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## Delayed Reinforcement and Delayed Response in Discrimination Learning of Developmentally Retarded Children

Robert Preston Gelhart  
*Central Washington University*

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DELAYED REINFORCEMENT AND DELAYED RESPONSE  
IN DISCRIMINATION LEARNING OF DEVELOPMENTALLY  
RETARDED CHILDREN

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A Thesis  
Presented to  
the Graduate Faculty  
Central Washington College of Education

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In Partial Fulfillment  
of the Requirements for the Degree  
Master of Education

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by  
Robert Preston Gelhart

August 1961

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APPROVED FOR THE GRADUATE FACULTY

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Eldon E. Jacobsen, COMMITTEE CHAIRMAN

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Howard B. Robinson

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Theodor F. Naumann

## ACKNOWLEDGMENT

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## CHAPTER I

### THE PURPOSE AND DEFINITIONS OF TERMS USED

The introduction of delay in the temporal arrangement of events during discrimination learning seems to markedly affect speed of acquisition, and there is some evidence that developmentally retarded children, in comparison to the non-retarded, are especially sensitive to these effects. However, review of the present literature has not produced significant quantitative evidence concerning the effects of delay on discrimination learning for mentally retarded children.

#### I. THE PURPOSE

Statement of the purpose. As a preliminary investigation of delay factors in discrimination learning, the present study was designed primarily to contrast the effect of a short delay in response with the same duration of delay of reinforcement in order to evaluate the possibility that reinforcement-delay alone during the standard response-delay experiment is responsible for decremental effects. The existence of what the writer would choose to label a "covert" response during stimulus presentation would change the delay period

from one of simple response-delay to one in which both reinforcement-delay and response-delay are correlated. It is hypothesized that a brief delay interval should have the same effect on performance for both reinforcement-delay and response-delay should a "covert" response exist.

Testing the possible correlation between response-delay and reinforcement-delay could produce one of the four following results.

1. Failure in both reinforcement-delay and response-delay tasks. This might be interpreted as evidence of a correlation of response and reinforcement-delay in the standard-type of delayed response task.
2. Failing reinforcement-delay and passing response-delay tasks. This result would provide some evidence contradicting the existence of a correlation of response and reinforcement-delay in the standard-type of delayed response task.
3. Passing both reinforcement-delay and response-delay tasks. This would provide no evidence for hypothesis.
4. Passing reinforcement-delay and failing response-delay tasks. These results might also provide some evidence contradicting a correlation of response and reinforcement-delay.

A second purpose of this study was to relate the discrimination performance of developmentally retarded children to intelligence quotient, mental age, chronological age, diagnostic categories, and length of institutional residence factors.

Practical implication. Both primary and secondary purposes are not only of theoretical importance but have practical significance as well. When considering the implication of this study for teaching simple discrimination problems to mentally retarded children, the purposes stated would be relevant for learning as affected by:

1. Short delays of reinforcement.
2. Short delays of response.
3. Mental age and intelligence quotient.
4. Chronological age.
5. Diagnostic categories.
6. Length of institutional residence.

## II. DEFINITIONS OF TERMS USED

Delay in reinforcement. In delayed-reinforcement, the correct response may be made immediately upon stimuli presentation, but a predetermined interval of time elapses before the reinforcement is delivered. Stimuli are withdrawn from the subject's view during

the delay interval.

Delay in response. In delayed-response, the subject first is shown the correct stimulus. Then the stimuli are withdrawn from view for a pre-determined interval. The stimuli are re-presented, and the subject may overtly respond and be immediately reinforced if the choice was correct.

Covert response. This is a response involving muscles or glands or both, not easily observable by another person without instrumental or experimental aid. It includes contractions or secretions of the stomach as well as changed tonus in biceps muscle or subvocal speech movement.

### III. ORGANIZATION OF THE THESIS

Chapter one has so far presented a statement of the purpose and the practical implications of the study and defined basic terms. A preview of thesis organization will conclude this chapter.

The literature on theory and research will be reviewed in chapter two its limitations mentioned.

Chapter three will explain the method, including population and sample, apparatus, reinforcement, procedure, and stimulus objects. A statistical treatment of the findings will follow the method sections.



Chapter four will give results of this study; a discussion and summary will be given in Chapters five and six.

## CHAPTER II

### LITERATURE ON THEORY AND RESEARCH

Reinforcement and response problems are significant to learning theory and practice in that these variables may be manipulated as a means of modifying performance--a primary purpose in training programs.

The standard type of delayed-response task consists of showing the subject which of two choices will lead to reinforcement but not allowing actual choice until after a predetermined interval.

#### I. THEORY

Hilgard makes the distinction that the

. . . delayed-reaction experiment is to be distinguished from the delayed-reward experiment, with which it may be verbally confused. In the delayed-reaction experiment the response is delayed, but the reward follows the successful response immediately; in the delayed-reward experiment the correct response may be made promptly, but time elapses before the reward is delivered (8:520).

However, the delayed-reaction (or response) experiment can be viewed as a complex of response-delay and reinforcement (or reward)-delay if the subject "covertly" chooses when being shown the location of the correct choice but is not reinforced until the delay has elapsed. When

considered in this manner, then, there may be not only verbal confusion between the two delay conditions but also confusion within the response-delay experiment itself; hence an unambiguous interpretation of the effect of response-delay alone would not be possible since the two delay factors are confounded.

## II. RESEARCH

The existence of a "covert" response is suggested, at least to the writer, by Riopelle's delayed-response experiment with Rhesus monkeys. The monkey glances at the appropriate stimulus and then looks away, producing what could be considered a delay in reinforcement (14:746-753). Thus his original hypothesis that the longer periods of stimulus observation would lead to better performance could be incorrect (his results indicate that the reverse of his hypothesis was the case) since the control variable after the "covert" response could be reinforcement-delay rather than a response-delay. The studies to date indicate that the longer the reinforcement-delay the poorer the performance.

Other delayed-response experiments suggest the existence of this correlation between response-delay and reinforcement-delay. Michels and Brown's (12:737-740) experiment on delayed-response performance of raccoons showed performance decreased as delay length increased. French's (5:741-745) experiment with Squirrel

monkeys showed that an orientation towards the first visible cue was retained during the delay period regardless of its reinforcement value or whether a positive cue was presented later during the delay period. This latter condition did have a tendency, with training, to reorient the animal toward the positive position. However, this reorientation would occur most often during trial setting and sometimes early in the delay. Thus it could be interpreted that the subject's discrimination performance was dependent upon reorientation closely following the "covert" response. Longer reorientation intervals could be equal to delay in reinforcement intervals since the "covert" response had been made. This could serve to further illustrate that the longer the reinforcement-delay the poorer the performance.

Using mentally defective subjects, Harlow (7:253-263), Pascal (12:152-160), and Barnett (1:104-111) found performance decrement when the delay interval was increased, as did Spiker (15:107-111) in tests of normal pre-school subjects. The latter two studies suggest not only the "covert" response as stated above but also that by pre-training subjects to establish verbal symbols for the stimulus objects, a "covert" response might be produced. These subjects could "covertly" pronounce (respond to) the appropriate symbol throughout the delay interval.

Certain studies dealing primarily with reinforcement-delay

have provided evidence of performance decrease with delay increase. Duryeas's (3:343-357) experiment showed performance on a four second delay problem as being poorer than on that of a two second delay problem. "Performance decreased at a positively accelerated rate as . . . delay increased," says Bourne (2:207). Further, Kintsch and Wike's (10:11-14) results demonstrated that a thirty second partial delay resulted in slower learning than when no delay was used.

Aside from the stated major purpose of this study, subject variables (intelligence quotient, mental age, chronological age, diagnostic categories, and length of institutional residence) have been investigated by a few researchers. The evidence is contradictory to one seeking support of the hypothesis that subject variables are significant when considering subjects to be used for the response-delay problem (1:104-111; 7:253-263; 9:105-118; 13:152-160).

Variations in results have been shown to be a function of delay interval differences in Barnett's (1:104-111) study. Using retarded subjects with a mental age range of 5 years 7 months to 9 years, he reported significantly more correct choices followed a ten second delay period than one of thirty seconds, one minute, or five minutes. These subjects were given stimulus pretraining and were approximately the same mental age group as the subjects used for this study.

### III. LIMITATIONS OF EARLIER STUDIES

This study, intended as a preliminary investigation of delay factors in discrimination learning, was designed to evaluate the possibility that a "covert" response in the delayed-response problem is responsible for decremental effects. A review of the literature produced no other study which attempted to do this.

As demonstrated by the literature just reviewed, the limitations of the response-delay problem itself could lie in the failure to recognize the possibility of a "covert" response. In each case the decremental effects have only been reduced by delay length decrease and stimulus pretraining for verbal symbols. Consequently, studies have been designed to overcome the decremental effects by the manipulation of variables, not designed to investigate the existence of a "covert" response.

## CHAPTER III

### METHOD

The method employed in this study includes a description of the subjects, apparatus, reinforcement, and the experimental procedure followed. The stimulus objects are also described, and, finally, the manner in which the findings are handled is explained.

Included are two tables; one lists subject variables and the second illustrates individual subject stimulus objects. Four photographs are used to further illustrate stimulus objects and apparatus.

#### I. SUBJECTS

The subjects were twelve male residents of the Rainier State School for the retarded at Buckley, Washington. Subject variable ranges were intelligence quotient, 22 to 62; mental age, 3 years to 12 years 4 months; chronological age, 12 years 8 months to 21 years; and length of institutional residence, 1 year 4 months to 15 years 1 month. Selection was based upon subject variable ranges (mental age and chronological age) as indicated in Table I and successful meeting of criterion (20 correct responses out of 25 choices per session) on a simple two-choice "junk" discrimination problem. Intelligence

TABLE I  
MEAN AND RANGE FOR SUBJECTS ON INTELLIGENCE QUOTIENT,  
MENTAL AGE, CHRONOLOGICAL AGE, AND LENGTH  
OF INSTITUTIONAL RESIDENCE

Subject Variable	Mean	Range
Intelligence Quotient	41.00	22.0 - 62.0
Mental Age	5.11	3.0 - 12.4
Chronological Age	16.09	12.8 - 21.0
Length of Institutionalization	6.06	1.4- 15.1

N = 12



quotients were determined by means of different tests, with varying time lapses between time of testing and participation in the study. Therefore, any inferences regarding intellectual factors drawn from these data must be tentative. Diagnostic category and length of institutional residence were not selection variables; no attempt was made to achieve homogeneity on these factors. Table II describes the subjects in terms of diagnostic categories, and Table I includes length of institutional residence. All subjects were ambulatory, non-blind, and had no gross physical anomalies.

## II. APPARATUS

A modified Wisconsin General Test Apparatus<sup>1</sup> was used for this experiment. This is illustrated in Figures 1 and 2. The apparatus, including two one-way mirrors mounted in a subject-examiner dividing panel, provided for subject observation yet discouraged the subject's attempt to contact the examiner. Tables were mounted on either side of the dividing panel below the one-way mirrors at which the subject and examiner sat facing one another. A sliding 12 by 17 inch tray mounted in a track in the middle of the table was controlled

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<sup>1</sup>The Psychology Laboratory where the experiment was conducted is supported by United States Public Health Service, National Institute of Mental Health, under the direction of Dr. Sidney Bijou of the University of Washington. Dr. Robert Orlando was laboratory supervisor.

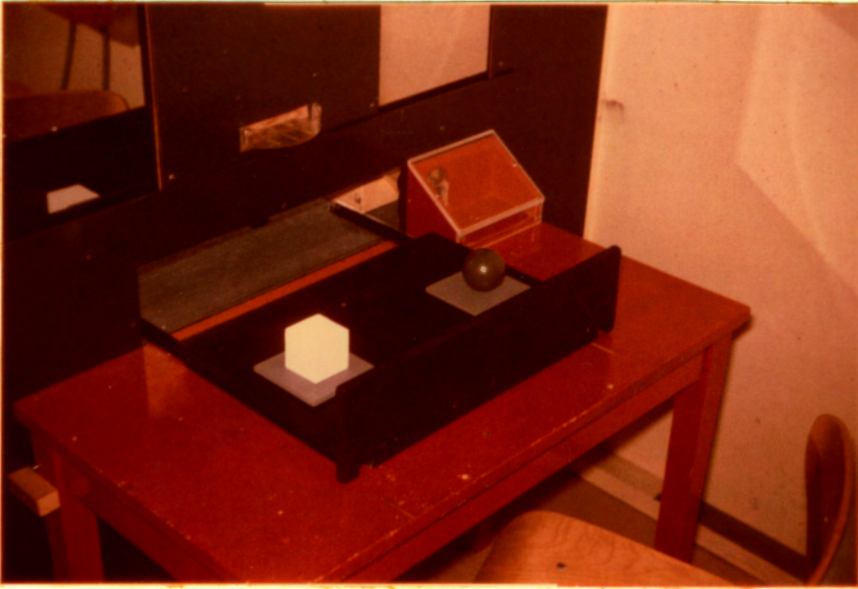


FIGURE 1

DELAY AND STANDARD OBJECTS IN RESPONSE POSITION  
AS VIEWED FROM SUBJECT'S SIDE OF MODIFIED  
WISCONSIN GENERAL TEST APPARATUS



FIGURE 2

DELAY AND STANDARD OBJECTS AND ONE BAITED FOOD  
WELL AS VIEWED FROM SUBJECT'S SIDE OF MODIFIED  
WISCONSIN GENERAL TEST APPARATUS

by the examiner. The subject's end of the tray had a 4 inch high screening board attached to it which fit flush against the dividing panel when the tray was in the closed position. This prevented any subject observation of the examiner's movements. Inserted in the middle of the tray, 9 inches apart, were two recessed wells in which the reinforcement was placed, then covered by stimulus objects. Above the one way mirrors, on the subject's side, was mounted a fluorescent tubular light which insured effectiveness of the mirrors.

Other apparatus included a stop-watch and an automatic vending machine used to deliver reinforcements to the subjects. Both items, controlled by the examiner, were located out of the subject's view.

### III. REINFORCEMENT

Reinforcements were small, bite size, multi-colored Hershey-ets candy which the subjects earned whenever a correct choice was made.

### IV. PROCEDURE

The experiment consisted of these four problems, in order: (1) Junk, (2) Delay in Reinforcement, (3) Delay in Response, and (4) a Standard. Non-correction procedure was employed on all four

TABLE II  
DISTRIBUTION OF DIAGNOSTIC CATEGORIES









































































Category	Number
Undifferentiated . . . . .	1
Cerebral Unknown . . . . .	1
Familial . . . . .	2
Post-Traumatic . . . . .	3
Congenital Cerebral Maldevelopment . . . . .	2
Mongolism . . . . .	<u>3</u>
Total	12

problems, and a 10 second delay interval was used. The Junk problem required the subject to discriminate between two stimulus objects which differed multidimensionally and to associate the reinforcement with the positive stimulus when the position of the stimuli was alternated in a random series (6:206-208). Once the subject had met the criterion on Junk, he was considered to have demonstrated minimum capability for two-choice discrimination on future problems. When a subject had completed the first three of the four problems, he was given the Standard as a means of deciding the significance of the delay intervals or whether the difficulty of the stimulus items themselves had produced any change in performance, since subjects received different stimulus objects on the Junk, Delay in Reinforcement, and Delay in Response problems. The subject received the same stimulus objects for the Standard problem as for the Delay in Reinforcement problem except that the positive-negative values were reversed (See Table III).

Each subject had a session (about 15 minutes) every other day, and he met the prescribed criterion (20 correct responses out of 25 choices, or 4 sessions without passing the problem) before progressing to the next problem, respective of the above order.

In presenting the Junk problem the subject was told to come into the room and sit down in a chair designated by the examiner. The examiner left the room and after several seconds reappeared with a

TABLE III  
STIMULUS OBJECTS ASSIGNED EACH SUBJECT

Subject	Reinforcement-Delay		Response-Delay		Standard	
	Positive	Negative	Positive	Negative	Positive	Negative
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

box of candy. The subject was shown the candy and told, "Now, you go sit in that chair over there (subject's chair at the apparatus) and I will give you a chance to win some candy." The examiner took his position behind the one way mirrors, and baited one food well in the sliding tray. The tray was presented to the subject and he was asked, "Can you find the candy?" If the subject answered positively he was allowed to take the candy. If the subject answered negatively he was shown the candy, allowed to take it, and then presented with the same practice trial again until he found the candy himself. If the subject was capable of finding the candy, the examiner rebaited the tray, placed the positive stimulus object over the food well and presented the tray to the subject. The subject was asked, "Can you find the candy this time?" If the subject answered negatively, the examiner removed the stimulus object and allowed the subject to take the candy. The subject was presented with additional practice trials until this criterion was met. Then the examiner baited the tray and presented it to the subject. The subject was again asked, "Can you find the candy this time?" and regardless of the answer the session was begun. There were 25 trials per session. To meet the prescribed criterion the subject had to get 20 of these 25 trials correct within one session, over a four session period. If the subject did not meet this criterion or didn't wish to participate for candy, he was dropped from the

experiment. If the subject did meet this criterion, he was started on the reinforcement-delay problem.

The two stimulus objects used had positive-negative values assigned in a quasi-random order for each subject. Figure 3 illustrates these objects.

For the Delay in Reinforcement problem there was no demonstration as past experiments have shown that this procedure (the same one used for the Junk problem) was simple enough for the subjects. Once the procedure is learned, it is maintained for additional problems within the same experiment. The stimulus objects differed from those used in the Junk problem, and the session began by the examiner presenting the tray to the subject with the stimuli in position. The subject responded at his own speed, and when the response was made the tray was immediately withdrawn and a stop-watch started simultaneously. At the end of 10 seconds, providing a correct response was made, the subject was reinforced using Hershey-ets from an automatic vending machine triggered by the examiner. Reinforcement was delivered to an open-topped receptacle at the subject's right. If the response was incorrect there was no reinforcement. Following the 10 second reinforcement-delay period was a 5 second period in which stimulus objects were rearranged by the examiner as prescribed by a Gellerman random series. This marked the end of the first trial.



