CONJUGATE REINFORCEMENT AS A METHOD OF STUDYING THE COMPARATIVE EFFECTIVENESS OF BLACK-AND-WHITE VERSUS COLOR TELEVISION

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ABSTRACT

CONJUGATE REINFORCEMENT AS A METHOD OF STUDYING THE COMPARATIVE EFFECTIVENESS OF BLACK-AND-WHITE VERSUS COLOR TELEVISION

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A study was conducted to investigate the comparative viewer interest in black-and-white versus color educational television, and to examine the relationship between viewer interest and recall of content. Forty graduate and undergraduate male and female students at Concordia University ranging in age from 18 to 45 comprised two groups of twenty subjects each. One group of subjects viewed the educational television program in color, the second group viewed an identical program in black-and-white. The technique used was that of conjugate reinforcement in which the subjects are required to operantly respond in order to maintain the brightness of the television screen at the desired level. Subjects moment-to-moment rates of operant responding were automatically recorded by a conjugately programmed apparatus. Formal learning or retention of the programs content was determined by the results of a questionnaire administered to all subjects immediately following the viewing of the television segment.

Results of the study showed that the mean number of operant responses of the black-and-white and color groups was not significantly different. However, the color group correctly answered a significantly higher number of test items. A strong positive relationship was seen between the number of test items answered correctly and the number of operant responses for the subjects who viewed color television. It was suggested that this was possibly due to color television providing more perceptual cues than black-and-white.

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CHAPTER 1

INTRODUCTION

STATEMENT OF PURPOSE FOR THE STUDY (OBJECTIVES)

The principle purpose for this empirical study was to measure and evaluate comparative viewer interest in black-and-white versus color educational television programs. These variables have attracted a great deal of attention in comparative effectiveness research. Viewer interest is defined by the amount of time that subjects will spend viewing the programs, and also by their willingness to work to see them. Subject's willingness to see the program is measured by their number of responses to a conjugately programmed operant behavior apparatus that controls the illumination of the television viewer screen.

A further objective of this study was to investigate the relationship between interest expressed in terms of operant responding, and recognition of the programs content. Learning was determined by a questionnaire of the programs' content, designed to measure information gained.

The basic questions that were investigated in this study were: 1) do black-and-white versus color educational television programs generate differential degrees of interest, i.e., rates of

operant responding? 2) is there a relationship between demonstrated viewer interest in a program, and recall of information gained from the program, and 3) do subjects who express more attention in relation to the program (by operant responding), learn more, and will they perform significantly better on the post-viewing questionnaire?

According to Coldevin (1976), the controversy surrounding the effect of color television is far from resolved. The situation has been intensified by the rapid increase in color facilities in both formal learning and home environments. There are three areas which merit additional investigation: (1) the comparative utility of color versus other techniques of isolating critical information, (2) the interaction of attention, interest and involvement in and formal learning from color television, (cf Chu and Schramm, 1967), and (3) if subjects were given a choice of broadcasted programs, one in color, the other in black-and-white, which one would he/she watch? Would he tune into the color program and ignore the black-and-white, or vice-versa?

A technique devised by Lindsley purports to measure how rewarding a program is to a viewer by measuring how hard he will work to look at it. The measure is continuous, immediate, objective and sensitive. This technique avoids most of the validity problems inherent in verbal recall methods in that there are printed graphs for the experimenter to refer to for a measure of the subjects willingness to work in order to view a specific program. Lindsley has used this

technique in advertising research to pretest the effectiveness of commercials in gaining consumer interest. The procedure requires the subject to work in order to view or hear the stimulus material. The technique evolved from work done by Skinner and Lindsley on operant behavior. The specific concept underlying the technique is that of conjugate reinforcement, i.e., where "a subject's rate of responding controls directly and immediately the intensity of a continuously available reinforcing stimulus" (Nathan and Wallace, 1965 p. 14).

Since we are concerned only with measuring the rate of the response, a special technique of recording it has been developed. Recording paper moves continuously at 60 centimeters (almost 12 inches) per hour. Each response is indicated on the passing record by an upward movement of the recording pen. Thus the slope of the resulting graph indicates the rate of responding, and the original record can be fully interpreted without further analysis.

Operant responding as used to measure attention

The term "attention" has attracted a great deal of investigation in that there has been a variety of meanings, within psychological literature, attached to it. The inferred conceptual process underlying attentional behavior has also been the subject of diverse theoretical analyses. The mere act of listening to an instruction or looking at an object does not guarantee that a student is necessarily "attending" to it; a certain awareness or concentration

must also be present and be directed to the topic at hand. Fowler states that because the looking behavior that is actually manifested cannot guarentee the mental process that is presumed to operate, attentional processes would seem to be assessable only by means of introspective analysis. However, operant responding is a more precise record reflecting the subjects moment-to-moment interest (Fowler, 1965).

Television production variables (black-and-white vs. color)

One possible approach to improve the effectiveness of educational television programs would be to incorporate attention getting television production variables, (ex. close ups, zooming, shadowing, etc.). In this particular study, color versus black-and-white served as the independent variables. Perhaps the black-and-white images on the TV screen do not provide as vivid an impression as the real life objects because of the lack of color (Chu and Schramm, 1967). If so, then attention to black-and-white is likely to be less than to color. And if so, it follows that learning may also be less.

VanderMeer (1954), in an earlier experiment attempted to measure the amount of learning from color compared to black-and- white by verbal tests consisting of multiple-choice items, and non-verbal tests such as identification of maps, identification of sulphur types in glass vials, and identification of slide pictures of snakes.

The results of his experiment demonstrated that the students preferred color films to black-and-white films, but there was no correlation between preference and learning.

An experiment conducted among high school students in Toronto had similar results. Link (1961) divided ninth-grade students into three groups: One saw four films in color, one saw the same films in black-and-white via closed-circuit television, and the third group saw both. The group that saw both versions learned significantly more than the other two groups, but there were no significant differences between the one that saw the color films and the one that saw the black-and-white versions.

From these experimental results, it seems that the use of color in film or television does not significantly improve learning. If we look at the results from the more carefully controlled experiments by Kanner and Rosenstein, we can see no particular advantage of using color presentation, at least from the learning viewpoint.

In their study, Kanner and Rosenstein (1960) put the effects of color to a more rigorous test. They used 368 army trainees which they matched in pairs and randomly assigned either to color or black-and-white television presentation. The trainees were tested over each of the 11 lessons. Some of the questions were designed particularly to assess the influence of color on learning. Of the 11 comparisons, 10 yielded no significant differences. The remaining one favoring color presentation. The two groups had about the same number of correct answers on color and noncolor test items. The low ability trainees tended to learn more from color, while the high ability trainees tended to learn more from black-and-white.

It is hoped that the technique as used in this empirical study will constitute an improvement in research methodology used to explore various dimensions of "effectiveness of educational television programs." In particular it is hoped that the conjugate reinforcement technique will prove effective in researching and exploring the comparative utility of color versus black-and-white productions, and will deepen our understanding of the interaction of interest, attention and formal learning from educational television productions.

Stated Hypotheses

In light of the above discussion, the following hypotheses are put forth:

(1) Color educational television programs will generate higher levels of interest (rates of operant responding) than will black-and-white versions of the same production.

