1970

The Effects of Free and Forced Choice with a Time Gradient and Monetary Incentive in a Serial Learning Task

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THE EFFECTS OF FREE AND FORCED CHOICE WITH A TIME GRADIENT AND MONETARY INCENTIVE IN A SERIAL LEARNING TASK

A Thesis

Presented to

the Graduate Faculty

Central Washington State College

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

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November 1970

APPROVED FOR THE GRADUATE FACULTY

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ACKNOWLEDGMENTS

My appreciation to Patsy for her deep involvement in this project.

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CHAPTER I

INTRODUCTION

The scientific investigation of how man learns is being explored continuously by experimental psychologists in the area of verbal learning.

The serial method of rote learning has been used widely by investigators of human learning. In 1958, Deese said that, "behavior is usually sequential; acts follow one another in a continuous stream." One aspect of serial learning, by humans, occurs in verbal behavior which most often consists of chains of words and phrases emitted in a particular order to convey some meaning. The serial method of rote learning requires an individual to be exposed repeatedly to a series of stimulus materials. The items to be learned are exposed one at a time at a standard rate with subjects being required to anticipate each item before it is exposed to him (Deese, 1958). By controlling the presentation rate of the stimuli one measures performance levels when a criterion is reached.

Ebenholtz (1963) has proposed a relative-position hypothesis to account for the chain of events that occurs when a series of stimuli is learned in a serial fashion. This interpretation maintains that subjects form an

internal spatial representation of the series in learning a serial list. This spatial representation is an ordered dimension with each item located specifically in the array relative to the beginning or end points of the dimension. This hypothesis is distinct from the ordinal number hypothesis proposed by Jensen and Blank, 1962, which maintains that subjects mediate serial learning by counting. The ordinal number theory states that the learning of a serial list consists of the formation of stimulus-response bonds between each item and its ordinal position (or some symbolic equivalent thereof) in the series. The ordinal position of the item is the implicit stimulus for the response. It is as if the learner implicitly uses the ordinal numbers as a mnemonic device to which he can attach the specific items of the serial list. The comparative ease in learning the beginning and end items of the list is attributed to their ordinal positions being so definitely perceived, while the middle items are much more difficult to learn because of their ordinal positions are not always clear to the learner. The subject tends to remain confused about the ordering of the middle positions until he has first learned the ordinal position of the other items successively adjacent to the first and last items of the list.

In 1967, Shuell and Keppel proposed a chaining hypothesis which maintains that the preceding items in a

serial list are the cues for the immediately succeeding items. This hypothesis assumes that the subject associates each item in the list with the preceding item to form a sequence of paired associates. Young, (1959, 1961) investigated the transfer from a serial list to a paired-associate list which consisted of successive elements in the presumed serial chain. Such an arrangement forms a double function list, where all but two end items serve as both a stimulus and response function in different pairs. Except for an indication of positive transfer early in learning, the results of this type of experiment have been largely inconclusive.

Postman and Stark (1967) discussed certain inadequacies of both experimental designs by Shuell and Keppel, and Young because neither study used a reliable criterion measure and both failed to estimate the contribution of response familiarization. Specifically, Postman and Stark presented data in support of the chaining hypothesis when they included two experimental conditions in which the paired-associate transfer list either maintained or scrambled successive serial associations. A control was also included in which the two lists were unrelated. Following the serial learning task, a second experimental variable consisted of instructions about the specific nature of investigating the transfer effects from a serial

learning task to a paired-associate task. In the first of three cycles there was a marked superiority of the appropriately paired experimental condition over the two other conditions for the ten transfer trials. Instructions about the transfer task magnified the positive effect, while leaving the other conditions unaffected. These results show that (a) positive transfer can occur from the serial list to the paired-associate design, and (b) this effect is not due to increased response availability. The interpretation of these findings was that instructions increase the rehearsal or utilization of serial associations during the transfer trials.

