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Two Studies on the Effect of Audio-tape Structure on the Immediate Recall of Factual Information

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Problem

The last decade of educational research has witnessed an expansion of interest in the technology of education (Gage, 1963; Travers, 1973). This proliferation of research, however, was bothered by a continued confusion between the mechanics of the technology and the design rules for the process of education. The needed distinction between the instruments of instruction and the application of instructional processes was made clear recently by Armsey and Dahl (1974). Nevertheless, the confusion continues, particularly in the kind of research that is being conducted.

A useful separating rubric between the means and the process of educational technology was advanced by Tosti and Ball (1969). They suggested that "presentation form" be distinguished from "media". The former is more commonly labelled "context" and the latter, "means". That is, they suggested that the general term media could be understood if it were separated into two functions: one being the jumble of human and mechanical processes needed to present it and the second including the actual characterisation of the instrument used (e.g. focus, distance, speed, etc.).

Unfortunately this distinction has not been carried out in the literature. For example, McKeachie (1974) in his analysis of current instructional psychology, suggested that there were few media variables that appeared to influence learning. He suggested that it was the within-subject variables and the demands of the situation that appeared to be most related to the amount of learning. The detailed analysis of media suggested by Tosti & Ball (1969) was not recognised.

It does not seem useful to select either the context of learning or the function of media as single research points of interest. A better and more informative approach to instructional research would be to look at the effects resulting from combinations of media and student learning behaviour. Rothkopf (1970) has described certain student behaviours that appear to support learning and has labelled these organised responses "mathemagenic". The term is a literal combination of classic Greek for "gives birth to learning".

Combining the descriptions of media and student behaviour as a research

interest would therefore not be difficult: we would have an instructional technology that depended upon certain aspects of media as well as upon some selected routines of student behaviour. In fact, this exact combination has proved to be the most efficacious procedure for both list and sentence learning (Jenkins, 1974; Bower, 1972). This tandem of technology and human behaviour would avoid the past research emphasis upon "media" alone as the saving grace of education. It would place renewed emphasis upon the actual learning behaviour (i.e. "mathemagenics") of the student vis-a-vis the instructional material.

This research project was concerned with just this problem, namely combining prompted student learning behaviour with certain structural characteristics of audio tape. Audio tape was selected as the medium for a variety of reasons: first, because there was no available previous research in the field that dealt with characteristics of tapes (i.e. design dynamics); second, the college in which the project was conducted was heavily committed to audio tape production to support its large off-campus student population (it being estimated that over 150 new master tapes per month were being made and that these in turn generated 1500 student copies); and third, the planned design intervention was one that could be handled by technicians independent of the lecturing staff.

Related Research

Because of the predominance of the research work on visual media and learning (Travers, 1967) and also due to the recent developments in tape replay mechanics, research work on audio tape has been scanty. Existing studies concentrated on allowable tape speed and levels of comprehension (Foulke and Orr, 1971). It was found that audio tape speech could be compressed up to 30% with no appreciable loss in consequent comprehension (Henderson, 1972). But these studies were dependent upon complex equipment and did not involve any prompted changes in student mathemagenic behaviour. In addition, the structure of the information placed along the tape remained unchanged: that is, it was still linear, still lacking the organisational clues that prose has. This research was as described: studies in compressed speech.

The present project selected audio tape as the medium for analysis along with two types of mathemagenic behaviour: note-taking and cognitive rehearsal. The purpose was to investigate what combinations of these instructional variables would be best for immediate retention of factual information. The research emphasis was upon student learning techniques and their effects on learning as well as the impact of easily-organised media designs, namely summaries of information and opportunities to rehearse what has been listened to. There were no studies found that directly investigated the effect of variations in tape design and student study behaviour. However, in a series of experiments, Di Vesta and Grey (1972, 73) investigated the effect of various text styles and lengths and student learning behaviour (note-taking) on immediate and delayed recall of tape-presented information. They found that note-taking was helpful

and that its utility varied with the level of textual organisation: that is, with the amount of logical development that the material had as well as with amounts of student rehearsal. In a later study Di Vesta and Grey (1973) found that note-taking interfered with delayed recall, particularly for material presented in a series of short thematically related passages. Both of these studies appear to support the conclusion of a complex effect of material design, presentation and student behaviour (in this case note-taking).

