PERCEPTUAL-MOTOR LEARNING IN MENTAL RETARDATES AS A FUNCTION OF VARIATIONS IN: SOCIAL SITUATION, AMOUNT OF REINFORCEMENT AND DELAY OF REINFORCEMENT

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I. INTRODUCTION

One of the more recent surveys of experimental studies on learning in mental retardation cited only about fourteen papers (McPherson, 1948). Since that time federal support of research in the area has resulted in an increase of all types of research dealing with mental retardation. Despite this change, research in the area is still relatively meager in comparison to learning studies conducted with normals.

Classical learning studies on normals have mainly dealt with theoretical considerations. This has been much less true in the case of experimental studies on learning in mental retardation. Not only have there been fewer such experimental studies for this subnormal group, but these usually have not been theoretically oriented. The researcher conducting experimental investigations with the mentally retarded frequently finds it expedient to postulate his theoretical considerations in terms of previous research and theorizing done with normals.

Concerning the relationship between learning and the amount of reward, Thorndike (1932) took the position that reward operated in an "all-or-none" fashion. Variations in amount of reward were viewed as having little effect upon the learning process, provided only that the reward was sufficient to elicit the correct response.

There is evidence that performance increases as amount of reward increases. Hull (1950) regarded habit to be a function of reinforcement but considered the amount of reinforcement on any given trial to be unimportant in this respect. This Hullian assertion would seem to

conflict with the theoretical position of Thorndike that amount of reward was important only to the extent that the reward was sufficient in quantity to elicit the correct response. This apparent contradiction was reconciled via Hull's separation of habit from performance, holding that amount of reward determined performance rather than habit. Performance, that is, in respect to reaction potential, was held to be a multiplicative function of habit, amount of reward, and delay of reward. In the 1951 revision of his postulate system, Hull utilized the variable of amount or magnitude of reward to define the "incentive motivation" construct. This construct together with other intervening variables was assumed to multiply with "habit strength" to determine "reaction potential."

Animal studies of possible relevance were those of Crespi (1942) and Zeaman (1949). These studies provided data on acquisition performance values for animals trained under different magnitudes of food reward. The conclusions of these studies were in accord with Hull's formulation as to the effect of amount of reinforcement on performance in that they indicated concommitant changes in level of performance with changes in amount of reinforcement.

Although the experimental evidence on the role of magnitude of reinforcement is far from clear, human learning experiments on this problem appear to favor the "all-or-none" hypothesis advanced by Thorndike. With specific reference to mental retardates, a study by Cantor and Hottell (1955) revealed no significant differences in the learning of a discrimination problem for two different intelligence levels with differing amounts of reward.

The task of specifying two different amounts of reward which would be significantly different in terms of effect upon performance level would be difficult on the basis of the experimental evidence accumulated thus far. One study revealed that as amount of monetary reward increased from 0.1 cent to 0.4 cent for each correct response that there was an increase in level of performance for normal boys in a multiple choice experiment. However, there was no further increase as the amount of monetary reward was increased from 0.4 cent to 0.8 cent for each correct response (Thorndike and Forlano, 1933). Rock (1935) found that the addition of varying amounts of money to the simple confirming statement "right" was as effective as a verbally rewarding statement plus varying amounts of monetary reward. Although Eisenson (1935) found that a reward of two tokens led to a higher level of performance than a reward of one token, neither quantity of tokens was as effective as the announcement of "right." Hunt and Patterson (1957) obtained results which suggest that a physical reward which has been verbally emphasized is more effective than a physical reward alone. The above studies appear to indicate that there is no consistent direct relationship between the amount of reward and level of performance. It may be assumed that physical reward or at least verbal reward is necessary to facilitate performance (Hull, 1950; Miller and Dollard, 1941). Thus, if a physical reward is great enough and is accompanied by a verbal reward, it should result in a significantly higher level of performance than would result from what appears to be a zero amount of physical reward and no verbal reward. An investigation of this problem could be based upon an arbitrary amount of physical reward selected along with verbal reward. This could be assumed to be sufficient to modify and, possibly,

facilitate performance to a greater extent than would have been possible had there been no physical and/or verbal reward. As to the absolute amount or nature of different verbal rewards, the literature offers but little to help answer this problem for the researcher in this area.

Delay of reward and its effect upon the performance of some learned response has received much attention from the leading theorists. Numerous studies on the problem have appeared in the literature (Grice, 1948; Perin, 1943). In general, studies on delay of reward have tended to indicate that those responses which occur in close temporal contiguity to a reinforcing state of affairs tend to become more efficiently learned than those which are temporally more separate from the reinforcement. Eventually, with increasing delays of reward, extinction occurs at a more rapid rate than learning. Hence, there is implied a gradient of delay of reward or a functional relationship between immediacy of reward and efficiency of learning.

The series of studies performed by Perkins (1947), Wolfe (1934), Perin (1943) and Grice (1948) appear to culminate in the suggestion that all delay of reinforcement may be interpreted in terms of the operation of secondary reinforcement. Thus, interpretation of results of studies relevant to the shape of this gradient becomes rather ambiguous because secondary reinforcement has not been effectively controlled. The impact of the temporal delay upon primary reinforcement remains indeterminant for the most part because of the lack of control of secondary reinforcement.

Research on delay of reward has been almost exclusively limited to such subhuman species as the white rat. Saltzman (1951) employed human subjects and found that an immediate reward group required significantly

fewer trials and made fewer errors in learning a verbal maze than did a six-second delay group. Gardner (1945) compared the performance of mentally retarded human subjects with that of horses, sheep and cattle under different food reward conditions. The resultant performance curves indicated considerable similarity. Thus, it would appear that the effect of rewards may be comparable for subhuman and human learning.

Information from the studies of Perin (1943) and Grice (1948) would seem to indicate that a reward delay of 40 seconds would differ significantly from no delay of reward, i.e., from immediate presentation of reward after the desired response, in its impact upon rate of learning. Grice found learning to occur with up to approximately 10 seconds delay of "primary" reward whereas Perin found learning with delays as great as 35 seconds. The difference between the two findings has generally been interpreted as a matter of differences in control of secondary reinforcement.

