions ($M = 2.13$).

Consistent with previous research (Aiken et al., 1975; Bretzing & Kulhavy, 1981), an analysis of the correspondence between the notes and recall revealed that subjects tended to recall the information in their notes. Subjects recalled 44% of the propositions that appeared in their notes and only 6% of the propositions that were not in

their notes, $F(1, 23) = 90.67$, $MS_e = .06$, and these percentages were roughly equal across all importance levels. In summary, subjects tended to recall the propositions in their notes. Consequently, the greater recall of the high-importance propositions was due mainly to the disproportionately large number of high-importance propositions in the notes and not to a greater probability of recalling the most important propositions.

Past researchers (e.g., Howe, 1970) have argued that note-taking styles are related to recall. To examine this possibility, an efficiency measure (the average number of words used to express an idea in the notes) and a synonym score (the percentage of synonyms in the notes) were tabulated for each subject. No consistent or reliable relations were found between these measures and both the number of propositions recorded in the notes and the number of propositions recalled. Thus recall was related to the content of the notes more than to the style of note-taking.

Experiment 2

Given the importance of the encoding function of note-taking, Experiment 2 was performed to investigate processing differences between effective and less effective learners. Recent research in individual differences has proven very useful for identifying cognitive structures and processes that mediate differences in performance and for suggesting appropriate methods of remediation. Much of the research indicates that poor learners use less effective processing strategies, often because of metacognitive considerations. For example, Stein et al. (1982) found that academically successful fifth graders remembered more information than did less successful fifth graders, and this was related to their generation of precise elaborations during the reading of sentences. The successful students were more likely to spontaneously produce elaborations that made relations between the concepts in the sentences less arbitrary. In the present context, the individual differences approach seemed particularly promising for (a) further exploring the cognitive activities involved in note-

taking and remembering lecture information and (b) identifying processing differences between successful and less successful students.

Whereas previous research has shown that high-ability subjects outperform low-ability subjects (under note-taking and listening-only conditions) on transfer tasks (Peper & Mayer, 1978) and comprehension tests (McClendon, 1958), the cognitive activities that are related to these performance differences have not been clearly established. Successful and less successful students may differ in the amount and/or nature of the information they extract from lectures. Because little research exists on the type of information that subjects put in their notes, it has been difficult to determine how different students represent new lecture information in their notes and memory. To address these issues, we compared directly the notes and recall of successful and less successful college students. We also varied whether subjects had the opportunity to review their notes before recall. The latter variable was included because the important processes that lead to differential success among college students may occur when the notes are reviewed and not during encoding. Immediate and delayed retention were also compared to determine if the effects of reviewing one's notes vary over a 1-week retention interval.

Method

Design and Subjects

The design of this experiment was a $2 \times 2 \times 2$ factorial. The independent variables were academic success of the students (successful vs. less successful), time of testing (immediate vs. 1-week delay), and whether subjects were allowed to study their notes before recall (no review vs. review). All of the variables were manipulated between subjects, and memory for the lecture was evaluated with a free-recall test.

Grade point average (GPA) was used as the indicator of academic success. This was done because students with a high GPA are those who have previously done well in classroom situations and because effective processing of lecture information is usually necessary for a good grade in a course. To make this measure fairly comparable among students, only the grades from basic introductory courses that are required of all students at Furman University (e.g., math, English, science) were used to compute GPAs. Subjects' GPAs were not computed until subjects had

finished participating in the experiment. To meet our goal of 10 subjects in each of the eight groups, 24 subjects were randomly assigned to each of the four treatment conditions (immediate test–no review, immediate test–review, delayed test–no review, delayed test–review). After eliminating transfer students and those who had taken less than three of the required courses, the median GPA (Median = 2.53) among the remaining subjects was calculated and used as the cut-off for classifying students as successful or less successful. Because of the uneven distribution of successful and less successful students in the four treatment conditions, subjects were randomly eliminated from groups that contained more than 10 successful or less successful students. Also, a total of 15 subjects were added to the groups that contained fewer than 10 successful or less successful students. Although there are potential problems with this method of assigning subjects to conditions, there is no reason to suspect that the random elimination of subjects from conditions produced any biased effects. Further, the advantage of this method is that it prevents experimenter bias effects with regard to the academic success variable. All subjects were introductory psychology students who participated for course credit, and they were tested in groups of two to six.

