THE EFFECTS OF AUDIO-VISUAL SEQUENCING ON LEARNING FROM A SLIDE-TAPE PROGRAM

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ABSTRACT

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EFFECTS OF AUDIO-VISUAL SEQUENCING
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The instructional effectiveness of 3 different techniques of slide-tape production was examined in this study. An instructional program was presented under 3 different conditions: simultaneous presentation of audio and visual segments; presentation of audio before visual; and presentation of visual before audio.

The 60-slide program presented information on 6 groups of Canadian birds, at a level suitable for the test-sample: eighty-eight grade 9 and 10 students at a Montreal high school. A repeated-measures design was used.

Testing showed that simultaneous presentation of audio and visual segments resulted in better retention of information than either mode of sequencing ($\alpha = .05$). Additionally, sequencing of audio before visual segment resulted in significantly better retention ($\alpha = .05$). This outcome indicates that a slide-tape program intended to communicate information will be more effective if related audio and visual messages are presented simultaneously. If sequencing is necessary, presentation of audio before visual will be more effective.

ACKNOWLEDGEMENTS

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF GRAPHS

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

Today, in the midst of social and technological explosions in various fields of knowledge, as well as in the techniques by which this burgeoning knowledge is communicated, the teacher can no longer attempt to be the sole information-giving instrument in the classroom. Nor can the chief instructional medium, the textbook, be relied upon to communicate with efficiency. New instructional materials must be utilized in sufficient measure to provide pupils with the needed concrete, or quasi-concrete, experiences on the basis of which both old and new material may be made understandable. It is only in the very newest instructional materials - films, filmstrips, televisions, radio, slides, tapes, charts and other audio-visual media - that adequate experience with the modern world may be provided. Assimilation of both the visual and the auditory material is probably a prerequisite for learning and for more complex thinking processes to occur. What the process of assimilation involves and the conditions under which it can be facilitated are, therefore, matter of great interest to those concerned with the audio-visual field. Studies of the relative efficiency of the visual and auditory modes for the transmission of information have been typically undertaken in research, not in educational settings, but in settings where the problem has been to find ways of communicating efficiently with the operator of a piece of equipment.

This study focuses on the instructional effectiveness of three different techniques of slide-tape presentation. The problem in this research is whether auditory and visual material in the same message

should be transmitted simultaneously, or, by switching from one sense modality to the other. The basic problem to be faced in the use of the auditory and the visual channels is the difference in effectiveness of these channels in communicating the same instructional material. A major part of the function of the designer of slide-tape presentation is to attempt to arrange the presentation so that the important features are noted and retained. This can be done in a number of ways. One way is to design the slide-tape so that at the outset only the important features of whatever it presents are visible; the sound track follows and comments on the visual image. Another is to use the sound track simultaneously with the visual image to provide cues to the learner concerning what he is to perceive and what he is to ignore. A third approach is to provide such cues before the picture is shown.

Generally, when an attempt is made to restrict the attention of the observer to a particular aspect of a picture, there is a problem in ensuring that he will structure his perception properly into figure and ground. One suspects that man prefers to form concepts of objects from visual and auditory information simultaneously, rather than by switching sensory modalities from auditory to visual or vice versa, merely because the switching methods involve storing either an audio or visual image in memory.

A second problem to be considered in this regard is how the human perceptual system can handle a sequenced audio-visual presentation. This means that if a task requires the learner to receive information alternately through the eye and the ear, time will be lost in switching from visual to auditory portion of the instructional message. Although the amount of time lost is probably very small, it could be an important factor to consider in designing audiovisual materials.

In summary, there are three possible ways in which sequencing of the audio and visual portion of a message might prove detrimental to information assimilation: by mis-directing attention, by loading the memory capacity, and by requiring modality switching. Research bearing on these issues is discussed in the following section.

REVIEW OF RELATED RESEARCH

Travers (1966) has found that switching sensory modalities is a time consuming process that results in a loss in efficiency in transmitting information. In his studies a learning task involving nonsense syllables was used. A presentation rate of one syllable per second was chosen for the list of 10 syllables, since sense modality switching should then produce a decrement if time lost in switching was of the order 100 to 300 m. sec. This decrement in learning should be approximately 10 to 30 percent. Three experimental conditions were established by presenting the syllables in succession in the visual mode, or in the auditory mode or in alternation between the two modes. Travers has shown that the transmission of information through one sense modality makes it progressively more difficult or more time-consuming to switch to a source of information transmitted through another modality. It will also result in a less efficient transmission of information, and in the case of learning, less efficient learning. These findings are similar to those obtained by Broadbent and Gregory (1961). They followed the same method as Travers but used digits rather than syllables. They found that there was a decrement in the amount of recall between the suc-essive and alternating conditions of recall indicating that time was occupied by the switching process. However, in this study the difficulty of estimating perception time prevented the research workers from obtaining any estimate of time required for switching from one sense to the other. Moray (1960) observed that Broadbent's technique of presenting two digits simultaneously afforded the subject direct access to one digit of each pair but to only a trace of the other digit and surmised that this might account for the fact that successive recall was better than alternate recall in Broadbent's experiment. He there-

fore arranged for an alternation of the presentation of the digits, one to one ear and one to the other for a total of six digits. He confirmed Broadbent's earlier finding that the subjects' ability to recall the digits successively by channel was significantly superior to their ability to recall them in the order of presentation.

Donald A. Norman (1969) has studied recalling from short-term memory when subjects are requested to perform several tasks simultaneously. In his studies, subjects were asked to repeat aloud (to shadow) English words which were presented to one ear. They were then tested for their memory of two-digit numbers which were presented to their other ear. Thus, subjects are forced to devote a substantial portion of their attentional capacities to the task of shadowing. It was demonstrated that subjects have no memory for the digits presented to them if they must continue to shadow for 20 seconds before being tested on their memory for the digits. However, if tested immediately after presentation of each digit, they do remember some digits. Hence, verbal material presented on non-attended channels gets into a short-term memory, but is not transferred into long-term memory. Cherry as cited in Treisman and Geffen (1967) found that when the two messages come from different sources, subjects can repeat one back very efficiently, but can usually report nothing of the verbal content of the other, apart from a few highly important or relevant words.

Most of these studies have been done on nonsense syllables or digits which come alternately through ear and eye or ear and ear. There is no direct study of the efforts of presenting two related parts of a single message alternately through the ear and eye. The current research has been conducted to find out whether switching from one sense modality (e.g. a message arriving through the ears) to another sense modality

(e.g. a related picture arriving through the eyes) effects learning. A "related picture" means that if the audio portion describes the mating habits of spruce grouse (the male fans its tail, struts and flutters up into over head branches to attract the females) then the visual portion shows a male spruce grouse fanning its tail.

STATEMENT OF THE PROBLEM

In a slide-tape presentation, normally the audio portion of an instructional message is simultaneously accompanied by its related visual portion. This research makes an attempt to assess the effect of presenting the audio portion of an instructional message before the visual portion and the effect of presenting visual portion before the audio portion in a slide-tape program. A single instructional program is presented under three different conditions: The first condition does not involve switching between sensory modalities (the audio portion of the instructional message and its related slide are presented simultaneously; the second condition requires switching from auditory to visual sense modality (audio portion first then its related slide); the third condition requires switching from visual to auditory sense modality (slide first then related audio portion).

The purpose of this research is to determine the instructional effectiveness of these three different techniques in a slide-tape presentation. The results will be evaluated in terms of the scores on a post-test based on material presented in the slide-tape program.