The present investigation was concerned with the effects of certain variables on the learning of a serial task. The serial learning method was used to investigate the effects of time to respond, freedom to respond, and monetary incentive on the rote learning of nonsense symbols. Subjects were required to view a collection of four numbered nonsense symbols successively presented and then were asked to record anticipated symbols. Each symbol appeared twice in the series in a randomly ordered fashion.

One of the variables of the present experiment was designed to explore the effects of free and forced responses in serial learning situations. It was hypothesized that a forced response would have some interfering effect on performance while subjects were learning a series of nonsense

figures. Luchins and Luchins (1962) stated that the greater the degree of freedom the individual has in choosing his own solution to a problem the faster he will solve that problem. It was further suggested by Luchins and Luchins that pressure to make a response will severely limit the individual's course of action. Being forced to respond within a certain time period would require a certain amount of concentration that will interfere with the logical development of a solution.

Combs (1952) suggests that the perception of threat to self narrows the perceptual field to the object of the threat. Combs has also demonstrated that narrowing of the perceptual field as a result of a threat is not limited to high degrees but also occurs with mild threat. Combs postulated that if the individual were forced to make a response in a short period of time, this would create stress for him to respond and that this stress would be mildly threatening. The findings of Beier (1951) are consistent with those of Combs. Beier states that individuals who are faced with threat lose a certain degree of abstractive abilities, which are necessary to learn a task. Coleman (1960) supported the notions of both Combs and Beier when he said:

> "Where the decision has to be made at once, tension and anxiety mount accordingly, and the integration functioning of the organism is seriously impaired.--People with high levels of anxiety tend to be rigid and inflexible and to

> approach new problems in a more stereotyped way than people whose general anxiety level is lower." (Coleman, 1960, p. 166)

An experiment by Miller and Johnson, (1965) using college juniors for subjects found that subjects who were forced to respond verbally learned a serial task faster than subjects not forced to respond. It was suggested by the experimenters that college juniors had learned to cope with certain amounts of anxiety and were, therefore, able to learn the task under anxious conditions. In an extension of this same study by Miller and Lucier (1965), it was found that subjects exposed to nonsense symbols for five seconds with freedom of choice to respond, mastered the serial learning task with significantly fewer numbers of trials than the forced choice group. They further found that the forced choice groups with eight second exposure time attained mastery in fewer trials than those in the five second group.

A number of studies have shown that monetary incentives are not necessarily effective in certain classical and instrumental learning situations. Several hypotheses have been formulated to account for these results. Cantor and Hattell (1955); Terrill and Kennedy (1957) have suggested that basic incentive levels may be sufficient to mask small monetary incentives. Unreliable results might also be attributed to the possibility that motivation was at asymptote (Munzinger, 1934). These results were substantiated by Miller and Estes (1961) when monetary incentives

of fifty cents or one penny were used to reward two groups of third and fourth grade public school students learning a discrimination task. No reliable differences were found as a function of the magnitude of reward.

Baughman (1976) investigated the effects of reward and punishment on a paired associates learning task and found that money was effective as a reward. The experimental groups received a nickle or a penny for correct responses with a nickle or a penny being subtracted for wrong responses. There was also a reward-only group, which received a nickle or a penny for correct responses and a control group that received neither treatment effect. The reward-only group learned the task with significantly fewer trials than the control group.

Weiner and Walker (1966) found that college students, when given a five cent reward for retention on a paired associate learning task, performed significantly better than those receiving a one cent reward or no reward. Pihl (1966) also demonstrated the rewarding effects of money in the learning of nonsense syllables. His results indicated that magnitude of reward is important in some learning tasks.

Suedfeld, Glucksberg, and Vernon (1967) investigated the effects of sensory deprivation and monetary incentive on a problem solving performance. They were basically interested in the role that sensory deprivation had in a

learning situation. It was suggested that sensory deprivation and financial incentive had parallel effects upon problem solving performance because it was speculated that both have drive arousing capabilities. They operated from the theoretical framework provided by the Inverted U hypothesis of Yerkes and Dodson (1908), which postulates a non-monotonic relation between drive on activation and task performance. Performance should be better under a moderate drive level than under low and high drive levels. One group of subjects received sensory deprivation for twenty-four hours and another group was told they could win five dollars or twenty dollars extra, depending on how rapidly they solved the problem. The top 25 percent of the subjects would win five dollars, the best subject would win the twenty dollars. Low incentive subjects were offered nothing extra for performance. Results indicated that performance was better under moderate drive than either no sensory deprivation-low drive or sensory deprivation-high drive.