Not surprisingly, Verbal Scholastic Aptitude Test (VSAT) scores were correlated with GPAs. Students in the successful conditions had a mean GPA of 3.12 and a mean VSAT score of 575. The mean GPA and VSAT score of the less successful students was 1.93 and 485, respectively. A $2 \times 2 \times 2$ analysis of variance (ANOVA) was performed on each of these measures to test the equality of these measures among conditions. Each analysis revealed a reliable main effect of academic success, $F(1, 72) = 168.51$, $MS_e = .17$, and $F(1, 72) = 21.89$, $MS_e = 7,399.14$ for GPA and VSAT, respectively. No other main effects or interactions approached significance.

Materials and Procedure

All subjects were presented with the same videotaped lecture used in Experiment 1. They were told to listen carefully to the lecture and to try to comprehend it as if they were in a typical classroom situation. In addition, all subjects were asked to take notes on the lecture in their normal style. Following the lecture, all subjects rated their comprehension of the lecture on the same 7-point scale used in Experiment 1. The immediate subjects then either studied their notes or were given math problems to calculate for 5 min, depending on whether they were in the review or no review condition. These subjects were then given 10 min to write down as much of the lecture as possible. The delayed subjects were dismissed after rating the lecture for comprehension and went through the same procedures as the immediate subjects (math problems or note review followed by free recall) 1 week later.

Results and Discussion

For all analyses, the alpha level was set at

Table 1
Mean Number of Propositions Recalled as a Function of Review Condition, Time of Testing, and Student Type

Student type	Time of testing			
	Immediate		Delay	
	No review	Review	No review	Review
Successful	29.4	28.8	6.8	23.3
Less successful	22.2	26.8	5.1	20.5

.05. Effects that produced p values between .05 and .10 are reported as marginally significant effects. The analysis of the comprehension ratings (using all three independent variables as factors) produced a marginally significant main effect of the academic success variable, $F(1, 72) = 3.82$, $MS_e = 1.31$. This result indicated that the less successful students ($M = 2.68$) found the lecture more difficult to comprehend than did the successful students ($M = 2.18$). There were no reliable effects of the other variables and no significant interactions.

Recall

The number of propositions recalled was scored using the same method used in Experiment 1. Thirty-two recall protocols were randomly selected and scored by two reviewers. There was high agreement between these two reviewers ($r = .91$), and the remaining protocols were scored by one of these individuals. The mean number of propositions recalled in each of the eight groups is presented in Table 1. These scores were subjected to a $2 \times 2 \times 2$ ANOVA, and as can be seen in Table 1, all three main effects were reliable: (a) Successful students recalled more propositions than did less successful students, $F(1, 72) = 5.32$, $MS_e = 44.12$; (b) there was reliable forgetting over the 1-week retention interval, $F(1, 72) = 75.15$, $MS_e = 44.12$; and (c) reviewing the notes led to higher recall, $F(1, 72) = 36.52$, $MS_e = 44.12$. Further, a significant interaction occurred between the delay and review variables, $F(1, 72) = 22.06$, $MS_e = 44.12$, indicating that reviewing was

Table 2
Mean Number of Propositions Recalled for Each Importance Level for Successful and Less Successful Student Types

Importance	Time of testing			
	Immediate		Delay	
	No review	Review	No review	Review
Successful				
High	9.2	11.3	2.5	10.7
Medium	6.1	5.7	.6	4.9
Low	4.9	4.4	1.0	1.6
Less successful				
High	7.0	9.1	1.9	6.7
Medium	4.3	6.0	.7	5.0
Low	3.2	3.7	1.5	2.3

particularly effective in improving recall after a 1-week delay. In fact, a Newman-Keuls analysis revealed that reviewing the notes only improved recall at delayed testing. After a 1-week retention interval, subjects who reviewed their notes recalled nearly four times more propositions than did subjects who did not review their notes. Thus, the importance of the external storage function of note-taking increases with long delays. Although there was some variability in the differences between successful and less successful students under the different treatment conditions, academic success did not interact with either the review or time of test variables. Thus the successful students, compared with the less successful students, did not benefit more from studying their notes or forget less over a 1-week delay. Rather, it appears that they extracted more from the lecture during initial encoding.

