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THE EFFECT OF INTRINSIC AND EXTRINSIC REINFORCEMENT CONTINGENCIES ON LEARNER PERFORMANCE

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FOREWORD

This report represents a portion of the exploratory development program of the Technical Training Branch, Training Research Division of the Behavioral Sciences Laboratory. The effort was documented under Project 1710, "Human Factors in the Design of Training Systems," 171007, "Automated Training and Programed Instruction." Dr. Gordon A. Eckstrand was Project Scientist and Dr. Ross L. Morgan was Task Scientist. The report represents a portion of the effort under Contract AF 33 (615)-1507 with the Arizona State University, Tempe, Arizona. Principal Investigators under the contract were Dr. Robert L. Baker and Dr. Richard E. Schutz. The contract was initiated by Dr. John S. Abma. Dr. Ross L. Morgan served as the Air Force technical monitor during most of the period of the contract. The research was initiated in February, 1964, and completed in February, 1966.

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ABSTRACT

Seventy-six AFROTC Cadets studied a revised version of the text, The Military Justice System, for four 50-minute class periods distributed over 2 weeks. Unit-mastery tests of about 12 multiple-choice items each were administered at 11 points throughout the text. Half of the subjects (Cadets) received no knowledge of the correctness of their responses on the unit-mastery test. The other half of the subjects used chemically treated answer sheets which immediately indicated whether or not the subject's answer was correct. A 100-item multiple-choice test over the text was administered to all subjects 2 days after the final instruction period. All subjects had been informed of the final test. Half of the subjects in each of the above groups had been assured payment of $2.50 for participation in the study. Each student in the other half had been told that he would receive $4.00 if he scored 80% or higher on the final test, $2.00 if he scored from 50 to 79% and nothing if he scored below 50%. Compared with other subjects, students using the chemically treated answer sheets completed the study of the text in less time and appeared to depend on the mastery tests for additional instruction. They performed significantly poorer on the unit-mastery tests. On the final criterion test, however, none of the groups differed significantly. Rather complex factors must be considered in specifying the optimal conditions of reinforcement and incentives.

SECTION I

INTRODUCTION

The facilitating effect of reinforcement on student learning is well recognized. Yet, in studies of applied learning the term "reinforcement" frequently has been used to describe a variety of stimulus conditions without specifying the possible differential effects related to these diverse conditions. For example, in many studies knowledge of results for student responses to enroute test items over the instructional materials has been treated as reinforcement. Reinforcement in these studies is a condition that is intrinsic to (i.e., built into) the learning materials. In other studies reinforcement is a stimulus condition extrinsic to the learning materials. Here, the presentation of reinforcement is contingent upon level of performance on the instructional material, but the reinforcement is not a condition built directly into the material. Gold stars, course grades, and special awards for performance serve as examples of extrinsic reinforcement.

The present study sought to investigate the effects of both intrinsic and extrinsic reinforcement on student performance when both conditions were employed in the same instructional program. The intrinsic reinforcement condition included variations in the knowledge of results provided for student responses to sets of mastery items inserted at various points in the instructional material. The extrinsic reinforcement condition consisted of variations in the amount of money that could be earned by subjects for acceptable performance on a final criterion test over the material.

SECTION II

METHOD

Subjects. The subjects were 76 Air Force Reserve Officers Training Corps cadets who were second semester freshmen enrolled in the AFROTC program at Arizona State University. Subjects were selected at random from among approximately 100 cadets who volunteered to participate in the experiment during the time when they normally attended AFROTC classes and drill periods.

Design. The study employed a 2x2 factorial design. The variations in intrinsic reinforcement conditions served as one factor in the design. The variations in extrinsic conditions served as the second factor.

Procedures. Subjects attended four 50-minute class periods on a twice-a-week basis to read the instructional material and answer the mastery items. Each subject was randomly assigned either to a room in which knowledge of results was provided for responses to mastery items or to a room in which no knowledge of results was provided. The extrinsic reinforcement conditions were randomized within both the "feedback" and "no feedback" rooms. Printed instructions explaining the appropriate extrinsic reinforcement contingency and specifying the time schedule for the experiment were given to each subject at the beginning of the first class meeting. The final criterion test was administered to all subjects at a fifth session 2 days after the final instruction period.