Smith and Epstein (1967) investigating the effects of monetary incentive on conflict resolution found that incentive had no effect upon the mode of conflict resolutions, but found that it did influence both speed and accuracy of response. A low incentive group was simply required to approach and avoid a white and red light by moving a pencil as rapidly as possible along a path of a maze which had

exits at both corners, and to leave the start point as soon as either light flashed. A medium incentive group was given one dollar in dimes and told they could win ten dollars or nothing. The effect of incentive on speed was curvilinear, with highest speeds obtained by the medium incentive group. The low and high incentive groups were about equal. The high incentive group made fewer errors than the other groups, who were identical. Their results revealed that medium incentive increased speed but not accuracy, while high incentive increased accuracy but not speed.

Results of a study by Farr (1967) support the hypothesis that money is an incentive and increases performance on certain memory tasks. Subjects were required to learn two paired associate nonsense syllable lists by the method of paced anticipation. Various treatment groups were given ten and twenty cents for every correct response. His results support the conclusion that heightened motivation (induced through monetary incentive) to recall specified nonsense material can selectively facilitate such recall. The view was taken that the subjects in his experiment deliberately initiated purposeful cognitive operations (strategies) in response to what they interpreted as a problem solving challenge. The incentive then acted to facilitate the organization of specific memory events so that retrieval of needed cues becomes more apparent.

The present experiment was an extension of the Miller

and Lucier (1965) study with the addition of a monetary incentive variable. This study postulated that a forced response, in a short period of time would increase stress to an interfering level which would in turn be threatening and cause the perceptual field to be narrowed, therefore impeding learning. Further, a learner who is allowed the choice to respond would not develop stress to a detrimental level and would therefore learn the same material much more rapidly. Two different time intervals were introduced to investigate whether more time to respond would facilitate performance. The final factor was the effect of a monetary incentive on the previous treatments. If the monetary incentive acted as a motivator the effects of the other variables may be less apparent. This means that the higher monetary incentive groups would reach a higher level of performance on the serial learning tasks by requiring a fewer number of exposures to criterion.

Hypotheses

It is predicted that the level of performance in each of the treatment groups will be arranged in the following order: (a) Subjects who may either respond or refrain from doing so will take fewer trials to learn the correct presentation order relative to subjects who must make a response on every presentation. (b) Subjects who have a longer time interval to make a response will reach a higher level of performance than those who have a shorter interval

in which to respond. (c) Performance by all subjects will be facilitated as the magnitude of monetary reward is increased. (d) The specific ordering of difficulty between each treatment group will depend on the variable of consequence. For example, the lowest level of performance should be achieved by the non-rewarded subjects who are required to respond within a short time interval. Contrastingly, the highest level of performance should be obtained by subjects who have a high monetary incentive and are free to respond within a longer time interval. Performance by all other groups should reach an intermediate level somewhere between the worst and best depending upon the variables presented in (a), (b) and (c).

CHAPTER II

Method

This experiment was designed to determine the effects of various treatments upon the number of trials necessary to learn a series of nonsense symbols. Figure 1 shows the stimuli that were projected on a screen in front of the subjects. One symbol was projected on a screen for the appropriate time interval with subjects being required to anticipate the symbol that would be projected next. There was a total of twelve groups with three subjects assigned to each group. The independent variables used in the present study were free and forced choice responses, five and eight second exposure times of each symbol, and no money, fifty cents, and five dollar monetary incentives. The dependent variable was the number of trials necessary for mastery, which was defined as three complete correct trials. A trial consisted of eight presentations from Symbol One through Symbol Eight. Figure 2 shows the ordering of the stimuli as they were presented to the subjects.

