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ABSTRACT

Although there is general acceptance that information presented in formal learning situations must be encoded linguistically by the learner, there is little research on the differential aspects of various types of linguistic encoding strategies. A study sought to determine the differential effects of three linguistic encoding strategies on subjects' processing of information presented in lecture format. Subjects, 43 ninth and tenth graders in 3 classes, were assigned to one of 4 conditions: no linguistic processing (control); verbal linguistic processing; written linguistic processing; and structured linguistic processing. Subjects listened to a lecture and then took essay and objective tests. Results indicated that no one strategy was clearly superior to another. Additionally, evidence was found to support the assertion that strategy instruction might hinder information processing for more able students. (Two tables of data are included and 30 references are attached.) (Author/SR)

The Effects of Three Types of Linguistic Encoding Strategies on the Processing of Information Presented in Lecture Format

by

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Abstract

Although there is general acceptance that information presented in formal learning situations must be encoded linguistically by the learner, there is little research on the differential effects of various types of linguistic encoding strategies. This study sought to determine the differential effects of three linguistic encoding strategies on subjects' processing of information presented in lecture format. Ninth and tenth grade subjects in three classes were assigned to one of four conditions: no linguistic processing (control), verbal linguistic processing, written linguistic processing and structured written linguistic processing. Subjects listened to a lecture and then took essay and objective tests. Results indicated that no one strategy was clearly superior to another. Additionally, evidence was found to support the assertion that strategy instruction might hinder information processing for more able students.

Although there are many theories of information processing, most make a distinction between linguistic versus nonlinguistic modes. This distinction is commonly referred to as the dual coding hypothesis. Paivio (1970, 1971) is commonly credited with first articulating the dual coding theory, yet its roots can be traced to the turn of the century when the Wurzburg psychologists demonstrated that thought processes could take place without the mediation of consciously experienced language (Richardson, 1983).

Current theory asserts that the nonlinguistic form of processing is the one initially used in a developmental sense, but that the linguistic mode gradually becomes dominant over time. Specifically, research on the neurological functioning of the brain indicates that over time the linguistic neural networks or paths are more dominant than the nonlinguistic (Gazzaniga & Le Doux, 1978; Gazzaniga, Le Doux, & Wilson, 1977) when processing information in formal learning situations. This is supported by the research on classroom tasks which indicates that they are heavily skewed toward a linguistic form of processing (Doyle, 1983; Fisher & Hiebert, 1988). In other words, over time, within instructional situations, more and more information is presented to students linguistically, creating increased demands on the linguistic mode of processing.

Despite the relatively clear indication of the importance of linguistic processing in the theoretical literature, there is little clarity on the type of linguistic processing which is most effective under specific conditions. That is, there is little research which differentiates between types of linguistic processing and their differential effects. One exception is the research on note-taking which has begun to specify the conditions under which this form of linguistic processing is most effective. For example, in a review of over 30 studies, Ganske (1981) concluded that the effectiveness of note-taking is dependent on the amount of time allowed for review. That is, the simple act of note-taking is not enough to ensure increased depth and effectiveness of processing. Ganske explained this as a function of the generative or constructive hypothesis which asserts that note-taking facilitates the creation of a synthesized linguistic representation of the information on which notes are taken. Given that this representation is itself a new cognitive structure, it must be reviewed to be processed deeply enough to be useful at a later date. This interpretation is consistent with Kintsch and van Dijk's (1978) concept of a macrostructure.

A related finding is that note-taking improves performance on far but not near transfer tasks. In a series of studies, Peper and Mayer (1978, 1986) found that note-taking improved performance on far transfer tasks such as applying information in unique ways. However, note-taking did not enhance performance on near transfer tasks such as verbatim recall or recognition of isolated facts. Again, the generative hypothesis helps explain these results. Given that note-taking generates a new linguistic structure which must be assimilated and that this assimilated structure requires a certain amount of attention, it would seem reasonable that it would distract the learner from the literal microstructure of the original information. In short, the construction of a macrostructure detracts from the processing of the verbatim microstructure of the original information (Kintsch, 1974).