(2) It is expected that color subjects will perform significantly better than black-and-white subjects on a questionnaire designed to measure information gained, i.e., formal learning.

(3) Subjects who express more attention in relation to the program (by operant responding) will learn more, and perform significantly better on the questionnaire.

In summary, this study is attempting to demonstrate that greater attention and interest produces greater learning, and that color is an important factor in gaining viewer attention.

CHAPTER TWO

RELATED RESEARCH

Lindsley (1962), states that if an educational television program is to be effective as a vehicle for learning, it must first induce looking and listening. The only effecient educational television programs are those that are seen and heard by the viewer-learners. How can the producer of an educational television program insure that his production will be thus perceived, and how can he enhance viewer perception?

The producer may attempt to predict viewing and listening on the basis of past experience with other productions. He may attempt to measure recall by administering objective tests of program content. These methods tell the producer only what subjects recall. These methods do not tell the producer anything about his subject's immediate moment-to-moment reaction to the program. In order to predict accurately viewer interest, the producer must pretest, and for accurate pretest methods he has turned to the behavioral sciences (Lindsley, 1962).

According to Lindsley (1962), pretest based on experimental psychological methods are more objective than reports of raw past experience. Using a representative sample of a target viewer

population, a pretest can compare two media bearing the same message, two different messages in the same medium, or compare black-and-white versus colored versions of the same program. The best techniques evaluate the program by recording the viewer's immediate response to it without interviews, without recall, and without pausing. If the response is continuously recorded, it can be used to examine what variables contribute to the program's effectiveness as an educational television production.

One such behavioral measure described and reported by Lindsley (1962) is based in the operant conditioning methods developed in the past 30 years by B.F. Skinner (1959). These methods have been widely applied in the pharamaceutical industry to predict the effects of drugs and more recently in the classroom to program instruction by "teaching machines."

Lindsley's technique shows how rewarding a program is to a viewer by measuring how hard he will work to look at it. The measure is continuous, immediate, objective and sensitive. It avoids most of the validity problems inherent in verbal or recall methods. Lindsley has used this technique in advertising research to pretest the effectiveness of commercials in gaining consumer interest. This technique requires the subject to work in order to view or hear the stimulus material. It evolved from work of Skinner and Lindsley on operant behavior. The specific content underlying the technique is that of conjugate reinforcement, i.e., where "a subject's rate of responding controls directly and immediately the

intensity of a continuously available reinforcing stimulus." (Nathan and Wallace, P. 14, 1965).

A response which involves little effort can be emitted by the subject faster than he can make decisions is chosen to be the "operant." By selecting a simple response, physiological fatigue is ruled out of the experimental data and behavior can be analyzed in very fine units. This would not be the case with responses such as writing down words, talking, or operating a complicated apparatus. One response often used in human behavioral analysis is the pressing of a small switch, (requiring no more than 33 grams of force through a distance of two centimeters (Lindsley, O.R., p. 3, 1962). It may be thought of as the sharply pointed fulcrum on a chemical balance. The more delicate and sharp the response, the more finely can the behavior be measured (Lindsley, O.R., 1962).

Almost anyone can press a button several times a second. When his responses are recorded on a moving paper graph, the record permits behavioral analysis in units shorter than the time it takes to make most gross responses. Thus operant conditioners have a behavioral yardstick with measurement units finer than the behavioral process which they wish to measure. High behavioral "resolution" is achieved, since operant methods are sensitive to very slight and subtle behavioral changes which occur in fractions of a second.

One may speculate that a colored educational televison pro-

gram versus a black-and-white version of the same production will generate higher levels of interest, i.e., rates of operant responding. Hypotheses 2 was developed in order to demonstrate that a correlation does exist between expressed viewer interest in color to that of black-and-white television. Subject's who also attend to the television program in color, will display greater interest, and are expected to perform better on a questionnaire designed to measure retention of formal learning.

Color versus black-and-white in instructional films

A.W. VanderMeer continued to explore color versus black-and-white, and in 1954 performed two experiments to examine the effectiveness of instructional films. Apparently, color versus black-and-white films in instruction has been a concern of Audio-Visual educators.

The purpose of his investigation was to test the validity of three common reasons for using color in selected instructional films. The three investigated were: (1) Color may be an important cue in learning what the film is intended to teach' (2) Contrasting colors in graphic presentations could be used for emphasis to make certain things stand out, and (3) Color may be pleasing to the learner, and its aesthetic appeal may have an indirect effect in promoting greater learning, even though the color itself provides neither important meaningful cues nor emphasis.

Two types of tests of perceptual and conceptual learning were developed for each film. Non-verbal tests which included the use

of pictures, diagrams, or sample as supplements to the verbal questions or statements was the first type, and verbal tests the second. In contrast to the non-verbal tests, the larger number of items were of the conventional multiple-choice type in which the learner was required to select a response in terms of completing a purely verbal statement or answering a purely verbal question. The same tests were used as pre-tests, post-test and recall measures, except that the items were arranged in different orders.

Each test item that was developed was designated as relating to one of the three reasons for using color in film production, which was stated earlier. The validity of these distinctions among items was then checked by independent viewings of films to determine the type of use to which color was put at the point or points in the films where the requisite data for the correct answering of each test item was given.

Generally, the results do not indicate any persistent superiority for color film versions over black-and-white. The results did demonstrate that color contributes in reducing the rate of forgetting.

Black-and-white films may be as good as color films in communicating visual learning cues related to texture, light and dark contrast, shape, and size. Color may, unless more carefully employed, actually operate to reduce the effectiveness of some of these cues by distracting the learner. The absence of color in

black-and-white films may operate to increase the effectiveness of such cues by requiring more attention on the part of the learner to such cues as texture, contrast, shape and verbal description.

The overall results of both experiments of film preferences demonstrated that (1) learners generally prefer color films to black-and-white films, (2) color as a factor in preference for a given film version does not appear to correlate highly with differences in learning attributable to color, and (3) there is not much difference between males and females in overall preference for color films.

Viewing commercials using the conjugate reinforcement technique

One of Ogden Lindsley's studies dealt with subjects' reaction to viewing commercials using the Conjugate Reinforcement technique. The subject's were placed in a comfortable room which isolated the individual from other people and unwanted variables which might disturb their viewing behavior. A television receiver was mounted in the wall about six feet from the viewer. The subject was able to control the brightness of the program by pressing a small switch. As stated earlier, by pressing this switch, a slight increase in the brightness of the television image occurs. If the subject was to continually hold the switching device down, only a brief period of illumination would take place. A response definer converts each press of the switch to an electrical pulse which operates the conjugate reinforcer. Therefore, a high rate of responding keeps the picture brightly illuminated for comfortable viewing; if the subjects

rate of response is produced at an intermediate rate of responding, the picture will be less dim for viewing, and if no responding takes place, the picture tube remains dark.

The subject's operant response rate is recorded on a cumulative response recorder. The slope of the line on these records indicate the rate of pressing the switch and the brightness of the subject's receiver. These records provide a direct measure of the subjects moment-to-moment interest, or desire to work for the video portion of the television program (Lindsley, 1962).

The subject's were paid for attending the viewing. The payment however, did not interact with the subject's viewing responses but merely his attendance.