Subjects

Thirty-six subjects selected from lower division psychology classes at Central Washington State College

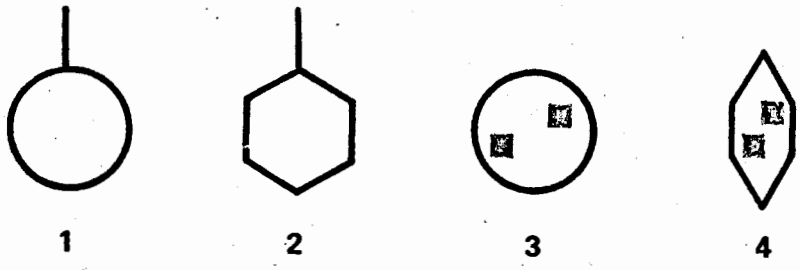

FIGURE 1: The symbols used in the experiment.

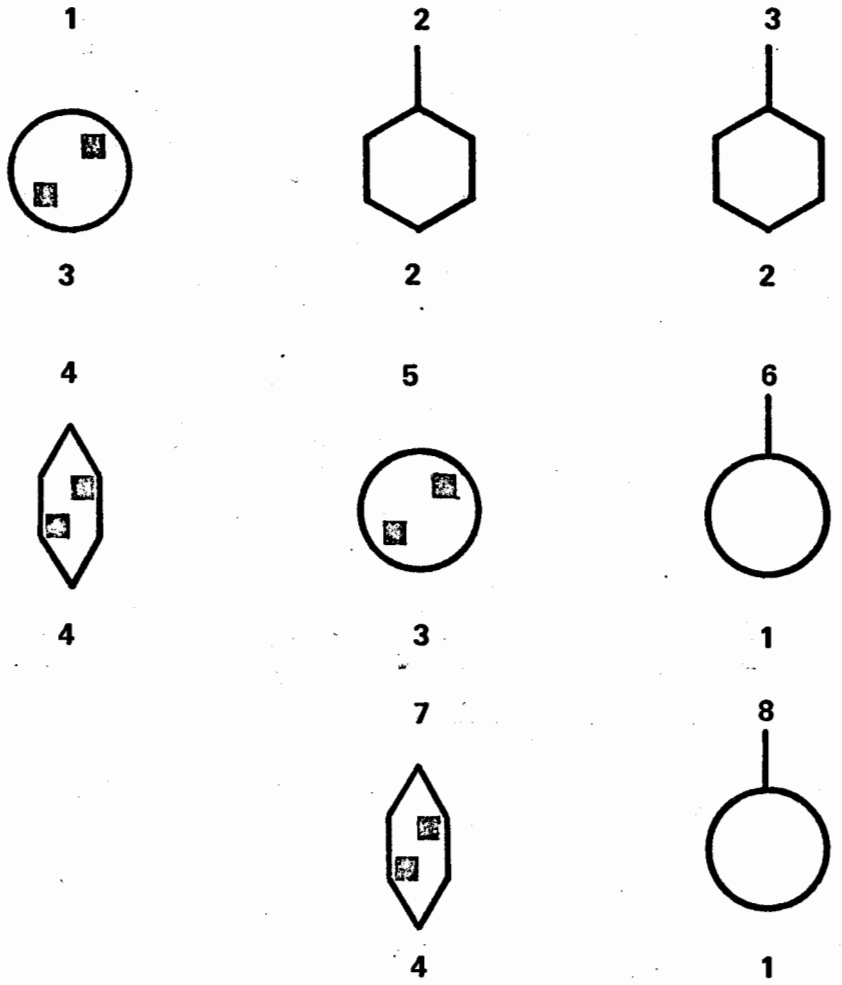

FIGURE 2: Order of symbol presentations

were utilized for the study. Three subjects at a time were assigned randomly to one of the twelve treatment conditions in the experiment. To insure that three subjects would participate in each session and because of the competitive nature of the experiment wherein only one of the three subjects could win any money, an extra subject was allowed to sign up for each session. Extra subjects who were not utilized were told that they would still receive academic credit for participating and were then excused.