In respect to the third experimental variable, social situation, Miller and Dollard (1941) stress the importance of social context and its effect upon learning. One of the more relevant studies in this area is Abel's (1938) investigation with the mentally retarded in which he found that the performance of those individuals who worked in small groups was significantly superior to those who worked alone. Hurlock (1927) found that group rivalry apparently facilitated performance. Perlmutter and de Montmollin (1951) obtained results which were consistent with the findings of both Abel and Hurlock. The experimental literature, then, appears to suggest that learning in a small group can have a facilitative effect upon performance. But if the groups become larger and there is individual performance in the presence of a

group rather than performance as a co-operating member of a smaller group, it is questionable as to what effect this would have upon performance. Performance in prior experiments has generally been in groups of two (Abel, 1938; Sidowsky, Wyckoff, and Tobory, 1956) or three (Perlmutter and de Montmollin, 1951) subjects. If sheer numbers were relevant to the facilitory effects of the individual's performance within a group then performance within a group of five or more individuals should reflect these effects.

Summarizing the proposed experimental variables, it has been indicated that the variables of amount and delay of reward have positive and inverse relationships, respectively, with performance level. The variable of social situation or grouping condition appears to facilitate performance, at least, in groups of two or three individuals.

Gardner (1945) found crackers to be quite comparable in relative efficiency as incentives for mentally retarded subjects on a discrimination learning task. Azrin and Lindsley (1957) employed jelly beans as reinforcement for performance as a co-operation versus opposition task with normal children. The authors concluded that the presentation of a single reinforcing stimulus, i.e., one jelly bean, was sufficient to the extent that it resulted in significantly more co-operative responses between pairs of subjects than opposing responses.

The present author found a preference for jelly beans from four types of candy used with a group of 84 mentally retarded subjects in a test of the relative value of different types of candies.

The pursuit rotor involves what is considered to be a perceptual motor task. There might be some question as to whether or not mentally retarded individuals, particularly those institutionalized, could

effectively perform such a task. This would be the view of some who assert that motor deficiency is part of the general picture of mental retardation. Doll (1946) and Tredgold (1937) have taken this position while Sherman (1945) held that no relationship existed between motor proficiency and intellectual ability. The experimental evidence is rather indefinite although Heath (1953) and Rabin (1952) obtained results which indicate some relationship between physical and intellectual deficiencies in the mentally retarded. However, the scope of the studies seems to have been too narrow to warrant any degree of unqualified generalization so that the evidence regarding these two factors and their relationship is inconclusive at present.

In rotary pursuit performance, a number of findings appear pertinent to the present study. Ammons, Alfin, and Ammons (1955) found evidence for an overall increase in proficiency with an increase in age for pre-adult subjects. Males appeared to be superior to females in another study relevant to this task (Buxton and Grant, 1939). Right-handed subjects performed more proficiently than left-handed subjects when the rotor revolved in a clockwise direction (Grant and Kaestner, 1955). In another study, performance of the mentally retarded appeared quite similar to the performance of normal subjects on the pursuit rotor although they functioned at a somewhat lower level (Barnett and Cantor, 1957).

II. STATEMENT OF PROBLEM

The learning processes of the mentally retarded have not been subjected to experimental scrutiny to the extent that such investigations have been made with normals. This situation would not appear to be critical except for certain considerations which involve a distinction between data obtained with normal subjects and data obtained with retarded subjects.

One apparently prevalent etiological consideration in mental retardation contains the notion that the ineptness of the mentally retarded individual is a function not alone of a basic deficiency in native ability but also of a failure to utilize existing native ability.

The literature in mental retardation is rife with elaborations of applied methodological considerations in administrative and "educational" practices with retardates. However, these views lack a sound body of evidence regarding the basic processes of learning in the mentally retarded. The validity of many of these conclusions hinges on the results of more basic investigations such as the proposed study. Without an experimentally validated approach, conjecture will continue to be indistinguishable from fact.

Hence, this investigation seeks to extend the classical studies of normal learning processes to those of the mentally retarded. The variables of amount and delay of reward have received much attention in such research with normals. Generally, the third variable of social situation has been avoided in classical studies because of its tremendous

complexity. However, the present author considered the potential effect of such a variable upon performance promising enough to warrant its inclusion in the study. These variables were investigated in a rotary pursuit task.

The problem of the present study was to determine the relationship between perceptual-motor performance and variations in social situation, amount of reinforcement, and delay of reinforcement for mental retardates.

The following null hypotheses were advanced:

1. There would be no significant relationship between pursuit rotor performance and delay of reward.
2. There would be no significant relationship between pursuit rotor performance and amount of reward.
3. There would be no significant relationship between pursuit rotor performance and social situation or grouping conditions.

III. EXPERIMENTAL PROCEDURE

A. General Methodology

The general procedure was to study the relevance of the independent variables of social condition, amount of reward, and delay of reward to the learning of a rotary pursuit task by institutionalized mentally retarded subjects.

A 2 X 2 X 2 factorial design was utilized with subjects randomly assigned to each of the various experimental conditions. The sequential order in which the subjects were run, under each experimental condition, was also randomly determined.

There were three major experimental conditions. Under each of these conditions, Social Situation, Amount, and Delay of reward were systematically varied. These conditions were:

Group 1 - These subjects performed under the Individual social condition, with No Reward, and No Delay of the reinforcement condition.

Group 2 - Performance was under the Individual social condition, with No Reward and a 40 second Delay of the reinforcement condition.

Group 3 - These subjects performed under the Individual social condition, with a Reward and No Delay of the reinforcement.

Group 4 - Subjects performed under the Individual social condition, Reward, and a period of 40 seconds Delay of reward.

Group 5 - These individuals performed under the Group social situation (self plus four others) with No Reward and No Delay of the reinforcement condition.

Group 6 - These subjects performed under the Group social condition with No Reward and 40 seconds Delay of the reinforcement condition.

Group 7 - These subjects performed under the Group social condition with Reward and No Delay of the Reward.

Group 8 - In this group were those who performed under the Group social condition with Reward and 40 seconds Delay of the reinforcement condition.

B. Subjects

Eighty right-handed mentally retarded individuals were employed as subjects. They were selected from the Enid State School population from those with a chronological age between 12 and 35 years and an intelligence quotient between 40 and 70. An attempt was made to control possible variations in performance due to sex differences by assigning the same proportion of females to males in each of the eight experimental conditions. Subjects were randomly assigned to each of the experimental conditions with ten subjects performing under each particular combination of experimental conditions.

C. Apparatus

A modified Koerth pursuit rotor revolving clockwise at 60 r.p.m. was utilized as the learning task. Trials and rest intervals were timed automatically. Time on the target was recorded for each trial

in units of .01 seconds on a Standard Electric timer. The size of the target was 1 inch in diameter. The total length of the stylus was 6 3/4 inches. The diameter of the turntable was 6 1/2 inches. The apparatus was so arranged that during the Grouping condition, the group was able to observe the performance of the practicing subject without crowding or, in general, interfering with the subject's performance. Scoring was in terms of time the stylus was kept in contact with the target.