The results of this experiment were, (1) few looking responses occurred, (2) only when the program's content changed did the subject begin to respond operantly again, and (3) the commercials did not generate looking behavior, and that the show itself was not suitable for television. Since this program did not generate looking behavior, a radio broadcast would have been as effective.

Summary

The experiment performed by VanderMeer demonstrated that the use of color in instructional films, which may seem to call for color, does not appear to be justified in terms of greater learning on the part of those who viewed the films. If we are to effectively use color in films, we should be concerned with careful pre-production considerations of the probable psychological im-

pacts of specific uses of color upon the learner.

It was also observed that the contribution of color in films seems to be related more to the retention of learning than to the immediate acquisition of learning. People who view the colored versions of films may not actually learn more than those who view the same films in black-and-white, but they are likely to forget less of what they learned than those indivjduals who viewed the black-and-white films.

VanderMeer states that "while liking for a film and learning from a film are probably positively related the influence of color in determining such liking is not great enough to warrant its use as a means of increasing liking and therewith increasing learning" (VanderMeer, 1954, p. 134). The aesthetic value of color as a contribution to learning effectiveness appears to be less than that of the intrinsic appeal of the subject matter.

In relation to the other experiments, the operant viewing responses described can be thought of as giving the experimental subjects an additional, artificial eyelid over which he has volitional control. With these operant procedures, the looking responses are externalized.

CHAPTER THREE

METHODOLOGY

Subjects

Forty graduate and undergraduate students at Concordia University were selected as subjects of the study. Participation in the experiment was voluntary. Subjects' ages ranged from 18 - 45 years. The subjects were randomly assigned to two groups. The first group comprised of 10 males and 10 females viewed the selected educational television program in black-and-white, hereafter referred to as the black-and-white group. The second group comprised of 9 males and 11 females viewed the same television program in color, hereafter referred to as the color group.

Procedure

Before viewing the selected television program, students were read instructions as to what exactly each person participating was to do. He was told that this experiment was in no way a test of his IQ nor would he be given a grade based on his performance. Instructions were given to each subject dealing with the proper procedure to maintain the image on the screen. The subject was able to practice the technique by switching the television station to a regular broad-

casting corporation, (ex. CBC, CTV, etc.). Then the subject viewed the experimental television program in the lab. Next he was asked to answer the questionnaire on the program's contents. (Refer to Appendices A and B for a copy of instruction, and questionnaire that were read and given to each subject.

A response, pressing a button, is used as the operant, this means that the behavior operationally defines attention. In the experimental lab, a subject is seated in front of a television receiver which was modified so that the brightness of the screen is controlled by a handheld switch. By pressing this switch the subject is able to view the video portion of the television program. If the subject holds the switch down, he will only keep the television illuminated for a brief period of time, resulting in the picture to be blackened. In other words, to illuminate the picture, the switch must be pressed several times thus allowing the subjects operant behavior to be demonstrated. By continually assessing the degree of attention, it is possible to determine how much attention is paid to the picture.

The subject's operant response rate is recorded on a cumulative response recorder. The slope of the line on these records indicates the rate of pressing the switch and the brightness of the subjects receiver. The purpose of these records is to allow a direct measure of the subjects moment-to-moment responses, or his willingness to work in order that he may view the video portion of the television program. Appendices C and D provide examples of records produced by subjects who viewed the 18 minute segment of "Science

Magazine" in color and in Black-and-White. The rate of response is indicated by the upward slope of the line, however, when the responses are stopped, they can be identified as a horizontal portion in the response line. The apparatus and procedures used in this experiment are similar to those made by Lindsley in his original research (Lindsley, 1962).

The subjects environment can be any comfortable room which isolates him from other individuals and other noises which may disturb his viewing behavior. The rooms used in this experiment are painted white and are equipped with a comfortable chair and television receiver whose brightness the subject controls. The subject is able to hold a small switch in either hand, and by continually pressing this switch, able to view the video portion of the educational television program selected. The response definer converts each press of the switch to an electrical pulse which operates the conjugate reinforcer. High rates of responding allows the picture to remain illuminated for comfortable viewing: intermediate rates of responding keep the picture at dimmer levels: and when the subject is not responding at all, the picture tube is dark. The experimenter monitored the television program by two small television sets in his control room. (For a design of the experimental equipment used, and subjects rooms, refer to Figures 1 and 2).

Apparatus

The apparatus located in the experimenters room was designed to measure and record the subjects operant rate of responses. The

apparatus itself consisted of a counter-printer which recorded the subject's operant responses over a 30 second period and printed the number of responses every 30 seconds. The equipment also contained a cumulative recorder which actually produced a graph of the subject's operant response rate, i.e., his viewing behavior. (See Figures 3 and 4)

The equipment allowed the experimenter to control the viewing rate of each subject by selecting an appropriate setting of the steps-up, steps-down, and interval controls. This step was taken in order that each subjects viewing rate could be adjusted for his comfort and level of responding to the hand held switch.

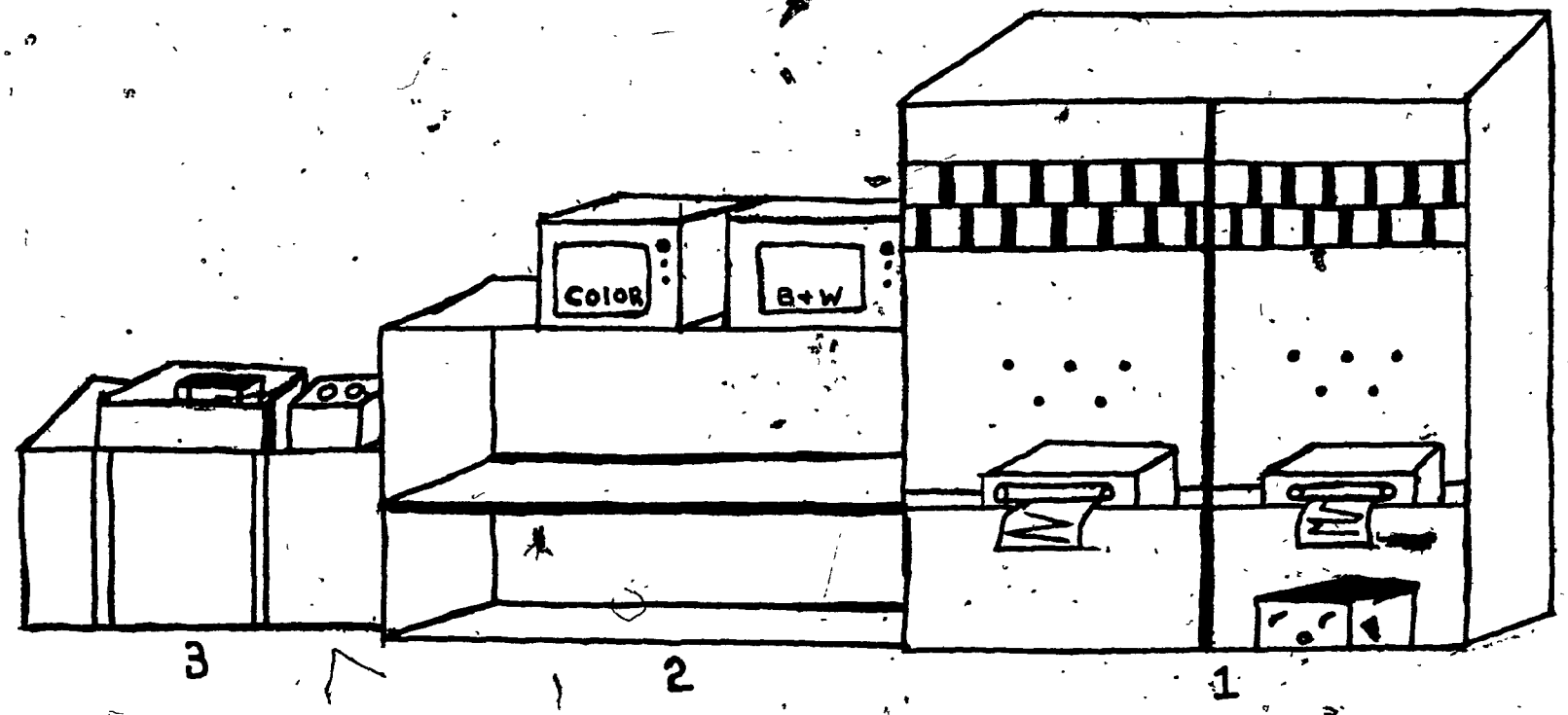
The hand held switch was connected to the conjugate control apparatus which controlled the television screens brightness and operated the recorder and counter. Because the automatic counter gave print outs every 30 seconds the experimenter had to calculate and multiply the total number by 2. For example, one subject's recorded response was 21;this number multiplied by 2 = 42 responses per minute.