Apparatus

A series of eight slides were repeated in the same order so that forty presentations of the eight slides could be shown to the subjects by the use of an automatic Kodak carousel slide projector. Subjects were required to respond by activating one of four push-buttons mounted on a control panel stationed on a desk in front of them. A card showing drawn reproductions of each of the symbols, with the numbers one through four assigned to each, was taped on the front panels of each control box. The recording device was synchronized to the projection system and was set up according to the diagram in Figure 3. Responses were recorded on a predetermined counter which was monitored by the experimenter.

Lehigh Valley Electronic Programming equipment was the main apparatus used. The slide projector and the

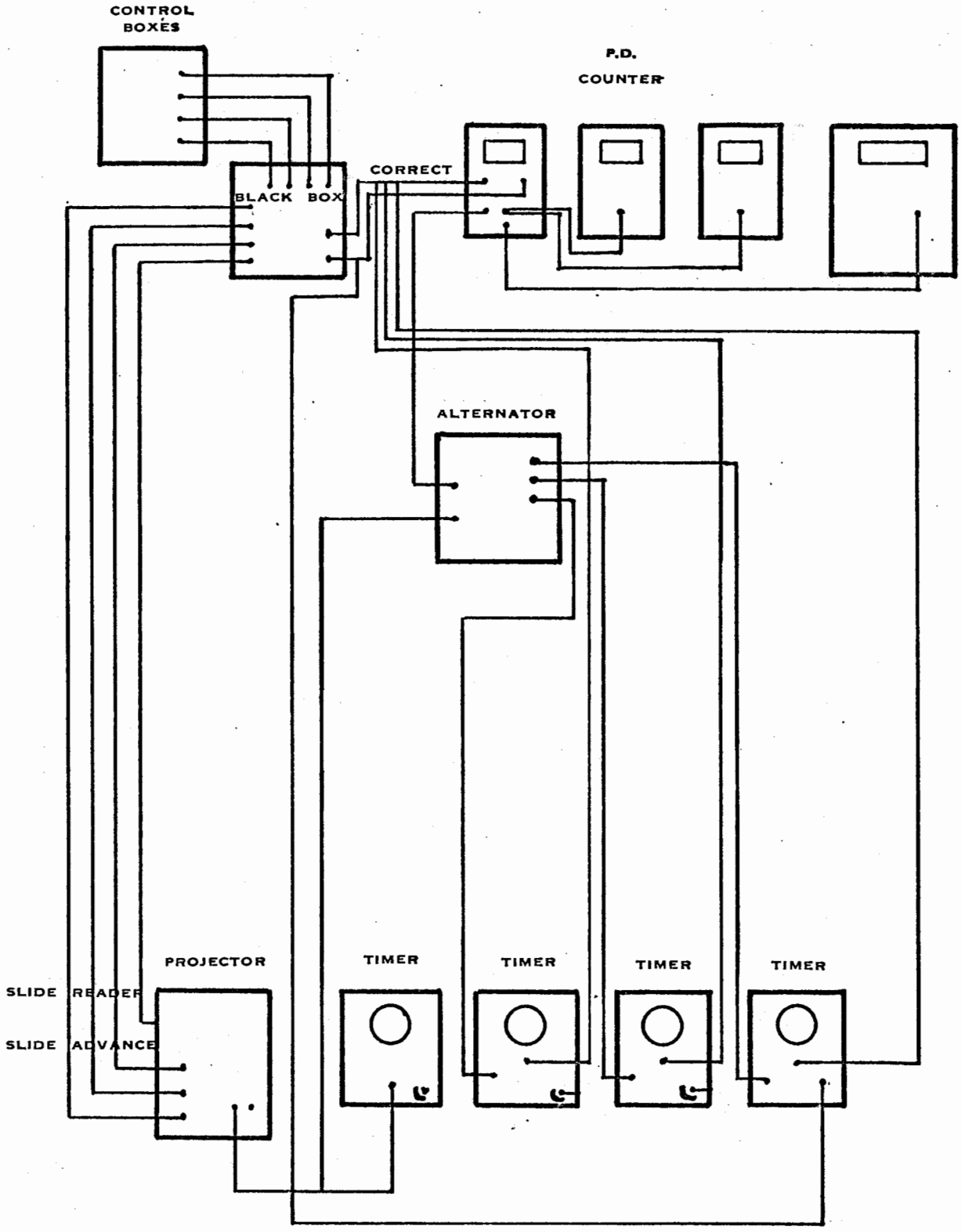

FIGURE 3: Schematic diagram of recording apparatus

three control panels were connected to a central control panel, which in turn, was connected to a Lehigh Valley Electronic Program Panel. Four timers were connected to the electronic program panel. One timer was attached to each of the three control boxes and one timer was attached to the slide projector. These timers were used to control response time and slide exposure time. Three counters were used to record subjects' responses with one counter assigned to each control box. These counters were pre-set to twenty-four and counted down as subjects made the correct responses. When twenty-four correct responses were recorded on the counter the experimenter recorded the total number of slides presented and by dividing this by eight calculated the number of serial presentations needed to reach criterion. Another counter was used to record the number of slides presented to the group.

Each of the forty slides had four holes drilled into the plastic frame for standard Kodak templates used in programming stimulus materials. Slides were placed in the carousel so that an empty slot was left between each slide, thus allowing for standard exposure and response time.

Procedure

Subjects were directed into the experimental room in groups of threes and instructed to be seated behind a control panel device stationed on three desks. Subjects were then instructed to write their names on a sheet of paper