HYPOTHESIS

The purpose of this study is to test the following hypotheses:

1- In a slide-tape program, simultaneous presentation of the auditory and visual portions of an instructional message (i.e. no modality switching) will result in higher retention scores for subjects at the grade nine and ten levels than (a) presentation of auditory before the visual portion or (b) presentation of the visual before auditory portion.

2- Presentation of the auditory before the visual portion of an instructional message will result in higher retention scores for subjects at the grade nine and ten levels than presentation of the visual before the auditory portion in slide-tape program.

RATIONALE FOR HYPOTHESES

Studies related to the use of audiovisual materials in teaching have long claimed the superiority of presenting information through two sense modalities as opposed to one. The concept underlying this claim seems to be that the learner will gain a greater amount of exposure when stimuli are presented simultaneously through two sense modalities, since he receives at least two instances of the same material, each one of which might be conceived as a separate learning trial. A simultaneous audiovisual presentation may also be more successful than a purely auditory or a purely visual program at focusing the learner's attention on the content of the presentation. Day and Beach as cited in Travers (1966) reviewed 10 studies which compared the relative efficiency of an audiovisual presentation of redundant information with the efficiencies of the auditory and visual channels alone. They found a combined audiovisual mode of presentation was superior over the auditory or the visual mode.

In the case of presenting the visual before the auditory portion of an instructional message, the visual portion is expected to be less effective in attracting the subjects' attention to the presented information, in comparison with the auditory. In this case the information does not pass through two sensory modalities and one of them (auditory) is free to attend to other signals in the environment (irrelevant message) which can compete for attention. Norman (1964) found that the irrelevant message gets into short-term memory and can interfere with learning of the relevant message which is transferred into long-term memory. Sequencing of audio and visual portions means that all information is not available at one time; hence, there are several possible

reasons to expect poorer performance:

(1) switching time (2) attention and (3) memory, as discussed under "Related Research."

CHAPTER TWO

PREPARATION OF INSTRUCTIONAL MATERIAL

The slide-tape presentation focused on six groups of Canadian birds. These birds are classified according to the kind of environment they usually live in. This subject was chosen because it is visually interesting yet unfamiliar to the test sample.

The purpose of this instructional production was to achieve the following objectives:

1. Given information on the name and life, and noted special characteristics, such as living in colonies, of some of the Common birds of Canada and the kind of environment they usually live in, the student will be able to identify the correct name and habitat of these birds by selecting one correct answer out of three possible answers.
2. Seeing different pictures of males and females of some Canadian birds via slides and hearing special characteristics of their mating habits and singing habits via tape-narration, the student will be able to identify the male and female of some common Canadian birds according to their characteristics by selecting one correct answer out of three possible answers.

Testing consisted of a total of thirty-nine multiple choice questions, in written form; fourteen minutes were allowed for completion of the test (thirty-five seconds per question and thirty-five seconds for reading instructions).

DESCRIPTION OF THE PRODUCTIONS

Sixty slides with accompanying synchronized audio tape (reel-to-reel) were used. Under each audiovisual condition, twenty slides were shown. The simultaneous condition took about five minutes of the program; because of the sequencing of messages, switching from auditory

to visual or vice versa each occupied about ten minutes of the program (total program time: about twenty-five minutes). Although the number of slides was equal and the number of words used was nearly equal in all three conditions, the switching from auditory to visual or vice versa stretched the duration of conditions 2 and 3 to two times that of the simultaneous condition.

A test production showed that grouping the twenty slides under each condition in a single block made the two "switching conditions" very tedious, and unnatural. Consequently, slides from each of the three conditions were sequenced as follows: for the first slide, switching from visual to audio message was used; in the second slide, the simultaneous condition; and in the third slide, switching from audio to visual was used. This sequence of presentation was followed throughout the whole production, so that the three different conditions would occur equally in the six groups of birds. When the audio portion was presented alone, blank slides were used to avoid bright illumination of the projection screen. The particular order of the conditions was chosen to minimize the number of blank slides used, and to obviate the need for two blank slides following one another; the program format is shown in Figure 1.

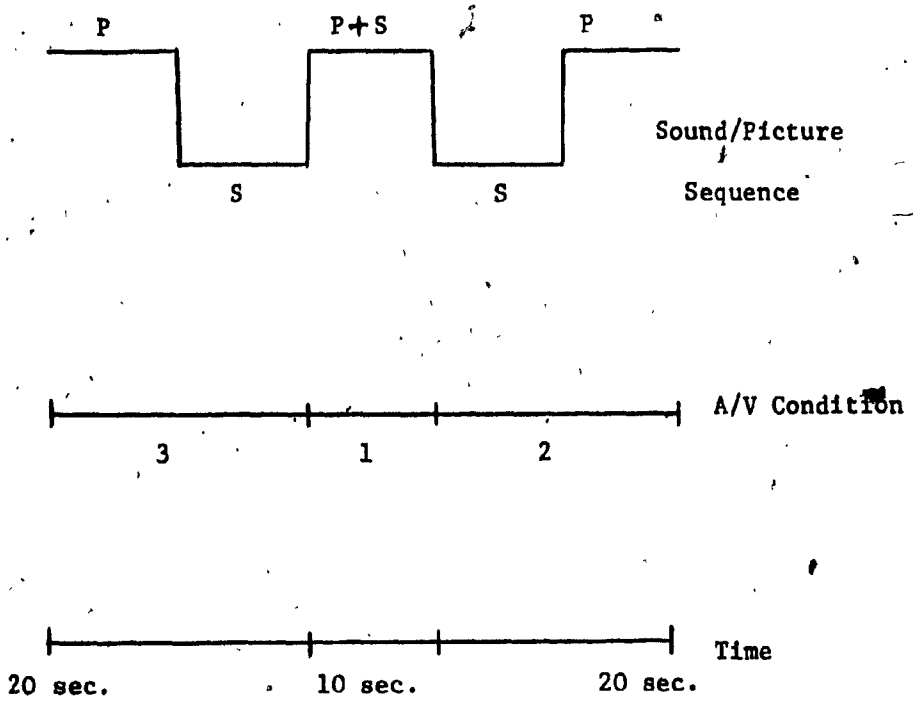


Fig. 1: The program format in diagrammatic form, showing the sequence of sound and picture elements, and the time occupied by each of the three conditions.

P - Picture alone; S- Sound alone;

P+S - Sound and picture simultaneously

Table 1 shows two complete cycles of the three conditions, indicating the order of events in both auditory and visual channels. In this fixed format all possible sequences of the three conditions do not occur, and so there is a risk of confounding the results by "order effects". However, the pilot production suggested that "order effects" posed less danger to the study than the disruption caused in the production by lengthening periods of blank screen which occur if condition 2 follows condition 3.

CONDITIONS	VIDEO		AUDIO
3	Picture	V	Music
	Blank Slide	A	Music & Text
1	Picture	A/V	Music & Text
2	Blank Slide	A	Music & Text
	Picture	V	Music
3	Picture	V	Music
	Blank Slide	A	Music & Text
1	Picture	A/V	Music & Text
2	Blank Slide	A	Music & Text
	Picture	V	Music

Table 1: Order of presentation of the three A/V conditions. The sequence of audio and visual events for two of the twenty cycles is shown.

VISUAL AND AUDITORY MATERIALS

All slides were full-colour copies, prepared by the researcher in the Graphics Lab, Concordia University in Montreal, using a 35 mm. Nikon Camera + 35mm. film. Slides have been copies from the "The Illustrated Natural History of Canada" and from the illustrated books of "The Birds of Canada". For narration, a female voice was used for all conditions of the production and the voice level remained the same throughout the program. The narration was edited on one channel of a tape-recorder and light music was used as a background during the presentation. The level of music was louder when the picture was presented without spoken text to prevent boredom.