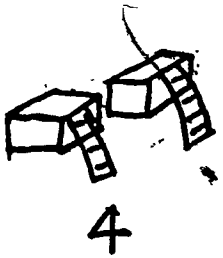
Statistical procedure

Two groups viewed the educational television program in either color or in black-and-white. These two groups will be known as Type 1 and Type 2. Type 1 represented the subjects who viewed the program in color, and Type 2 the black-and-white ETV subjects.

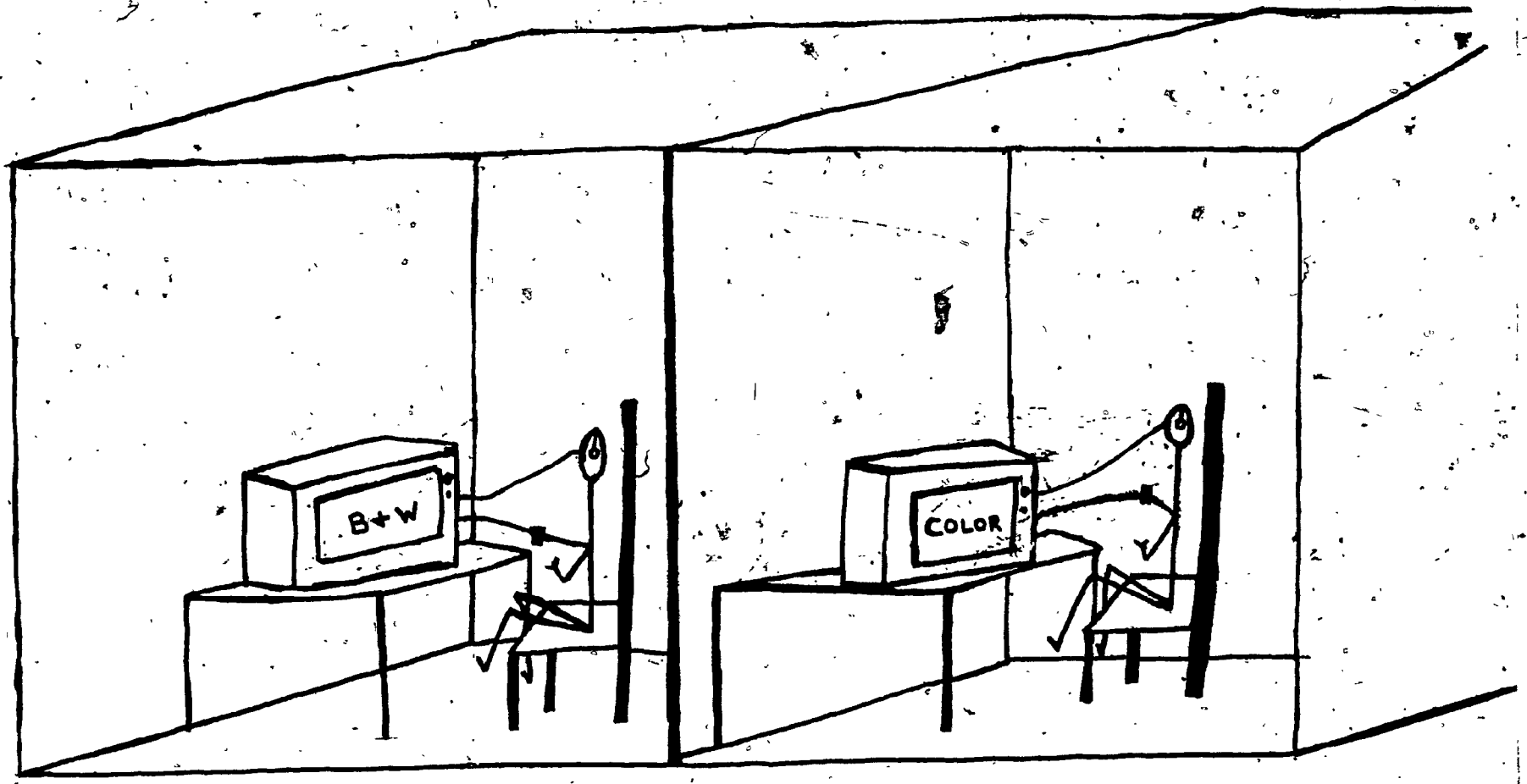
T-tests were used to compare group means between Type 1 and Type 2 viewing behavior and the number of correct responses to

(FIGURE 1)