Subsequent trials were identical. Prescribed criterion for this problem and the two to follow was 20 correct responses out of 25 choices within one session or four sessions without passing the problem before progressing to the next problem.

Four stimulus objects were used. Positive-negative values were assigned in a quasi-random order to each subject. Figure 4 illustrates these objects.

The Delay in Response problem began when the tray was pushed toward the subject a distance sufficient to clear the examiner-subject dividing panel yet not discourage the subject's efforts to respond. The examiner baited the appropriate food well in full view of the subject and placed the positive and negative stimulus objects over the wells. Should the subject try to respond while the examiner was baiting the tray he was told "No." Baiting the tray took 5 seconds. At this time the tray was withdrawn from the subject's view and the 10 second response-delay period began. After this delay period the tray was again presented to allow for a choice. The subject was allowed to respond at his own speed.

Each subject received different stimulus objects from those used previously, and the positive-negative values were assigned in a quasi-random order.

The procedure for the Standard problem was the same as for

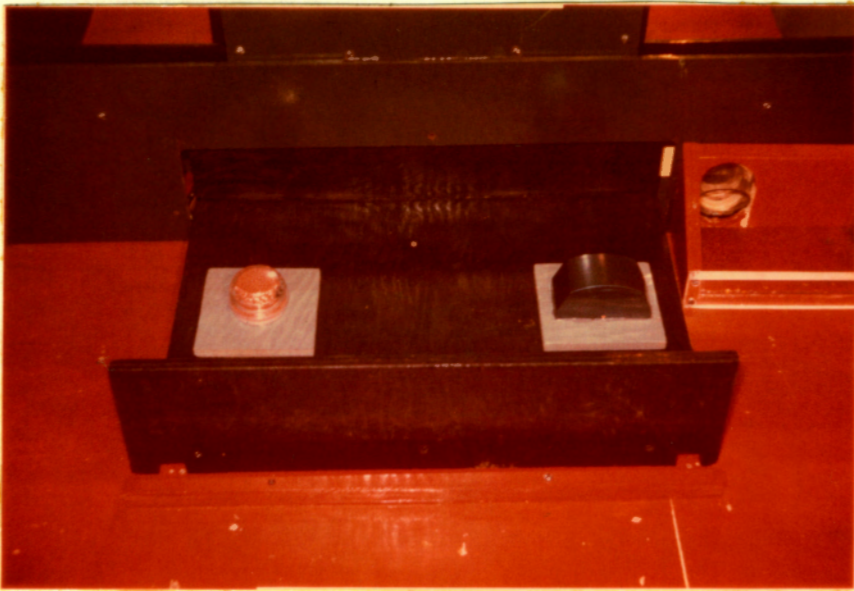


FIGURE 3

JUNK STIMULUS OBJECTS IN RESPONSE POSITION  
AS VIEWED FROM SUBJECT'S SIDE OF MODIFIED  
WISCONSIN GENERAL TEST APPARATUS

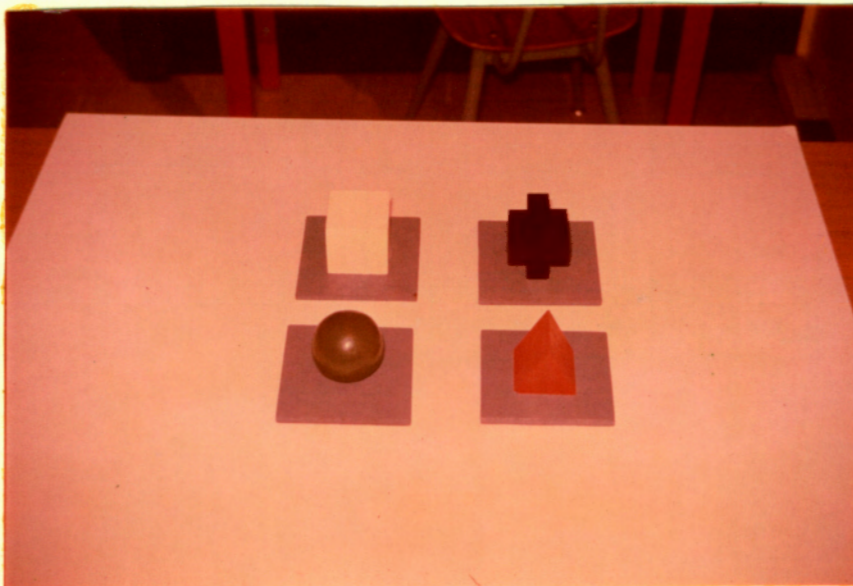


FIGURE 4

VIEW OF ALL STIMULUS OBJECTS USED  
FOR DELAY AND STANDARD PROBLEMS

the Junk problem, and the pass-fail criterion was the same as for the two delay problems. The assignment of stimulus objects for the Standard problem has been explained earlier in the Procedure section.

## V. STIMULUS OBJECTS

Junk stimulus objects consisted of a dark blue plastic jewel-box shaped like a half-moon with flat sides and a clear plastic medicine bottle top filled with small red beads. Both objects were of approximately equal height and width and were mounted on one-half inch masonite 4" x 4" flat gray squares. This was sufficient dimension to cover the food wells in the sliding tray of the modified Wisconsin General Test Apparatus. Color, transparency, texture, and three dimensional shape produced the different cues between objects. These objects, referred to earlier, are shown in Figure 3.

Stimulus objects used for the delay and Standard problems consisted of a white cube, a red triangle, a black cross, and a green sphere. All objects were of equal three dimensional size (height and width of 2") and mounted securely on one-half inch masonite 4" x 4" flat gray squares. Both color and shape produced the different cues between objects.

## VI. TREATMENT OF THE FINDINGS

A complex analysis of variance was used, with a two-way

classification (11:281-296) on the two delay problems to determine significance of differences between subject performance and their treatment.

A t-test (4:136-137) was conducted between the two delay problems. Then a series of t-tests between and within the two delay problems was used with the following trial blocks for both the first and last session. For both Reinforcement-delay and Response-delay, block one vs. block one, and block five vs. block five; for Reinforcement-delay, block one vs. block five; and for Response-delay, block one vs. block five.

Graphs compared performance in trial blocks of five on the criterion session with preceding sessions on each problem, as well as mean per cent correct on trial blocks for criterion session on all problems.

Individual subject trial block graphs were drawn to illustrate performance on all problems, and graphs compared mean per cent correct with diagnostic category for each problem.

Individual subject variables were compared with total errors for each problem as well as with mean and ranges for subject groups to demonstrate learning differences.

## CHAPTER IV

### RESULTS

The results of this study are divided into five parts:

- (1) differences between problems, (2) differences within problems,
- (3) subject variables, (4) patterns of learning and non-learning, and
- (5) individual analysis.

The probabilities given are for a two-tailed test of significance since differences in either direction of the means are of concern. Since the 5 per cent level of confidence was pre-selected, when probabilities are larger than .05, the results are considered non-significant.

#### I. DIFFERENCES BETWEEN PROBLEMS

The differences between problems provides the analysis for the primary purpose of this experiment as it measures the existence or non-existence of a "covert" response.

The subjects' mean per cent correct performance scores for reinforcement-delay and response-delay problems were compared by a complex analysis of variance using double classification. The results, Table 4, demonstrate that the performance difference is

TABLE IV  
 SUMMARY OF ANALYSIS OF VARIANCE BETWEEN  
 MEANS OF DELAY IN REINFORCEMENT  
 AND DELAY IN RESPONSE

Source	Sum of Squares	df	Mean Square	F	Signifi- cance
Performance Treatment	11266.667	1	11266.667	104.029	.01
Subject's Variability	1455.333	11	132.303	1.222	NS
Error Variance	1191.335	11	108.303	-----	--
Total	13913.335	23			

significant at the 1 per cent level and that the subjects' variability was non-significant. A t-test between means of reinforcement-delay and response-delay also demonstrated differences significant at the 1 per cent level of confidence. These data demonstrate that the 10 second delay interval did not produce the same effect in both problems.

Mean per cent correct is plotted by trial blocks for the criterion sessions in Figure 5 for all four problems. The trial blocks consist of five trials each.

The Junk problem. The data show Junk performance well above the chance level, with 100 per cent correct being reached on the final trial block. This session was the first session for ten subjects and the second session for two subjects.

The Delay in Reinforcement problem. Under conditions of a 10 second delay interval, mean performance on the reinforcement-delay problem was near the chance level, with 70 per cent correct being reached on the final trial block. One subject met the criterion on the first session, one subject on the third, and ten subjects met the failure criterion (four sessions without passing the problem) on the last session.

The Delay in Response problem. Performance on the

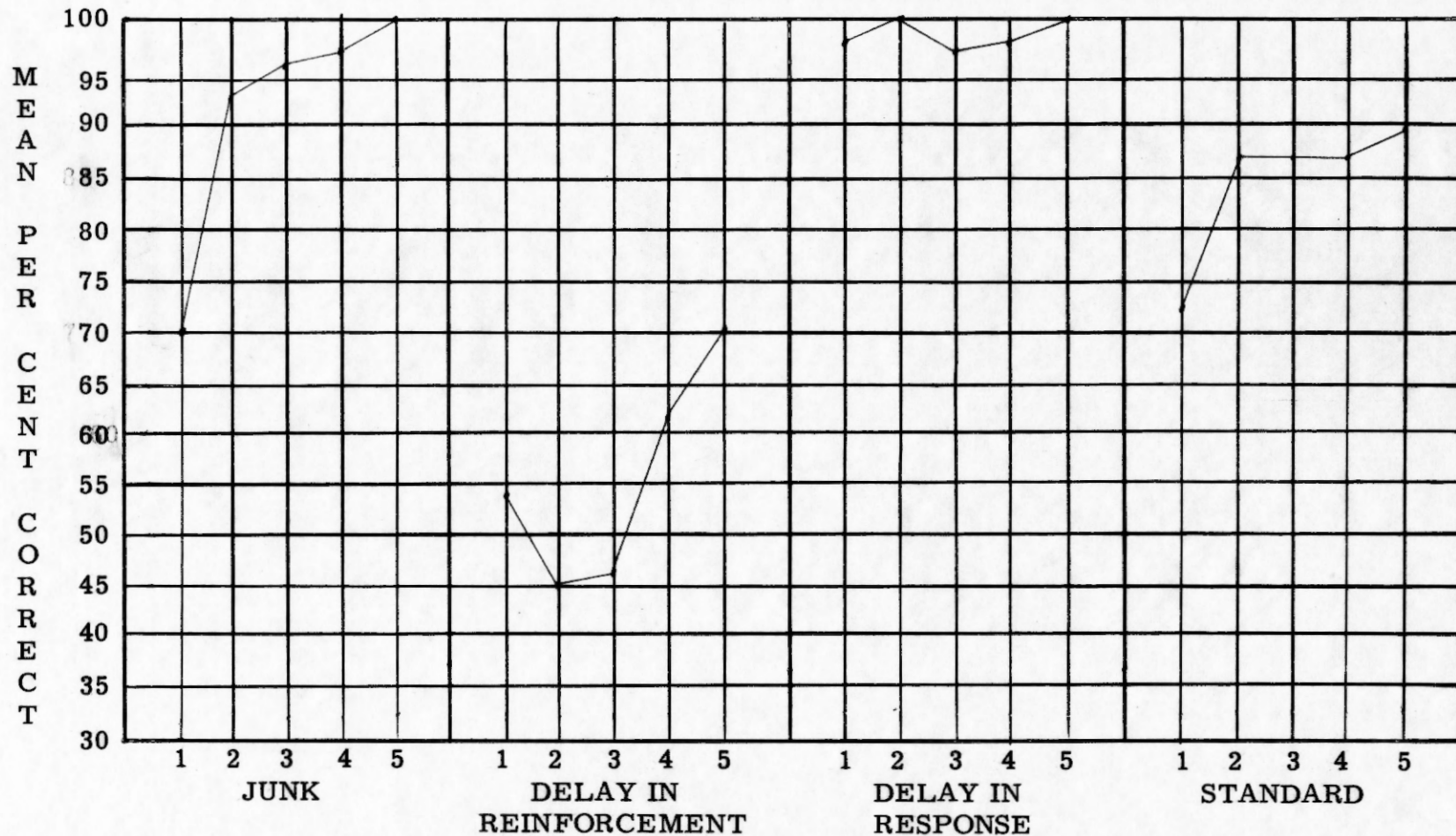


FIGURE 5

MEAN PER CENT CORRECT BY TRIAL BLOCKS  
ON CRITERION SESSION FOR ALL PROBLEMS



response-delay problem was considerably higher than on the reinforcement-delay problem, and the 10 second delay interval did not produce a decremental effect. Eleven subjects met the criterion on the first session and one subject on the second session.

The Standard problem. The level of performance continued above chance on the standard problem, which did not have a delay-interval variable but rather a reversal (positive-negative values) of the same stimulus objects used for the reinforcement-delay problem. Eight subjects met the criterion on the first session, one subject on the second, and three subjects, who developed position habits, met the failure criterion on the fourth session.

A series of four t-tests using individual subject performance scores between reinforcement-delay and response-delay, by trial blocks, demonstrated significance at the 1 per cent level for session one between block one and block one and between block five and block five. On the last session the 1 per cent level of significance was demonstrated between block one and block one. Results between block five and block five on the last session were not significant.

These data indicate further that the 10 second delay interval had a decremental effect upon performance on the reinforcement-delay problem. This same effect was not present in the response-delay problem.

## II. DIFFERENCE WITHIN PROBLEMS

Two factors are significant when considering the difference in learning performance within a given problem. One is the progression of performance through all the sessions until the criterion is met on the final session. This is pertinent to such questions as: "Was the problem designed with adequate difficulty?" and "Was reinforcement strength adequate for learning performance?" The other factor is the relation of performance between other problems in the experiment and whether this performance is characteristic of learning as demonstrated by other experiments. This is relevant to such a question as "Was the level of performance within these other problems relative to the performance within this problem?"

To illustrate these performance factors, the mean per cent correct is plotted on "backward" curves (leading up to criterion session) for all problems in Figures 6, 7, 8, and 9 by trial blocks on the criterion session and all preceding sessions (criterion 1, criterion 2, and criterion 3).

The Junk problem. Session one, Figure 6, illustrates performance near the chance level between trial blocks one and two. Trial blocks three and four show significant improvement above the chance level and on trial block five performance reaches 100 per cent. Performance on the criterion session is demonstrated by a positive