so that they would obtain credit for participating. A coded group designation was then assigned according to Table 1: Free choice (FR), Forced choice (FO); five seconds to respond (5), eight seconds to respond (8); Monetary incentive for zero, 50 cents, and five dollars (0, 50, and 500, respectively). Subjects were then given instructions regarding the operation of the control panel. The instructions are presented in Appendix A.

Instructions for the monetary incentive groups were the same as in Appendix A, except that they were told, "An individual in this group will receive fifty cents or five dollars if he completes the task with the fewest number of exposure trials." They were told that they would receive the money as soon as the experimenter scored the answer sheets.

The projector was turned on and the experiment began. The subjects in FR-5 and FO-8 were allowed an eight or five second exposure time for each slide. There was a five or eight second pause, depending on the treatment variable, between each series of slides. The experiment continued until all subjects reached criterion. At the end of this time the projector was turned off and the experimenter thanked the subjects for their co-operation and encouraged them to remain silent about the experiment. Subjects were asked not to discuss the nature of the study with their classmates and they were told that a short summary of the

results of the study would be distributed to all participants following data analysis.

CHAPTER III
RESULTS

The mean number of presentations to solution for the main conditions is presented in Table 2. The most striking difference between any of the treatment effects occurs between both money conditions and no money. The latter group required more presentations than any condition in the money group since the performance levels for all the no monetary incentive groups appears worse than any condition in the money groups. The analysis of variance for these data is presented in Table 3.

The results indicate that the monetary incentive variable was a significant source of variance ($F=12.72$, $df=2/35$, $p<.01$). A t-test performed between the monetary vs. no money groups supported the hypothesis that money would act as an incentive ($t=2.31$, $df=2/34$, $p<.05$). The hypothesis that the freedom of choice group would reach criterion before the forced choice group was not supported ($F=1.22$, $df=1/35$, $p>.05$). Differences between the five and eight second groups were non-significant although a trend toward reliability is visible ($F=3.24$, $df=2/35$, $p>.05$). Significant interaction effects were evident

TABLE 1

FACTORIAL DESIGN OF THE PRESENT EXPERIMENT WITH CODE LABELS FOR THE MAIN CONDITIONS.