The auditory and visual materials were presented by means of a Sony TC-270 stereo tape-recorder and a Kodak carousel 750 H projector. The stereo unit was equipped to read and record on one channel and had an internal signal generator which controls a circuit to operate the slide projector.

POPULATION AND SAMPLE

The population selected for this study consisted of students in grade nine and ten, between fifteen and seventeen years of age. The choice of students at this level was an arbitrary decision.

The experimental groups consisted of eighty-eight students from one grade nine and one grade ten class at St. George's High School, a private academic high school, in Montreal's Westmount district. Numbers of males and females were approximately equal. Most of the students of this high school are from middle-class families. The school was suitable for experimental purpose because audio-visual equipment and facilities were present in the school and students co-operate with admini-

strators and teachers in making radio programs, slide-tape shows and 16 mm. films.

This sample consists of two intact classes representing a range of intellectual abilities. However, a repeated-measures design was used to minimize the effect of individual differences. To evaluate the test procedures and to determine the baseline knowledge, a Control group of about twenty subjects, grade nine and ten, from the same school was used. This group did not take part in the final experiment but viewed the program during class hours and took the same post-test. They were supervised during the testing by their regular instructor. Two experimental classes viewed the presentation during regular class hours and were also supervised during the presentation and testing by their regular instructor.

EVALUATION OF THE PRODUCTION

The topic and level of information of the production were selected in a way to be interesting and educational for ninth and tenth grade students. The presentation was planned through discussion with some nine and ten teachers from the target school of the general knowledge of their students about the Canadian birds. The consensus was that the topic and type of information to be used were appropriate for the experiment as students at these levels do not know much about the life of birds. Also a pilot study was carried out prior to the experiment on samples of the target population who did not take part in the final experiment; on a group of Educational Technology students who had experience in teaching at the high school level; and on teachers versed in audio-visual techniques, to determine whether the materials were suitable in regard to the amount of information for each slide, length

of the program and the way of presenting three different types of audiovisual message. Additional objectives in the pilot study were to evaluate test procedures and obtain a measure of baseline knowledge in the target population. Sixty slides with accompanying synchronized audio-tape were used for the pilot study. In the pilot stage, the three different techniques were presented separately and in the following order: in the first twenty slides, the visual and its related audio portion were presented simultaneously; in the second twenty slides, the technique was switching from auditory to visual portion; and for the last twenty slides the technique was switching from the visual to the auditory portion of the instructional message. For each different condition, two different groups of Canadian birds were shown to the sample of the target population.

Comments on the pilot study suggested, first, that the three different conditions did not occur equally in the six groups of Canadian birds; secondly, that grouping the slides under each condition made the production boring.

As a result of the pilot study, the way of presenting the three different techniques was changed into the order previously explained in the section "Description of the Production".

METHOD AND PROCEDURES

Before the presentation the necessary equipment was set-up in the classroom during break time. The equipment employed consisted of a Sony stereo tape recorder (reel-to-reel) with one amplifier speaker, one Kodak carousel 35 mm. slide projector and one projection screen. The slide and tape equipment were fifteen feet from the screen. The sound level was adequate throughout the room. The room was dimmed by drawing curtains. The chairs were rearranged in such a way that many

of the subjects could be seated parallel to, or in front of the projection equipment.

Sixty slides, forty blank slides and two additional slides, (one title "The Canadian Birds" as the first slide; and another title "The End" as the last slide) were loaded in one tray. The changing of slides was synchronized in relation to the audio-narration.

Prior to experiencing the audio-visual presentation, subjects were given a short verbal introduction by their regular instructor. The subjects were told:

> You will be watching and listening to a tape-slide show about the Canadian birds. The show is about twenty five minutes long and its purpose is to give you information on the name, life and habits of some of the common birds of Canada.
>
> After the presentation you should be able to recognize some of the common birds of Canada by name, and distinguish the kind of environment they usually live in and some of their specific characteristics.

The program was then started. The pupils' regular instructor and the researcher remained in the room throughout the program.

TESTING PROCEDURES

As soon as the presentation ended, the subjects were asked to complete a written test. They were supervised by their regular instructor, and at this point, they were told:

> Please complete this written test.
> The purpose of this show was to investigate the best technique for presenting the instructional message in a slide-tape program. Your answers on the test, hopefully, will help the researcher to find out the best technique. After finishing the answers to the questions, please write your comment (s) about the technique of the presentation on the back of the answer sheet.

Then the test booklets were distributed (Appendix B) and instructions for completing the questions were read to the subjects.

They were also asked to write their age on the answer sheet, but no information was obtained regarding sex and name. After they were told not to talk or consult with each other in answering the questions, the testing began.

TEST MATERIALS

Assessment of the instructional success of the production was determined by scores on the posttest which was administered to the students immediately after the presentation. The test was based on the content of the production, and consisted of thirty nine multiple-choice questions on different facts about the birds, thirteen questions being drawn from material presented in each of the three conditions of the production. Questions took the multiple-choice form in order to reduce the time required the subjects to answer (Tuckman 1972). Three choices were available for each answer. Questions were in random sequence regardless of which condition of the presentation they referred to. Questions were designed to test the students' memory and recall of information presented in all three parts of the production.

DESIGN OF THE STUDY

In this repeated-measures design all subjects experienced both experimental conditions and the control condition. The simultaneous condition of the presentation was considered as a control for the two other conditions (auditory portion preceding the visual and visual preceding the auditory). The design is illustrated in Figure 2.

VARIABLES

Independent..... The independent variable is production techniques, with 3 levels:

1) Control conditions: simultaneous presentation of audio and visual messages.

2) condition 2: switching from auditory to visual message.

3) condition 3: switching from visual to auditory message.

Dependent variable... The dependent variable is learning as measured by recognition scores of the subjects on a multiple-choice test presented immediately after the production.

Controls..... 1) the number of slides are equal in all three conditions.

2) the number of words used are nearly equal for all three conditions.

3) sound levels and lighting conditions are the same throughout the presentation.

4) screen brilliance is controlled when the audio is presented alone.

5) previous knowledge is equally low for all six groups of birds (according to teacher judgement).

6) the three different conditions occur equally over the six groups of birds.

G. X_3 X_1 X_2 X_3 X_1 X_2 ..... O

G. experimental group.

X_1 simultaneously visual and auditory condition.

X_2 switching from audio to visual condition.

X_3 switching from visual to auditory condition.

O post-test

Figure 2: Design of study. A repeated measures design was used. The subjects experienced all experimental and control conditions and wrote the post-test based on material presented in the program.