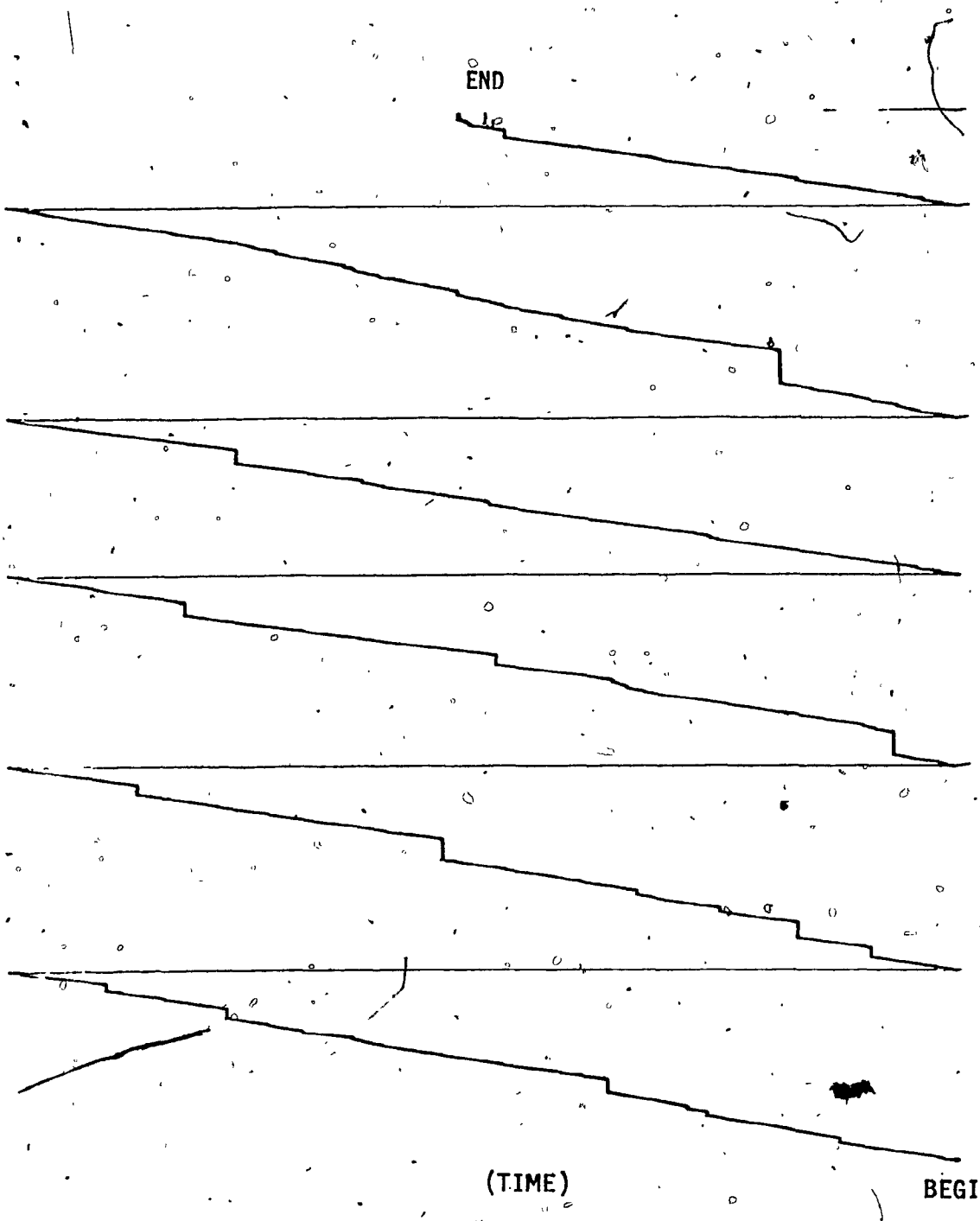


1. Conjugate reinforcement apparatus
2. Color and black-and-white TV monitors
3. Video cassette and reel-to-reel playback recorders.
4. Automatic recorder of operant responses produced every 20 seconds.



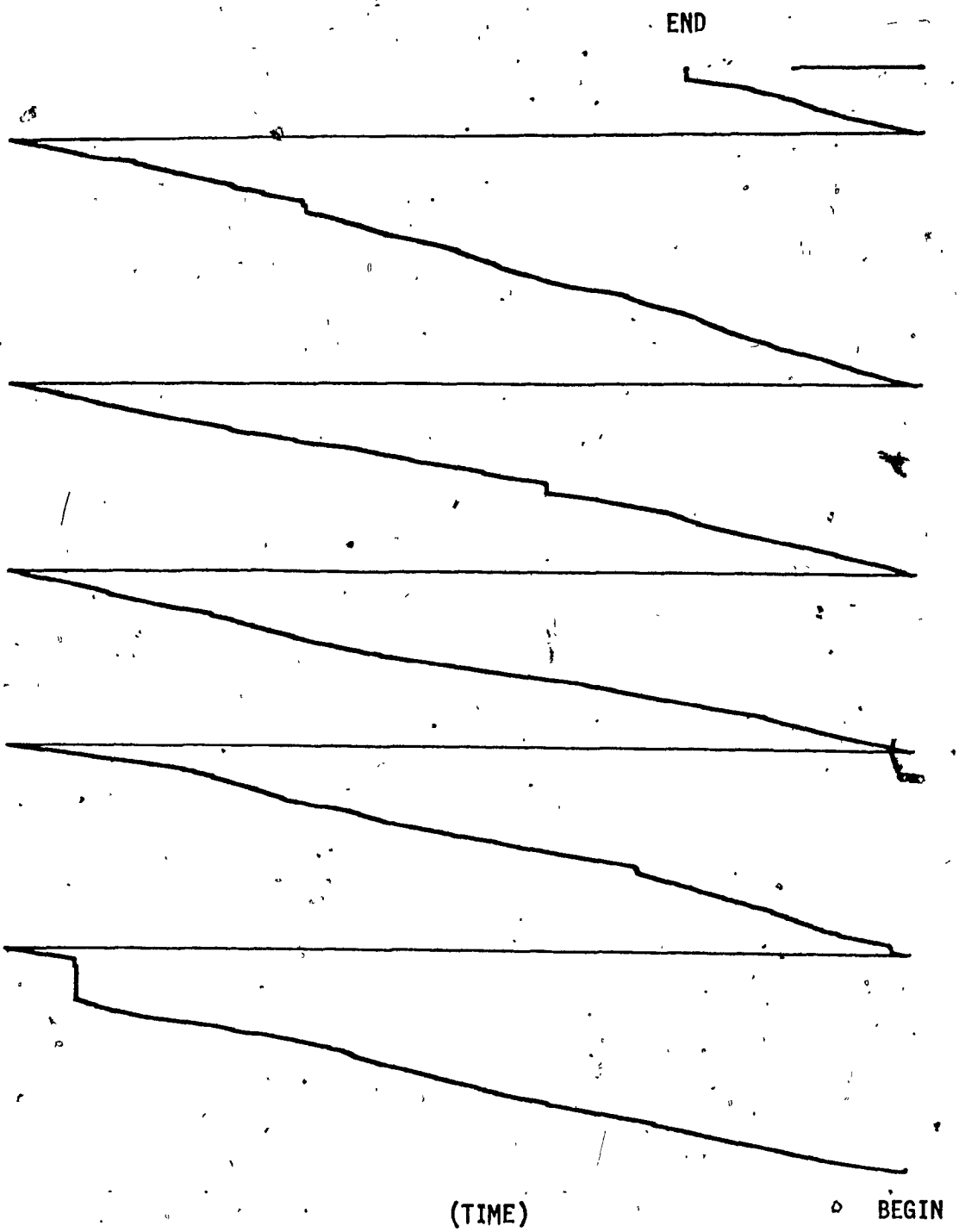
(FIGURE 2)

A VIEW OF THE SUBJECTS EXPERIMENTAL LABS



(FIGURE 3)

Printed graph of color subjects viewing behavior based on operant rates of responses.



(FIGURE 4)

Printed graph of black-and-white subjects viewing behavior based on operant rates of responses

the post viewing tests answered by the subjects in each group. A correlation ratio was also done based on the data collected.

Finally an Item Analysis and Kuder-Richardson Reliability, Formula 21 was performed on the data in order to determine which items on the questionnaire would survive the test for their discriminability, difficulty and reliability. (For a more detailed report of the findings refer to Appendix C)

CHAPTER FOUR

RESULTS

Table I shows that the results failed to support the first hypothesis that groups of subjects viewing black-and-white or color educational television programs would differ significantly in levels of interest. The mean number of viewing responses for the black-and-white groups (Type 2) viewing was 2796- and the mean for the subjects who viewed the color educational television program (Type 1) was 2709, ($t = .36$, $df = 38$).