Monetary Incentive	Free choice five second	Forced choice eight second	Free choice eight second	Forced choice five second
0	FR-5-0	FO-8-0	FR-8-0	FO-5-0
50 cents	FR-5-50	FO-8-50	FR-8-50	FO-5-50
five dollars	FR-5-500	FO-8-500	FR-8-500	FO-5-500

TABLE 2

MEAN NUMBER OF PRESENTATIONS TO SOLUTION FOR THE TWELVE TREATMENT GROUPS.

Monetary Incentive	Free choice five second	Forced choice eight second	Free choice eight second	Forced choice five second
0	FR-5-0 12	FO-8-0 12.6	FR-8-0 12.66	FO-5-0 18
50 cents	FR-5-50 8.3	FO-8-50 8	FR-8-50 9	FO-5-50 7.6
five dollars	FR-5-500 9	FO-8-500 7	FR-8-500 9.6	FO-5-500 9

TABLE 3

ANALYSIS OF VARIANCE FOR

ALL TREATMENT GROUPS

Source of Variation	df	ss	ms	F
Monetary Incentive A	2	147.39	73.69	**12.72
Choice B	1	7.11	7.11	1.22
Time C	1	18.78	18.78	3.24
AB	2	12.03	6.01	1.03
AC	2	63.71	31.85	*5.50
BC	1	29.33	29.33	*5.06
ABC	2	49.88	24.94	*4.30
Within Cells (w)	24	139.00	5.79	
TOTAL	35	468.23	13.37	

**$p < .01$
*$p < .05$

($F=5.50$, $df=2/35$, $p<.05$). For the choice and time groups a reliable interaction effect was also obtained ($F=5.06$, $df=1/35$, $p<.05$). There was a significant triple interaction between the monetary incentive groups, five and eight second time groups and the free and forced time groups with($F=4.30$, $df=2/35$, $p<.05$).

No comparison was made between the 50 cent group and the five dollar group because very little variance was obtained between these conditions. The mean for all 50 cent monetary incentive groups was 8.25 and the mean for all five dollar monetary incentive groups was 8.33.

A comparison of the group that was predicted to obtain the lowest level of performance (FO-5-0) with the group that was predicted to obtain the highest level of performance (FR-8-500) indicated a reliable difference ($t=2.63$, $df=2/4$, $p<.05$). The subjects who were not forced to respond within a longer period of time with a high rate of pay performed better than subjects who were forced to respond within a shorter time period without any pay.

CHAPTER IV
DISCUSSION

The results of the present experiment support the hypothesis that money is an appropriate incentive for increased performance in serial learning. When the 50 cent monetary incentive groups are combined and compared with the groups that received no monetary incentive a significant difference in performance occurred. The performance levels of the 50 cent monetary incentive groups compared to the five dollar incentive groups indicated unreliable difference since no variance was obtained. These results are partially consistent with the theoretical framework provided by the Inverted U hypothesis of Yerkes and Dodson (1908) which postulates a nonmonotonic relation between drive activation and task performance. Performance should be better under a moderate drive level than under a high drive level or low drive level. If the Inverted U hypothesis is valid, then some moderate monetary incentive should be sufficient to produce optimal performance on any given learning task. If this theory were to be applied outside the laboratory, it appears that the only thing necessary to obtain optimum task performance would be to find the right level of

monetary incentive. Since the performance of the five dollar monetary group was not lower than the 50 cent group a performance curve resembling the Inverted U is not apparent. These results are consistent with the findings of Weiner and Walker (1966), Suedfeld, Glucksberg, and Vernon (1967), Smith and Epstein (1967), and Farr (1967).

It was predicted that the lowest level of performance would be obtained by the forced, five second, zero money condition. This prediction was borne out. It was also suggested that the best performance would be achieved by the (FR-8-500) free, eight second, five dollar condition. This did not occur since the forced choice, eight second, five dollar group solved the problem with the fewest number of presentations. However, all the treatment groups in both money conditions were almost equal in terms of mean performance levels. There was very little overall difference between any of the scores in the money groups.