CHAPTER THREE

RESULTS

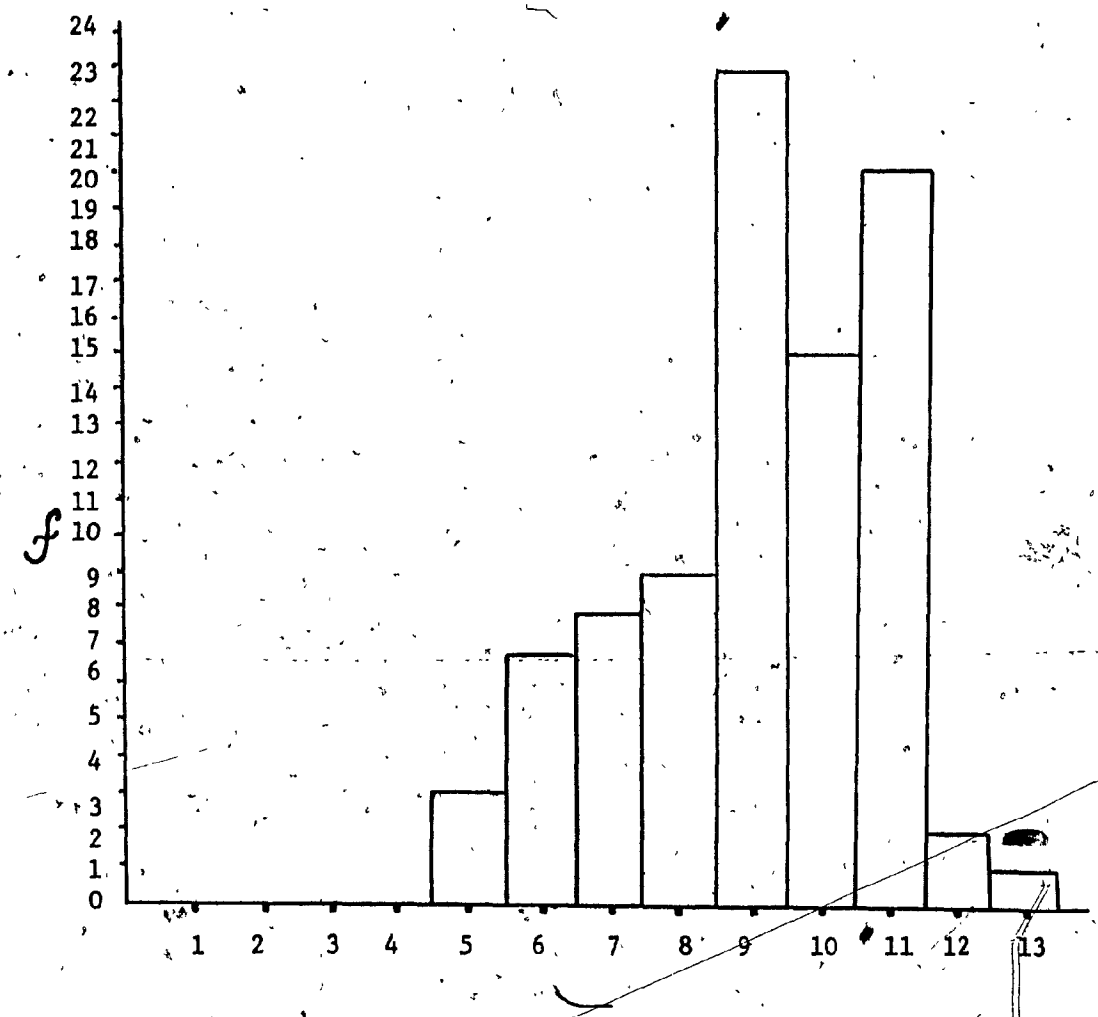
Forty-four subjects from grade nine and forty-four subjects from grade ten were sampled for the experimental group. All subjects viewed the same production during their class hour and took the same test. Each subject provided three scores on the post-test, one for each of the three production techniques. Graphs 1,2 and 3 show frequency distribution of correct answers for test scores on items presented under the three different conditions. In condition 1 all scores are located between 5 and 13; the ranges for conditions 2 and 3 are 1-12 and 2-11, respectively. Generally, the graphs show superior performance under condition 1 than under condition 2 or 3. As the graphs show, there is also poorer performance under condition 3 than under condition 2. Table 2 shows a summary of means, modes and medians for the three different conditions. Condition 1 has the largest mean which is very close to its median and mode. Condition 2 has the middle mean which is relatively close to its median and mode and condition 3 has the smallest mean which is relatively close to its median but not to its mode.

One way analysis of variance with three levels was applied to the number of correct answers to assess the differences between production techniques. A repeated-measures design was used (Winer, 1962, p. 105). The results of this analysis, shown in Table 3, indicated that statistically significant differences existed between condition 1 and conditions 2 and 3.

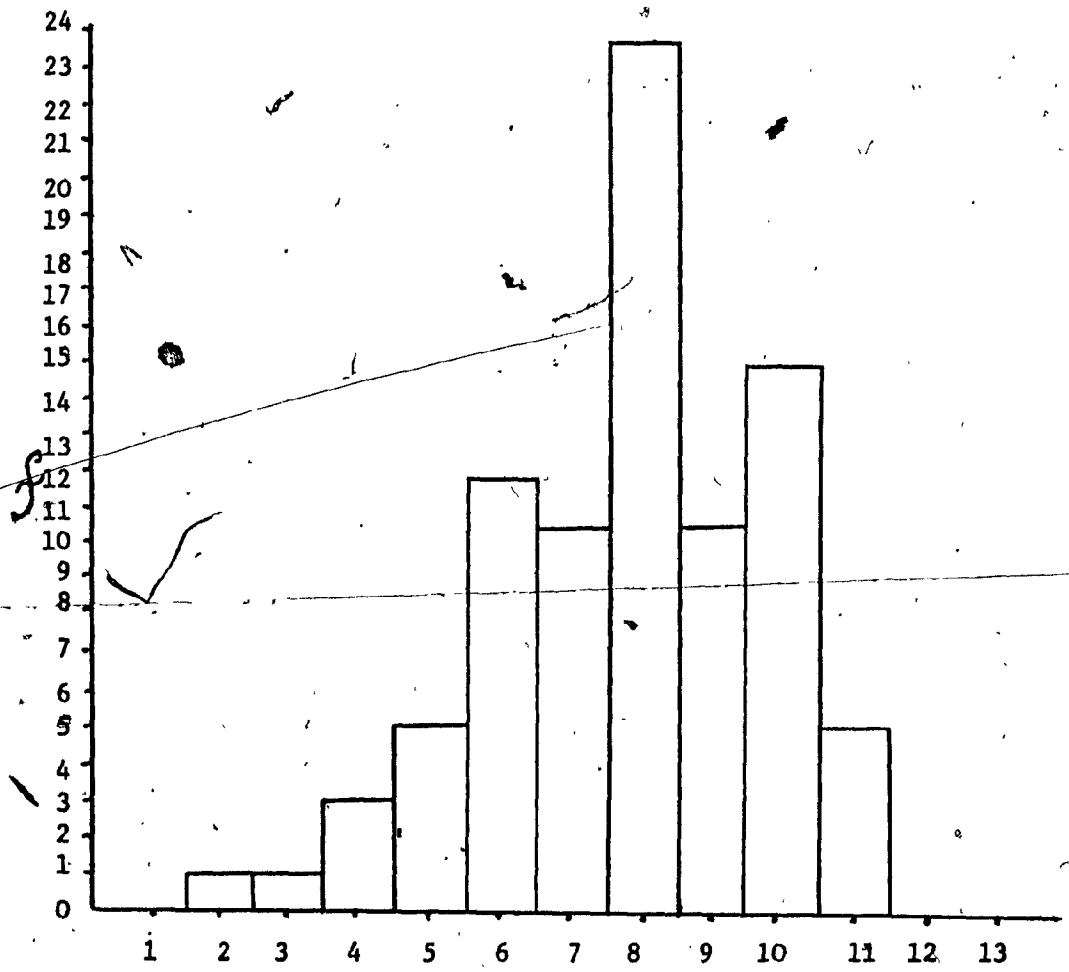
To separate the means statistically, the Scheffé test was used (Winer, 1962, p. 88). The mean of the simultaneous condition (1)

is significantly greater than two other conditions (2; 3) and the mean of condition 2 is significantly greater than condition 3 at the .05 level of significance. The results of this analysis are shown in Table 4.