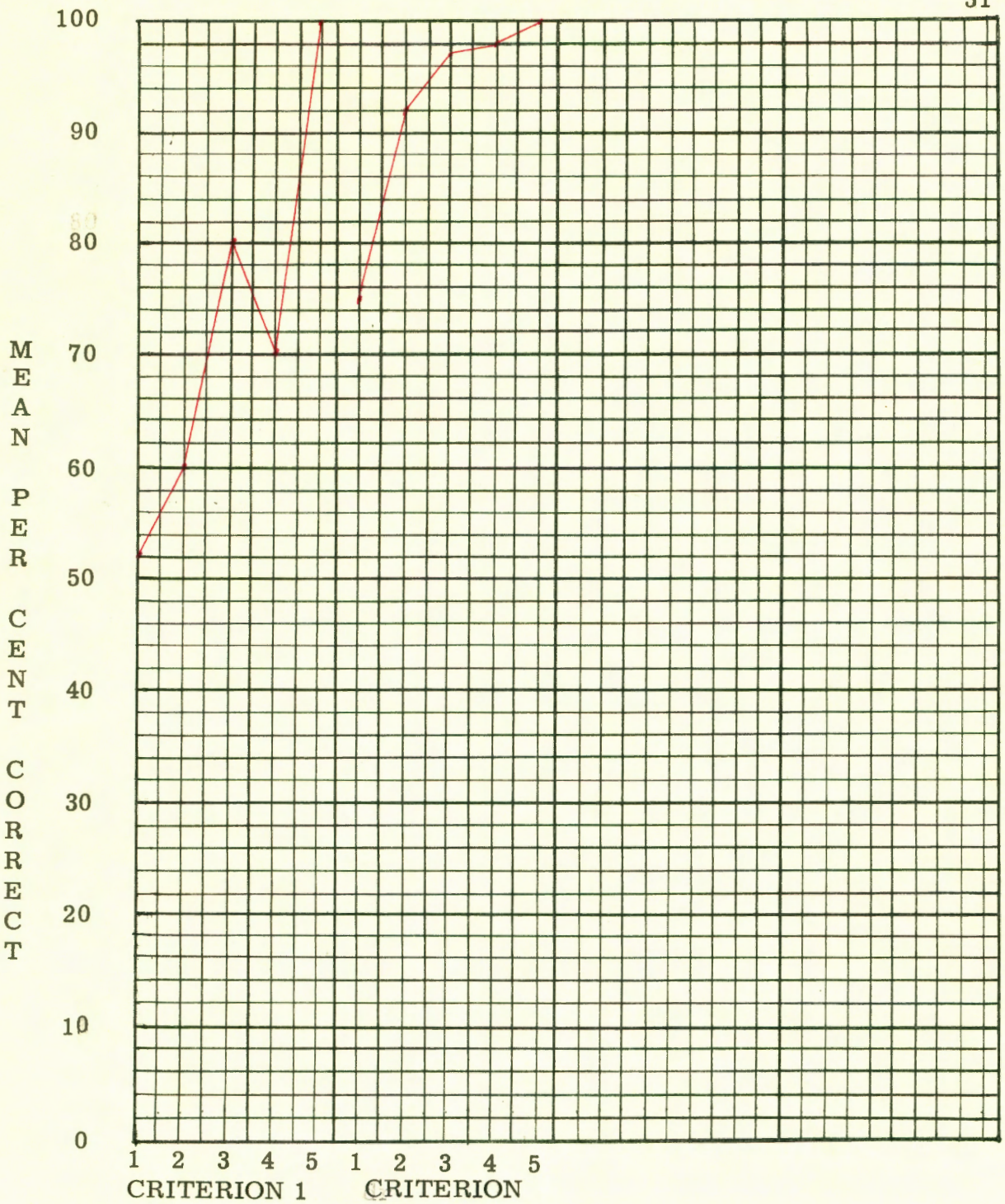


FIGURE 6

MEAN PER CENT CORRECT BY TRIAL BLOCKS  
ON BACKWARD CURVES FOR  
THE JUNK PROBLEM



FIGURE 7

MEAN PER CENT CORRECT BY TRIAL BLOCKS ON  
 BACKWARD CURVES FOR THE DELAY IN  
 REINFORCEMENT PROBLEM

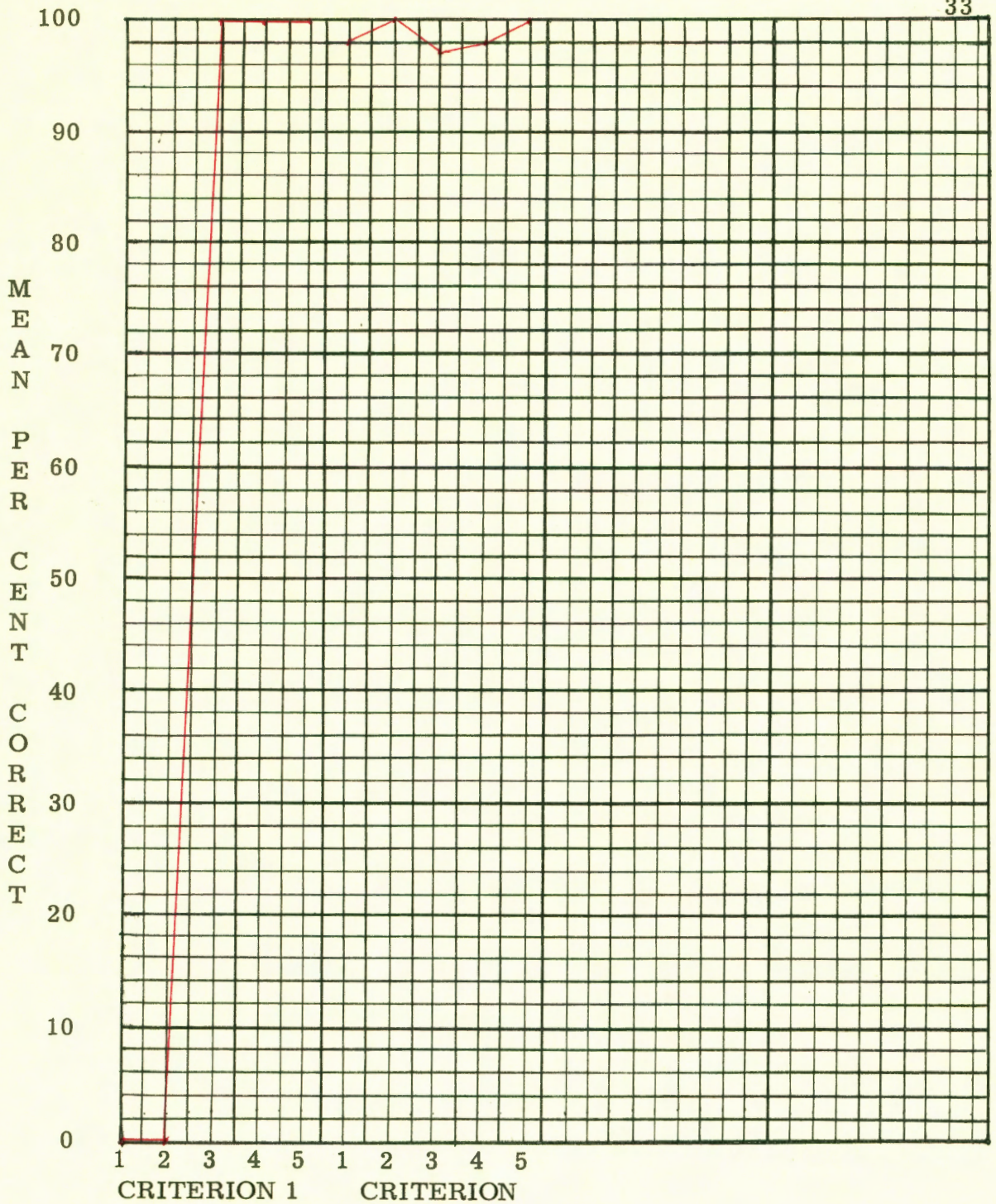


FIGURE 8

MEAN PER CENT CORRECT BY TRIAL BLOCKS ON  
 BACKWARD CURVES FOR THE DELAY  
 IN RESPONSE PROBLEM



FIGURE 9

MEAN PER CENT CORRECT BY TRIAL BLOCKS  
ON BACKWARD CURVES FOR  
THE STANDARD PROBLEM

curve ranging from 73 per cent on the first trial to 100 per cent on the final trial block.

The Delay in Reinforcement problem. Performance, Figure 7, is near the chance level for the first three sessions. On the criterion session, performance increases from 45 per cent on the second trial block to 70 per cent on the final trial block. For the first and last sessions, results on t-tests, using individual subject performance scores for trial block one vs. trial block five, were not significant.

The Delay in Response problem. The data in Figure 8 show performance at 0 per cent for the first two trial blocks in session one with an increase between trial blocks two and three of 100 per cent. Performance stabilizes at 100 per cent for trial blocks three, four, and five. On the criterion session, performance is above the chance level with a curve range between 97 per cent and 100 per cent. For the first and last sessions, results on t-tests, using individual subject performance scores for trial block one vs. trial block five, were not significant.

The Standard problem. Performance, plotted in Figure 9, is near or below chance for the first two sessions and for trial blocks, one and two of the third session. Between the third and final trial

blocks of session three, performance increases from 34 per cent to 70 per cent. On the criterion session 72 per cent is plotted for trial block one, 87 per cent for trial blocks two, three, and four, and 88 per cent for trial block five.

The data illustrate that sufficient difficulty was present in the experiment as a whole in that performance fluctuated, generally improving from one session to another. Strength of reinforcement was adequate since the performance level increased throughout a problem, in some cases reaching 100 per cent. Performance, in general, fluctuated, tending to decrease just prior to increased learning performance. And, finally, this learning pattern was characteristic of performance as reported in other laboratory studies.

### III. SUBJECT VARIABLES

Whether choosing subjects for an experiment in a laboratory setting or placing students in a special class or group where performance is important, it has been demonstrated that subject variables might be important indicators of performance. The following evidence is used as an attempt to demonstrate the significance of these variables as performance indicators. This evidence is organized in the following manner. First, that gathered by statistical measures is reported in Table V. Second, bar graph illustrations of performance for diagnostic



TABLE V

## SUMMARY OF ANALYSIS OF TOTAL ERRORS WITH SUBJECT VARIABLES

Test	Errors Problem	Subject Variable	t	Rho	z'	r	Significance Level
Spearman Rank							
Correlation (Rho)	All Problems	I. Q.		.22	.224		N. S.
		C. A.		.19	.198		N. S.
		M. A.		.39	.418		N. S.
		L. I.		.48	.523		N. S.
	Junk	I. Q.		.22	.224		N. S.
		M. A.		.46	.497		N. S.
		C. A.		.09	.010		N. S.
		Product Moment					
Correlation (r)		L. I.			.64	.01	
Spearman Rank							
Correlation	Delay In Reinforcement	I. Q.		.16	.161		N. S.
		M. A.		.12	.121		N. S.
		C. A.		.17	.172		N. S.
		L. I.		.20	.203		N. S.
t-test							
Standard	I. Q.	2.52				.02	
	C. A.	1.71				N. S.	
	M. A.	1.56				N. S.	
Product Moment							
Correlation		L. I.			.83	.01	

category groups is presented in Figures 10 through 13. And third, a comparison between the means and ranges for groups demonstrating different learning is presented in Table VI.

Table V contains a summary of the correlational analysis between subject variables and number of errors made by subjects on the different problems. Spearman rank correlation (Rho) scores were transformed to  $z'$  scores to determine levels of significance. None of the correlations were large enough to reach significance at the 5 per cent level for subject variables when correlated with total errors from all problems using the Spearman rank method. The same method of measurement provided no significant correlations with total problem errors for the reinforcement-delay problem. Errors were ranked from low to high and subject variables, with the exception of length of institutionalization, were ranked from high to low. Rank order for length of institutionalization was from low to high. This procedure converted all signs to positive for the convenience of the reader. The Pearson product-moment correlation provided evidence significant at the 1 per cent level for length of institutionalization on both the junk and standard problems, demonstrating that shorter periods of institutionalization resulted in better performance. The results of a series of three t-tests on the standard problem are also presented in Table V. Error scores for subjects with higher mean intelligence