Experiment I

Purpose

In this pilot study the effect of tape "pauses" and "summaries" was investigated. These tape dynamics were selected because they are common practice in lectures, either deliberately or incidentally, and they are design techniques that can be easily added to existing tape material. The pauses were actually added blank spaces occurring at equal intervals. The summaries were spoken sentences about the immediately preceding taped information. These summaries also occurred at equal intervals and were of the same length as the pauses, namely 10% of the original taped material. It was hypothesized that Ss who received the summaries would recall less than those students who received less information and time to think it over. These expectations were based on the number of studies on text learning reviewed by McKeachie (1974).

Design

Because of the straightforward nature of the treatments it was decided to organise a replication by groups experimental design. Using the notation of Campell and Stanley (1969) the study design can be envisaged as follows:

Table 1 Experimental Design

Group I	X1 Summaries X2 Pauses	01 post-test 02
Group II	X1 Summaries X2 Pauses	01 post-test 01

Subjects

Two groups (N = 23, N = 16) of undergraduate students from a psychology course within a teacher education training programme participated in the experiment. All students were attending full-time academic programmes at a rural, Australian tertiary institution. None of the students

were over 21 (average age $\bar{X}$ = 19.62 years) and none had participated in any previous experiment.

Materials

Two cassette tapes were prepared from a 5,250 word speech, "Educational Technology and the Learning Process", by Gagne (1973). This material was selected because it contained the redundancies and style of spoken language and because it was interesting and relevant to the students' present course of study. One tape contained summaries of the major speech sections which were identified from headings. The second tape contained equal amounts of blank spaces at the same points as the tape containing the summaries. In both cases, the tape was lengthened by approximately 10%. In total, each tape contained 9 summaries or pauses, averaging 18 seconds' duration. Each pause and summary was signalled using a 600 CPS tone.

Procedure

Each of the two groups was run as a replication experiment, so both groups received similar treatment and information. They were given a five-minute explanation of the purpose of the experiment and were assured that their performance was not grade-related. A further attempt made to reduce anxiety in the experimental situation was to have a fellow student assure Ss that the experiment was enjoyable.

After random assignment to either the (a) Pauses condition or the (b) Summary condition, each student was given a cassette tape and assigned to a study carrel. Immediately upon tape completion, the post-test was given. No notes nor other supplementary learning aids were permitted during the listening, nor any other interruption allowed in the 41-minute programme.

Measures

A 20-item multiple choice post-test was given immediately after listening to the tape. The items were randomly arranged to minimize any recency effects. The test had a split ½ reliability coefficient of .59.

Results

The data gathered from the two experimental groups is summarised in Table II. The means of the summary and pauses conditions in Group 1 are $\bar{X}$ = 13.54, $\bar{X}$ = 16.75 and the S.D. 2.88, 2.57 respectively. In Group II the means for similar conditions are $\bar{X}$ = 14.63, $\bar{X}$ = 17.25. In both experimental situations, the differences between means were significant. In Group I, $t = 4.58$ where $P < .01$ level and in Group II, $t = 2.65$, where $P < .05$.

Table 2 Means, standard deviations and t-tests for all experimental groups.

	Mean	S.D.	
Group I (N = 23)			
Summaries (n = 12)	13.54	2.88	t = 4.58**
Pauses (n = 11)	16.75	2.57	
Group II (N = 16)			
Summaries (n = 8)	14.63	2.0	t = 2.65*
Pauses (n = 8)	17.25	2.0	

*P < .05 **P < .01

Discussion

This experiment was conducted to contrast the difference in recall effects between opportunities to rehearse attended information (presented by audio tape) and the effect of hearing periodic summaries on that information. From the results obtained it appeared that those students who received periodic informational summaries recalled less than those students who did not. This effect held for the two experimental groups involved: the psychology students and the teacher-education programme students.

One explanation of the results is in terms of interference and memory. An interference model suggests that (1) as the information approaches similarity there is an increase in confusion and (2) as the information approaches memory limits the consequent recall suffers (Underwood, 1957). The difficulty with this interpretation in the present study is that the brief summaries and supplementary passages would not have been learned adequately to interfere substantially with later recall. For example, in list learning it has been shown that the degree of initial learning and similarity of material are directly related to the amount of consequent forgetting (Keppel, 1968). In this study the supplementary material was related to the main body of information but the degree of initial learning was low. Subjects were not allowed to study the summaries adequately.

Similar results have been reached in sentence and prose learning: the better the material is learned, the less important the degree of thematic variation is. However, in the present experiment the tape was not stopped at any time. Ss had to listen to summaries as if they were new information. Consequently it appears that an interference explanation of the superiority of the pause condition and the summaries does not seem the best interpretation of the results.