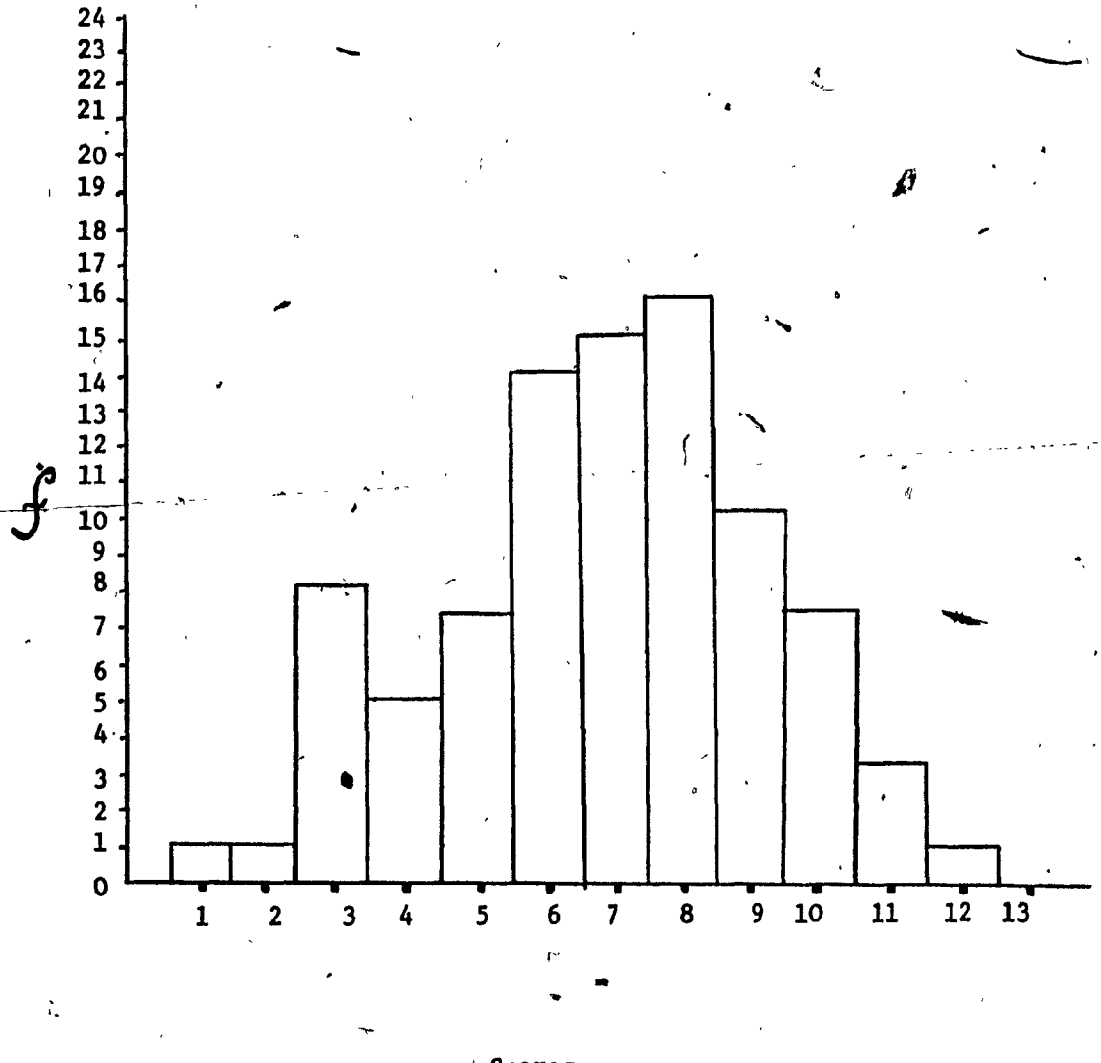
The attitudes of subjects towards the type of presentation differed. Most believed that the slide-tape show was interesting and educational, the music was good and suited the pictures, but the blank slides took their attention away from the slide-tape show and made the program boring. A few believed that the way of presenting materials was very good; that it kept their attention and also made the program interesting. A very few found the program very interesting because of the many different birds which they had never seen; they were indifferent to the type of presentation.



Graph 1: Distribution of correct responses to 13 test items based on information presented via condition 1 (simultaneous auditory and visual messages).



Graph 2: Distribution of correct responses to 13-test items based on information presented via condition 2 (auditory before visual portion of instructional message).



Graph 3: Distribution of correct responses to 13 test items based on information presented via Condition 3 (visual before auditory portion of instructional message)

CONDITIONS

	1	2	3
	S P	S	P
$\bar{X}$ (Mean)	9.07	7.80	6.86
M (Median)	9	8	7
M_o (Mode)	9	8	8
N	88	88	88

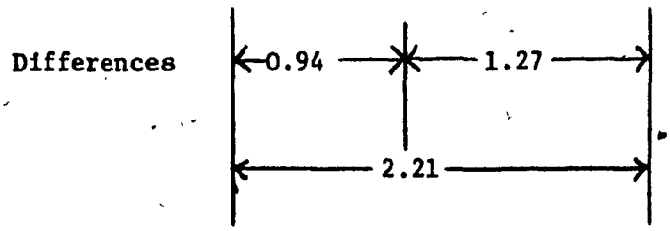
Table 2: Summary of means, medians and modes (no. of correct responses) for the three production techniques

Source	SS	df	MS	F
Within	1258.67			
Conditions	217.64	2	108.82	18.19*
Residual	1041.03	208	5.98	

* significant at .05 level

Table 3: Summary table for analysis of variance comparing the three different production techniques.

	Condition 3	Condition 2	Condition 1
Means	6.86	7.80	9.07



Min. Differences at . 05 level: 0.91

Table 4: Comparison of differences between mean number of correct responses for the three production techniques with minimum significant differences at $\alpha = .05$ (Scheffé test).

Results showed statistically significant differences between conditions 1 and 2, and conditions 1 and 3, and between conditions 2 and 3. ($\alpha = .05$).

CHAPTER FOUR

DISCUSSION AND CONCLUSIONS

This study was conducted to find out the instructional effectiveness of (3) different techniques of slide-tape presentation. The hypothesis set forth in this experiment, that the simultaneous presentation of the audio portion of the instructional message and its related slide would produce higher scores on the post-test than the presentation of the auditory before the visual portion of the instructional message or vice versa was confirmed. It was to be expected as this is the classic case described in audiovisual textbooks which all cite the same studies to support the contention that more efficient learning is achieved through the simultaneous presentation of the same information through two sensory modalities than through auditory or visual modality in turn.

The result here supports Day's view (as cited in Mowbray, (1953)) that a combined visual and auditory presentation of the same material results in better comprehension than the presentation of either auditory or visual material alone. It could be that the process of synthesizing the visual and audio modalities gives attention to the most pertinent parts of the message and, within the focus of attention, to the most pertinent features in the message. This suggestion supports Travers (1970) view that the simultaneous presentation of auditory and visual portions of the same instructional message eliminates all but the essential visual features and auditory message necessary for transmitting the pertinent information. It also could be that simultaneous use of the visual and auditory modes produces more information than the use of one modality alone. This finding is similar to that obtained by

Broadbent and Gregory (1961) that, if the transmission of information through one sense modality is interrupted by switching to a source of information transmitted through another modality, there is less learning than there would be in simultaneous transmission of information via both sense modalities. According to Travers (1970) in the simultaneous transmission of the same information through two sensory modalities, the auditory channel is used to cue perceptual processes in the visual channel. Thus if the sound track of the production says "male spruce grouse fans its tail, struts and flutters up into overhead branches to attract the female in its mating display " such a cue probably directs visual attention to the fan-like shape of the spruce grouse's tail. Of course, if much commentary is to be given, then more efficient communication can be achieved by presenting the audio and visual portion of the same instructional message simultaneously rather than sequentially.