To examine encoding of the thematic structure of the lecture, subjects' recall protocols were further analyzed for the number of high-, medium-, and low-importance propositions recalled. These data are presented in Table 2. The same importance level ratings from Experiment 1 were used to classify the recalled propositions into three importance level categories (each category contained 28 propositions).

A four-variable mixed ANOVA was per-

formed on these data, with student type, note review, and delay of test as the between-subjects variables and importance level as the within-subject factor. This analysis produced the same results as the analysis of total recall, and therefore only the new effects involving the importance level variables are presented here. A highly reliable levels effect appeared, $F(2, 144) = 110.61$, $MS_e = 3.82$. A Newman-Keuls analysis revealed that subjects recalled more high-importance propositions than medium-importance propositions and more medium-importance propositions than low-importance propositions, which was the case for both successful and less successful students. Further, there was a reliable two-way interaction between importance level and review condition, $F(2, 144) = 20.48$, $MS_e = 3.82$, and a significant three-way interaction among these two variables and the time of test variable, $F(2, 144) = 5.01$, $MS_e = 3.82$. As can be seen in Table 2, the cause of these interactions was the lack of a strong levels effect for subjects who did not review their notes and were tested after a 1-week delay. Under these conditions, recall of all propositions was uniformly low, regardless of their importance level. Students who recalled immediately and/or studied their notes before recall exhibited much higher recall of high-importance propositions compared with low-importance propositions, and in each of these groups, there was a reliable linear trend for the importance level variable, all $F_s(1, 144) \geq 18.91$, $MS_e = 3.82$.

The results of major interest from the importance levels analysis involved comparisons of successful and less successful students. In addition to a main effect of academic success, $F(1, 72) = 6.80$, $MS_e = 8.10$, there was a significant interaction between academic success and the importance level variable, $F(2, 144) = 6.56$, $MS_e = 3.82$. As Figure 2 shows, a Newman-Keuls analysis revealed that successful students differed from less successful students only in their recall of high-importance propositions and not in their recall of medium- and low-importance propositions. A marginally significant interaction among the variables of student type, review condition, and importance level, $F(2, 144) = 2.85$,

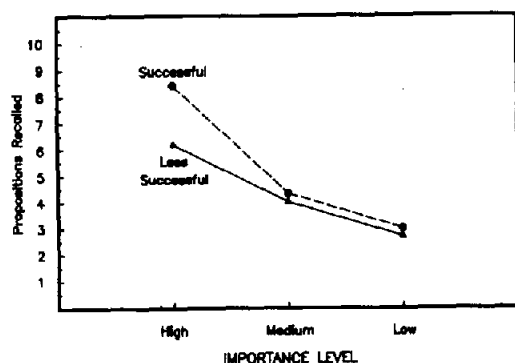


Figure 2. Mean number of high-, medium-, and low-importance propositions recalled by successful and less successful students.

$MS_e = 3.82$, indicated that the difference between successful and less successful students was more pronounced in the review conditions. Even so, a Newman-Keuls analysis revealed that successful students recalled more high-importance propositions than did less successful students in the immediate-no review, immediate-review, and delayed-review conditions. In the delayed-no review condition, in which there was little overall recall, successful students did not recall more high-importance propositions than did less successful students. Thus, whereas both types of students exhibited a levels effect in recall, successful students recalled more of the main ideas than did less successful students in nearly all of the conditions, and this is usually considered to reflect greater organizational processing of the material.

Note Content and Relation to Recall

The total number of propositions in the notes were counted, and the means for each group are presented in Table 3. The $2 \times 2 \times 2$ ANOVA performed on this measure showed only that successful students recorded more propositions in their notes than did less successful students, $F(1, 72) = 4.55$, $MS_e = 1.84$. No other effects were reliable.