A related finding is that note-taking enhances the processing of information on which notes are taken but this information is not necessarily what would be considered top-level structures such as those described by Meyer (1985) Specifically, Smith (1984) found that explicitness of important information is a significant factor relative to subjects' abilities to take notes which incorporate top-level structures. That is, if important information is not made salient, subjects do not necessarily take notes on that information, although they know the information best on which they took notes.

In general, then, the note-taking research suggests that this form of linguistic processing enhances knowledge of information on which notes are taken although guidance must be provided to ensure that learners place emphasis on important or top-level information. One type of linguistic processing not addressed in the note-taking literature is verbal rehearsal, even though theory suggests it too should have positive effects on processing. Specifically, the generative hypothesis asserts that for effective processing to occur, a linguistic representation of the information in the form of a macrostructure must be generated. Restating of information in written form via note-taking appears to facilitate the construction of a macrostructure. Given that note-taking is an intermediate step in the construction of a macrostructure, one could hypothesize that verbally rehearsing information would also facilitate the construction of a macrostructure in much the same way note-taking appears to. Specifically, Clark and Clark (1977) illustrate that the act of verbally representing information that has been read or heard requires many of the same cognitive operations as the act of representing the information in written form. Cognitive operations shared by both processes include a selective encoding function, a planning function and an evaluation function. This assertion is supported by much of the research of Baron (1982) and Sternberg (1977). Although there is a growing body of research on the nature and use of verbal rehearsal (see Weinstein and Mayer, 1986, for a review), it does not address the specific issue of its effectiveness in enhancing information processing especially as compared to other linguistic processing strategies.

In summary, the research thus far indicates that linguistic encoding in written form via note-taking positively affects the processing of information probably because it facilitates the construction of a macrostructure; however, the information processed must be structured to ensure that the macrostructure includes important or top-level information. Additionally, theory suggests that linguistic encoding in verbal form should be a viable information processing strategy because it, too, facilitates the construction of a macrostructure. Therefore, this study sought to determine the comparative effects of linguistic processing in oral versus written forms.

Method

Subjects and Design

Subjects were 43 ninth and tenth grade students from middle and upper middle income families enrolled in three sections of a required science course in a large suburban high school. Subjects within each section were randomly assigned to one of four conditions: no linguistic processing (control), verbal processing, written processing, and structured written processing.

Given the inability to randomly assign subjects to treatments across classes (i.e., the use of intact groups), a hierarchic design was used with treatments nested within classes. Table I represents the design matrix for the hierarchic model.

(TABLE 1 ABOUT HERE)

The unequal cell size depicted in Table I is a result of the fact that the study originally included 57 subjects. However due to absenteeism and partial or missing data, some subjects had to be dropped from the analysis after completion of the intervention. To account for differences between classes, four covariants were used: grade point average, rank in class, grade level, and mental age on the Iowa Test of Basic Skills (1986).

Two separate dependent measures were used in the study. One was an 10-item multiple choice test on the content presented in the lesson. The other was an essay examination that required subjects to synthesize and apply the information presented in the lesson. Both dependent measures, objective and essay, were analyzed for their content validity by a science teacher with ten years of experience. Additionally, a coefficient alpha of .65 was calculated for the objective test. Essay tests were scored blind by a single rater using a primary trait scale emphasizing the top-level information in the lecture.

Two separate analyses of covariance were conducted using the general linear model (Finn, 1977), one analysis using the objective test as the dependent measure, the other using the essay test as the dependent measure. Both analyses utilized all four covariants since each had a significant correlation at the .05 level or higher with both dependent measures.