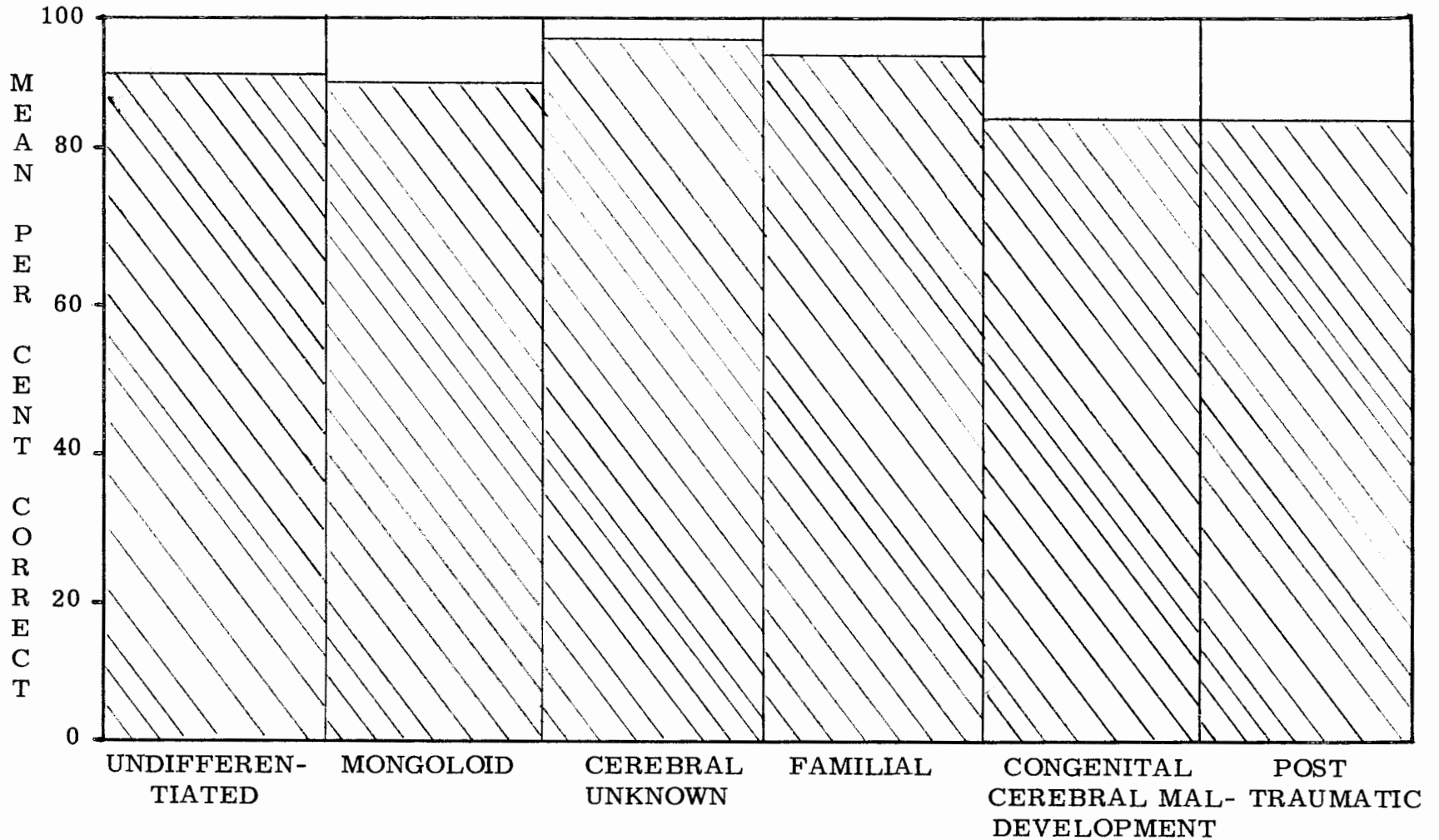


FIGURE 10

MEAN PER CENT CORRECT FOR DIAGNOSTIC CATEGORY GROUPS  
ON THE JUNK PROBLEM

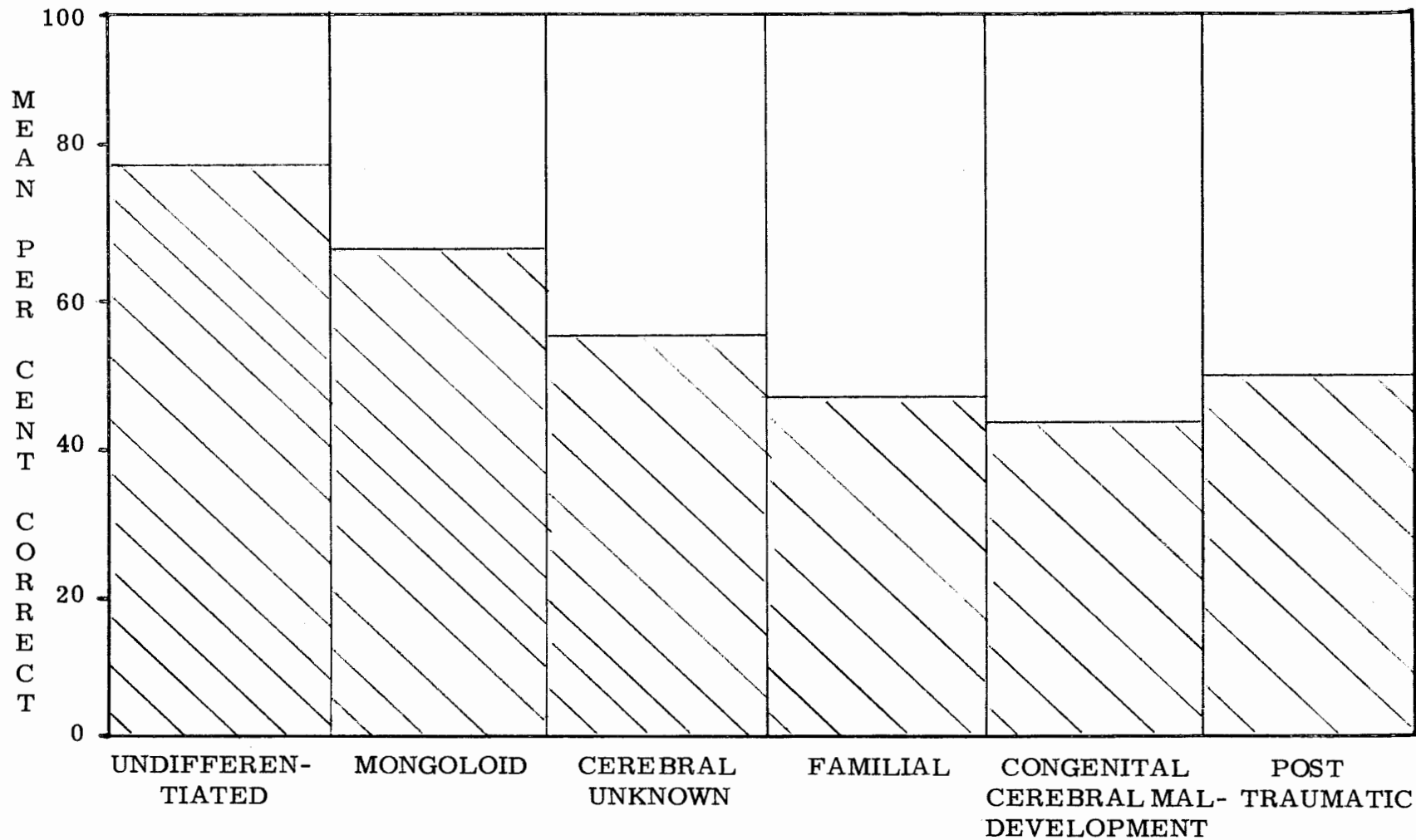


FIGURE 11

MEAN PER CENT CORRECT FOR DIAGNOSTIC CATEGORY GROUPS  
ON THE DELAY IN REINFORCEMENT PROBLEM

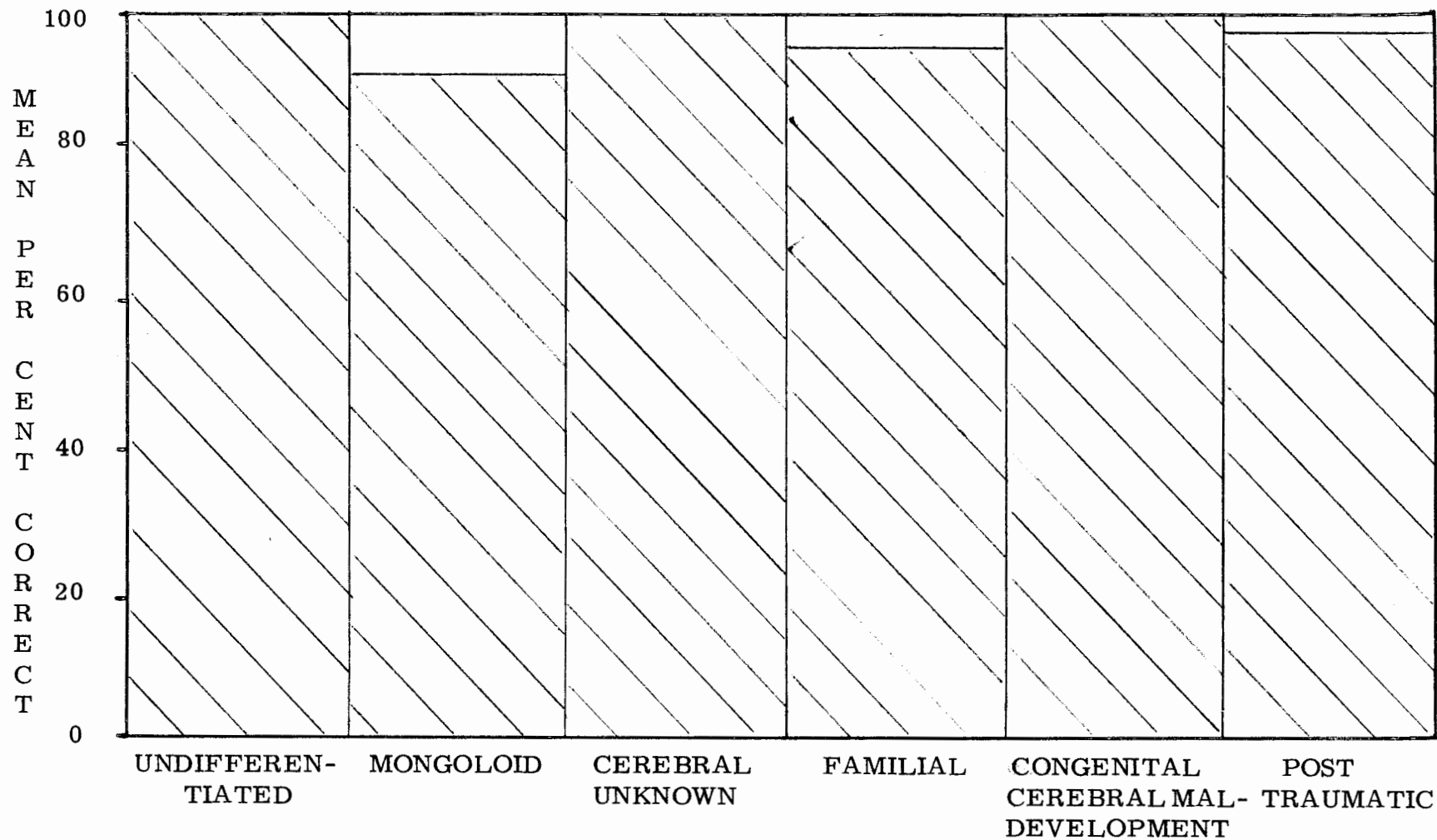


FIGURE 12

MEAN PER CENT CORRECT FOR DIAGNOSTIC CATEGORY GROUPS  
ON THE DELAY IN RESPONSE PROBLEM

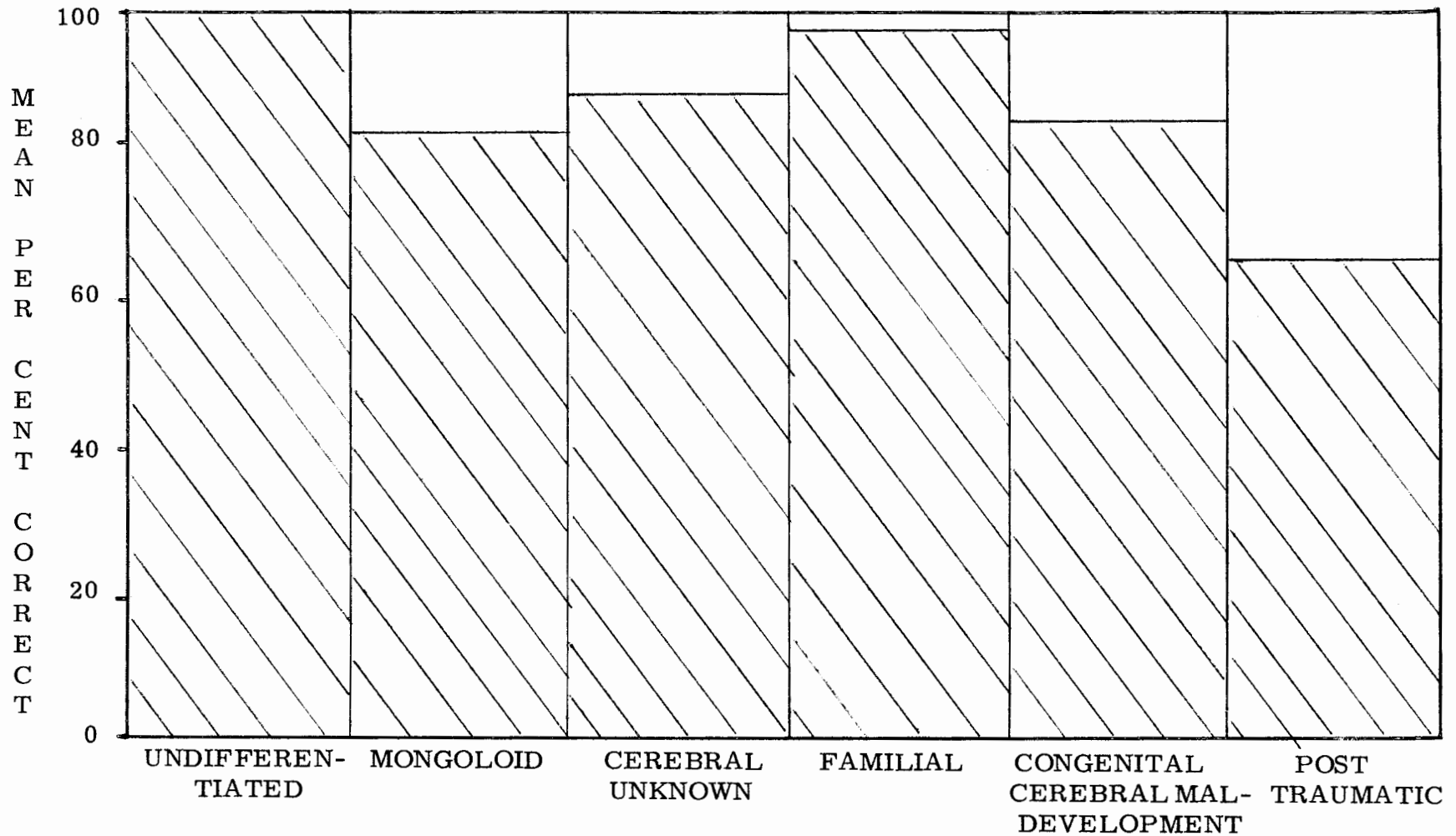


FIGURE 13

MEAN PER CENT CORRECT FOR DIAGNOSTIC CATEGORY GROUPS  
ON THE STANDARD PROBLEM

TABLE VI

MEAN AND RANGE FOR SUBJECT VARIABLES  
IN FIVE LEARNING GROUPS

Subject Variables	Group 1		Group 2		Group 3		Group 4		Group 5	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
I. Q.	41	22-62	34	22-40	43	31-62	43	31-55	43	34-62
M. A.	5.11	3.0-12.4	4.1	3.0-6.5	6.4	3.1-12.4	6.8	3.7-9.9	6.5	3.7-9.9
C. A.	16.9	12.8-21.0	18.1	16.2-21.0	16.4	12.8-20.9	16.5	14.1-18.10	16.4	14.1-18.10
L. I.	6.6	1.4-15.1	11.10	7.11-15.1	3.4	1.4-6.11	4.3	3.0-5.6	4.3	3.0-5.6

N = 12, Group 1; 3, Group 2; 9, Group 3; 2, Group 4; 7, Group 5.

quotients were compared with those who had lower mean intelligence quotients on the standard problem. The evidence is significant at the 2 per cent level of confidence to support the existence of a dichotomy on intelligence quotient; however, when using the same test for chronological age and mental age, the results were not significant. No analysis was conducted on the response-delay problem since error scores did not differ sufficiently to investigate.

Performance of diagnostic category groups is illustrated in Figures 10 through 13 by mean per cent correct for each problem. The categories are classified by medical terms. These results were compiled to determine if a diagnostic category, or categories, differed significantly on all problems in the experiment with other categories, which in turn could serve as performance indicators. The results do not indicate this. The Undifferentiated group performed higher on the reinforcement-delay and the standard problems; however, this is to be expected. Generally speaking, this group performs significantly higher in most learning situations in that the term Undifferentiated is used to classify medical patients who do not exhibit a categorized physical defect or damage. Thus, patients developing psychological syndromes are often included, and they could discriminate at a higher rate.

No group performance pattern is significantly higher than



that of other groups. Diagnostic categories were not a selection variable; thus, subjects were not matched. Consequently, these data provide evidence suggesting that diagnostic categories are not indicative of performance.

The final section, Table VI, illustrates subject variable means and ranges for different learning groups. Group 1 consisted of all the subjects who participated in the study. Group 2 was composed of the subjects who developed position habits on the standard problem, and Group 3 was all subjects who did not develop position habits. Group 4 consisted of subjects who passed the standard reversal with a performance score of 100 per cent correct. Group 5 included all subjects except those in Groups 2 and 4. Groups 1, 3, 4, and 5 did not differ significantly on any of the variables. Group 2, however, differs on all variables, demonstrating lower means on intelligence quotient and mental age, and higher means on chronological age and length of institutionalization. Possible significance of subject variables is mentioned in detail in Chapter V.

#### IV. PATTERNS OF LEARNING AND NON-LEARNING

Problem conditions designed to measure performance were responded to differently by experimental subjects, depending upon the heterogeneity of the group. When these different levels of performance

are present it is important to illustrate them as they are indicative of some behavioral or organismic variable peculiar to the individual or to the group. Thus, subjects are grouped by similar learning performance as a means of further isolating variables as they are indicative of performance.

Figure 14 compares the mean performance by trial blocks on all problems for three different learning groups. Group 1 included all subjects who participated in the study. The subjects who did not develop position habits composed Group 2, and Group 3 consisted of the subjects who neither developed position habits nor passed the reversal within the standard problem with a score of 100 per cent correct.

Trial block performance differed somewhat for each group on all four problems, with differences being most significant on the reinforcement-delay and the standard problems. In general, on all problems, Group 2 performed highest, followed by Group 3 and Group 1. The learning curve pattern for each session was approximately the same for all the groups.

Mean per cent correct by trial blocks is plotted on "backward" curves in Figures 15 through 18 for Group 1 (N of 12) and Group 2 (N of 9). The performance is plotted for the criterion session and all of the sessions preceding it. In general, these data indicate the