Subjects read the instructional material and responded to the mastery tests at their own pace. The "feedback" group received immediate feedback on their responses to each mastery item as a function of chemically treated answer blanks. Individuals in this group used special pens to mark their responses to the mastery items. When the subject marked the correct response blank, the blank turned red: when he marked an incorrect blank, it turned yellow. Subjects in this group were told that if their first response to an item was incorrect, they were to continue responding to the item until they answered it correctly. The "no feedback" group received no knowledge of results on their responses to the mastery items.

Two levels of extrinsic reinforcement were included in the study. Instructions for subjects under the Contingent Reinforcement condition stated that the subject would be paid $4.00 if he scored 80% or higher on the final test over the instructional material, $2.00 if he scored from 50 to 79%, and nothing if he scored below 50%. Individuals in the Assured Reinforcement group stated that there would be a final test over the instructional material, but the instructions did not relate the test to the $2.50 in any way. Thus, no extrinsic reinforcement based upon level of performance on the criterion test was available to the Assured Reinforcement group.

Materials. The textual material used in the experiment was a revised edition of the Air Force manual, The Military Justice System (AFROTC, 1962). This text was originally selected for revision because it included sufficient concept complexity and developmental continuity directly applicable to Air Force and ROTC curriculum. After subjecting the original version of the text to a logical analysis of objectives, a final list of 69 specific behavioral objectives was compiled. The Instructional Specification strategy (Schutz, Baker, and Gerlach, 1964; Schutz, Baker, Sullivan, and Gerlach, 1966) was then employed to specify the stimulus conditions required for the attainment of these objectives. The materials were revised on the basis of these specified conditions, item analyses of the performance of cadets from earlier studies on the final criterion test, analyses of interview data from individual cadets

who had read the materials, and application of the gap and mastery principles of programed instruction (Silberman, 1964).

A set of 131 mastery items was developed pertaining to the behavioral objectives specified for the instructional materials. These items were grouped into eleven unit-mastery tests and inserted at appropriate points in the 60-page revised text. Each mastery test contained items covering only the material from the section of the text immediately preceding the test. Determination of the place in the text where each mastery test was inserted was a function of optimum length or logical determination of appropriate homogeneous blocks of content.

A final criterion test of 100 three- and four-choice multiple-choice items was developed from an original pool of 200 items. Only items with a difficulty index of .75 or lower for a sample of 50 subjects who had read the original text were included in the final 100-item test. The reliability coefficient for the criterion test, computed by the KR-20 formula on a sample of 76 subjects who had read the revised text, was .86.

SECTION III

RESULTS

The mean score for each group on the 100-item criterion test is shown in Table I. It is apparent from the table that the Contingent Reinforcement group scored slightly more than three points higher than the Assured Reinforcement group. However, as shown in Table II, none of the F-ratios for criterion-test performance was statistically significant.

Analyses of performance on the mastery tests, however, did reveal important differences between the treatment groups. Only 3 of the 38 subjects in the "feedback" group failed to complete all 11 mastery tests during the four periods of the instructional program. In the "no feedback" treatment, however, 15 of the 38 individuals completed only 10 or fewer tests and failed to reach the final mastery test. Clearly, the "no feedback" group was spending more time studying either the textual material or the mastery items than was the "feedback" group.

Descriptive statistics relating to the mean standard score on unit-mastery tests completed by each subject are shown in Table III. Since data on mastery-test scores were not available on 4 subjects from the contingent-reinforcement-plus-feedback cell when the statistical analyses were performed, these subjects were assigned the computed mean

standard score for their cell on mastery-test performance. This accounts for the slight variation of the grand mean score (49.85) from a grand mean of 50.00. The results of the analysis of variance on these data are presented in Table IV.

The data in Tables III and IV reveal that the "no feedback" subjects performed considerably better on the mastery items than did the "feedback"subjects. The mean standard score for mastery-test performance is 5.52 standard score points higher for the "no feedback" group. This effect is significant at the .001 level of significance. Neither the extrinsic reinforcement contingency effect nor the interaction between intrinsic and extrinsic reinforcement approached statistical significance.