However, as can be seen in Table II subjects viewing the black-and-white (Type 2) versus color (Type 1) educational television program differed significantly at a ($p < .001$) in the number of test items answered correctly. The mean for the black-and-white group was 10 test items answered correctly, whereas the group viewing color educational television had a mean of 13 correctly answered test items, ($t = -4.25$, $df = .38$). This supports hypothesis 2 that color subjects will perform significantly better than black-and-white subjects on a questionnaire designed to measure information gained, i.e., formal learning.

Thus the colored educational television programs did not stimulate higher levels of interest than black-and-white versions of the same program. On the other hand, color and black-and-white media

proved to be significant variables in effecting the measures of information gained. The results of this study showed that formal learning is significantly related to whether a television program is presented in color or black-and-white.

The results in Table III showed that a positive relationship existed between operant rates of response and number of test items answered correctly. The correlation ratio for the total number of subjects was significant with $r = .31$. When the subjects were looked at as two separate groups (i.e., color and black-and-white groups) a strong positive relationship ($r = 0.58$) was seen between the two variables for the 'color' group. However the correlation for the black-and-white group of subjects was a low correlation ($r = 0.22$). This supports hypothesis 3 that subjects who express more attention in relation to the program (by operant responding) will learn more, and perform significantly better on the questionnaire.

Table IX demonstrates that based on the results of the Item Analysis only five items would survive the test; items 2,4,10,11, and 14. Tables X, XI, and XII show that a low reliability coefficient of $r = .33$ was arrived at for both color and black-and-white groups, but when looked at as separate groups, the black-and-white group had a $r = .51$ and the color group $r = .54$ thus demonstrating a low reliability on the questionnaire.

TABLE I

COMPARISION OF GROUPS VIEWING BLACK-AND-WHITE VERSUS COLOR EDUCATIONAL TELEVISION PROGRAMS FOR TOTAL OPERANT RESPONSES

Variable	N	M	SD	t	p
B/W	20	2795.80	841.97		
				.36	NS
COLOR	20	2708.60	684.20		

df = 38

TABLE II

COMPARISION OF GROUPS VIEWING BLACK-AND-WHITE VERSUS COLOR EDUCATIONAL TELEVISION PROGRAMS FOR NUMBER OF TEST ITEMS CORRECT

Variable	N	M	SD	t	p
B/W	20	10.35	1.69		
				-4.25	.001
COLOR	20	12.65	1.73		

df = 38

TABLE III

CORRELATION BETWEEN OPERANT RATES OF RESPONDING AND NUMBER OF TEST ITEMS CORRECTLY ANSWERED

Correlation Components	Subjects B/W N= 20	Color N= 20	Total N= 40
Operant Rates of responding and number of test items answered correctly	r = .22	.58	.31
	p = .179	.004	.028

TABLE IV

BREAKDOWN OF SUBJECTS RAW DATA

BLACK-AND-WHITE

SUB. NO.	VARIABLE	SEX	NO. OF OPERANT RESPONSES	NO. OF TEST ITEMS ANSWERED CORRECTLY
1.	B/W	F	806	7
2.	B/W	F	2824	7
3.	B/W	M	3132	9
4.	B/W	M	3220	9
5.	B/W	M	2204	9
6.	B/W	M	2706	9
7.	B/W	M	2638	10
8.	B/W	F	2708	10
9.	B/W	F	1592	10
10.	B/W	M	2124	10
11.	B/W	F	3330	11
12.	B/W	F	3826	11
13.	B/W	F	2514	11
14.	B/W	F	3240	11
15.	B/W	M	2084	11
16.	B/W	F	3456	12
17.	B/W	M	2704	12
18.	B/W	F	2370	12
19.	B/W	M	4462	13
20.	B/W	M	3976	13

TABLE V

BREAKDOWN OF SUBJECTS RAW DATA
(Color)

SUB. NO.	VARIABLE	SEX	NO. OF OPERANT RESPONSES	NO. OF TEST ITEMS ANSWERED CORRECTLY
1.	Color	F	1008	9
2.	Color	M	2804	9
3.	Color	M	3214	10
4.	Color	M	2732	11
5.	Color	F	3240	12
6.	Color	F	2850	12
7.	Color	M	1408	12
8.	Color	F	2458	13
9.	Color	F	3612	13
10.	Color	M	2790	13
11.	Color	F	3060	13
12.	Color	M	3470	13
13.	Color	F	3078	14
14.	Color	F	2464	14
15.	Color	M	3562	14
16.	Color	M	2424	14
17.	Color	M	3204	14
18.	Color	F	2676	14
19.	Color	F	1888	14
20.	Color	F	2230	15

TABLE VI

BREAKDOWN OF TEST ITEMS ANSWERED INCORRECTLY BY

COLOR VS. BLACK-AND-WHITE SUBJECTS

SUB. NO.	VARIABLE	ITEMS INCORRECT	SUB. NO	VARIABLE	ITEMS INCORRECT
1	Color	1,4,10,11,14,15	1	B/W	1,4,6,7,8,11,12,14
2	Color	3,4,9,11,14,15	2	B/W	1,2,3,4,7,8,9,10
3	Color	5,9,10,12,15	3	B/W	4,6,8,10,12,13
4	Color	9,10,11,12	4	B/W	2,5,8,11,14,15
5	Color	3,6,14	5	B/W	4,5,10,12,13
6	Color	1,9,11	6	B/W	1,4,9,10,14,15
7	Color	4,11,14	7	B/W	4,7,10,11,14
8	Color	6,11	8	B/W	1,3,9,10,12
9	Color	4,11	9	B/W	1,3,4,11,14
10	Color	3,4,	10	B/W	1,10,11,13,14
11	Color	4,14	11	B/W	7,8,11,12
12	Color	9,14	12	B/W	3,4,14,15
13	Color	13	13	B/W	1,4,11,13
14	Color	1	14	B/W	4,5,6,9
15	Color	9	15	B/W	1,4,11,14
16	Color	6	16	B/W	10,11,14
17	Color	14	17	B/W	4,6,11
18	Color	11	18	B/W	4,11,14
19	Color	11	19	B/W	10,14
20	Color		20	B/W	8,9

CHAPTER FIVE

DISCUSSION

The results of this study showed that color was an important variable in learning from educational television programs. These results are in contrast to those obtained by VanderMeer (1964) who found that although subjects preferred color films to black-and-white those who viewed color films did not show significantly higher rates of learning than those who viewed black-and-white films. The difference in the results of this and VanderMeer's study is less surprising since VanderMeer's tests of learning included non verbal tests, identification of pictures etc., whereas this study was limited to verbal tests of true or false items.

The results of this study also contradicted those by Kanner and Rosenstein. These experimenters found learning rates were not related to whether a presentation was in color or black-and-white.

This study showed no significant differences between color and black-and-white groups in level of interest as measured by cumulative viewing response. Yet a significant difference was seen in learning between the two groups. This seems to suggest that learning is not related to interest. Yet table IV shows a correlation does exist between express viewer interest and learning. This is an area which would need further investigation in order to arrive

at some concrete statements. It is, perhaps, more accurate to state that cumulative viewing response is not always an indication of learning because the cumulative response measure masks intra-and inter-subject variability (eg. two sums of 12 need not reflect equal viewing behaviors).