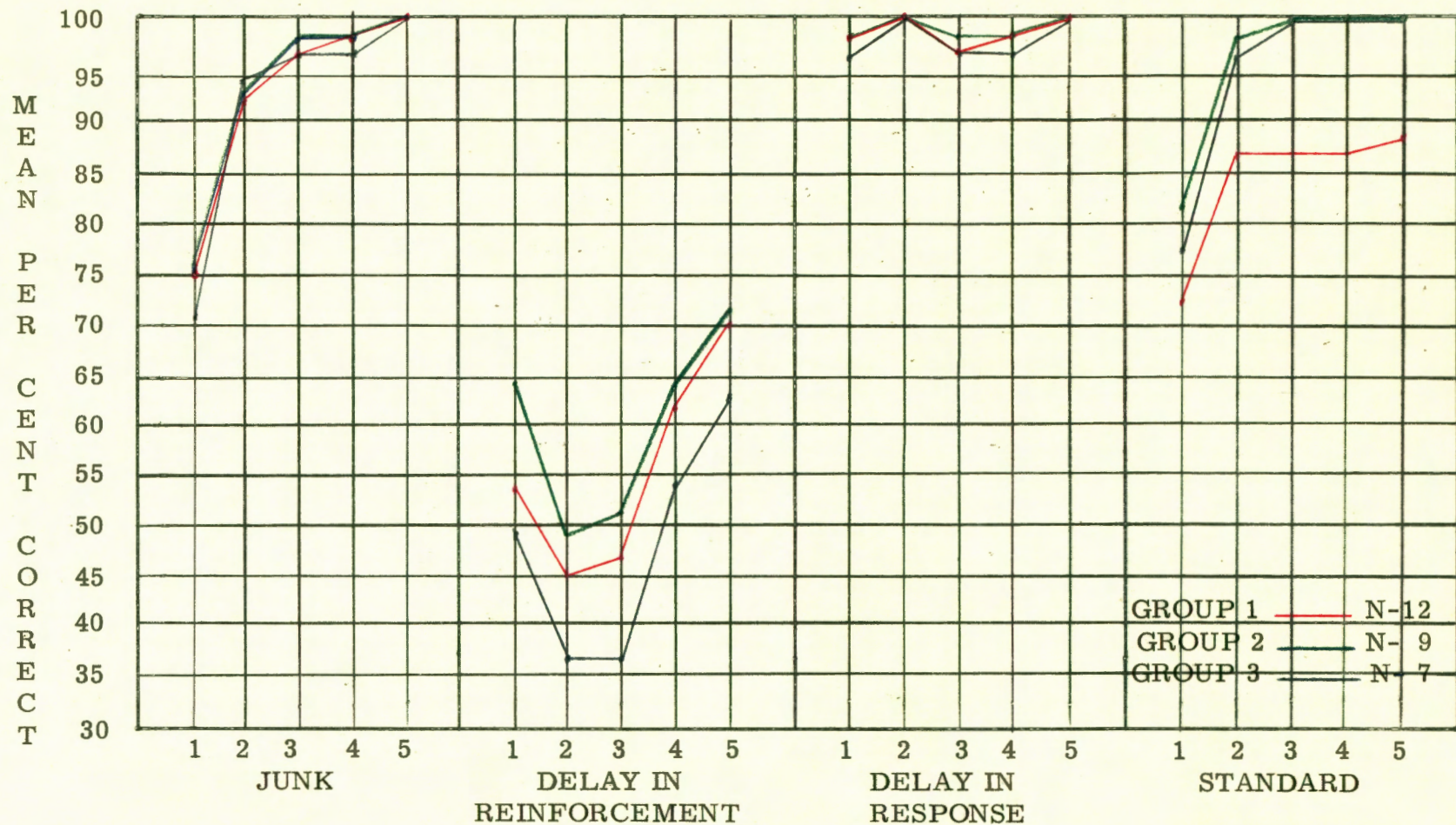


FIGURE 14

LEARNING GROUPS MEAN PER CENT CORRECT BY TRIAL BLOCKS  
 ON CRITERION SESSION FOR ALL PROBLEMS

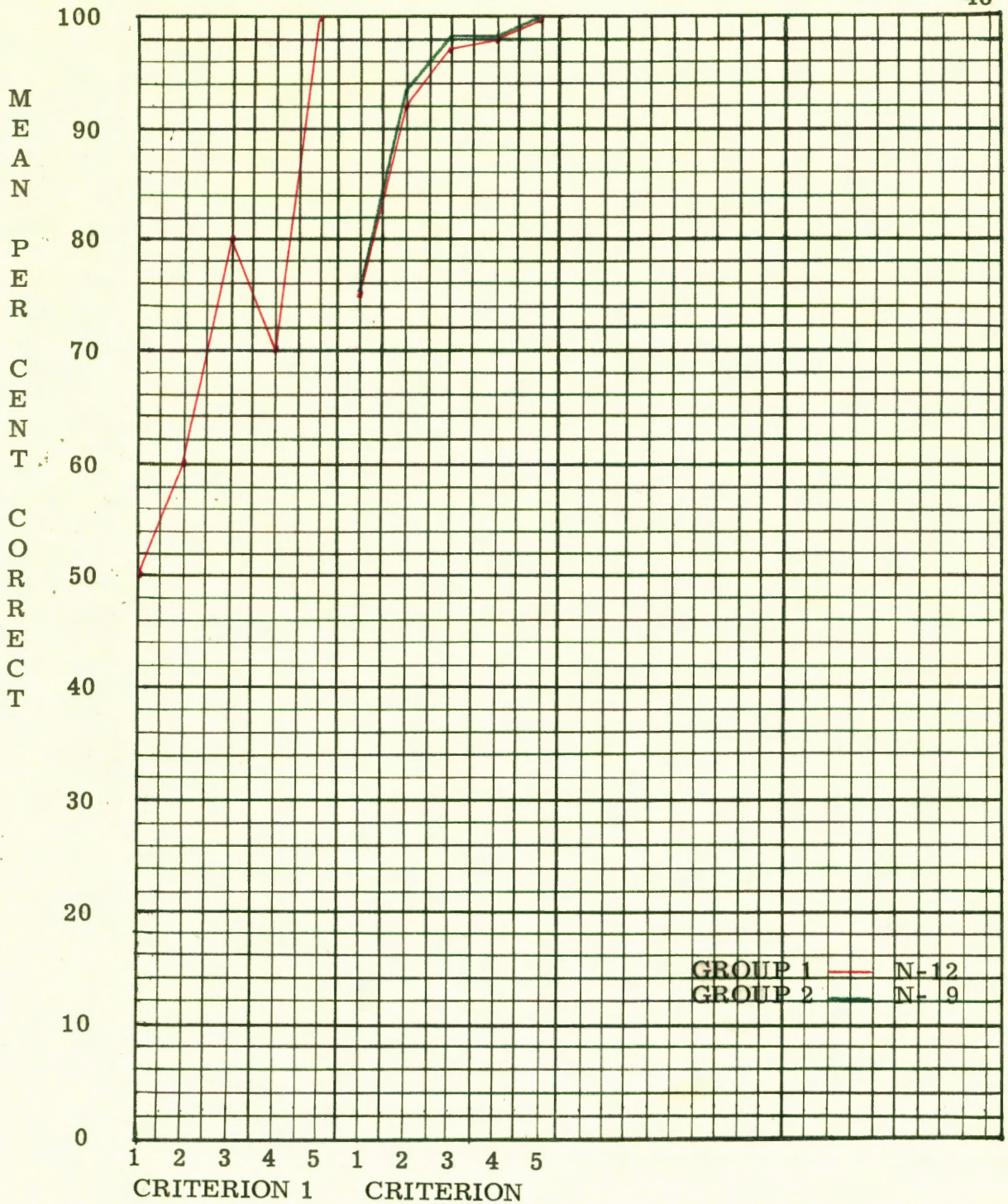


FIGURE 15

LEARNING GROUPS MEAN PER CENT CORRECT  
 BY TRIAL BLOCKS ON BACKWARD CURVES  
 FOR THE JUNK PROBLEM

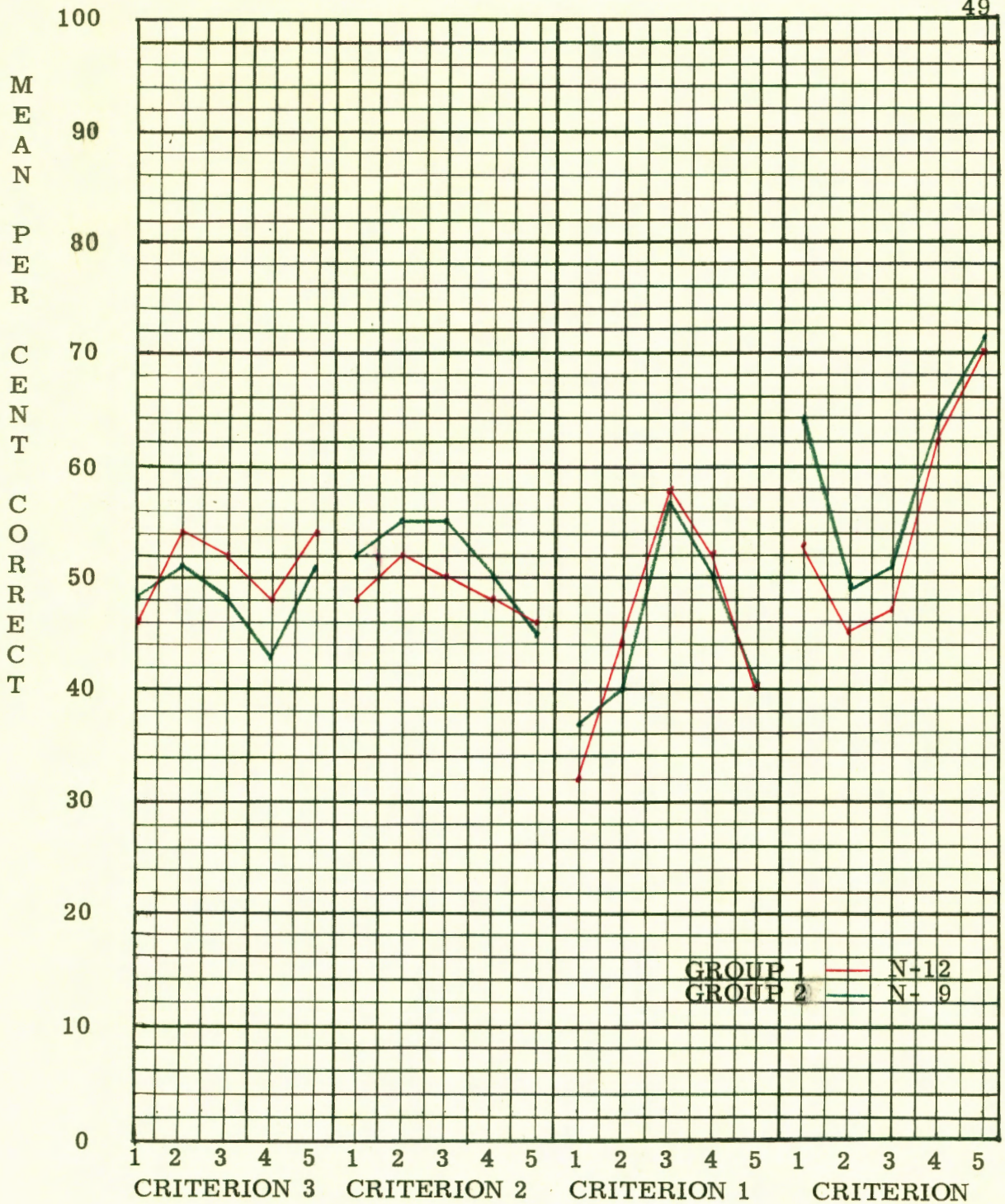


FIGURE 16

LEARNING GROUPS MEAN PER CENT CORRECT  
 BY TRIAL BLOCKS ON BACKWARD CURVES  
 FOR THE DELAY IN REINFORCEMENT PROBLEM

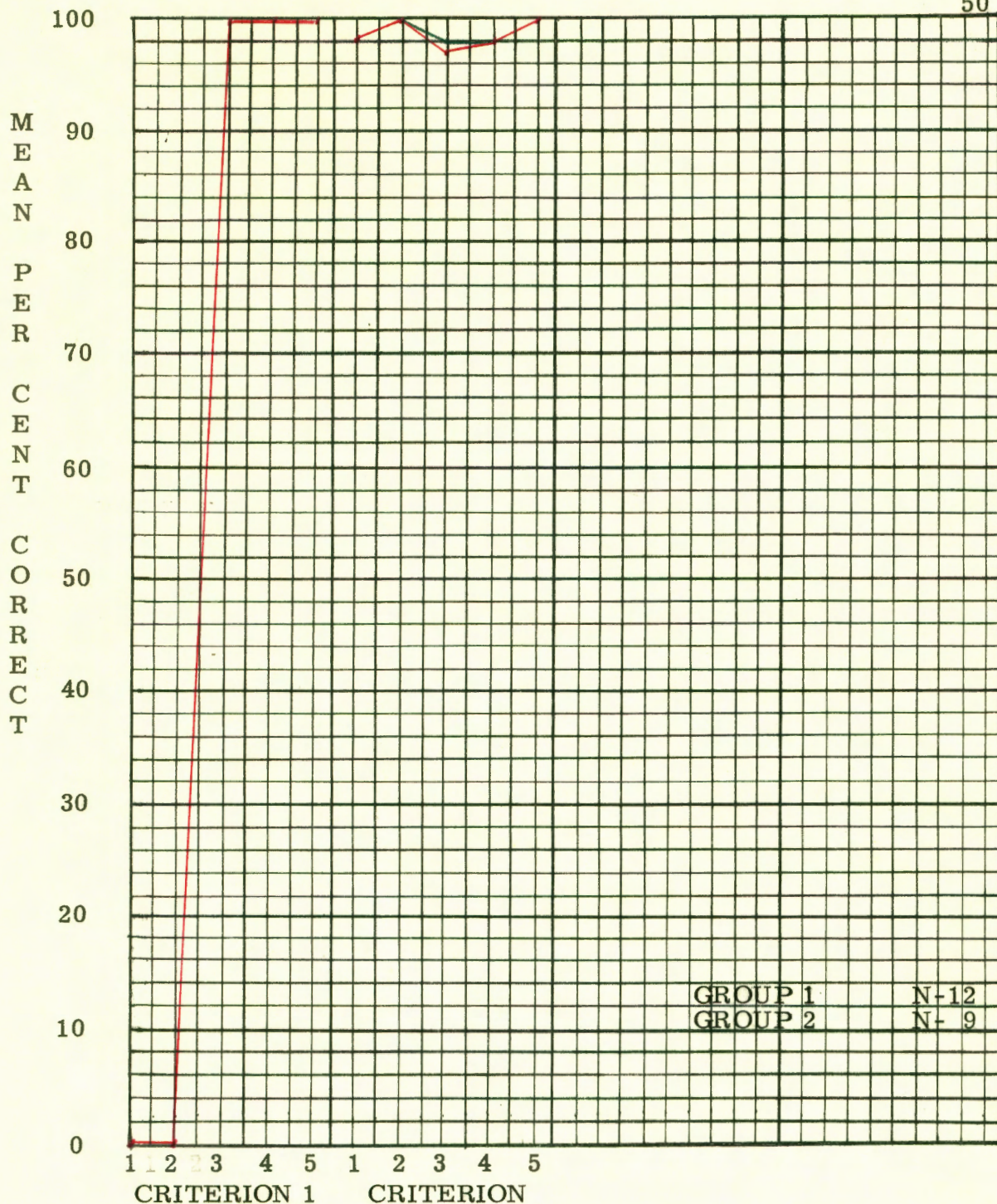


FIGURE 17

LEARNING GROUPS MEAN PER CENT CORRECT  
BY TRIAL BLOCKS ON BACKWARD CURVES  
FOR THE DELAY IN RESPONSE PROBLEM

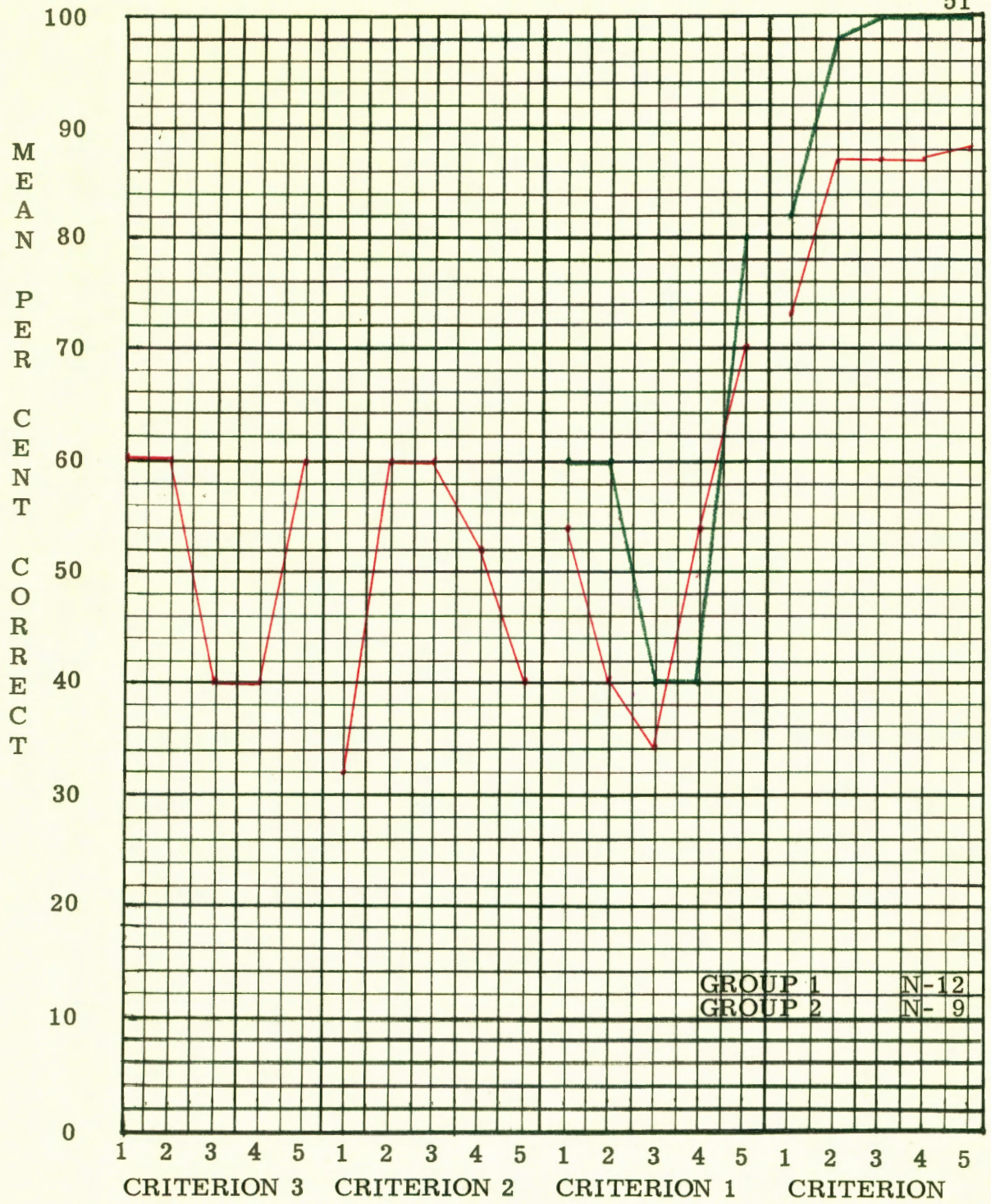


FIGURE 18

LEARNING GROUPS MEAN PER CENT CORRECT  
BY TRIAL BLOCKS ON BACKWARD CURVES  
FOR THE STANDARD PROBLEM

same results as shown in Figure 14. Group 2 performed higher than Group 1; however, the standard problem and the junk problem are the only problems in which the two groups differed significantly.

## V. INDIVIDUAL ANALYSIS

Through an individual analysis of each subject, it is possible to demonstrate further the differences in performance for three learning groups. The criteria for selecting these groups are: Group 1, all subjects who passed the standard problem with a performance score of 100 per cent; Group 2, all subjects who developed position habits; and Group 3, all subjects not included in either Group 1 or 2. Data which are particularly revealing of these groups' performance are illustrated by presenting one subject's performance from each of the three groups. Figures 19 through 21 present these data by trial block means with the individual subjects referred to by their group. Each problem (P) on the individual analysis sheets is represented by a number 1 through 4. The problems and their respective numbers are: Junk, P 1; Delay In Reinforcement, P 2; Delay in Response, P 3; and Standard, P 4. This procedure will also be used with the remaining nine subjects' data presented in the Appendix.

Performance for the subject illustrating Group 1 is plotted in Figure 19. The criterion session on the junk problem has a score



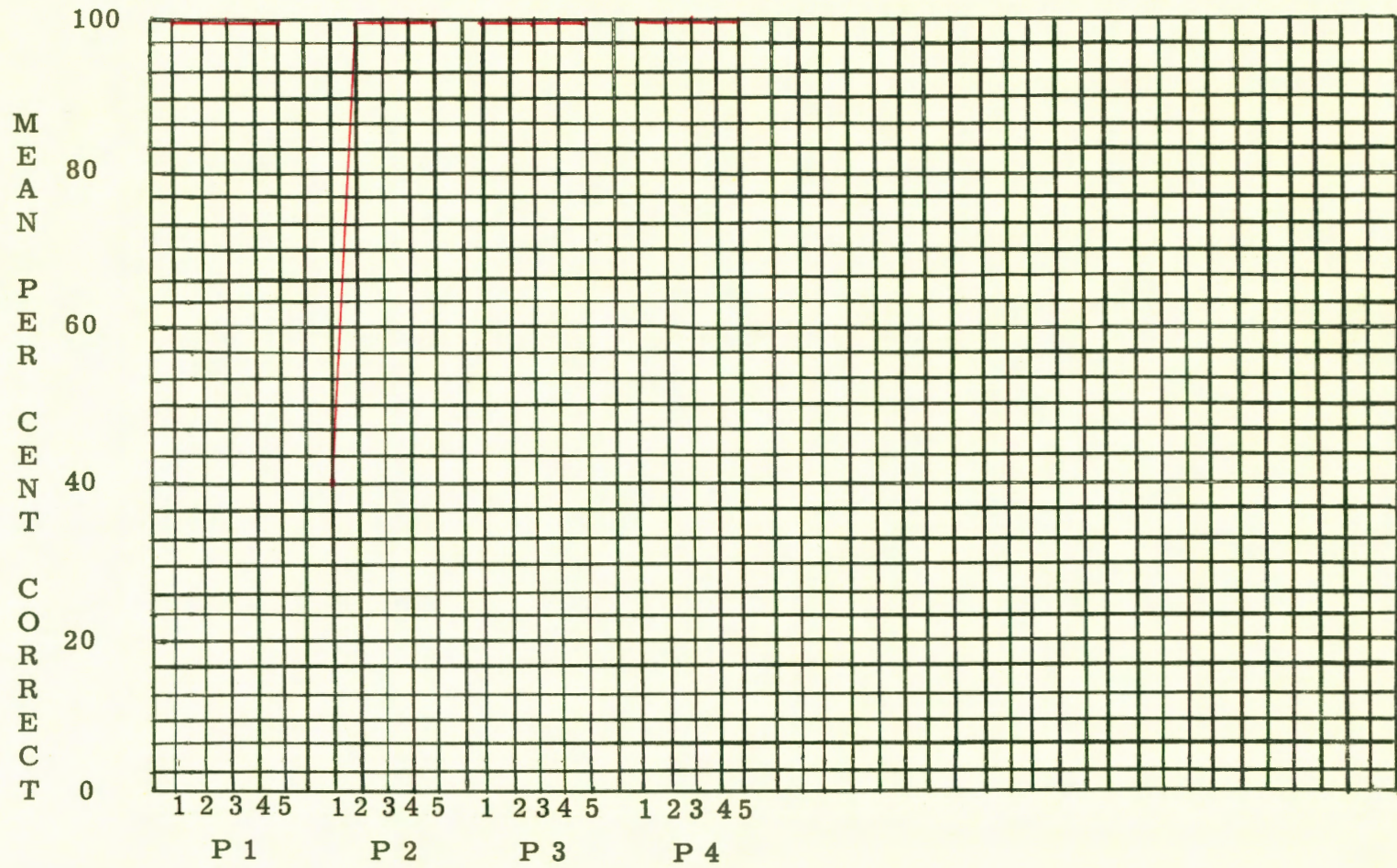


FIGURE 19

MEAN PER CENT CORRECT BY TRIAL BLOCKS  
FOR ALL PROBLEMS FOR SUBJECT 8, GROUP 1

of 100 per cent. The range on the criterion session for the reinforcement-delay problem is 40 per cent to 100 per cent with a mean of 88 per cent. The subject performed at the 100 per cent level on the criterion session for both the response-delay and standard problems.