As it was expected by the experimenter, statistically significant difference was found in the retention of scores on the post-test between the presentation of the auditory before the visual portion of an instructional message and the presentation of the auditory after the visual portion of an instruction message. The problem in switching sensory modalities arises because the two perceptual systems do not function as analyzers of information at the same time. If in switching from auditory to visual modality, the student concentrates on some minor detail when he is supposed to be scanning the entire screen and deriving some general impression, he may end up learning trivia. The same is true in switching from visual to auditory modality, if he surveys the entire visual presentation when he should be examining carefully some central feature. To a great extent the auditory channel can be used to provide information to control the student's attention, when it accompanies the visual channel.

In dealing with the switching sensory modalities, one must consider the amount of information that the perceptual system can use from a single and static presentation. The auditory channel is thoroughly accepted by most people as the channel for symbolic communications, and the visual channel is taken for granted as the channel through which direct information about the major features of a concrete image are received. Probably for this reason, when symbolic material is presented through the visual system, as it is when picture alone is presented, there is a marked tendency for the viewer to reject such material or ignore relevant information in the picture presented. In the case of sensory modalities switching, it means that each time the subject has to block one channel and less is learned through the remaining channel in comparison with the simultaneous condition.

Several factors have to be considered in determining the effect of such switching on learning. For instance there may be a loss of time involved in switching since Reid and Travers (1968) found that switching of perceptual channels resulted in a decrement in learning of about 15 percent as compared with the conditions under which no switching was required and attributed it to the time lost in switching. Switching time was computed to be approximately one-fifth of a second per switch. Secondly, there may be a memory problem in switching, for Corballis (1966) has suggested that short-term memory storage of unrehearsed digits is more effective in auditory than visual modality. There is also the possibility, raised by Broadbent (1958), that after one perceptual system has been used for a time, other perceptual systems become less sensitive.

We can reach the conclusion that learning involving switching sensory modalities is less efficient than learning with simultaneous presentation of related material in a slide-tape program. Also learning

involving switching from auditory to visual modality seems to produce higher retention scores on the post-test than switching from visual to auditory mode.

The commentary in many "informative" programs (e.g. educational broadcasts) must accompany the video presentation in order to help the viewer sort out the relevant from the irrelevant in the video presentation. The present results indicate that information is not satisfactorily stored when the viewer is exposed sequentially to related audio and visual inputs, though some learning may occur under such circumstances. Consequently, in the production of informative programs, it is advisable to present related audio and visual messages simultaneously, where possible. Still, if a task requires switching sensory modalities, switching from auditory to visual is perhaps to be suggested as the receiver's gaze may be misdirected in the reverse case.

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APPENDIX A

SLIDE-TAPE SCRIPTS

The conventional signals used to describe the framing of pictorial slides and indicate directions for the sound are as follows:

MS = Medium shot

LS = Long shot

CU = Close-up

FU = Fade up

FO = Fade out

F-under = Fade under

	SLIDE	CONDITION	TAPE
1-	Blank slide		FU Music
2-	Title	P	The Canadian Birds
4-	LS of a few birds on a mountain	P + S	From the earliest time of recorded history, men have been fascinated by the beauty and mystery of birds.
6-	LS of a bird in flight.	S	Somehow, birds have seemed to be set apart from the rest of the animal kingdom by their power of flight and their beauty of plumage.
7-	LS of a few birds on an island	P	Men have been studying birds for a long time. One aspect of the study of birds is the classifying of them according to the kind of environment they live in.
9-	Title	P + S	The Prairie Birds
11-	LS of two sage grouse	S	Sage grouse is the largest grouse of the continent. As the name implies, the sage grouse belongs to

SLIDE	CONDITION	TAPE
11- cont....		the sage brush, where there are small streams and springs, from British Columbia through the Rocky mountain states.
12- LS of male and female of sage grouse	P	Both sexes have narrow, pointed tails. In addition, males have blackish brown throats, narrowly separated by white from a dark V-shaped pattern on the neck and white breast feathers. Females lack these structures but in other respects resemble males.
14- LS of a few sage grouse in open terrain	P + S	The mating habits of the sage grouse are remarkable. In early spring, many sage cocks gather in open terrain.
16- LS of male and a few females of sage grouse	S	The male chooses a partner at random. He spreads his spearlike tail feathers in a splendid fan. He drops his wings and fluffs his

SLIDE	CONDITION	TAPE
16- cont...		plumage.
17- LS of male and female sage grouse	P	He dances about his chosen lady, expanding his breast and pushing it on the ground before him until it becomes ragged by the end of mating season.
19- LS of male and female of prairie chicken	P + S	The most common grouse which is found from the plains of central Canada to central Texas is the greater prairie chicken. In this picture male and female are shown together.
21- MS of male prairie chicken	S	The neck of both sexes has elongated "pinnea" made up of about 10 graduated feathers. Males have a yellow comb above the eyes and bare areas of yellowish skin below the pinnea that are exposed and expanded during sexual display.

SLIDE	CONDITION	TAPE
22- LS of female prairie chicken	P	Females have relatively shorter pinnea and are more extensively barred on the tail and they lack the bare areas of yellow-ish skin below the pinnea. These birds will disappear as the native prairie is broken up for acrigulture.
24- LS of male willow ptarmigan	P+ S	In British Columbia, Alberta and Central Quebec, we can see a kind of small grouse known as the willow ptarmigan. As you will notice in the picture males have a scarlet "comb" above the eyes and during summer the feathers are rusty brown in color.
26- LS of female willow ptarmigan	P	Females lack the bright reddish "eye brows" of males, are more grayish-brown and lack the rusty brown color of males in summer. The female in autumn is similar to the

SLIDE	CONDITION	TAPE
26- cont...		male but is more grayish above and more white below.
27- LS of males and chicken willow ptarmigan	P	It is almost impossible to differentiate completely between male and female behavior patterns in the willow ptarmigan. In the picture a male was taking care of the chicks and as you noticed you could see the dark brown feathers of the male in the summer.
29- LS IV male ruffed grouse	P+S	In Central Saskatchewan, Northern Ontario, and Southern Quebec, there is a kind of sage grouse known as ruffed grouse. Males have relatively long, slightly rounded tails. The fan-shaped and distinctively banded tail and neck ruffs of both sexes make field identification easy.

SLIDE	CONDITION	TAPE
31- LS of female ruffed grouse	S	Females have shorter tails than do males and their central tail feathers lack complete subterminal bands near the middle of the tail. Although the ruffed grouse is one of the best adapted of all grouse, especially to withstanding cold weather.
32- Title	P	The Mountain Birds
34- LS of female rufous hummingbird and her young	S + P	Canada's smallest, fastest and brightest birds are the hummingbirds. In western Alberta the common species is the rufous hummingbird, found at the coast and north to the Yukon. In this picture a female rufous hummingbird tends to her young bird in the nest.
36- LS of male and female calliope hummingbird	S	In the dry southern valleys are found the calliope hummingbird. In the picture a female calliope

SLIDE	CONDITION	TAPE
36- cont...		hummingbird is about to feed insects to her fledgling. These hummingbirds are able to fly backwards.
38- Title	P	The Forest Birds
39- LS of sparrow hawk resting with its prey		The forest of the Maritimes region offer a great variety of living spaces to specific types of birds. The majority of forest birds feed on insects while predatory birds prey on the aboundant small rodents of the forest floor. One of these birds is the sparrow hawk resting with its prey, a deer mouse.
41- MS of a goshawk resting in the trees	P+S	The goshawks, large, well-built predators, are capable of killing prey the size of rabbits and pheasants. They hunt at low levels, but build their bulky nests of twigs lined with bark high up in the