An alternative explanation concerns the amount of rehearsal time permitted. In his review of instructional research, McKeachie (1974)

reluctantly admits the salience of the principle of "active participation", not from an associationist but from an information-processing point of view. That is, instruction will be more effective if the student is helped to process actively (i.e. "work with", "rehearse", "study") the material. In this present study the summaries condition did not allow the students' personal study skills to operate. The experimenter supplied the tape summaries, and while they were assumed to be helpful and time-saving, they functioned probably as a prevention of the kind of rehearsal that Atkinson and Shriffin (1971) suggest is needed to effect long-term storage of information. This rehearsal, at least in free recall of lists, is interrupted by the intrusion of similar material, preventing the transfer of that information into more permanent memory.

Consequently, to clarify the effects of "spaced" rehearsal time, another experiment was organised to assess the effect of varied amounts of opportunities to rehearse actively factual information presented by tape. The main purpose of this follow-up research was to attempt to define the temporal limits of rehearsal. Is rehearsal best as covert or as overt process, and are there limits to the amount of usable rehearsal time?

Experiment 2

It was found in Experiment 1 that the opportunity to rehearse during the taped presentation of factual information appeared more helpful to later recall than listening to periodic summaries of that material. This result raises two questions: do the chances to rehearse within tapes have temporal limit? and what is the effect of the common study behaviour called note-taking, on these spaced rehearsal processes? To answer these questions a 3 X 2 analysis of variance study [Tape Pauses (30%, 60%, 0%) X Note-Taking] was organised.

Subjects

Forty-eight undergraduate psychology students participated. The average age was 19.3 and their GPA 2.34. All attended a rural college and had no more than two semesters of college experience. None had ever participated in an experiment. The group was 40% female and 60% male.

Materials

A 2,500 word passage about the life of primitive primates (Dillon, 1972) was recorded on a master cassette. There were three tape masters arranged with varied amounts of periodic blank spaces for either covert rehearsal of heard information or note taking. The amount of available tape space was either 30%, 60% or 0%. The unfamiliar material on primates was selected to help control for previous knowledge. The basic recorded content was 32 minutes, not augmented by periodic spaces. It should be noted that the upper 60% rehearsal limit was selected because of cassette design restrictions and not any cognitive parameters. The proportions could have been 25%/50% as well; however, it was thought best to err on the side of more rather than less time for student rehearsal.

Procedure

All of the students were randomly assigned to one of six listening conditions: (1) 30% spaced and notes; (2) 60% spaced and notes; (3) 0% spaced and notes; (4) 30% spaced and no notes; (5) 60% spaced and no notes; (6) 0% spaced and no notes.
Each spaced condition (3 levels) was contrasted with the notes (2 kinds) to complete the factorial design.

Before the experiment began, all students listened to a brief introduction of the experiment's purpose and a description of the particular structure of their tape treatment. Each group was allowed to ask questions and practise for five minutes on the listening or note-taking conditions they were assigned to.

For economy and because of limited listening facilities, each experimental group listened simultaneously through earphones on an 8-unit listening post normally used for reading instruction.

Immediately after the tape ended, each student completed the post-test and was free to discuss the nature of the experiment. A 25-item, four alternatives, multiple-choice test on the taped material served as the criterion learning measure. It had an internal split-half reliability of p = .51 (Spearman-Brown) formula.

Results

The immediate post-test scores were analysed by a two-way analysis of variance procedure (Hayes, 1973). The means and S.D.s for the component groups are presented in Table 3.

Table 3. Means and standard deviation for all treatment groups.

		Amount of Pauses		
		30%	60%	0%
Notes	Yes $\bar{X}$	13.0	10.63	12.13
	SD	2.45	3.11	1.55
	No $\bar{X}$	13.1	11.37	9.50
	SD	2.39	3.07	2.87

N = 48
n = 8

From Table 3 the means for the Notes conditions were $\bar{X}$ = 13, $\bar{X}$ = 10.63, $\bar{X}$ = 12.13 along the 30%, 60%, 0% of pauses; and for the No-notes condition the respective means were $\bar{X}$ = 13.1, $\bar{X}$ = 11.37 and $\bar{X}$ = 9.50.

An analysis of variance was carried out on the immediate, multiple-choice post-test scores. The results of the analysis are displayed in Table 4. The results of the notes condition, where Ss were allowed to take notes, yielded an F of .68 (df= 1/47, P > .05 and was not significant. However, the pauses resulted in a significant F of 3.40 (df = 2/47, P < .05).