Figure 20 presents performance of a member of Group 2. The range for session one on the junk problem is 40 per cent to 100 per cent. The mean is 72 per cent. On the criterion session a range of 80 per cent to 100 per cent is plotted with a mean of 96 per cent. On the reinforcement-delay problem the range is 20 per cent to 100 per cent for session one and the mean 68 per cent. Session two has a range of 40 per cent to 60 per cent and a mean of 44 per cent. The range for session three is 20 per cent to 80 per cent and the mean is 52 per cent. The failure criterion session has a range of 20 per cent to 80 per cent. The mean is 48 per cent. The subject passed the response-delay problem with a performance score of 100 per cent. He developed a position habit on the standard problem. Session one has a range of 40 per cent to 60 per cent and a mean of 56 per cent. The range on session two is 20 per cent to 60 per cent and the mean is 44 per cent. Session three and the failure criterion session both have means of 52 per cent. Session three has a range of 40 per cent to 60 per cent and the failure criterion session has a range of 20 per cent to 80 per cent.

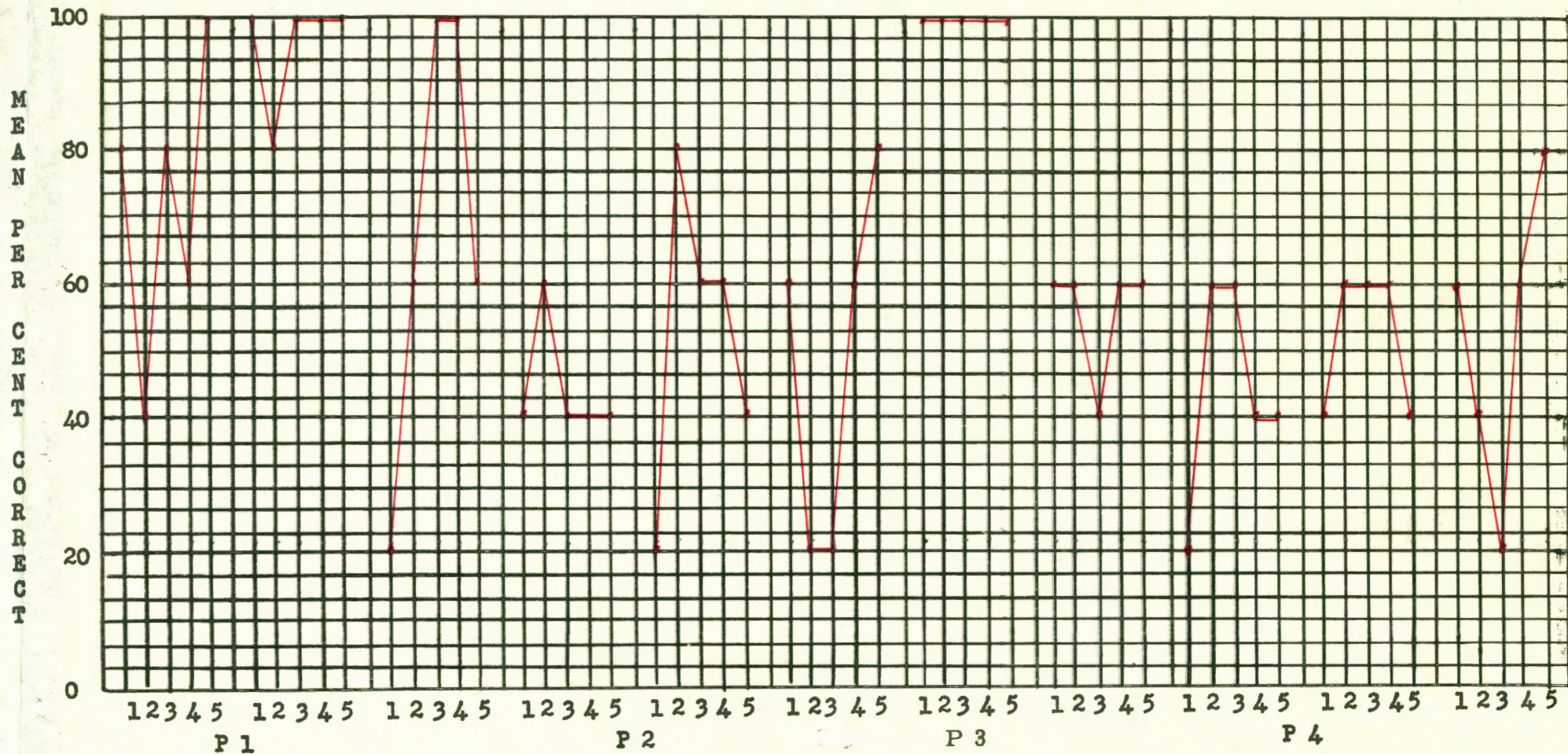


FIGURE 20

MEAN PER CENT CORRECT BY TRIAL BLOCKS FOR ALL PROBLEMS  
FOR SUBJECT 9, GROUP 2

Figure 21 suggests subject performance for Group 3. The range on the junk problem for the criterion session is 40 per cent to 100 per cent with a mean of 84 per cent. Performance on the reinforcement-delay problem was below chance on all four sessions. The range on session one is 20 per cent to 60 per cent with a mean of 40 per cent. On session two the range is 20 per cent to 60 per cent and the mean is 36 per cent. On session three the range is 0 per cent to 60 per cent with a mean of 31 per cent. The failure criterion session presents a range of 20 per cent to 80 per cent and a mean of 44 per cent. Performance on the criterion session for the response-delay problem is 100 per cent. The criterion session on the standard problem has a range of 80 per cent to 100 per cent with a mean of 96 per cent.

From analysis of these individuals and those presented in the Appendix, it is possible to compare performance of the groups in more detail as they are characterized by the individual analysis.

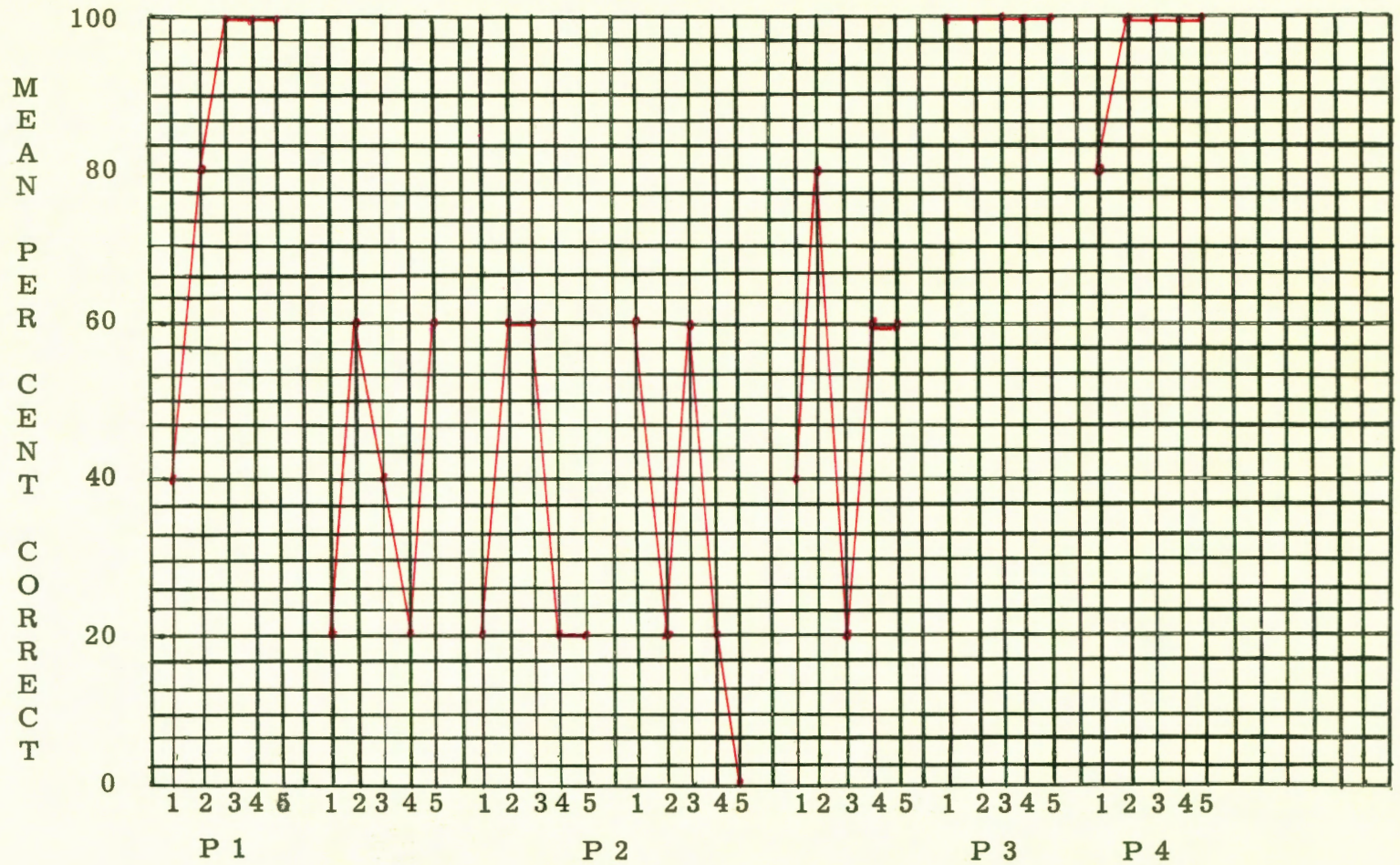


FIGURE 21

MEAN PER CENT CORRECT BY TRIAL BLOCKS  
FOR ALL PROBLEMS FOR SUBJECT 4, GROUP 3

## CHAPTER V

### DISCUSSION

The results of this experiment will be presented in the following order: (1) primary purpose, (2) secondary purpose, and (3) the practical implications.

Possible hypotheses are suggested regarding the reasons for different results; however, since this experiment was not designed to investigate these additional hypotheses, they are presented as suggestions. The limitations of each problem and the experiment itself will be presented.

#### I. PRIMARY PURPOSE

The primary purpose of this study was to evaluate the possibility that due to a "covert" response, reinforcement-delay alone during the response-delay problem was responsible for decremental effects. The 10 second delay interval used should have had the same effect on performance for both reinforcement-delay and response-delay should a "covert" response exist.

This study failed to demonstrate the existence of the "covert" response in the response-delay problem. The analysis of variance,

t-test, and curves illustrating problem performance all demonstrated differences between the reinforcement-delay and the response-delay problems. The differences derived from the statistical analysis were significant at the 1 per cent level of confidence.

Performance on the two delay problems indicate that either the delay period of 10 seconds was inadequate to measure different performance levels or that some other cue-producing variable might be present during the response-delay problem which would account for the higher performance here. Such a non-observable variable could be labeled a "covert" reinforcement, initiated during the same "covert" response period. This would tend to produce a delay interval in the response-delay problem which would be both reinforcement and response-delay. Such a reinforcing condition could account for the higher performance on the response-delay problem; however, the decremental effects of a "covert" response would need to be considered as it relates to the literature. Perhaps because of the stimulus pre-training, as reported in Harlow's and Barnett's studies, the "covert" response cue was recognized in such strength that the subjects did not discriminate between this and the additional cue of "covert" reinforcement. Although this may be inferred from the data, such a hypothesis needs to be put to an empirical test.

The statistical measures have demonstrated that reinforcement-delay alone is not responsible for decremental effects on learning in the

response-delay problem. Further, it has been suggested that multiple cue factors (i. e., "covert" response and "covert" reinforcement) or delay length inadequacies contributed to the high level of performance reported on the response-delay problem.

## II. SECONDARY PURPOSE

The second purpose of this study was to relate discrimination performance of developmentally retarded children to subject variables. These variables were (1) intelligence quotient, (2) mental age, (3) chronological age, (4) diagnostic categories, and (5) length of institutionalization. Each subject's total number of errors, first for each problem and then for the entire study, were correlated with individual subject variables as a means of discovering any relationship which would provide evidence of performance indicators.

The correlational analysis indicates that performance, in terms of errors on the junk and on the standard problems, is significantly related to length of institutionalization. The subjects having the greater number of errors had also been institutionalized longer. A closer observation of these results on the standard problem indicate that the three subjects (Group 2 in the experiment) who developed position habits had been institutionalized longer. These data produced a skewed effect upon the total subject results which, in turn, effected a



correlation significant at the 1 per cent level of confidence. Thus, all subjects did not demonstrate these findings. It is important, however, to note the consistency of results present in both the junk and standard problems. The skewed effect was not present in the junk problem. It is possible, therefore, to infer that if the reinforcement-delay and the response-delay problems had an effect which better discriminated behavior, then the same consistency results would have been present. The group means, shown previously in Table VI, indicate that the mean years of institutionalization for Group 2 was significantly higher than that of other groups. Consequently, these longer periods of residence are related to poorer performance.

Group 2 developed position habits on the standard problem, which was a reversal of the stimulus objects used for the reinforcement-delay problem. The performance of this group on the reinforcement-delay problem was initially randomized, near chance, and increased on trial blocks 3, 4, and 5 for the final session, indicating improved discrimination. However, with the reversal on the standard problem, position habits were developed. This suggests that some factor or factors associated with residence effects the rigidity of learning behavior. One possible explanation would be that subjects with a long history of institutional residence are more stereotyped and rigid when learning new behavior.

A t-test was used on the standard problem to test the existence of a dichotomy on the subject variable, intelligence quotient. The results, in terms of total errors on the standard problem, show that the subjects who perform higher on psychometric measures of intelligence had fewer errors. These data are related to the results reported for the length of institutionalization variable. The subjects having a longer history of institutional residence demonstrate lower performance on psychometric measures. There are two possible explanations for this condition. First, institutionalization early in life may have been necessitated by low levels of intelligence. And second, some factor present in institutionalization may effect performance on intelligence tests. The data merely are indicative; these hypotheses, however, could be put to empirical test.

Other analysis conducted on the remaining subject variables (mental age, chronological age, and diagnostic category) provided evidence demonstrating that these variables are not significant as performance indicators.

In reviewing the positive findings, then, performance decreases as length of institutionalization increases, and this is consistent for both the junk and the standard problem. It is also suggested that the institutionalization variable has some effect upon behavior rigidity as it relates to the development of position habits. Concomitant

with this data there is correlational evidence suggesting relationship between length of institutional residence and intelligence quotient. Both reasons for and factors produced by institutionalization could support this observation. Finally, there was a positive relationship between intelligence quotient and performance.

### III. PRACTICAL IMPLICATIONS

The implications of this study for teaching simple discrimination problems to mentally retarded children are relevant for learning in the following manner: the effect of short delays of reinforcement and response on performance, and the significance of mental age and intelligence quotients as performance indicators. Further, the importance of chronological age, diagnostic categories, and length of institutional residence is indicative of performance.

It has been established that a reinforcement-delay period of 10 seconds is decremental to discrimination learning. This factor is significant for instruction. When teaching mentally retarded children it is strongly suggested that the sooner the child is reinforced for a response the quicker he will learn to discriminate accurately on the problem.

For a response-delay situation, a high level of performance can be maintained when the response delay is 10 seconds. Consequently, when teaching a mentally retarded child, if he is shown the correct

response he can maintain this discrimination for delay periods of 10 seconds and over before performing the established response.

When considering mentally retarded children for placement in a learning situation, two factors are significant as performance indicators: intelligence quotient and length of institutional residence. It has been demonstrated that children with higher intelligence can discriminate better. Thus, when placing a child in a class or a new problem situation, his intelligence quotient should be relative to his peer group as well as considered in relation to the difficulty of the problem.

The institutional residence factor is important, especially for mentally retarded children who have a long history of residence. This factor should be considered for placement along with intelligence quotient in that there may be a degree of correlation between the two factors. It is expected, however, that the children with a long residence history will be less capable of learning new modes of discrimination behavior. This latter point should be considered by institutional administrators when planning the degree of routine for resident requirements. Some factor such as routine or regimentation effected by institutional regulations could be decremental to learning behavior.

Mental age, chronological age, and the diagnostic categories present in this study do not affect simple discrimination learning to a

degree significant to consider them as performance indicators.

In retrospect, then, mentally retarded children should be reinforced for a response prior to 10 seconds. They would be capable, however, of retaining a discrimination for longer than 10 seconds before responding. Intelligence quotient and length of institutional residence are important predictors of performance, and the latter variable is suggestive of the decremental effects of institutionalization upon discrimination learning.

## CHAPTER VI

### SUMMARY

Twelve mentally retarded subjects were presented with a visual-motor discrimination learning task under conditions of 10 second delay intervals of reinforcement and response. This procedure failed to demonstrate a positive relationship in performance between reinforcement-delay and response-delay. If such existed, it would be indicative of a "covert" response in the standard-type response-delay problem. However, it may be interpreted from the evidence that a "covert" reinforcement cue is present in the response-delay problem.