Although operant responding for black-and-white and color groups was not significantly different, the black-and-white group had a 3% higher cumulative response (2795 versus 2708). We cannot conclude from this that the black-and-white group was more interested in the program than the (color) group. If further investigation were to reveal that black-and-white is indeed higher it may be that the black-and-white screen provides fewer perceptual cues such as shadow, depth, shape, etc. than do individual color images. It is possible that the black-and-white subjects respond more in order to increase the technical brightness of the screen and subsequently to increase these perceptual cues. Thus the question arises whether cumulative viewing of responses are a good indicator of interest in a television program.

A correlation ratio obtained for operant rates of response and number of test items answered correctly further illustrates the problems of drawing any conclusions from this study that high operant rates of response result in greater learning. When the total number of subjects was looked at the correlation ratio was too low to predict a relationship between these two variables. When only black-and-white subjects are looked at the correlation ratio obtained

was even less meaningful. On the other hand for the color group, the operant rate of response was fairly strong ($r = 0.58$) related to the amount learned. The color group had a slightly lower though not significant rate of operant responding than the black-and-white group yet it was the color group that showed a stronger relation between items correctly answered. The black-and-white subjects had a slightly lower rate of operant rates of responding, while the color subjects were significantly better in learning. Yet the fact that test items correctly answered and operant rates of response was strongly related only for color subjects seems to support the previous suggestion that for black-and-white subjects operant rates of response were an indicator not only of interest but were more related to perceptual cues missing in dimmer images.

The results also seem to suggest that for black-and-white subjects the necesity of operant responding was a distracting factor. For the color group, operant responding may not have been as much of a distractor since perceptual cues may have been less effected by slightly dimmer images. This is an area that further research should investigate.

Had Lindsley's approach to conjugate reinforcement been followed more closely, these difference in rates of operant responding and number of test items answered correctly could possibly have been examined more closely. Since Lindsley's technique allows the experimenter to examine the subject's moment-to-moment responding (by refer-

ring to the individuals printed graph) these discrepancies and possibly not perceptual cues, which I have reported in this study, could be better examined and explained.

Suggestions for further research

This study was limited in that the subjects were only graduate and undergraduate students. This could have had some effect on the outcome of the results in that most students feel obligated and more motivated to perform well on experiments they know are academically oriented. In order to test this theory one would have to sample more subjects outside of a university setting using a wider range of subjects (ex. housewives, businessmen, etc.). Also one could increase the age range of subjects to include a larger spectrum of the population.

One could also perform research with conjugate reinforcement to prove that retention or formal learning was not related to operant rates of response, but rather to listening to the programs content. In order to research this possibility one could have subjects not only respond operantly to the video portion of the education television program, but to operantly respond, by pressing a switch, to hear the audio portion of the program as well. This kind of research would no doubt be a more accurate testing procedure to examine this theory.

One could also incorporate filmstrips, or 16 mm film in black-and-white versus color to investigate whether these results prove valid when incorporating varied media. Lindsley found that subjects responded more to certain portions of a programs content,

and therefor programs, ex. high suspense, versus low suspense should be included in further research.

One could also look at the possibility of using animation to test Lindsley's theory. Today commercial television is developing short (3 minute) production of educational animation films. This mostly occurs on Saturdays while children are watching cartoons. Do these types of educational animations actually teach these children anything significant about math, parts of speech, etc. which they are intended to teach? This theory or idea certainly warrants additional investigation.

Looking at the item analysis we are able to determine that items 2,4,10,11, and 14 would survive the test, in that they discriminate well, and were proven to be difficult enough thus allowing for adequate testable items. However, based on the results of the Kuder-Richardson Reliability test we see that a low r = .33 reliability coefficient was obtained. This demonstrates that the questionnaire has a low reliability. Based on these results I would suggest future researchers ca-ry out a pilot testing of the questionnaire which they are considering for their experiment. It is extremely important for the results of the experiment that the questionnaire discriminate well, is difficult enough, and has a higher reliability.

By further investigating these theories or ideas it is hoped that Lindsley's technique of conjugate reinforcement will prove both valuable and important to future researchers. It is also hoped that my study has proved effective in demonstrating the use of color versus black-and white productions of an educational television program.

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APPENDIX A

List of instructions that were read to each subject before his participation in the experiment

INSTRUCTIONS TO STUDENTS TAKING PART IN A RESEARCH PROJECT INCORPORATING EDUCATIONAL TELEVISION

1. This experiment is not a test of your I.Q. or your personality. It is a research project to determine people's interest in selected aspects of educational television programs. It will take about one half hour of your time.

2. You are able to control the viewing aspect of the television program by pressing a small switch. By repeatedly pressing the switch, you are able to watch the television program. The program runs for 18 minutes. When you stop pressing the switch, the television screen will fade to black. If you want to watch again, you must press rapidly until the picture appears again. Our recording apparatus will give us an indication of the parts of the program that interest you. A record of your interest will be combined with those of a large number of people in order to determine whether certain portions of the program are more or less interesting than others.

3. Upon completion of the television program we will ask you some questions about the program and what interested you. Your answers will <u>not</u> be graded, rather all the replies from many people will be used as data in this particular research.

4. Thank you for your time and cooperation in helping me with my thesis in the Educational Technology Program. If you wish the results of the research, please leave your name and address with me and I will send them to you.

July 1978

APPENDIX B

Questionnaire issued to each subject following the viewing of the educational television program

SCIENCE MAGAZINE

Decide whether the following statements are true or false. Write 'T' or 'F' in the blanks provided.

1. _____ In the second experiment when the model highrise was surrounded by thick white paint and placed in a wind tunnel, nothing happened.

2. _____ These experiments can be useful to architects and to city planners.

3. _____ When a mild breeze is forced between two highrise buildings, it dies down.

4. _____ Building in Calgary on the exposed lot by the Bow river will have disastrous results.

5. _____ Entrances to garages are often blocked by blowing snow. This problem can be avoided.

6. _____ The work being performed on the monkey has immediate relevance to various neural disorders in human beings.

7. _____ Lucy is rewarded with fruit juice when she successfully centers the handle of the experimental device.

8. _____ The work done by Dr. Tatton on monkeys has had no direct application to humans.

9. _____ The experiments being done on the nervous system of humans will eventually tell doctors how much medication to issue a patient who has Multiple Sclerosis.

10. _____ Certain medical centers are already using this technique to detect Parkinson's Disease at an early stage.

11. _____ Man's crops have been created by years of careful crossing of wild plants possessing characteristics such as low yield and disease and drought resistence.

12. _____ Selecting a plant which possesses all the characteristics a farmer wants is a relatively fast process.

13. _____ In nature, barley plants fertilize each other with showers of wind blown pollen.

14. _____ Because they have only two sets of chromosomes, the haploid seeds cannot develop the starch that should nourish them when they are planted.

15. _____ Artifical plant breeding begins with emasculation to prevent the plant from fertilizing itself with its own pollen.