Procedure

Subjects in all treatment conditions were presented with a 20-minute lecture by the same teacher on the properties of various types of soil. In each instance the teacher followed a highly structured outline to ensure consistency of content presentation. Subjects in the control and verbal processing conditions were instructed to listen carefully to the lecture. Subjects in the written processing condition were instructed to listen carefully and take notes, subjects in the structured written processing condition were instructed to listen carefully and take notes following an outline provided for them in which top- level information from the lecture had been previously filled in. All subjects were informed that they would be tested on the content of the lecture.

Immediately after the lesson, students were provided with ten minutes to prepare for the objective and essay tests. Subjects in the non- linguistic processing (control) condition were asked to review the information quietly and independently. Subjects in the verbal processing condition were asked to review the information in the lecture by verbally restating the information. Subjects in the written processing condition were asked to independently review their notes. Subjects in the structured written processing condition were also asked to independently review their notes. At the end of the review period, subjects were given the 10-item multiple choice test and the essay test. Subjects were allowed all the time they needed to complete both tests.

Table II presents the means on the objective and essay measures for the conditions nested within classes adjusted for the four covariants and for the nesting factor (class).

(TABLE II ABOUT HERE)

The analysis of covariance on the objective measure produced a significant effect for the conditions, $F(9,27)=2\text{-}14$, $p=.041$ as did the analysis of covariance for the essay measure $F(9,27)=3.15$, $p=.016$. Post hoc LSD analyses revealed that control and structured written response groups were significantly different on the objective measures. t (27) = 1.88, p < .10[1], and on the essay measure t (27) = 2.05, p < .05.

At first glance one might weakly infer that the linguistic processing conditions outperformed the nonlinguistic processing condition since the overall adjusted means for all linguistic conditions were higher than the adjusted mean for the nonlinguistic condition for both objective and essay measures (see Table II). A stronger inference might be that structured written linguistic processing was the only condition that was clearly superior to the no linguistic processing condition since it was the only condition significantly different. However, a close examination of Table II negates both of these inferences.

Specifically, Table II illustrates that the pattern of differences between adjusted means for class 3 for both objective and essay measures was unlike that for classes 1 and 2. In fact, post hoc LSD pairwise comparisons using all adjusted means (i.e., not collapsing means within any given condition), revealed that in class 3 the structured written processing, written processing and verbal processing conditions all had significantly higher means than the nonlinguistic processing condition on the objective measure, t(27), p < .05. However, this pattern was not found in any of the other two classes. In fact, the control group in class 1 and the written linguistic group in class 2 significantly outperformed the structured written linguistic processing group in class 1, t(27), p < .05, whereas no other comparisons within classes were significant.

A similar pattern was found for the essay measure. In class 3 all linguistic processing conditions had significantly higher means than the control condition, t(27), p < .05. However, in classes 1 and 2 no condition significantly outperformed any other within the class. In short, the very powerful pattern of effects exhibited in class 3, masked the lack of effect in classes 1 and 2. It also masked the comparative effect of the verbal linguistic processing condition. Specifically, the post hoc pairwise comparisons for the disaggragated adjusted means showed that within classes no condition significantly outperformed the verbal linguistic processing condition.

The reason for the differential effects in class 3 is probably due to the differences in the mental ages of those students. That is, an ANOVA's on the three classes using each of the covariants as dependent measures illustrated that class 3 was significantly different on their Iowa Mental Age scores from classes 1 and 2, $F(2,40)$, $p = .07$.

Discussion

One major finding of this study is that the three linguistic processing techniques studied had somewhat differential effects on subjects' abilities to process information. Those subjects with lower mental ages profited from the linguistic processing techniques. However, those subjects with higher mental ages did not profit from the linguistic processing strategies. In fact, within one class (i.e., class 1) their ability to process information may have been hindered.