Intelligence quotient and length of institutionalization were the only subject variables which correlated with performance. This demonstrated that both factors, probably because of their inter-relationship, are important as performance indicators. It is suggested as well that a factor effected by institutionalization has a decremental effect on discrimination learning.

In conclusion, then, this study failed to demonstrate the existence of a "covert" response. It does, however, suggest the possibility of "covert" reinforcement. Intelligence quotient and length

of institutionalization were determined to be significant as performance indicators.

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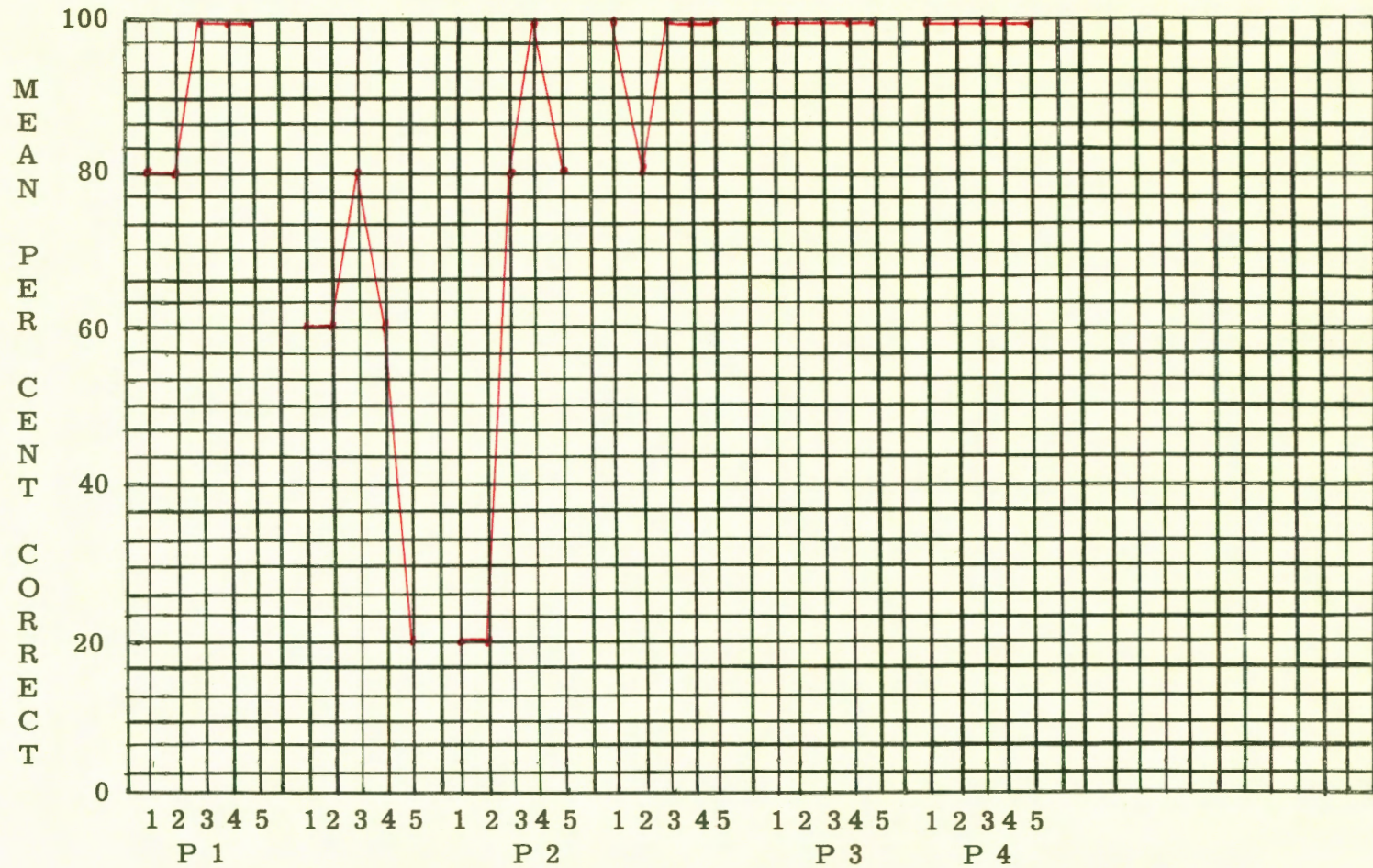
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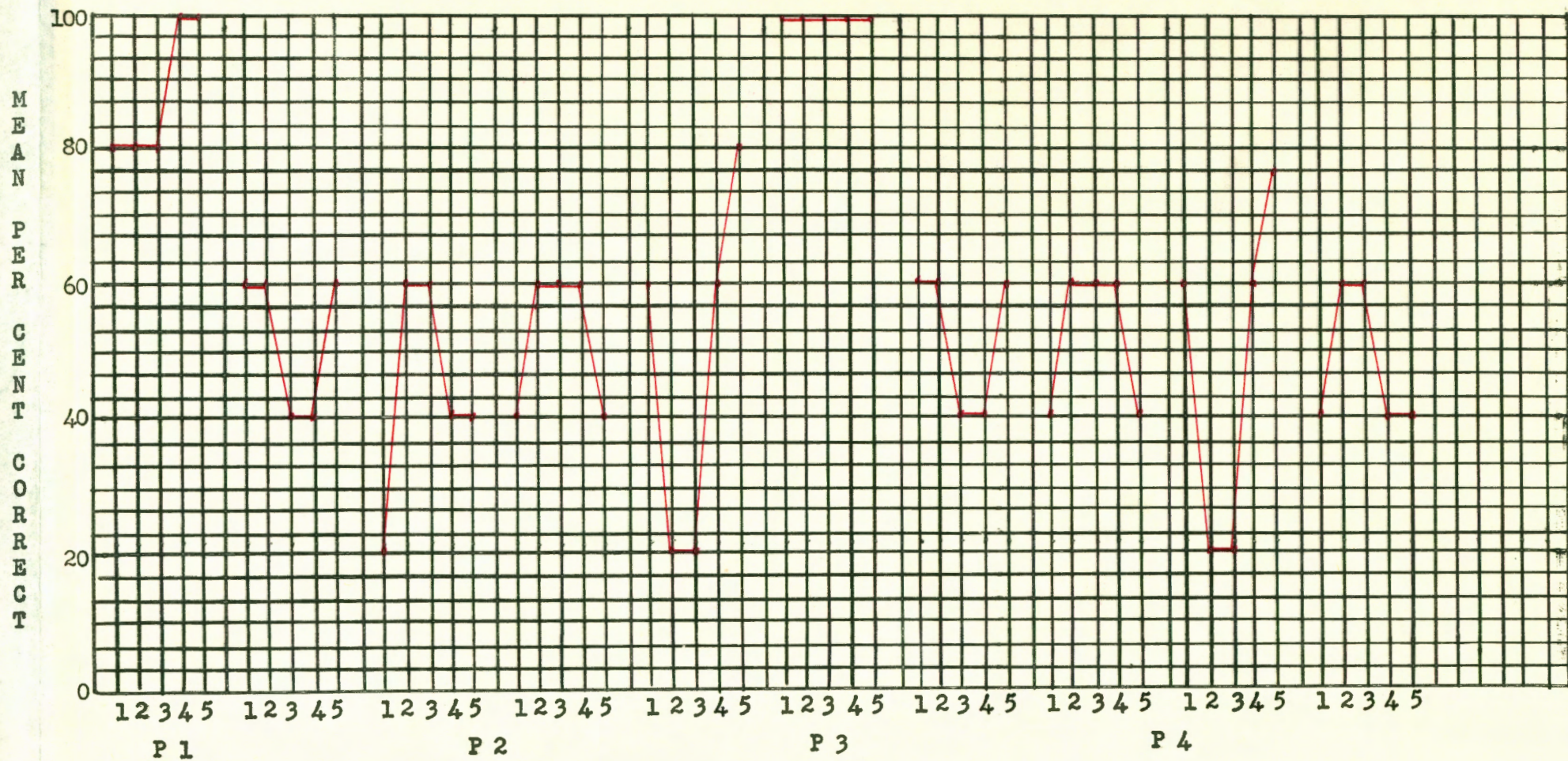
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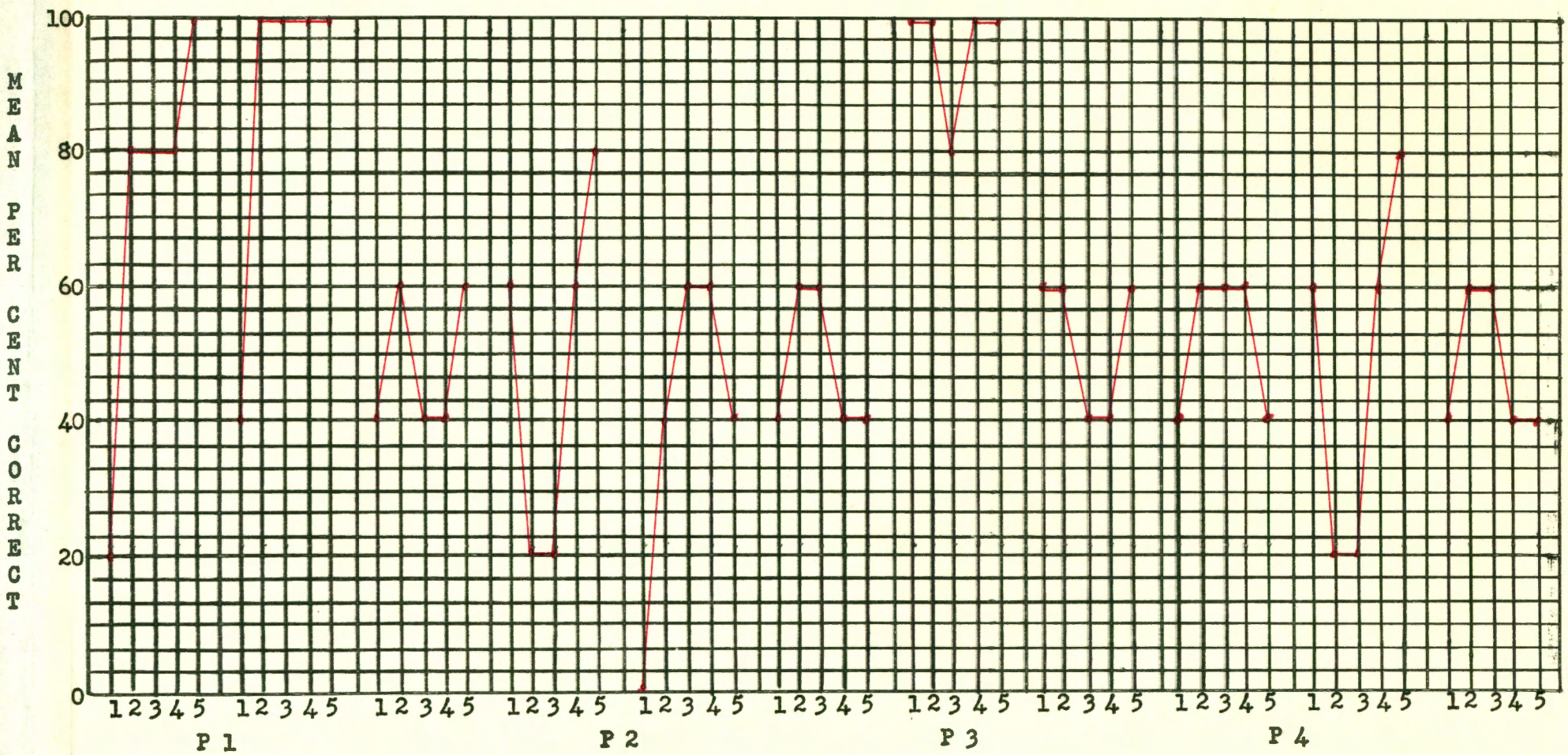
## APPENDIX