D. Procedure

Each subject had a total of 20 trials of thirty seconds each. An inter-trial interval of 10 seconds was included along with the appropriate delay of the reinforcement condition for each experimental group. The first ten trials were practice trials in which the subject was allowed to gain some familiarity with the task. It was hoped that these trials would permit a greater degree of subject understanding of the task situation and aid in establishing some measure of subject-experimenter rapport. The practice trials formed the basis for determining possible sampling errors. The practice conditions for trials 1 - 10 were identical for all experimental groups. The experimental variables were not introduced until trial 11. The experimental conditions involved only trials 11 - 20.

Groups 1, 2, 5, and 6 received No Reward but groups 3, 4, 7, and 8 received a Reward, one jelly bean per test trial, after the appropriate period of Delay. The Reward condition was Delayed forty seconds for groups 2, 4, 6, and 8 while the Reward condition occurred with No Delay for groups 1, 3, 5, and 7. The forty second delay was accomplished by allowing the timing device for the pursuit rotor to make one additional

complete cycle between each trial although the rotor itself was not in motion. Groups 1, 2, 3, and 4 performed under the Individual social condition with only the experimenter present. Groups 5, 6, 7, and 8, however, performed in a Group social condition and in the presence of the experimenter. Each of the subject spectators, in a randomly predetermined order, served his turn as a subject.

The independent variables were conditions of Grouping (alone vs. self plus four other subjects), amount of Reward (no candy and no verbal praise vs. one jelly bean and a predetermined verbal statement of praise), and Delay of reinforcement (immediate reinforcement vs. 40 seconds delay of reinforcement). The dependent variable was the amount of time the stylus was kept in contact with the pursuit rotor target during each 30 second trial interval.

A modified version of the Standard Air Force rotary pursuit instructions (Irion and Gustafson, 1952) was employed. Reward was given following the appropriate delay and accompanied by predetermined verbal statements.

IV. RESULTS

A 2 X 2 X 2 factorial design was employed as the experimental design and the corresponding analysis of variance was attempted. However, the Bartlett's test of homogeneity of variance yielded a highly significant chi-square value, a value significant at beyond the .01 level of probability. The coefficient of variation was computed for the data in order to ascertain the feasibility of a logarithmic transformation. The results, however, were negative. Other pertinent transformations were deemed inappropriate.

In an effort to obviate the heterogeneity problem, a weighted deviation analysis of variance procedure which did not require homogeneity of variance was attempted (Snedecor, 1956). But when the procedure was applied to the practice trials (trials 1 - 10), where no treatment conditions were operative, a statistically significant value was obtained.

The fact that an estimate of treatment effects would be contaminated by the operation of some unknown, uncontrolled variable(s) prevented any straight-forward conclusions.

The covariance technique was considered a potential indicant of possible effects from an unknown origin which were operative in the practice trials. But the presence of heterogeneity of variance made the covariance technique inappropriate in this situation.

Although the data failed to meet the assumptions requisite to the use of the various parametric statistical procedures considered, the decision was made to attempt a number of such parametric approaches and to note the consistency (or inconsistency) of the obtained results from

these several methods. The use of the F - test of analysis of variance and t - test of differences has been empirically studied by Norton and Bartlett, respectively, in experimental situations in which the underlying assumptions are in serious doubt (Bartlett, 1935; Norton, 1952). It was concluded that, in general, when the violations were "marked" but not "extreme," allowances could be made by setting a higher "apparent" level of significance for the tests of treatment effects than would otherwise be employed. For this reason the accepted level of significance was set at the .01 probability level rather than the more customary .05 probability level.

Three analysis of variance procedures were employed. The technique noted above, in which weighted deviations were included as corrections for heterogeneity of variance, was utilized and yielded an overall F value that was significant at the accepted level of probability (.01 level). This analysis also revealed significant F ratios for both Group and Reward treatment variables. A conventional analysis of variance was made of the deviations of data obtained on test trials (11 - 20) from a regression line projected from the practice trial data (1 - 10), i.e., from the first ten trials to the last ten trials. This analysis of variance procedure yielded an overall F ratio that was significant at the 1% level of probability. Finally, difference scores were computed between practice and test trials and the factorial relations (analysis of variance) were computed. This analysis yielded statistically significant F ratios for Reward, Delay and Reward X Delay interaction. The analysis of variance procedures are presented in tabular form in Table 1.

A Multiple Range test of difference was applied to the difference scores for the various experimental groups. This statistic yielded

TABLE 1

OBTAINED F RATIOS BY VARIED ANALYSIS OF VARIOUS PROCEDURES

Variance Component	Absolute Scores df	Absolute Scores F - Ratio	Deviation Scores df	Deviation Scores F - Ratio	Difference Scores df	Difference Scores F - Ratio
Overall	7,29	4.65 **	7,72	18.45 **		
Group	1,78	.27			1,78	4.77
Reward	1,74	7.12 **			1,78	79.18 **
Delay	1,53	9.23 **			1,78	52.81 **
Group X Reward	1,78	.41			1,78	1.09
Group X Delay	1,78	.29			1,78	2.22
Reward X Delay	1,78	.80			1,78	29.72 **
Group X Reward X Delay	1,79	.08			1,78	.07

** Significant at .01 level

results which indicated that Group 4 (Individual performance with Reward and Delay of reward condition) and Group 8 (performance in a Group with Reward and Delay of Reward condition) were different from each other and from all other experimental conditions to a statistically significant extent.

Finally, a t - test of differences between practice and test trials was computed for each experimental group as a test of difference between the respective beta coefficients for practice and test trial blocks (see Table 2). The obtained t values were significant for groups 1, 4, and 8. Group 1 was that experimental condition in which there was Individual performance with No Delay and No Reward condition. Contrary to the direction of difference for groups 4 and 8, the practice trial beta coefficient for group 1 was significantly greater than the beta coefficient for test trials. Groups 4 and 8 were also found with the Multiple Range test to differ from all other experimental groups to a statistically significant extent, i.e., at the .01 level of probability.