The numbers of high-, medium-, and low-importance propositions in the notes were tabulated to examine any differences between the successful and less successful students in the nature of the propositions

Table 3
Mean Number of Propositions Written in the Notes as a Function of Review Conditions, Time of Testing, and Student Type

Student type	Time of testing			
	Immediate		Delay	
	No review	Review	No review	Review
Successful	41.5	36.1	36.5	32.7
Less successful	34.3	29.8	29.8	35.7

recorded. Consistent with the results of the overall measure of the number of propositions in the notes, a $2 \times 2 \times 2 \times 3$ ANOVA performed on these data indicated that successful students recorded more propositions in their notes than did less successful students, $F(1, 72) = 4.03$, $MS_e = 11.62$. As can be seen in Table 4, there was also a strong effect of importance level, $F(2, 144) = 522.55$, $MS_e = 4.02$. According to a Newman-Keuls analysis, both successful and less successful students wrote more high-importance propositions in their notes than medium-importance propositions and more medium- than low-importance propositions. More important, however, was the reliable interaction between

Table 4
Mean Number of Propositions Recorded in the Notes for Each Importance Level for Successful and Less Successful Student Types

Importance	Time of testing			
	Immediate		Delay	
	No review	Review	No review	Review
Successful				
High	13.7	14.0	13.2	14.5
Medium	8.5	8.9	8.6	7.0
Low	3.8	2.3	2.5	2.0
Less successful				
High	12.2	11.0	12.1	12.1
Medium	7.9	7.7	6.9	8.6
Low	3.4	1.6	2.2	3.0

the student type and importance level variables, $F(2, 144) = 4.73$, $MS_e = 4.02$. A Newman-Keuls analysis indicated that successful students included more high-importance propositions in their notes than did less successful students. These two groups of students did not differ in the number of medium- and low-importance propositions recorded in the notes. Further, a marginally significant interaction among the student type, importance level, and review variables, $F(2, 144) = 2.89$, $MS_e = 4.02$, indicated that the effect was stronger in the review (compared with the no review) conditions. This result is difficult to interpret because subjects had no prior knowledge of whether or not they would have the opportunity to review their notes. Nonetheless, a Newman-Keuls analysis revealed that the difference between successful and less successful students in noting high-importance propositions was reliable for subjects in the review conditions and marginally significant for subjects who did not review their notes. In summary, the content of the notes closely paralleled recall. That is, the differences between successful and less successful students emerged only with high-importance propositions.

An analysis of the probability of recalling propositions that did and did not appear in the notes indicated that noted propositions were very well recalled. Subjects recalled 40% of the propositions that were in their notes and only 7% of the propositions that were not in their notes. Separate analyses were performed on each of these measures, and they indicated that successful and less successful students did not differ in the probability of recalling propositions that appeared in their notes, $F(1, 72) = 1.75$, $MS_e = .011$, or in the probability of recalling non-noted propositions, $F < 1$. These results reveal that successful and less successful students used their notes in a similar fashion and that recall differences were related to what they initially recorded in their notes.

Somewhat surprising to us, we could find no other reliable differences between the notes of successful and less successful students. An efficiency and an abbreviation measure were tabulated for each subject,

and successful and less successful students did not differ on either of these measures.

General Discussion

The results of the first experiment provide strong support for the encoding function of note-taking. Although note-taking did not lead to higher overall recall, the recall patterns of note-takers and non-note-takers differed markedly. Although these results are in agreement with claims that overall retention measures are not highly sensitive to the effects of note-taking (Barnett, DiVesta, & Rogozinski, 1981), note-taking does appear to have pronounced effects on the outcome of learning (Peper & Mayer, 1978). Note-takers recalled more high-importance propositions than did non-note-takers, but these two groups did not differ in their recall of medium- and low-importance propositions. Also, the levels effect was exhibited only by subjects who took notes. Thus, our results are not particularly consistent with the quantitative view of note-taking, wherein note-taking is predicted to improve the recall of propositions at all levels of importance. Rather, note-taking appears to encourage students to engage in qualitatively different types of processing.

The present results also provide some insight into the specific encoding processes induced through note-taking. Our view is based primarily on the presence of a levels effect in the recall of all note-taking conditions in both experiments (except in the delayed test-no review group, wherein overall recall was very low) and the absence of such an effect when subjects did not take notes. In past research, the levels effect has been used to assess the encoding of thematic information and factors that increase the encoding of the structure of text, such as salient organizational structures and orienting activities that foster relational processing (Einstein et al., 1984; Thorndyke, 1977), have all been shown to enhance the levels effect. By contrast the levels effect is not observed under conditions that do not allow the discovery of the organizational structure of material, for example, when story segments are presented in a random order (Thorndyke, 1977) or when subjects