SLIDE	CONDITION	TAPE
41- cont...		trees, and usually return to them each year.
42- LS of a yellow warbler	P	Our most common warbler, the yellow warbler, prefers thickets and forest fringes, yet is often found in the shrubbery around houses. A male may sing over 3,000 songs a day in the summer breeding season.
44- LS of a hawk-owl resting on a tree	P + S	As predatory birds of the northern forest, owls are superbly equipped to be master hunters with sharp powerful talons and a compact, hooked beak. The hawk-owl, with the speed of a hawk and the silent flight of an owl, is a daytime hunter in the far north, where summer nights are short.
46- MS of the great horned owl	S	The most powerful of all, the great horned owl is formidable in the defense

SLIDE	CONDITION	TAPE
46- cont...		of its nest. It takes a long time to rear a family of owlets. The male calls to the female with a reasonant hoot. It breeds early in the year and incubates eggs while snow lies all around.
47- LS of a great gray owl	P	The great gray owl is thickly feathered, and not as fearsome as its size suggests. It can be frequently seen in winter, forced into populated areas to search for food.
49- MS of a boreal owl	P+S	The boreal owl is a particularly effective hunter. This one has carried its prey to a concealed branch, and warns off intruders with a yellow-eyed stare.
51- CL of a bald eagle	S	"King of Birds" is the popular title for the majestic bald eagle. The name "bald eagle" was

SLIDE	CONDITION	TAPE
51- cont...		given, not because the bird is bald, but because the tight hood of white feathers makes the head appear bare.
52- LS of an eagle	P	This dark-plumaged, immature eagle will not acquire the white head and tail of maturity until it is about three years old. A larger species living chiefly in Alaska and Canada is known as the northern bald eagle.
54- LS of a golden eagle	P+S	The golden eagle, one of the most magnificent of birds, can be seen in Southern Saskatchewan. Careful studies show that their diet consists of about two-third jack rabbit and cottontails. This one feeds on a newly killed small marmot.

SLIDE	CONDITION	TAPE
56- LS of a rose-breatested grosebeak and her young bird	S	Every summer, the woodlands of the Maritimes region welcome the activity of migrant birds, arriving in waves from tropical climes to seek out breeding places. One of them is the rose-breasted grosebeak. In this species both sexes sing, an unusual phenomenon among birds.
57- LS of a scarlet tanager and her young bird in the nest	P	Another migrant bird is the scarlet tanager. This bird builds its loose, rather shallow nest, well out on a horizontal branch of a tree, anywhere from 10 to 50 feet above ground. In the picture the elder scarlet tanager was feeding the young.
58- Title	P+S	The Valley Birds
59- LS of a spruce grouse	S	Although there is a predominance of aquatic birds

SLIDE	CONDITION	TAPE
59- cont...		in the St. Lawrence River valley the area also plays host to many land species like the spruce grouse. Spruce grouse also called Canada grouse. Both sexes have brown or blackish tail feathers.
62- LS of male spruce grouse struts and flutters his fan shape tail up into over-head branches	P	Male spruce grouse use a vocal signal in mating, a low-pitched "hoot". He also fans his tail, and struts and flutters up into overhead branches to attract the female in its mating display.
64- LS of a snow goose	P+S	Pure white snow geese with black wing tips nest throughout the mountains, favouring braod valleys with ponds and back water like along much of the Columbia River, in the Rocky Mountain trench.

	SLIDE	CONDITION	TAPE
66-	LS of a goose	S	The geese inhabit lakes, where islands are favourite nesting places. The Canada goose, like the maple leaf, has become a national symbol.
67-	LS of an eider duck and a small duckling	P	Ducks are also well adapted water birds, but not authentic seabirds. They nest on the fresh water lakes and marshes of the St. Lawrence River valleys. In the picture the eider duck supports a small eider-down industry in the valley.
69-	LS of two white pellicans	P+S	Our biggest bird is the white pellican with a wingspread of between 8 to 10 feet, very impressive during flight with their snow-white colouring and V-shaped formation. They can still be seen in a few places.

	SLIDE	CONDITION	TAPE
71-	Title	S	The Seabirds
73-	LS of a gannet on the island	P	That was a gannet and its mate preparing for nesting. A characteristic of seabirds is their habit of nesting together in dense, massed colonies. The largest and most accessible colonies of gannets is on Bonaventure Island.
74-	MS of a gannet with his beak full of sticks	P + S	A gannet collects sticks and other debries which is to be used as nesting material. Gannets spend most of the year feeding and sleeping at sea. In spring numbers of gannets cover the cliffs, making ready their nesting territories.
76-	LS of a male sitting on an egg	S	Both male and female help to incubate the single, whitish egg, but the parents desert the young

SLIDE	CONDITION	TAPE
76- cont...		bird after 12 weeks. It may spend a week at the nest site, then falls from the cliffs to water, where it quickly learns to fish for itself.
77- LS of a gannet	P	There is evidence to suggest that gannets, like gulls, are very sensitive to D.D.T. which may effect their reproduction and cause them to be born with thin fragile shells.
79- LS of a few puffins	P+S	Puffins are the most attractive seabirds on the Pacific coast, their breeding grounds are in Newfoundland and Greenland. Puffins of the far North are important additions to Eskimo diet.
81- LS of a few puffins resting on the island	S	In the Norther Pacific Ocean puffins reach the Arctic islands in the Bering Sea

SLIDE	CONDITION	TAPE
81- cont...		and cliffs close to the Bering Strait. They feed on the plankton of the Northern Pacific coast.
82- MS of a puffin	P	Puffins with a huge, parrot-like bill which takes on a variety of colours in the breeding season are the most colourful of the Arctic seabirds.
84- LS of a few puffins with beaks full of fish	P + S	Puffins are deep-water feeders that operate well offshore, but they eat small fish. They fly to their nest burrows with beaks full of as many as eight fish held in their huge bills.
86- MS of a puffin with beaks full of fish	S	The manner in which a puffin manages to hold on to a half a dozen wriggling fish when it opens its bill to capture another one is one of nature's mysteries.

	SLIDE	CONDITION	TAPE
86-	cont...		It may hold the previously caught fish against its upper mandible with its tongue.
87-	LS of a cormofant resting in the nest	P	The high cliffs along the Maritime coast provide the main Canadian nesting sites for the great cormorant. They are capable of deep diving and rapid underwater swimming.
89-	LS of a nesting colony of cormorants	P+S	A nesting colony along the Maritime coast is filled with cormorants. The reason for the nesting colony is that they require a cliff from which they can pitch off into mid-air or at least a steep slope to aid them in getting airborne.
91-	LS of a gull in flight	S	That is a gull, an Atlantic species which

SLIDE	CONDITION	TAPE
91- cont...		breeds as far north as Bear Island in the Arctic. These birds are predators and they nest on flat or rolling ground rather than cliffs. Gulls are intensely social birds.
94- LS of two gulls fighting with each other	P	Two gulls fight for living space on an overcrowded bird colony. They kill other birds on the wing and steal eggs and young.
95- Title	P+S	The Park Birds
96- LS of two whooping cranes	S	The whooping cranes are Canada's tallest birds, standing 4 feet high. Their only permanent breeding ground lies within the park boundaries, in wooded Buffalo National Park.
99- LS of two whoopers in flight	P	With a majestic wing spread of 8 feet, white whoopers are recognised by their outstretched

SLIDE	CONDITION	TAPE
99- cont...		neck and legs.
101- LS of two whoopers, coming down to the ground	P + S	Announcing their arrival with loud whoops, a pair of cranes prepare to settle for the short sub-arctic summer. A warm dry season encourages mating.
103- LS of a young whooper and its parents	S	The young cranes quickly matches their parents in size, and start to wade in shallow marshes where they feed mainly on aquatic insects, and berries.
104- LS of a whooper and sandhill	P	This readily distinguished young whooper feeds alongside its near relative, the sandhill crane.
Title		The End FU music - slowly FO

APPENDIX B

CRITERION TEST

Direction: In each of the following questions, there are three possible answers. Only one answer is correct for each question. After reading carefully, select the correct answer and circle the proper letter. All correct answers have equal scores.