TABLE 2

T-TEST OF DIFFERENCE BETWEEN PRACTICE AND TEST TRIAL BETA COEFFICIENTS

Experimental Condition	Practice Beta	Test Beta	T-Value
Individual, No Reward, No Delay	.0472	.0181	6.500 **
Individual, No Reward, Delay	.2230	.3780	2.162
Individual, Reward, No Delay	.1580	.2250	1.032
Individual, Reward, Delay	.1330	.6290	4.765 **
Group, No Reward, No Delay	.0510	.0910	1.220
Group, No Reward, Delay	.1630	.1900	.3510
Group, Reward, No Delay	.0860	.2020	2.3918
Group, Reward, Delay	.1350	.5130	4.6097 **

** Significant at .01 level

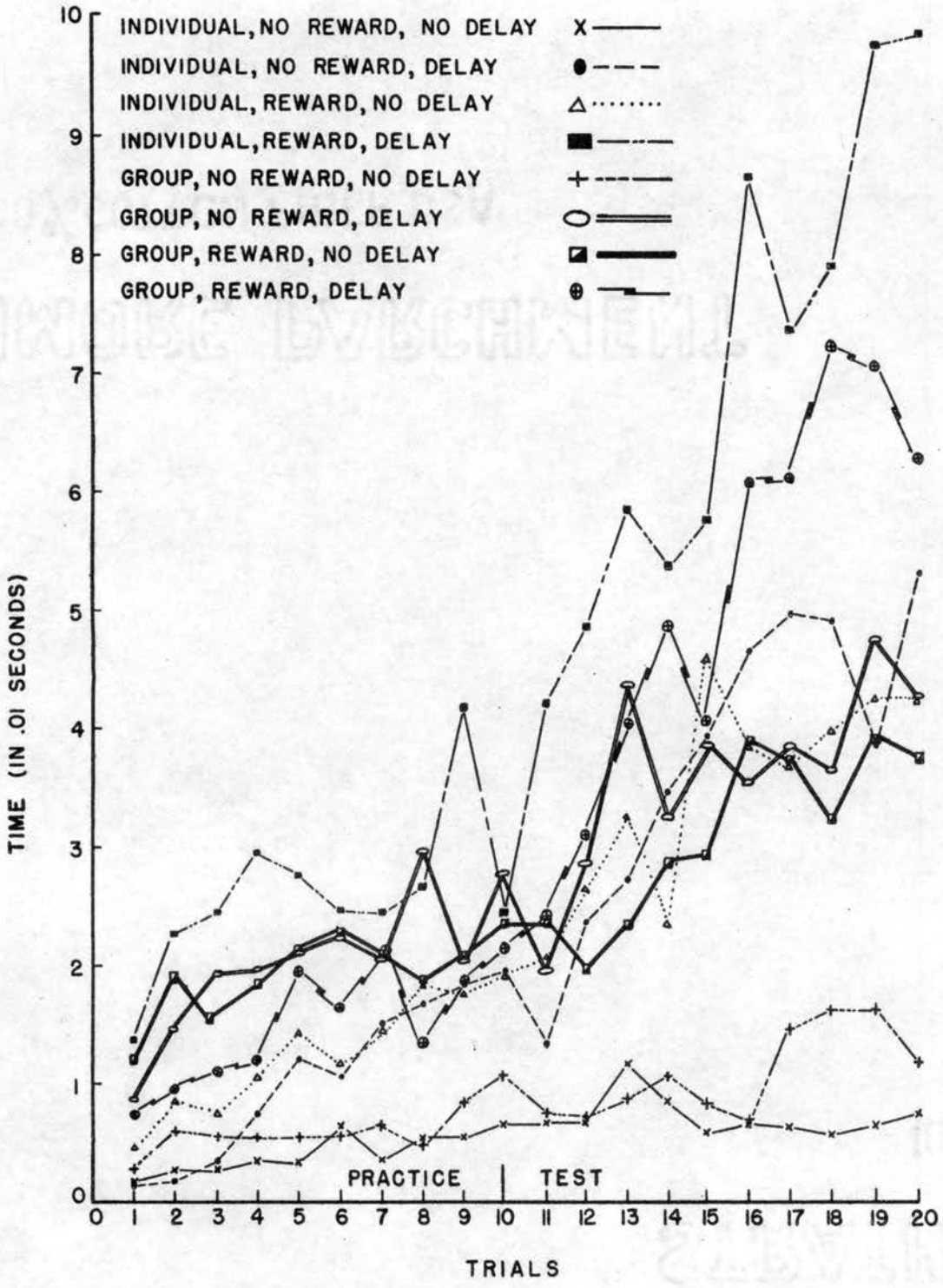

Fig. 1. Mean Performance of the Eight Experimental Groups

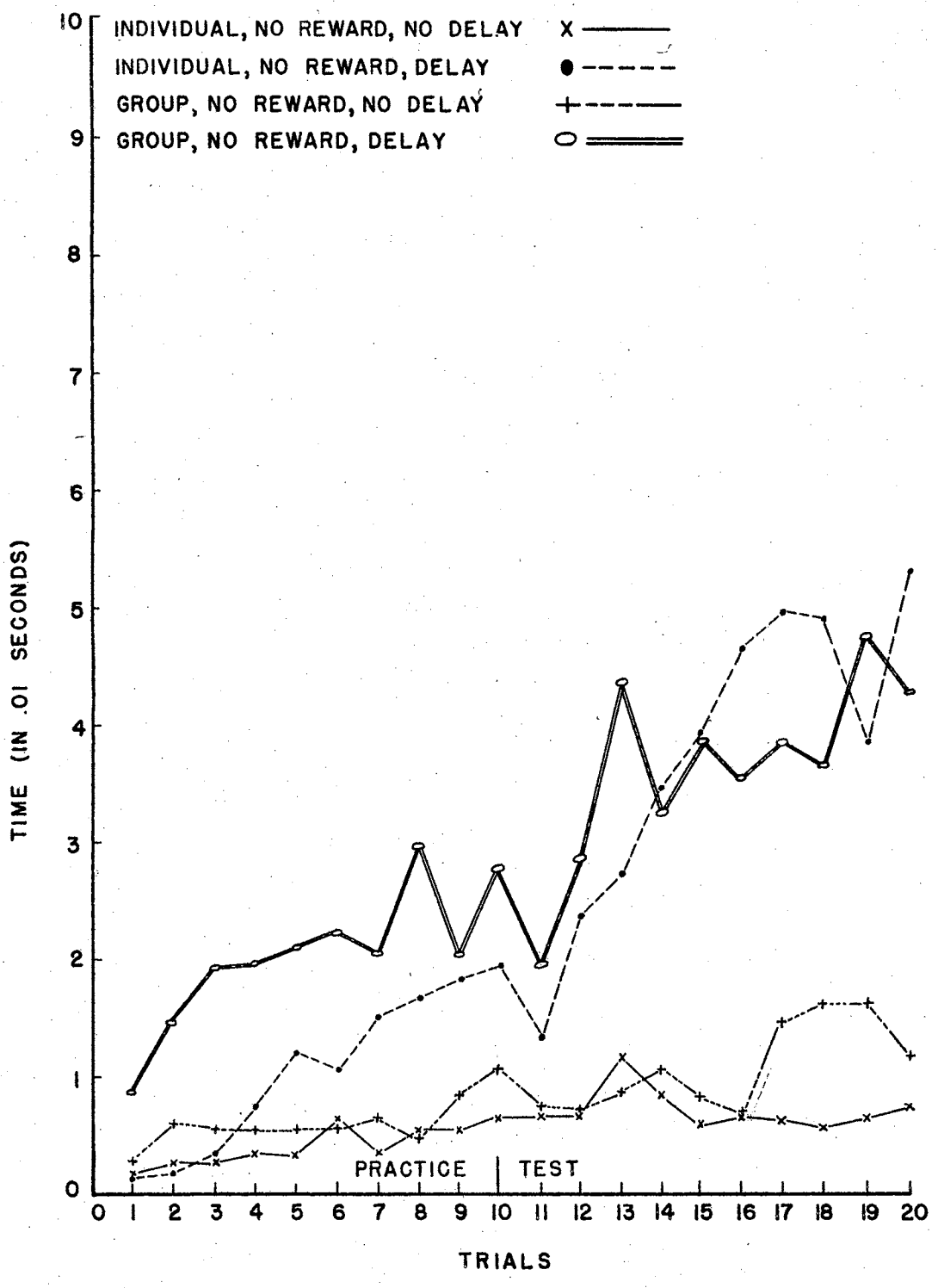

Fig. 2. Mean Performance Scores Under Constant No Reward Condition

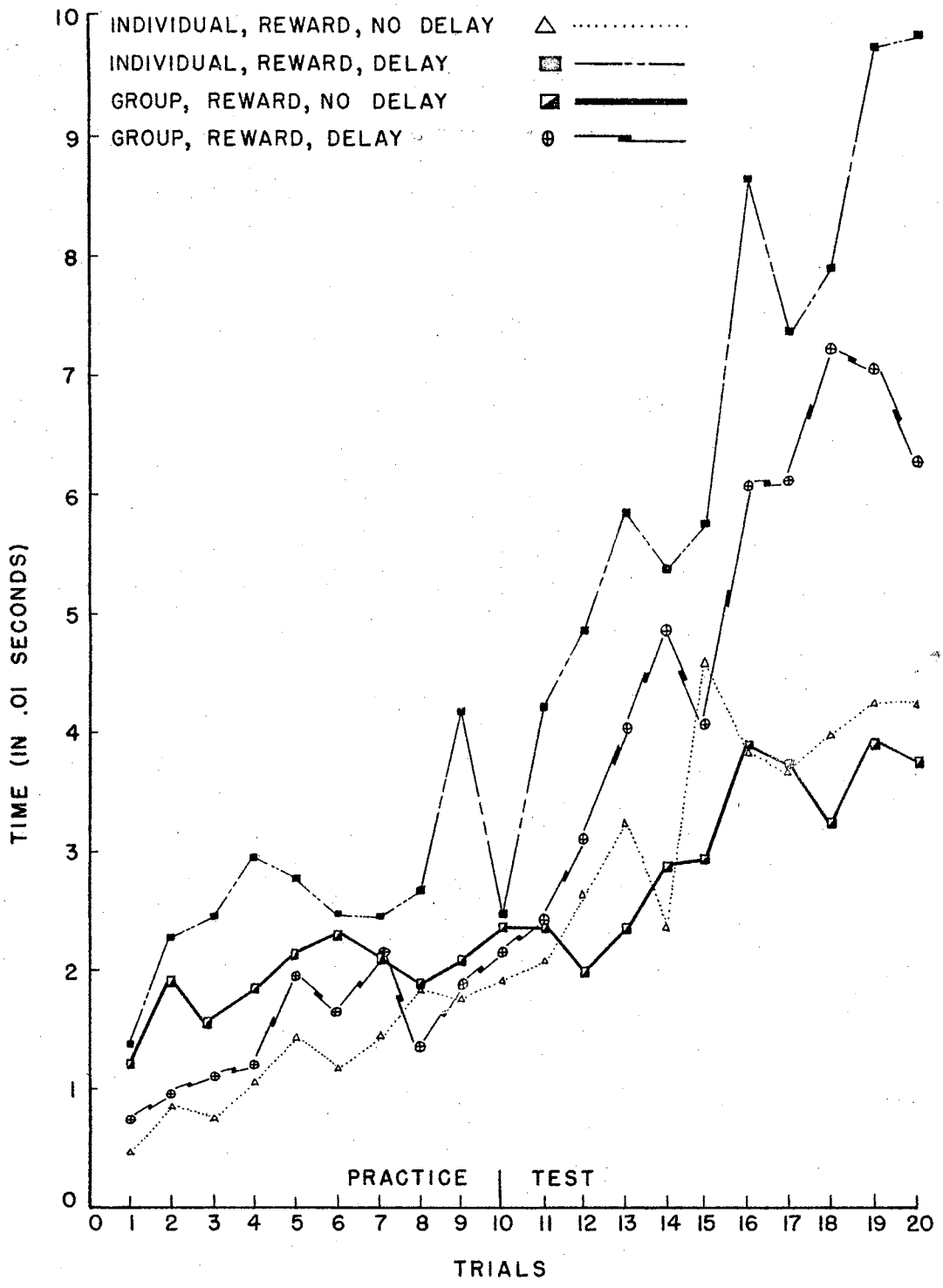

Fig. 3. Mean Performance Scores Under Constant Reward Condition