Table I

CRITERION TEST MEAN SCORES

Extrinsic Reinforcement	Intrinsic Reinforcement				Totals	
	Feedback		No Feedback			
	N	Score	N	Score	N	Score
Contingent ($4 - $2 -0)	19	61.37	19	61.32	38	61.35
Assured ($2.50)	19	57.00	19	59.63	38	58.32
Totals	38	59.18	38	60.47	76	59.83

Table II

ANALYSIS OF VARIANCE FOR CRITERION TEST SCORES

Source	df	SS	MS	F
Extrinsic	1	174	174	2.69
Intrinsic	1	32	32	.50
E x I	1	34	34	.53
Within	72	4653	64.6	
Totals	75	4893		

Table III

MASTERY TEST·MEAN STANDARD SCORES

Extrinsic Reinforcement	Intrinsic Reinforcement				Totals	
	Feedback		No Feedback			
	N	Standard Score	N	Standard Score	N	Score
Contingent	19	47.10	19	53.24	38	50.17
Assured	19	47.07	19	51.97	38	49.52
Totals	38	47.09	38	52.61	76	49.85

Table IV

ANALYSIS OF VARIANCE FOR MASTERY TEST PERFORMANCE

Source	df	SS	MS	F
Extrinsic	1	8.08	8.08	.31
Intrinsic	1	577.94	577.94	22.08*
E x I	1	7.40	7.40	.28
Within	72	1884.07	26.17	
Totals	75	2477.49		

* $p < .001$

SECTION IV

DISCUSSION

The results of the study suggest that there were important differences between the "feedback" and "no feedback" treatment groups in the strategies that they employed to learn the instructional material. The better performance of the "no feedback" group on the mastery tests and the failure of 15 subjects from this group to finish the instructional program indicate that the "no feedback" subjects expended more time and effort attempting to learn from the prose textual material. For these individuals, of course, this is the only instructional material in the text. The "feedback"subjects, on the other hand, apparently neglected the textual material to some degree and used the instructional value of the immediate feedback to their mastery-item responses. Such a procedure would account for their greater speed in working through the textual material and their inferior performance on the mastery items. That the "feedback" subjects were successful in learning from the immediate feedback to their mastery-test responses is demonstrated by their subsequent performance on the criterion test. This criterion-test performance was comparable to that of the "no feedback" group, even though their mastery-test performance was significantly inferior.

An interesting phenomenon to note here is the apparent sensitivity of the learner to subtle procedural cues implicit in the instructional material. For example, one might predict that both the "feedback" and "no feedback" groups would study equally hard on the textual material and that no difference would occur in mastery-test performance between the two groups. Since feedback is not received until after the learner responds to a mastery item, one would expect that on subsequent items over the same material (e.g., the criterion test) the feedback would result in an advantage for the individuals receiving it. However, it appears that "feedback" subjects quickly observe that they need not labor over the textual materials to learn the material to be covered on the criterion test. Where individuals in the "no feedback" group may choose to look on the preceding pages for the correct answer to a puzzling mastery item, a subject in the "feedback" group can employ the easier and simpler expedient of marking in succession his highest-order response choice until the feedback indicates a correct response.

How can one capitalize upon the advantages of the intrinsic reinforcement involved in the immediate feedback procedure on the mastery items while at the same time maintaining the control of the textual material over the reader's learning? One possible procedure would be to provide the learner with extrinsic reinforcement for acceptable performance on the mastery items, as well as for acceptable performance on the criterion test. Thus, performance of the "feedback" subjects on the mastery tests should be improved because of the extrinsic reinforcement associated with good mastery performance. The immediate feedback on these items should still serve to facilitate subsequent performance on the criterion test.

A final word should be said concerning the effect of extrinsic reinforcement in using instructional materials. The differences in the levels of the monetary reinforcement contingency employed in the present study were not of sufficient strength to significantly affect student performance. However, there is little doubt that extrinsic reinforcement is required in the learning task to maintain control of the instructional material over student responses. In the military setting such reinforcers as passes, coffee or cigarette breaks, and preferential assignments may be employed to develop and maintain desired learner responses to learning materials. The use of these and other available reinforcers by the military instructor is an essential technique for maximizing the effectiveness of instructional materials. No matter how excellent the quality of the material, the student will not learn it well unless he is provided with an incentive for doing so.

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