Table 4. Analysis of Variance for Treatment Groups

Source	SS	df	MS	f
(Notes)	4.69	1	4.69	.68
(Pauses)	47.04	2	23.52	3.40*
Interaction	24.12	2	12.56	1.82
Error (within)	290.43	42	6.92	
Total	367.48	47		

*P < .05

In order to assess the particular effects of various pause conditions, a post-hoc Scheffe's analysis was made (Hayes, 1973). The results of this analysis of the means is summarised in Table 5.

From the table it can be seen that the comparison between Groups 6 and 4 (No-notes 0% practice interval and No-notes 30%) was significant P < .05 as well as that between Groups 6 and 1 (No-notes 0% practice and Notes 30% practice interval).

Table 5. Table of Differences Among Group Means

Mean Group		II 10.63	III 12.13	IV 13.1	V 11.37	VI 9.50
I	13.0	2.37	.87	−.10	1.63	3.50*
II	10.63		−1.50	2.47	−.74	1.13
III	12.13			−.97	.76	2.63
IV	13.1				1.73	3.60*
V	11.37					1.87

* P < .05

Groups 1, 2, 3 (Notes in the 30%, 60%, 0% pause condition)
Groups 4, 5, 6 (No-notes in the 30%, 60%, 0% pause condition)

Discussion

The present study was designed to investigate the effect of two kinds of mathemagenic behaviour, namely note-taking and cognitive rehearsal, on tape-presented information. Specifically, it attempted to answer this question: are varied amounts of within-tape rehearsal time better for immediate recall than traditional note-taking during similarly spaced

intervals? The data does not adequately answer that question. As found in Experiment I, there appeared to be an overall facilitating effect of pauses, but this result should be examined in greater detail.

Within the groups who experienced an allowed pause during the tape, there were performance differences. First, none of the 60% pause groups recalled more than the 30% groups did. This result was unexpected because of the increase in allowed study time. One interpretation for the lack of observed differences could have been the need for better experimental controls. This is possible because there were physical space problems during experimentation that seemed at that time to interefere with Ss concentration. A theoretical point of view, however, would suggest that there may be a limit to the amount of useable within-tape study time; that is, Ss may only be able to take advantage of brief respite during the active accumulation of information. The limits of time may be among the lower values (5%, 15%, 25%), rather than the 30-60% contrast used in this study. However, such an interpretation is related to information input, and not to time spent trying to "master" content. Bloom (1971) and Underwood's (1961) results demonstrate a direct relationship of amount of relevant study and practice time to amount of recall. Therefore, the present lack of observed differences between the 30 and 60% pause conditions may only be informative in regard to the mathemagenics of accumulating new information.

Another interpretation of the overall lack of clearer effects among the groups who received the pause is the one offered by Costin (1972). He suggested that it did not matter what kind of general study methods or review procedures students used. The important principle involved was to prompt the Ss to do something relevant to the instructional task, the material, and the context of learning. Such a sobering observation implies that in this study, taking notes on recalled facts or thinking about what was heard are mathemegenically similar. Both procedures should be better than active listening — or whatever it is Ss do when they are asked to listen.

It should be noted that this present study tried to approximate the conditions under which Ss listen to tapes. They were not informed of the subsequent test; they were not given pre-test study time as commonly occurs in educational practice. We wanted to control for the varied amounts of study time that students usually engage in before exams. Consequently our results may not be related to ordinary methemagenic behaviour under higher motivational conditions and clearer student knowledge about performance expectations.

If we examine the data under the no-notes conditions, we find some interesting results. The groups that performed most poorly were the no-notes 0% spacing; they had both hands tied behind them so to speak. They were expected to do badly; however when this group was allowed some measure of consolidating and recording the information heard (namely in the form of notes), they performed on a par with the 30% and 60% groups. In other words, note-taking in this study seemed to help

those students who were given no time within the taped lesson to do so. Again the results among the no-notes condition can be interpreted in a related way. Among those groups, the Ss who received time to think recalled more than those in the 0% condition who were in effect hurried along.

It can be seen then, that when Ss are engaging in some form of active mathemagenic behaviour during presentation of information (i.e. thinking about what is being said or taking notes on that content), their performance on an immediate-recall test is assisted. So it appears that this study found what has been rediscovered innumerable times before: that an active, thinking involvement with a learning task and sufficient time for such activity are an excellent learning prescription. But our original problem remains: what can be done to prompt these relevant mathemagenic behaviours to occur while the tape is progressing? Certainly taking notes and thinking about heard material are only two of scores of useful mathemagenic behaviours. Additional research should concentrate on examining (1) the effects of various amounts of tape pauses on levels of material difficulty; (2) the source of control of mathemagenic activity; and (3) pre- and post-listening behaviour. At present much of the audio tape research is still in the hardware design stage.

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