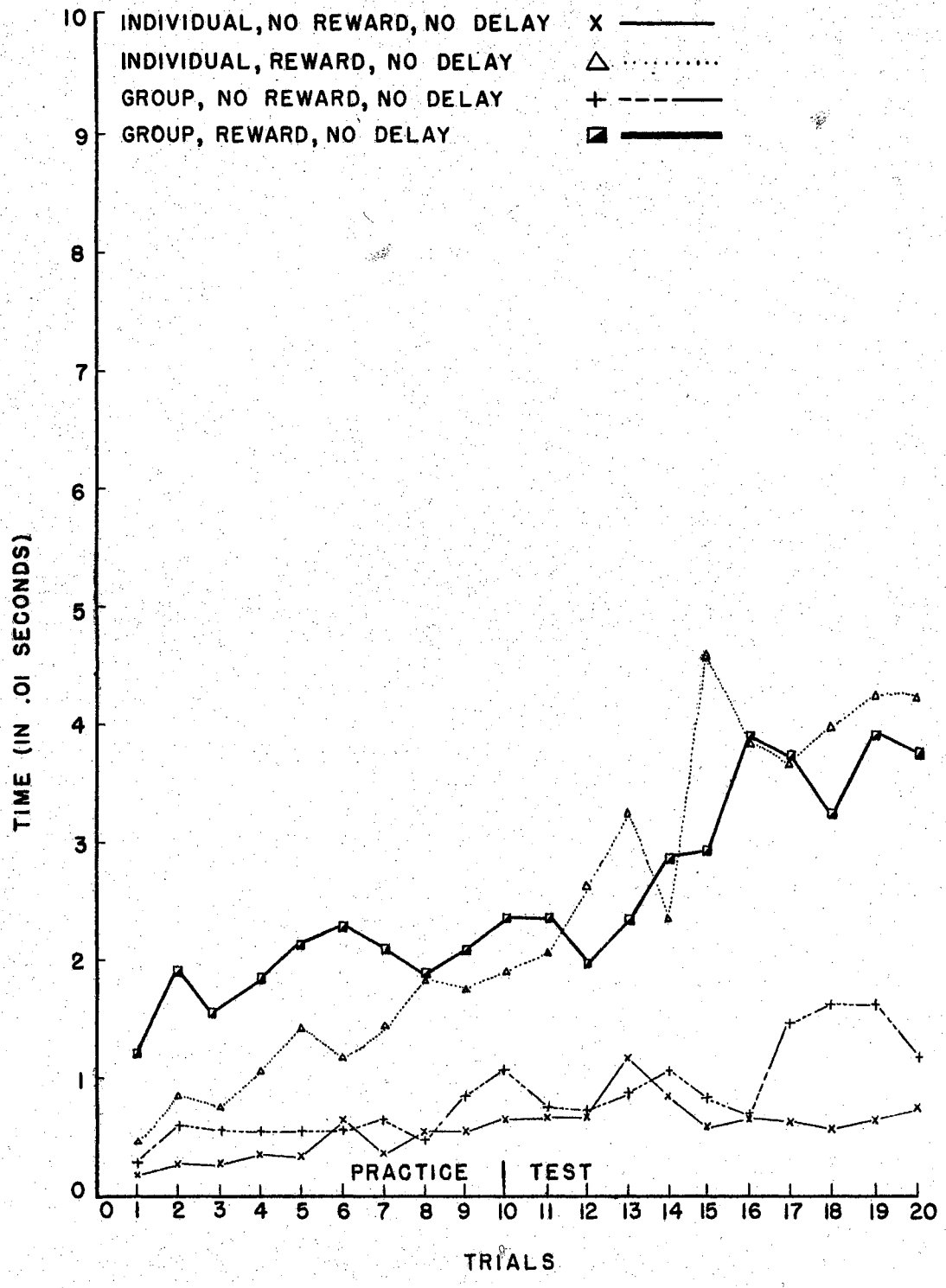

Fig. 4. Mean Performance Scores Under Constant No Delay Condition

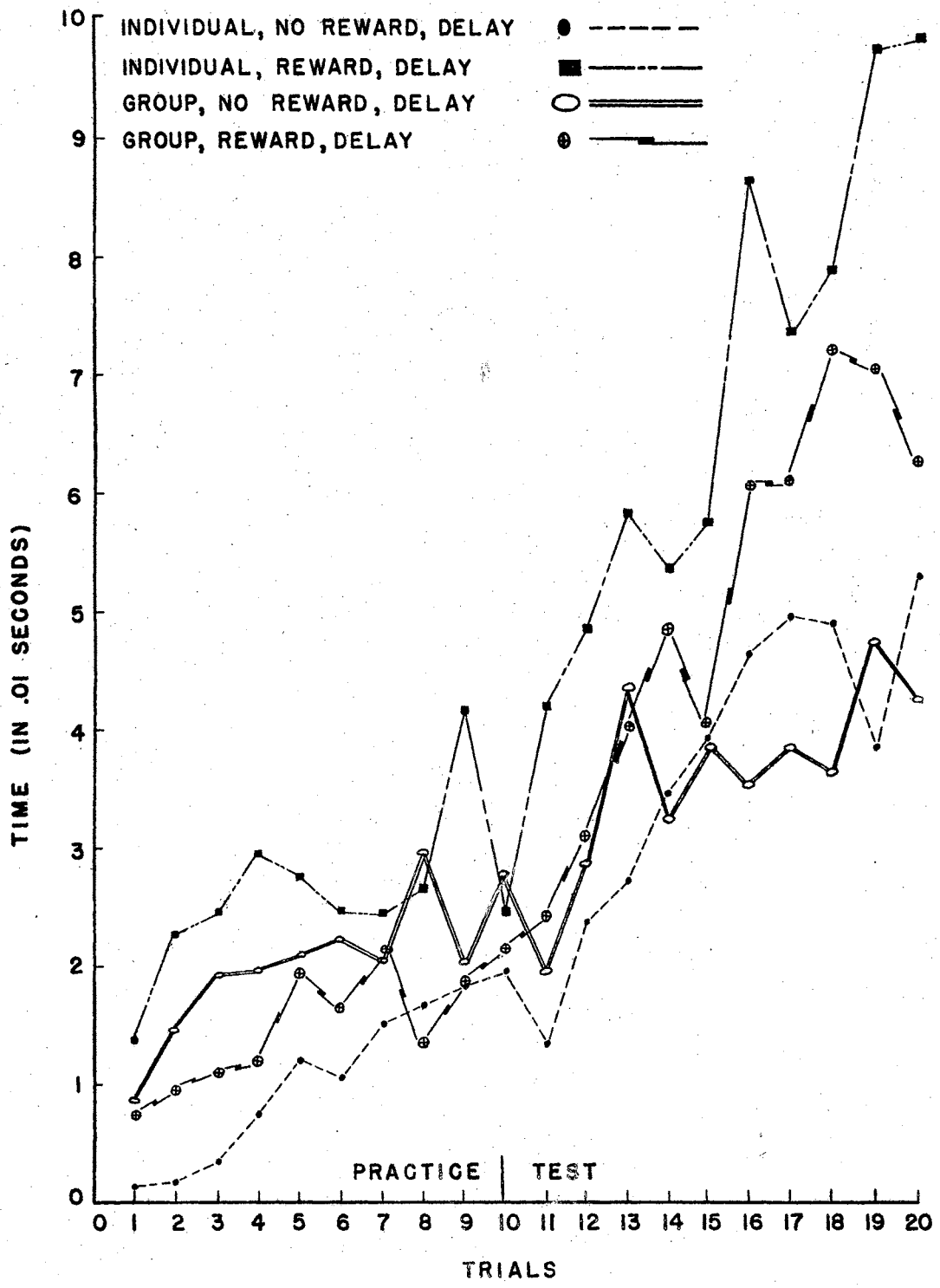

Fig. 5. Mean Performance Scores Under Constant Delay Condition

V. DISCUSSION

The present investigation was concerned with the relationship between perceptual-motor learning in the mentally retarded and variations in social situation, amount of reinforcement, and delay of reinforcement.