One interpretation of these findings is that subjects with higher mental ability have developed information encoding strategies that can be performed quickly and efficiently at the time they are initially receiving information. Thus, requiring them to utilize a linguistic processing strategy actually distracts them and renders their processing inefficient. This interpretation is supported by much of the research on automaticity. Specifically, it has been found that cognitive processes once learned are executed at the level of automaticity and can be performed with little conscious thought (Anderson, 1983; Fitts, 1964; LaBerge & Samuels, 1974). If an individual has developed information processing strategies that can be performed automatically and then is asked or required to use another strategy, his performance will be negatively effected. This interpretation is also supported by much of the aptitude x treatment interaction (ATI) research. Specifically, Tobias (1976) proposed that the higher the level of skill proficiency possessed by the learner the lower the level of instructional support required to complete the task.

A second interpretation is that no one form of linguistic processing is clearly superior to another for all subjects. Presumably, this is because the construction of a macrostructure is a highly subjective and individual process. There are not only many different types of macrostructures which can be used to effectively represent linguistic information, but there are also many different techniques or strategies which can help the learner mediate the construction of such a structure. This is supported by much of the research in cognitive styles. Specifically, Messick (1976, pg 14-22) listed nineteen constructs such as field independence--dependence, reflection--impulsivity, convergent--divergent thinking which are considered to be aspects of cognitive style, each of which is best served by specific types of learning strategies. Additionally, Snow (1978) concluded that strategy instruction is most effective if the strategy used matches the stylistic tendencies of the learner. Similarly, Frank (1984) found that field independence versus field dependence significantly affected the effectiveness of the type of linguistic rehearsal utilized in lecture situations.

Both of these interpretations have implications for strategies instruction. One implication is that strategy instruction is useful for those students who have not yet developed their own strategies in a given area. It improves performance. However, strategy instruction for those students who have already developed strategies in a given domain can be detrimental to their performance. Rothkoph (1970) makes the distinction between helpful and harmful strategies in his discussion of mathemagenic versus mathemathanic instruction. Mathemagenic strategies are those that are helpful to the completion of a task; mathemathanic strategies hinder the completion of a task. The results of this study suggest that any given strategy is not inherently mathemagenic or mathemathanic; rather strategies are mathemagenic if they meet subjective processing needs and provide the learner with a technique for accomplishing something for which he has not already developed his own. However, they are mathemathanic if they force the learner to replace an already effective strategy with a new one or do not match with the learner's individual style characteristics. This would mean the programs which purport to enhance learner strategies (for review, see Derry and Murphy, 1988) should not be applied to all populations. Another implication is that a wide variety of options should be offered within programs designed to enhance learning strategies. That is, within such programs target cognitive skills should be identified along with a number of strategy options from which learners select those that are most useful.

To substantiate these implications, further research must be conducted on the types of learning characteristics which render specific strategies mathemagenic or mathemathanic.

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[1]A significance level of .10 was used for the analyses of covariance and post hoc LSD comparisons using the Posavac and Carey (1980) suggestions for avoiding Type II errors with analyses that use small sample sizes.

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TABLE I

Design Matrix for Hierarchic Model

	Class 1	Class 2	Class 3	Totals
No Linguistic Processing (Control)	n = 3	n = 3	n = 3	9
Verbal Processing	n = 4	n = 4	n = 3	11
Written Processing	n = 4	n = 4	n = 3	11
Structured Written Processing	n = 3	n = 5	n = 4	12
Totals	14	16	13	43

TABLE II

Means on Objective (O) and Essay (E) Measures for Conditions Nested Within Classes Adjusted for Covariates and Nesting Factor

	Class 1	Class 2	Class 3	Overall
No Linguistic Processing (Control)	O=8.33 E=4.67	O=6.33 E=3.33	O=4.00 E= .67	O=6.22 E=2.89
Verbal Processing	O=6.75 E=3.25	O=6.50 E=4.25	O=7.67 E=3.33	O=6.91 E=3.55
Written Processing	O=6.50 E=3.50	O=8.00 E=4.25	O=7.00 E=2.67	O=7.18 E=3.64
Structured Written Processing	O=6.00 E=3.67	O=8.00 E=3.40	O=7.75 E=4.50	O=7.47 E=3.83
Overall	O=6.86 E=3.71	O=7.31 E=3.81	O=6.69 E=2.92	