APPENDIX C

Item analysis and results
based on questionnaire

An item analysis was performed on the questionnaire in order to determine if the test items were valid and discriminating between black-and-white and color subjects. The population, (consisting of forty subjects) was divided into high third scorers, middle third scorers, and low third scorers based on the information provided on Table VI. The number of high third scorers and low third scorers were then identified, and a table designed based on this information (Refer to Table VII). Using this information, and the formula for measuring an items discriminability and difficulty, an item analysis was perform (Refer to Table VIII). An items discriminability refers to the "extent to which a test item is responded to correctly by those students possessing more of the quality being measured and incorrectly by those students possessing less of this quality. An items difficulty refers to the "extent to which a test item can be responded to correctly by any student." (Tuckman, 1972, p. 154-155). Based on each item that was tested, (15 items), a data table was then established, (Refer to Table IX).

The results of the analysis performed showed that only three of the fifteen items tested have satisfactory discriminating power in that two-thirds (.67) are in the high third group. These items are 4, 10, and 11. For their level of difficulty only one item would survive the test because fewer than 1/3 (.33) got it wrong. This would be item 14. Because it was a relatively easy item for

both the high third and low third scorers, and it may have some motivational value, item number two may be included because it is a uniformly easy item. Hence, the total number of items that would survive the test are five, items 2, 4, 10, 11, and 14.

Reliability test

An estimated reliability of test scores was performed on the data in order to determine the consistency from one measurement to another. A certain amount of variation in test performance can be expected from one time to another, from one sample of items to another, and from one part of the test to another.

One of the simplest means of estimating the reliability of test scores from a single administration of a test is by using Kuder-Richardson Formula 21. The formula required three types of information: (1) the number of items in the test, (2) the mean (or arithmetic average), and (3) the standard deviation. (Cf. Gronlund, 1968). Below is a simplified version of the formula that was used.

Reliability coefficient (KR 21)

$$1 - \frac{M\,(K-M)}{Ks^2}$$

where K = the number of items in the test

M = the mean of the test scores

s = the standard deviation of the test scores

The results of the reliability test showed that when the color group and black-and-white group were tested together a reliability coefficient of .33 was found, (see Table X). However, when the

TABLE VII

NUMBER OF HIGH THIRD AND LOW THIRD SCORERS IDENTIFIED

	HIGH THIRD	LOW THIRD
1.		14. 3, 4,
2.	11	15. 1, 4, 6, 7, 8, 11, 12, 14
3.	11	16. 1, 2, 3, 4, 7, 8, 9, 10
4.	14	17. 4, 6, 8, 10, 12, 13
5.	6	18. 2, 5, 8, 11, 14, 15
6.	9	19. 3, 4, 9, 11, 14, 15
7.	13	20. 5, 9, 10, 12, 15
8.	13	21. 4, 5, 10, 12, 13
9.	8, 9	22. 1, 10, 11, 13, 14
10.	10, 14	23. 1, 4, 9, 10, 14, 15
11.	13	24. 1, 4, 10, 11, 14, 15
12.	9, 14	25. 4, 7, 10, 11, 14
13.	4, 14	26. 9, 10, 11, 12

TABLE VIII

FORMULAS FOR MEASURING AN ITEMS
DISCRIMINABILITY AND DIFFICULTY

1. Difficulty

$$\text{Index of Difficulty} = \frac{\text{number who fail an item}}{\text{total number in both groups}}$$

$$\text{For Item 1: } \frac{26 - (12 + 8)}{13 + 13} = \frac{6}{26} = .23$$

2. Discriminability

$$\text{Index of Discriminability} = \frac{\text{number of high 1/3 who pass an item}}{\text{total number in both groups who pass the item}}$$

$$\text{For Item 1: } \frac{12}{12 - 8} = \frac{12}{20} = .60$$

Sample item analysis on the data from among a group of forty.

TABLE IX

RESULTS OF DATA ON ITEM ANALYSIS

Item	Number of High 1/3 Who Pass	Number of Low 1/3 Who Pass	Index of Difficulty	Index of Discriminability
1	12	8	.23	.60
2	13	11	.08	.54
3	13	10	.12	.57
4	12	4	.39	.75
5	13	10	.12	.57
6	12	11	.12	.52
7	13	10	.12	.57
8	12	9	.19	.57
9	10	8	.31	.56
10	12	6	.31	.67
11	11	5	.39	.69
12	13	8	.19	.62
13	11	10	.19	.53
14	9	6	.42	.60
15	13	7	.23	.65

color group and black-and-white group were tested alone, a reliability of .54 was arrived at for the color group, and .51 was concluded for the black-and-white group (Refer to Tables XI, and XII).

According to Kuder-Richardson the reported reliabilities for classroom tests, typically range between .60 and .80. Given this range, and the results of the reliability test, the questionnaire used for this study is not highly reliable.

TABLE X

KUDER-RICHARDSON RELIABILITY TEST
ON TOTAL NUMBER OF SUBJECTS

Upper 6th	No. of items correct
1 -	15
2 - 11	14
3 - 11	14
4 - 14	14
5 - 6	14
6 - 9	14
7 - 1	14
	total 99

Lower 6th	
8 - 1,4,6,7,8,11,12,14	7
9 - 1,2,3,4,7,8,9,10	7
10 - 4,6,8,10,12,13	9
11 - 2.5.8.11.14.15	9
12 - 4,5 10,12,13	10
13 - 1,4,9,10,14,15	9
14 - 4,7,10,11,14	10
	total 61

Total for 40 subjects 461 The mean = 11.53 (rounded to 12)

Standard deviation $\frac{99-61}{20}$ = 1.90 rounded SD 1.9

K = 15

M = 12

s = 1.9

$$1 - \frac{12 (15-12)}{15 (1.9)^2}$$

$$1 - \frac{12 \times 3}{15 \times 3.61} = \frac{36}{554}$$

$$1 - .67$$

$$= .33$$

TABLE XI

KUDER-RICHARDSON RELIABILITY TEST OF COLOR GROUP

Upper 6th	No. of items correct
1 - 0	15
2 - 11	14
3 - 11	14
total	43
Lower 6th	
4 - 1,4,10,11,14,15	9
5 - 3,4,9,11,14,15	9
6 - 5,9,10,12,15	10
total	28

Total for color subjects 257 The mean = 13

Standard deviation $\frac{43 - 13}{10} = 1.8$

K = 15

M = 13

s = 1.8

$$1 - \frac{13\ (15-13)}{15\ (1.8)^2}$$

$$1 - \frac{10 \times 2}{15 \times 3.24} = \frac{20}{48.6}$$

$$1 - .42$$

$$= .54$$

TABLE XII

KUDER-RICHARDSON RELIABILITY TEST
OF BLACK-AND-WHITE

Upper 6th	No. of items correct
1 - 8,9,	13
2 - 10,14	13
3 - 4,11,14	12
total	38
Lower 6th	
4 - 1,4,6,7,8,11,12,14	7
5 - 1,2,3,4,7,8,9,10	7
6 - 4,6,8,10,12,13	9
total	23

Total for black-and-white subjects 208 The mean = 10.4 (rounded 10)

Standard deviation $\frac{38-23}{10} = 1.8$

K = 15

M = 10

s = 1.8

$$1 - \frac{10\,(15-10)}{15\,(1.8)^2}$$

$$1 - \frac{10 \times 5}{15 \times 3.24} = \frac{50}{48.6}$$

$$1 - .49$$

$$= .51$$