The statistical analyses of the results obtained from the present study indicated that the null hypotheses for perceptual-motor learning as a function of amount and delay of reinforcement should be rejected. The analysis of variance procedures employed indicated, without exception that reward and delay of reward were related to pursuit rotor performance to a statistically significant extent. The analysis of variance of difference scores also indicated a significant interaction between reward and delay. This finding, if accepted, would make difficult an interpretation of the main effects of these two variables in isolation. The seemingly appropriate inference, on the basis of the analysis of variance of the difference scores, appeared to be that the presentation of a reward after a forty second delay was superior to the absence of one or both of these variables in terms of effect upon the perceptual-motor performance of mentally retarded subjects. The other statistical analyses of treatment effects tended to support the conclusion that the effects of the delay and amount variables were significant but did not support the interaction conclusion. The analysis of variance procedures utilizing weighted deviations and deviations from a regression line projected from practice to test trials indicated precisely the same variance components to be significant as was found in the analysis of variance of difference scores. The t-test and Multiple Range tests of

differences also supported the inference cited above. In all the statistical procedures the null hypothesis was supported concerning the relationship of the third main effect, social situation, and all other interaction effects to pursuit rotor performance as indicated by the amount of time the stylus was kept in contact with the target in each thirty second trial. Thus, the several statistical procedures employed in the study were markedly consistent indicants of the relationship between social situation, amount of reward, and delay of reward variables and performance levels.

The results of the present study essentially support earlier findings in the literature of studies concerned with amount or magnitude of reinforcement (Crespi, 1942; Thorndike and Forlano, 1933; Zeaman, 1949). The present results obtained with a mentally retarded population tend to parallel the findings of earlier investigations with "normal" populations to the extent that Reward conditions were superior to No Reward conditions in terms of time on rotary pursuit target. Thus, one may infer that the role of amount of reward in perceptual-motor learning in mentally retarded subjects is similar to the role of that factor with normals in such a learning situation. The inference could only be a gross approximation to the nature of the factor because the experimental design was factorial, i.e., the three different experimental variables were presented in only two different degrees of variation. A more precise specification of the role of amount of reward would entail the use of an experimental design which was functional in type in which the experimental variables would be presented in more than two amounts.

The results obtained with the variable of social situation do not reflect the trends in the experimental literature concerning its role in

perceptual-motor learning. Earlier investigations have generally obtained a significant positive relationship between performance and group situations. One possible explanation of this discrepancy may lie in the fact that the size, composition, and activity of the present study's groups differed to some extent from earlier investigations. Performance in prior experiments has generally been in groups of two or three subjects. The present study involved groups of five subjects. Performance in prior experiments has generally involved groups composed of only one sex or groups in which heterosexual interactions were not unusual. The institutional population involved in the present investigation was subject to rather rigorous restrictions of activities involving both sexes. Further, in contrast to a number of earlier studies, the present investigation was dealing with a population which was predominantly mature sexually. Finally, the earlier investigations have generally involved active co-operation or competition of all subjects simultaneously whereas the present study involved only one member of the group being active at one time while in the presence of group spectators. It may be that the discrepancies between the present investigation and earlier experiments are due to one or a number of these differences such as group size, composition, and activity.

The data obtained regarding the significance of Delay appear to indicate some differences in the effects of this factor with retardates as opposed to the effects obtained with normals. The literature would represent the relationship between delay of reinforcement and performance as an inverse one in which the less extensive the delay, the higher the performance level. The inference appropriate to the results obtained in the present study would be that the relationship between delay of reward and performance is a direct one, i.e., the presence of Delay has a facilitative effect upon performance. At least part of this conflict may be

interpreted as reminiscence effects, i.e., increments in the performance of a partially learned task following an interpolated rest (Bell, 1942; Irion, 1949; Kimble and Horenstein, 1948). The delay would allow a period of rest during which fatigue factors might dissipate while this recovery from fatigue would not occur to the same extent where there was no delay. However, the delay does not appear to have been extensive enough to totally account for the degree of increment in performance obtained following the Delay condition. Another potential explanatory factor may be the rigidity of the retardate as opposed to the normal subject. The generalization has long been accepted that the subnormal individual is more rigid than the normal (Masland, Sarason, and Gladwin, 1958). The relevance of this variable to the Delay factor lies in the possibility that a period of inactivity might allow the retardate an opportunity to adjust to perceptual-motor cues other than those cues to which he originally attended. If this were the case then the absence of the delay would not allow the retardate as much inactivity in which to modify his set for attending to certain cues and not attending to other cues.

The analysis of variance of the difference scores indicated a significant interaction factor for Reward X Delay. The rigidity notion also has some relevance here. In one study of rigidity (Stevenson and Zigler, 1947) in which the degree of supportive comments made by the examiner was varied, evidence was obtained that the subnormals who received verbal support (Reward) performed at a higher level than did those who did not receive such verbal support. The relationship of delay and rigidity indicated above presents the results of this study in a new light. This might be viewed as some degree of confirmation of the statistically significant interaction component for Reward and Delay.

In an overview of the present investigation, two control factors might be viewed as deficient.

The subjects were selected for a given experimental group on a randomized basis. The intelligence quotient (Binet) and chronological age factors made up the criteria for delineating the population of concern. It may have been that this random selection procedure resulted in a distribution of intelligence level, chronological age level, and, possibly, other pertinent variables that were not comparable within each experimental condition. Figure 1 points up the inequalities in initial performance level for the eight experimental conditions, which may reflect a lack in the control by randomization.

A second control factor which might be considered relevant to the differences obtained in this study and in previously cited literature might be due to the fact that earlier studies were based upon groupings of members of the same sex.

By the same token, one control factor appeared especially effective. The specification of task variables appeared to be markedly explicit in the case of the pursuit rotor employed in the present study (Ammons, Alfin, and Ammons, 1955; Buxton and Grant, 1939; Grant and Kaestner, 1955). The pursuit rotor was quite effective in terms of lending itself well to rapid and easy quantification.