1- Birds are set apart from the rest of the animal kingdom by:

A. laying eggs.

B. power of flight.

C. having a beak.

2- The largest grouse on the continent is:

A. sage grouse.

B. willow ptarmigan.

C. spruce grouse.

3- "King of Birds" is the:

A. cormorant.

B. gray owl.

C. bald eagle.

4- The "master hunter" birds are:

A. owls.

B. goshawks.

C. sparrow hawks.

5- What habit of the sage grouse is remarkable?

A. singing habit.

B. habit of nesting together.

C. the mating habit.

6- The male of what kind of grouse has a bare area of yellowish skin below the pinnea?

A. willow ptarmigan.

B. great prairie chicken.

C. sage grouse.

7- Which bird, like the maple leaf, has become a national symbol?

A. Canada goose.

B. Canada eagle.

C. Canada grouse.

8- White snow geese live in:

A. the river valleys.

B. the sea valleys.

C. the river valley marshes.

9- The low pitches "hoot" in a sexual situation belongs to:

A. spruce grouse.

B. golden eagle.

C. bald eagle.

10- Which bird is recognised in flight by its outstretched neck and legs?

A. gull.

B. whooper.

C. gannet.

11- The most common characteristic of the seabirds is:

A. the habit of nesting together.

B. the mating habit.

C. the singing habit.

12- Which one spends most of the year feeding and sleeping at sea?

A. gannet.

B. puffin.

C. crane.

13- Ruffed grouse can be easily identified by:

A. its fan-shaped tail.

B. its beautiful beak.

C. its beautiful song.

14- Both sexes of this bird sing which is an unusual phenomenon:

A. warbler.

B. scarlet tanager.

C. grosebeak.

15- The breeding grounds of puffins are in:

A. Newfoundland and Greenland.

B. Central Quebec.

C. British Columbia.

16- Which are considered prairie birds?

A. sage grouse.

B. cormorant.

C. goshawks.

17- The only bird able to fly backwards is:

A. the hummingbird.

B. the warbler.

C. the sparrow hawk.

18- Which is considered the valley bird:

A. the willow ptarmigan.

B. the duck.

C. the tuff puffin.

19- In which part of Canada do sparrow hawks live?

A. the forest of the Maritimes.

B. British Columbia.

C. Central Quebec.

20- Which is considered the forest bird?

A. yellow warbler.

B. spruce grouse.

C. pelican.

21- The most common warbler is:

A. the yellow warbler.

B. the brown warbler.

C. the gray warbler.

22- The day-time hunter with silent flight is:

A. great horned owl.

B. hawk owl.

C. boreal owl.

23- The most powerful owl is:

A. great horned owl.

B. hawk owl.

C. gray owl.

24- The common name of bald eagle was given because:

A. the bird is bald.

B. the white feathers on the head.

C. no specific reason.

25- It is impossible to differentiate completely between male and female behavior in:

A. willow ptarmigan.

B. great prairie chicken.

C. sage grouse.

26- The diet of which bird consists of about two-thirds jack rabbit and cottontails?

A. golden eagle.

B. gray owl.

C. sparrow hawk.

27- Which one is also called "the Canada grouse"?

A. the sage grouse.

B. spruce grouse.

C. ruffed grouse.

28- The most attractive and colourful of the Arctic seabird is:

A. puffin.

B. gulls.

C. crane.

29- The most common grouse which is found from the plains of central Canada to central Texas and Ohio is:

A. the great prairie chicken.

B. spruce grouse.

C. sage grouse.

30- The largest and most accessible colonies of gannets are on:

A. Bonaventure Island.

B. North Pacific Ocean.

C. Atlantic Coast.

31- Which bird, like the gulls, is very sensitive to D.D.T?

A. puffin.

B. gannet.

C. pelican.

32- The eagle chiefly lives in:

A. the forests of Canada and Alaska.

B. the park boundaries of Canada and Alaska.

C. the prairie lands of Canada and Alaska.

33- Which one is considered as a park boundaries bird?

A. sparrow hawk.

B. yellow warbler.

C. whooper crane.

34- The male of what kind of grouse has a scarlet "comb" above the eyes?

A. ruffed grouse.

B. great prairie chicken.

C. willow ptarmigan.

35- Which is Canada's tallest bird standing four feet high?

A. whooper crane.

B. owl.

C. scarlet tanager.

36- Which bird is intensely social?

A. gull

B. gannet.

C. puffin.

37- Which one is a predator?

A. spruce grouse.

B. puffin.

C. gull.

38- The owls live in the:

A. Northern forest.

B. prairie lands.

C. parks.

39- The biggest bird with a wingspread of between 8 and 10 feet is:

A. gannet.

B. golden eagle.

C. pelican.

APPENDIX C

SCHEFFÉ TEST

Analysis of Variance with Repeated Measures

$$SS_W \text{ People} = \Sigma\Sigma X^2 - \frac{\Sigma P_i^2}{K} = 1258.67$$

$$SS_{\text{Condition}} = \frac{\Sigma T_i^2}{n} - \frac{G^2}{Kn} = 217.64$$

$$SS_{\text{Residual}} = (\Sigma\Sigma X^2) - \left(\frac{\Sigma T_i^2}{n}\right) - \left(\frac{\Sigma P_i^2}{K}\right) + \left(\frac{G^2}{Kn}\right) = 1041.03$$

$$MS_B = \frac{SS_{\text{cond.}}}{K-1} = 108.82$$

$$MS_W = \frac{SS_{\text{red.}}}{(n-1)(K-1)} = 5.98$$

$$F = \frac{MS_B}{MS_W} = 18.19$$

Scheffé Test

$$\text{Minimum difference} = t'_{.05}\sqrt{\frac{2MS_W}{n}}$$

$$t'_{.05} = \sqrt{(K-1)(n-1)\,F_{.05}}$$

Minimum difference = .91

Then, any difference between means which exceeds .91 is significant at .05 level.

APPENDIX D

POST-TEST

RELIABILITY

Test Reliability - the Soupe Test

Soupe has developed a simple method for assessing test reliability, based on the Kudar-Richardson formula 20. The method is only applicable to tests scored by assigning 1 and 0 to correct and incorrect responses, respectively. Application of Soupe's method yields a slightly more conservative estimate of test reliability than the split-half technique. (Scannell and Tracy, 1975, p.207-210).

Calculations:

$$r_t = 1 - \frac{.19K}{SD^2}$$

where r_t = reliability coefficient

SD^2 = variance

k = no. of items in test

.19 = a constant

Condition 1: $r_{t_1} = 1 - \frac{.19(13)}{20.25} = .89$

Condition 2: $r_{t_2} = 1 - \frac{.19(13)}{24.5} = 0.9$

Condition 3: $r_{t_3} = 1 - \frac{.19(13)}{20.25} = .89$

The above calculations show that in the part of the post-test related to condition 1, 89% of variance is due to true differences between subjects scores. Similarly, the figures for condition 2 and 3 are 90% and 89%.