perform proposition-specific processing on texts that have an ambiguous structure (Einstein et al., 1984). Thus, the contrasting recall patterns of note-takers and non-note-takers indicate that note-taking enhances the degree to which students relate propositions to one another and discover the underlying theme or structure of the lecture. The disproportionately large number of high-level propositions in the notes of note-takers further supports this interpretation. Our position on the functional effects of note-taking is quite similar to that presented by Mayer and his colleagues (Mayer, 1980; Peper & Mayer, 1978) in describing the effects of note-taking and mathemagenic activities in general. Our results, in conjunction with Peper and Mayer's (1978) research showing that note-taking leads to processing that supports good performance on far transfer tasks, provide converging evidence for the important role of note-taking in encouraging integrative processing.

Another major goal of the present research was to examine how successful and less successful students differ in terms of their processing and recall of lecture information. Although past studies have shown that high-ability subjects have better memory for lecture material than do low-ability subjects (McClendon, 1958; Peper & Mayer, 1978), little research exists on the processes underlying this difference in performance. Comparisons of successful students with less successful students revealed that they differed in their recall and noting of the main ideas. Although total recall was higher for the successful students, this was due entirely to greater recall of the highly important propositions. Consequently, the successful students do not appear to exert greater overall attention or effort to all types of propositions in the lecture. Also, it is not the case that successful students organize and less successful students do not. Both groups of students appeared to organize and structure the lecture information (both groups recalled and noted more high-importance propositions than low-importance propositions), yet the successful students exhibited a stronger levels effect in their notes and in recall. Thus, it appears that successful and

less successful students differ primarily in terms of degree to which they organize and structure lecture information. The analyses of the notes and the comparisons of the notes with recall indicated that the recall differences between successful and less successful students were due to factors occurring at encoding (rather than at retrieval) and to factors involved more with what ideas were included in the notes than with note-taking style. Successful students did not remember a greater percentage of their notes, nor did they benefit more from reviewing their notes. The general pattern of results indicates that successful students have more powerful organizational skills for structuring expository materials. Further research is needed to determine what successful students use to help them better structure the lecture and identify the central concepts. For instance, they may have richer knowledge structures that they apply to the encoding of lecture information, they may be more capable of handling the heavy information processing demands of simultaneously listening to, organizing, and taking notes on a lecture, and/or they may be more sensitive to phrases, words, or speaking habits that lecturers use to signal central concepts. In any case, it appears that remediation programs or techniques for improving lecture processing should focus on the teaching of organizational skills. This view is entirely consistent with previous suggestions (Mayer, 1975) that devices that encourage relational processing and the identification of superordinate concepts, such as advance organizers, are especially effective with low-ability students.

Although the qualitative framework was found to be superior to the quantitative framework for predicting the effects of note-taking on the relative recall of high-, medium-, and low-importance propositions, other aspects of the data were consistent with a limited version of the quantitative theory.¹ In both experiments, the probability of recalling noted propositions was much higher than the probability of recalling non-noted propositions (regardless of importance level). If the interpreta-

¹ We wish to thank an anonymous reviewer for bringing this point to our attention.

tion of the quantitative hypothesis is that the attention and activities involved in writing an idea into one's notes cause better memory for that idea, then the probability results described above are in agreement with the restricted version of the hypothesis.² This version of the quantitative hypothesis is not incompatible with the qualitative hypothesis, and it seems that both theories are necessary for interpreting the entire pattern of results. The qualitative theory appears useful for explaining which ideas will be attended to and recorded in the notes, and the restricted version of the quantitative theory may explain why the noted propositions are well recalled.

Another result of interest in the present research was the interaction between the delay of testing and review variables. Whereas many researchers (e.g., Carter & Van Matre, 1975) have shown that reviewing one's notes increases recall (the external function of note-taking), our results suggest that the benefits of reviewing increase over a delay interval. At immediate testing, reviewing had no appreciable effects on recall. After a 1-week delay, however, reviewing produced a fourfold increase in the number of propositions recalled.

² It should be noted that we cannot unequivocally support this limited version of the quantitative theory because in the present experiments the variables necessary to test this theory were not experimentally manipulated. For example, note-taking per se may have caused the greater recall of noted propositions. Alternatively, the propositions in the notes may have been noted because they were salient ideas to the subject, in which case they may have been recalled even if they had not been written into notes.

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