Thus, the results of the present study present certain parallels between the role of the independent variables in the learning processes of the mentally retarded and the learning processes of normal subjects. This was apparently true in the case of Reward. However, the results failed to support the conclusions of earlier studies concerned with social situation and its relationship to performance level. Finally,

the variable of Delay in this study was apparently in direct conflict with the results of earlier studies. The presence of the interaction for Reward X Delay complicates the interpretation of the separate main effects but lends support to a rejection of the null hypothesis concerning the relation of the variables to performance level.

VI. SUMMARY AND CONCLUSIONS

1. An experiment was conducted in which the major variables of social condition, amount of Reward, and Delay of reward were investigated in order to determine the relationship of these variables to performance level in a pursuit-rotor study. There were eight experimental groups with 10 subjects in each group. Under Individual social condition, one half of the subjects received Reward and the other half received No Reward. In a like manner, one half of the Reward and No Reward subjects performed with a Delay of reward and the remaining half, in this instance, performed with No Delay of reward. Regression equations derived from performance on the practice trials and test trials were computed for each of the eight experimental conditions. Deviations of the test trial data were computed from the regression line projected from practice trial data. Difference scores were computed between practice and test trials. The absolute score data, the deviation score data, and difference score distribution data were subjected to several analyses of variance procedures. A Multiple Range test of differences was applied to the difference score data. A t-test of differences was employed in a comparison of the beta coefficients obtained in the practice and test trial regression equations. These several indicants provided a number of comparable estimates of the statistical significance of the treatment and interaction effects.

2. In considering the experimental variable of Reward, it was concluded that, in this study, pursuit rotor performance was significantly related to this variable.

3. The subjects under the experimental condition of Delay performed at a significantly superior level to those who performed under the experimental condition of No Delay. An attempt was made to explain the conflict between the results obtained in the present study and those of earlier investigations with normal populations. Particularly, this appears true when the interpretation is in terms of rigidity and reminiscence and their effects on the performance of mentally retarded subjects.

4. The subjects who performed under the Individual social condition did not differ significantly in their performance from those who performed under the Group social condition. The failure of the results of the present study to concur with the results of earlier investigations in respect to this variable was considered possibly related to differences in size, composition, and activity of the group.

5. A significant interaction effect was obtained for the Reward and Delay experimental variables. This was viewed as possibly reflecting the effects of a complex rigidity factor related in some subtle manner to both Delay and Reward.

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APPENDICES

APPENDIX A

INSTRUCTIONS

(Read to Ss performing under Individual social condition.) Each of you will have a chance to show how good you are in a pursuit rotor task (E points to apparatus). I want you to tell as well as show me the correct way to perform this task after you have had your turn.

(Read only to Ss performing under Group social condition.) Each of you will have a chance to show us how good you are in a pursuit rotor task (E points to apparatus). While one of you is doing this task, I want the rest of you to pay close attention to what he or she is doing. I want you to do this so that when your turn comes, you will be able to do a good job. I also want you to tell as well as show me the correct way after you have had your turn and watched the others perform.

(Read to all Ss following the above introduction appropriate to the social condition under which they perform.) We would like to see how well you can do on this pursuit rotor task. You are supposed to keep the point of this stylus on the target while it is moving (identify stylus and target by pointing). Hold the cord and handle it in this fashion while you are attempting to keep the stylus in contact with the target on the turntable (demonstrate with turntable moving). Make sure that you hold the stylus lightly between the thunb and fingers and stand back so that you are in a comfortable position. Now show me the correct way to hold the stylus and cord and the position in which you will be standing (if S doesn't indicate the correct position, then E will make the necessary corrections). Now hold the stylus above the target. You will be doing this a number of times. Each time you will hear a warning buzzer then the turntable will start. Do not try to put the stylus on the target until the turntable starts moving. Then try to get the stylus on the target and keep it on the target.

. . . . . .

(Following the appropriate delay during the inter-trial intervals, one of the following statements, according to a systematically predetermined order, was read to Ss performing under Reward condition.)

"Okay, that was fine."
"That was real good."
"You did very well that time."
"That was very good."
"You did well that time."

APPENDIX B

APPENDIX TABLE 1

MEAN PERFORMANCE SCORES (IN .01 SECONDS)
INDIVIDUAL SOCIAL CONDITION

	Reward		No Reward	
Trials	Delay Group I	No Delay Group II	Delay Group III	No Delay Group IV
1.	.17	.14	.48	1.39
2.	.28	.18	.82	2.28
3.	.27	.34	.74	2.45
4.	.35	.74	1.04	2.94
5.	.32	1.20	1.42	2.75
6.	.63	1.05	1.19	2.48
7.	.33	1.50	1.47	2.45
8.	.53	1.68	1.84	2.66
9.	.54	1.83	1.76	4.18
10.	.66	1.97	1.92	2.43
11.	.68	1.32	2.07	4.20
12.	.68	2.36	2.64	4.88
13.	1.16	2.71	3.33	5.83
14.	.83	3.47	2.35	5.38
15.	.59	3.91	4.60	5.76
16.	.66	4.67	3.86	8.65
17.	.63	4.96	3.69	7.37
18.	.58	4.90	3.98	7.90
19.	.64	3.85	4.24	9.75
20.	.76	5.30	4.23	9.81

APPENDIX TABLE 2

MEAN PERFORMANCE SCORES (IN .01 SECONDS)
GROUP SOCIAL CONDITION

	Reward		No Reward	
	Delay	No Delay	Delay	No Delay
Trials	Group V	Group VI	Group VII	Group VIII
1.	.29	.86	1.20	.72
2.	.60	1.44	1.90	.95
3.	.55	1.93	1.58	1.10
4.	.53	1.98	1.85	1.20
5.	.53	2.10	2.11	1.96
6.	.54	2.21	2.26	1.64
7.	.63	2.04	2.07	2.09
8.	.49	2.99	1.86	1.32
9.	.82	2.01	2.08	1.83
10.	1.05	2.79	2.39	2.13
11.	.73	1.96	2.39	2.37
12.	.69	2.85	1.98	3.10
13.	.86	4.38	2.34	4.01
14.	1.03	3.22	2.89	4.85
15.	.81	3.88	2.93	4.05
16.	.68	3.51	3.89	6.08
17.	1.45	3.86	3.74	6.10
18.	1.60	3.64	3.22	7.21
19.	1.60	4.72	3.88	7.03
20.	1.16	4.23	3.74	6.29

VITA

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