The hypothesis that subjects who could either respond or refrain from doing so would take fewer trials to learn the correct presentation order relative to subjects who had to make a response on every presentation was not supported. This does not fit the theoretical framework of Luchins and Luchins (1962) who indicated that the greater degree of freedom the individual has in choosing his own solution to a problem, the faster he will solve that problem. These

results are also inconsistent with the findings of Lucier and Miller (1965). They found that subjects exposed to nonsense symbols for five seconds with freedom to respond, mastered the serial learning task with a significantly fewer number of exposures than the forced choice group. However, they found that the forced choice groups with eight second exposure time attained mastery in fewer trials than those in the forced choice five second groups. The results of this experiment may not be directly comparable to those of Lucier and Miller because of the modification utilized in recording subjects' responses. In the present study subjects were only required to push a button in responding while the other study required subjects to record a written response.

The hypothesis that subjects who had a longer time interval to make a response would reach a higher level of performance than those who had a shorter interval in which to respond was not supported, although a definite trend in this direction was visible in the analysis of variance portrayed in Table 3. These results are partly consistent with the Lucier and Miller (1965) study in that their eight second group performed the serial learning task with fewer trials than their five second group. Once again the modification may have been different enough to account for the unreliability between effects. Pushing a button is less time-consuming than writing a response.

Two specific implications can be seen from the results of this study. First, money can be used as an effective method of facilitating learning and can act as an incentive. Perhaps in certain cases potential dropouts might be kept in school. The Department of Health, Education, and Welfare has recently implemented programs that provide allowances to students who complete their high school education and in many other cases support students in college. These types of programs have been particularly successful in areas where students must drop out of school for self-support or to assist in supporting families. Other programs that tend to use a monetary incentive to get people to continue with education are the GI Bill, scholarships for those who have demonstrated academic excellence, cultural minorities, and athletic scholarships for those who have a proficiency in various athletic skills.

Second, the use of monetary incentives for quality work could be reasonably successful if applied to the industrial world. This method was implemented into the industrial complex years ago but in most cases it has been forced out as a result of strong unionization. This method could be utilized successfully if only the unions and management could see how it could be used to their mutual benefit.

CHAPTER V

SUMMARY

This experiment was designed to determine the effects of free and forced choice within time gradients of five and eight seconds using monetary incentive on a serial learning task. A series of nonsense symbols were successively presented to thirty-six subjects whose task was to learn the serial with the least number of exposures.

Results indicated that money is appropriate as an incentive for learning. There were no significant differences between forced choice and free choice groups or between the five and eight second time gradients.

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APPENDIX A

APPENDIX A

INSTRUCTIONS TO SUBJECTS

Forced choice: "You will be viewing a series of slides. I will show you a slide, and while viewing that slide you are to guess what the next slide will be. On the card that you have are the figures that will be shown--no other figures will be used. Each time a slide is shown push the appropriate button of the slide that you think will appear on the control panel. You must make a guess every time a slide is shown."

"For example, if the first slide shown was a number one, and you thought a number two would appear next, you would push the button two on the control panel and repeat this operation throughout the experiment. Remember, you must make a response each time a slide is shown. Are there any questions?"

Free choice: "You will be viewing a series of slides. I will show you a slide and while viewing that slide, you are to guess what the next slide will be. On the card that you have are the figures that eill be shown--no other figures will be used. Each time a slide is shown, if you choose to respond, push the appropriate button of the slide that you think will appearn next on the control panel. Remember you are not required to respond every time a slide is shown."

"For example, if the first slide shown was a number one, and you thought a number two would appear next, you would push the button two on the control panel and repeat this operation throughout the experiment. Remember, you are not required to respond every time a slide is shown. Are there any questions?"

APPENDIX B

APPENDIX B

RAW DATA

Monetary Incentive	Free choice five second	Forced choice eight second	Free choice eight second	Forced choice five second
0	10 12 14	21 15 18	7 7 9	12 10 16
50 cents	10 7 8	10 7 6	5 10 12	8 5 11
five dollars	10 7 11	8 5 9	8 9 12	5 7 9