### INDIVIDUAL ANALYSIS OF SUBJECTS' PERFORMANCE

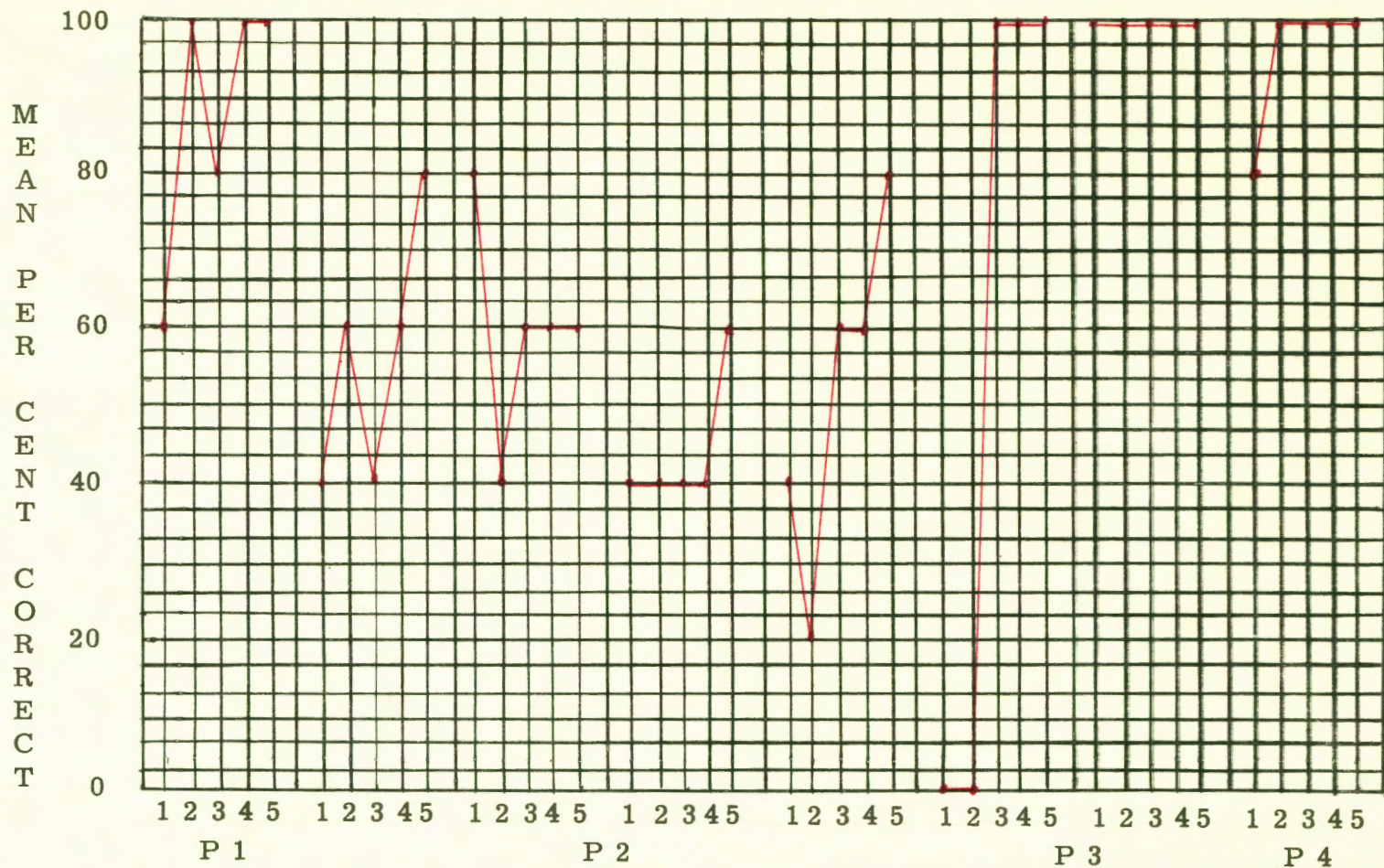


MEAN PER CENT CORRECT BY TRIAL BLOCKS FOR ALL PROBLEMS  
FOR SUBJECT 3, GROUP 1

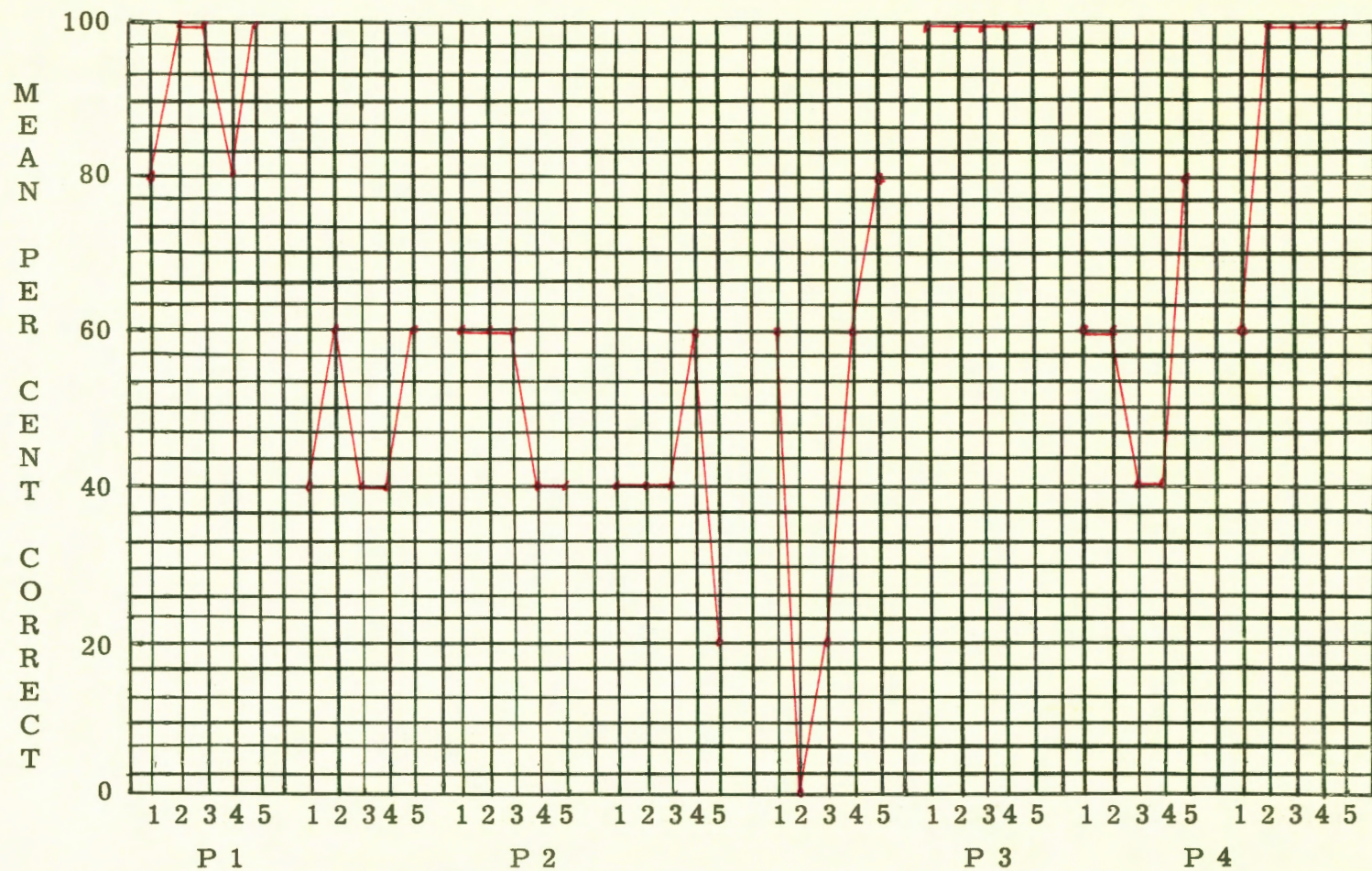




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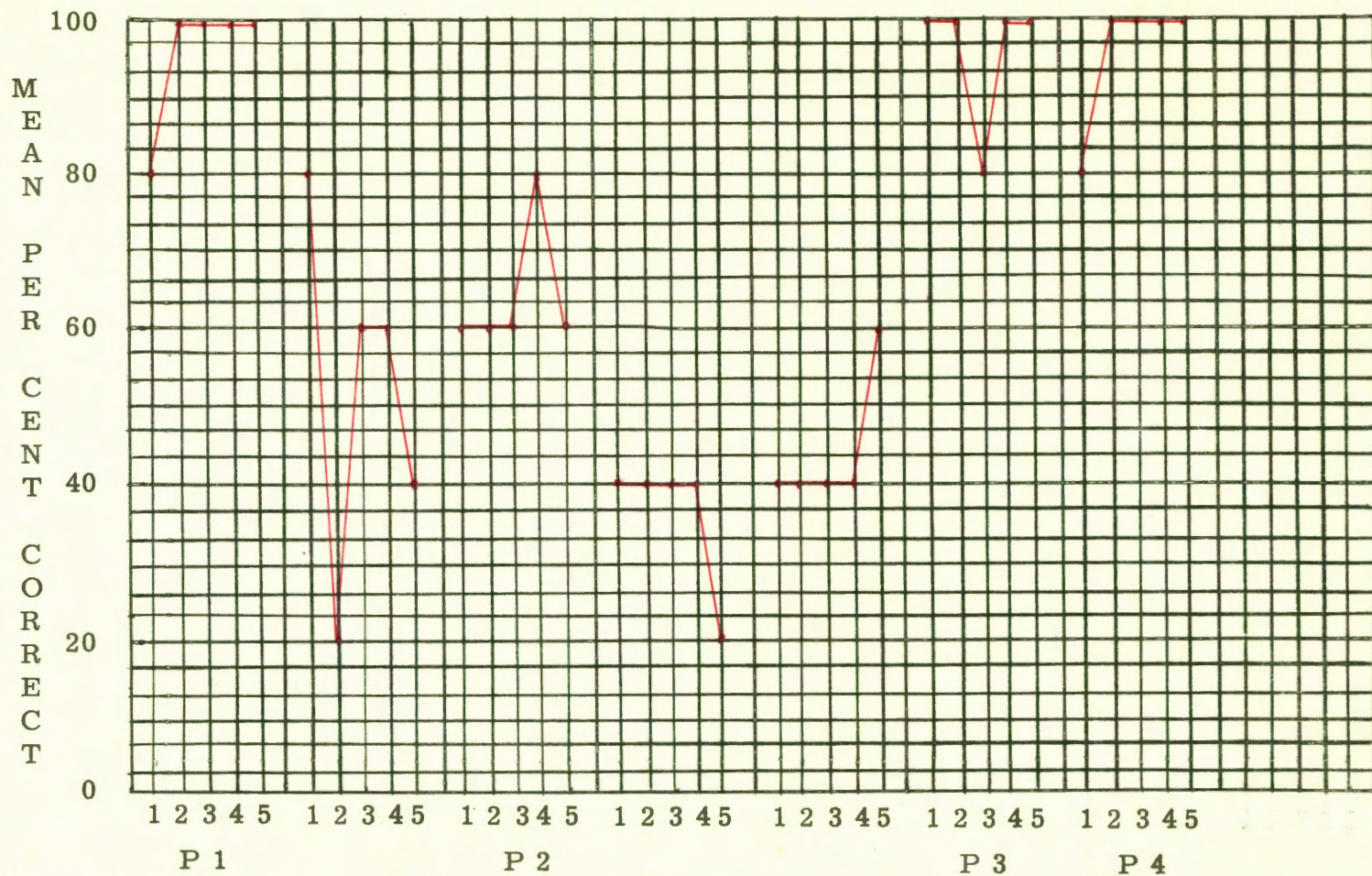


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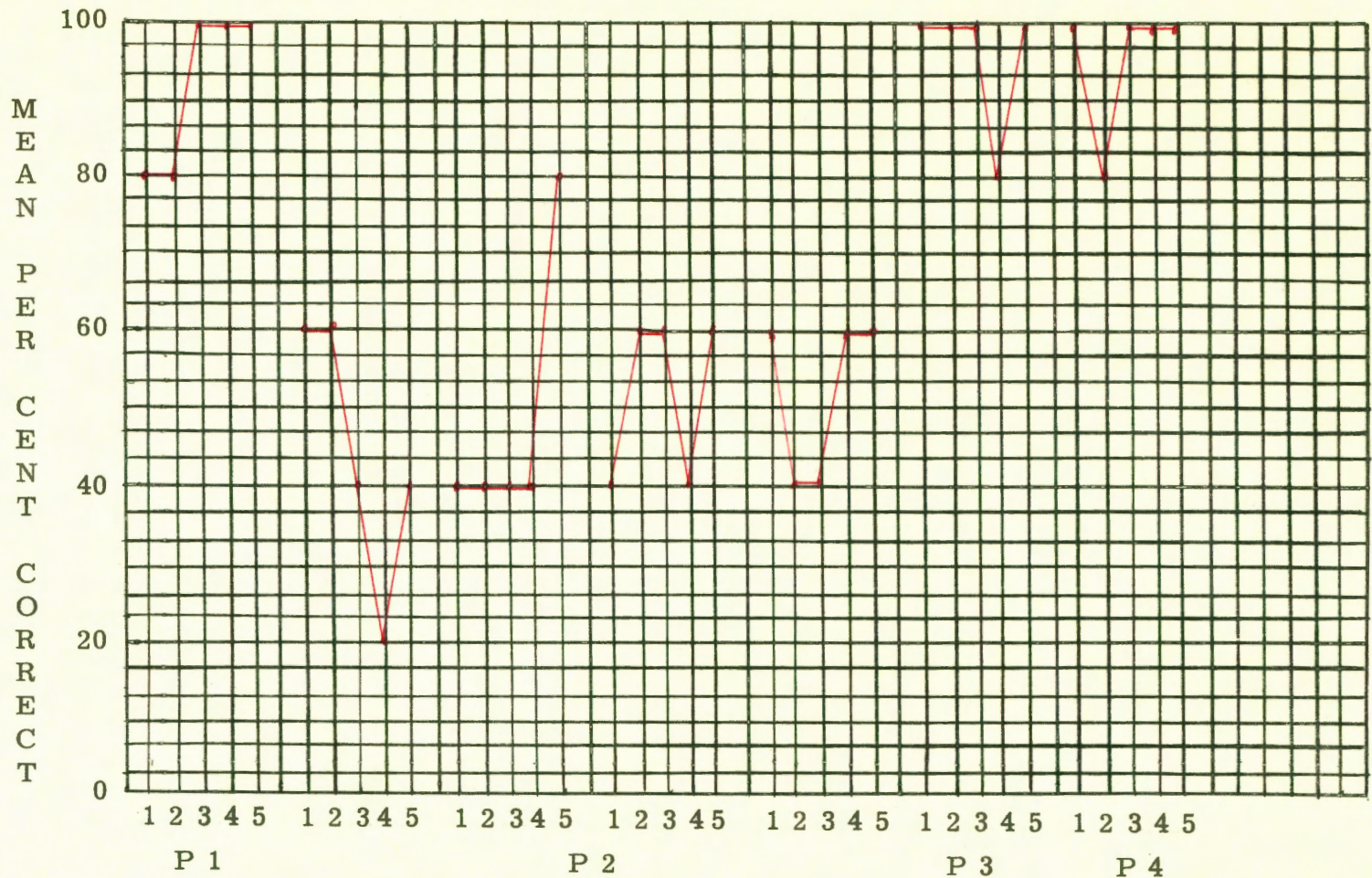


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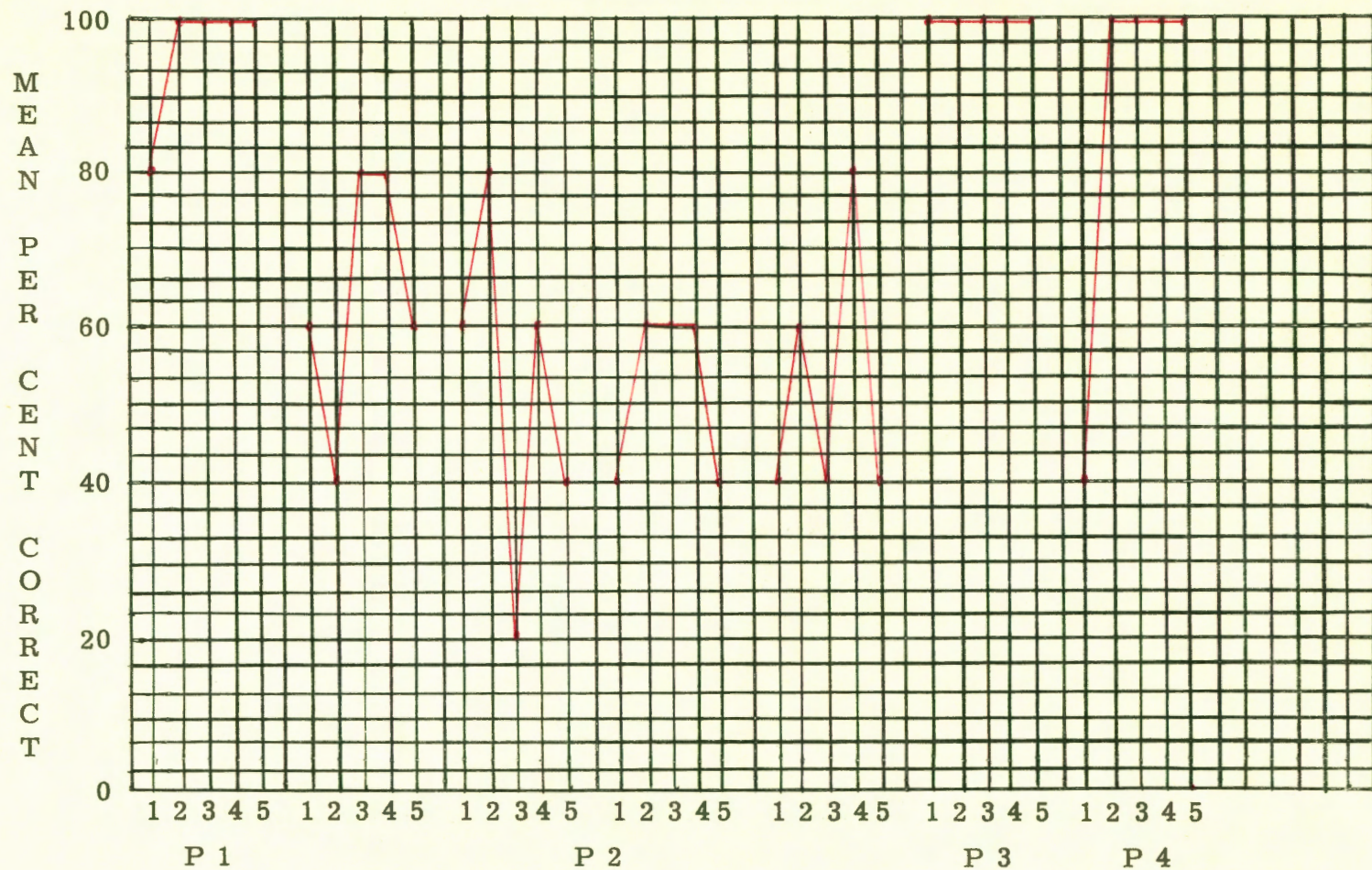




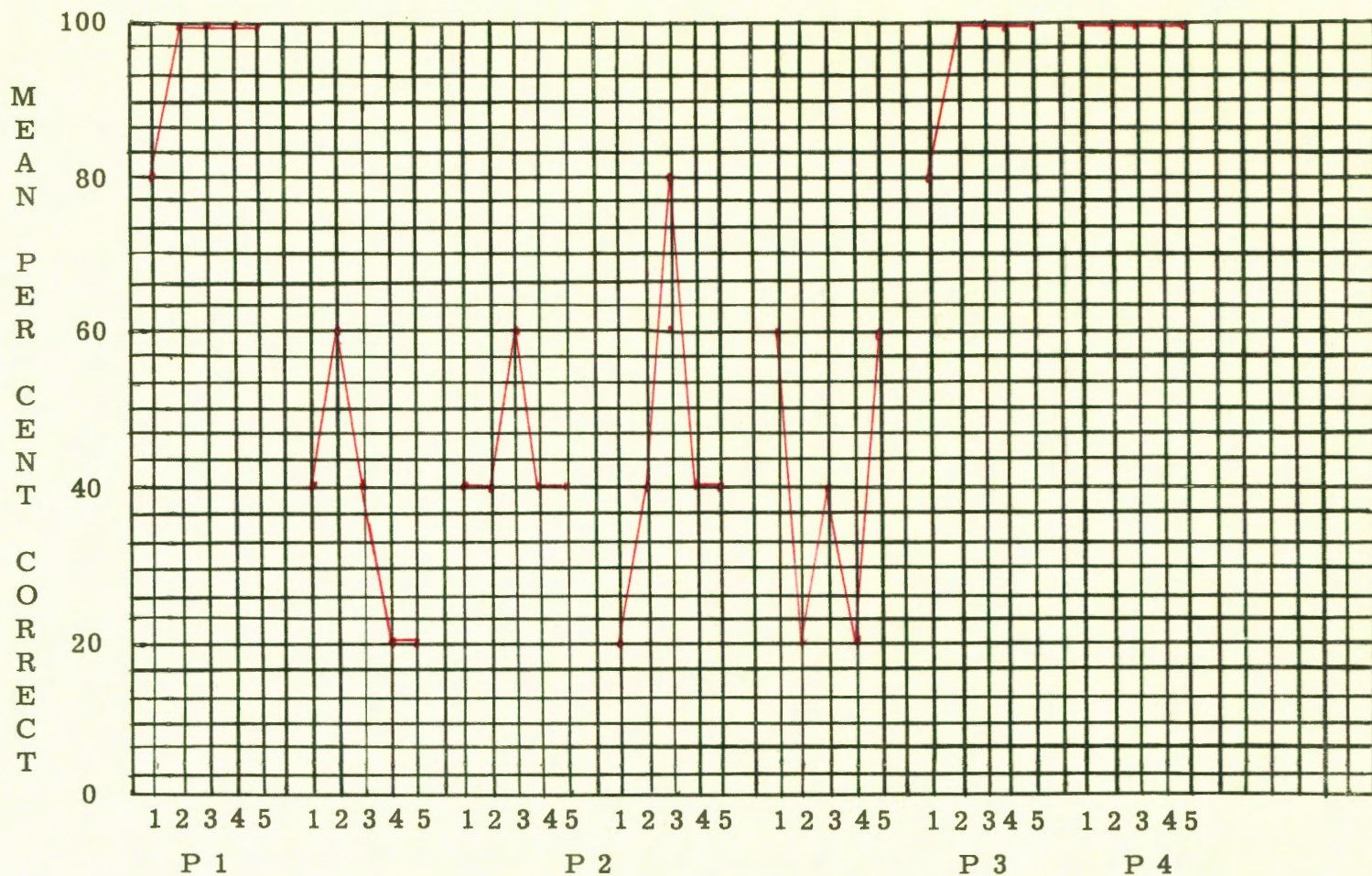
MEAN PER CENT CORRECT BY TRIAL BLOCKS FOR ALL PROBLEMS  
FOR SUBJECT 5, GROUP 3



MEAN PER CENT CORRECT BY TRIAL BLOCKS FOR ALL PROBLEMS  
FOR SUBJECT 6, GROUP 3



MEAN PER CENT CORRECT BY TRIAL BLOCKS FOR ALL PROBLEMS  
FOR SUBJECT 11, GROUP 3



MEAN PER CENT CORRECT BY TRIAL BLOCKS FOR ALL PROBLEMS  
FOR SUBJECT 12, GROUP 3