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THE RELATIONSHIP BETWEEN PERCEPTUAL PERFORMANCE
AND THREE TYPES OF LEARNING TASKS

To the Graduate Council:

I am submitting herewith a thesis written by
Clarence J. Rosecrans, Jr. entitled "The Relationship Between
Perceptual Performance and Three Types of Learning Tasks."
I recommend that it be accepted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy, with a
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THE RELATIONSHIP BETWEEN PERCEPTUAL PERFORMANCE
AND THREE TYPES OF LEARNING TASKS

A THESIS

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of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Doctor of Philosophy

by

Clarence J. Rosecrans, Jr.

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Clarence J. Rosecrans, Jr.

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CHAPTER I

INTRODUCTION

In recent years there has developed a considerable interest in learning as it relates to perception, motivation, personality, and psychotherapy. Prior thereto, much of the literature on variability in human learning had been concerned with the effects of sex, age, and intellectual ability on the rate of learning and the shape of the learning curves. Little study has been devoted to other sources of variability which individual differences produce in such investigations.

Although the existence of individual differences in learning performance has suggested that they are a major source of variability, for example the work on massed versus distributed learning, little has been done to investigate them other than to note such differences as a consistent phenomenon. While individual differences are inevitable in all investigations, the tendency has been to consider these sources of variability as products of apparatus error, experimenter error, or sampling (random) error.

There has been recognition of variability within and between subjects on learning tasks but until recently no extensive study of these sources of variability had been undertaken. The status of the situation is well put by Hovland (21, p.632):

Much of the literature on human learning is presented in terms of the broadest types of generalization possible. But every worker in the field is struck by the wide variability from individual to individual in even the simplest types of learning. Greatly needed are systematic investigations of the sources of variability.

The three factors that have been most extensively studied are age differences, sex differences, and differences in mental ability.

A. Scope of the Study

The purpose of the present investigation was to explore a possible source of variability in learning tasks when such factors as age, sex, and intelligence are controlled. A large group of SS was administered a perceptual task which the literature had suggested would reflect differences in personality attributes and/or perceptual "sets." The literature on learning has generally been reported in terms of group means and representative group curves. The present study attempted to explore the possibility of differences between individuals in their rate of learning and variability on three types of learning tasks when they were separated on the basis of performance on a perceptual task. If such differences exist, then such measures as group "representative" curves and group means might not reflect the performance of these individuals on the tasks and their differences would be masked in the "averaging" of the data. Furthermore, such differences would tend to increase the variability found in learning tasks.

B. Review of Literature

1. Perception and Personality

During the mid-forties a new trend, sometimes termed the New Look, emphasizing motivational and personality factors and hence

individual differences, gave impetus to a number of researches and theoretical analyses in the field of perception. A symposium Perception: An Approach to Personality (2) presents a series of representative articles in this area. Recently May (29) completed a review of the literature in this field.

Among the New Look theorists are those who would account for individual differences in behavior, be it in perception or in other areas, by positing a basic organizational quality in all persons. It is a revival of typological psychology which has been dormant in America. One of the foremost proponents of this trend is Klein (25). He speaks of Anschauungen, two of which he has named "leveling" and "sharpening", which he considers "attitudes" or consistent approaches which certain individuals bring to bear on, in his studies, perceptual stimuli. He has suggested (25, p.340) that his leveling-sharpening dimension may have its concomitants in other areas of behavior, e.g., motor patterns, learning patterns, concept formation, etc.

Recently, May (29) and Silverstein (36) attempted to relate performance on some perceptual tasks with aspects of performance on some personality tests. They used perceptual tasks which Klein (25, 26) had found to differentiate "levelers" and "sharpeners" or "lagers" and "non-lagers" in addition to some other selector tasks which they felt would measure the same area of perceptual set or Anschauung. From performance on the Gottschaldt figures (which Klein, Witkin (43, 44), and Thurstone (40), had previously employed), the Carmichael, Hogan,

and Walter figures (6), anagrams, and paragraph memory, they selected particular Ss from the total group in order to maximize differences between the two groups. Those chosen for the experimental groups of levelers and sharpeners were the maximal ten and minimal ten scorers on the composite selector tasks mentioned above.

The selected Ss were then administered the Thematic Apperception Test (31), Bender-Gestalt Test (32), a Sentence Completion Test, and the A-S Reaction Study (1). Only a chance distribution of differences between the two groups was obtained on the personality measures used in their study. Klein (25), to the contrary, has reported distinct personality differences between his levelers and sharpeners as have Witkin (43) and Pemberton (33). Klein's levelers and sharpeners, who were in psycho-therapeutic treatment, were rated by their therapists following "a pattern which we called 'self-inwardness' and emphasized a retreat from objects, avoidance of competition . . . exaggerated needs for nurture and succor, self-abasement, and passive drifting" for the levelers and "'self-outwardness' . . . manipulative and active . . . competitive and exhibitionistic . . . have high needs for attainment, aggressively push themselves forward and have a great need for autonomy" for the sharpeners (25, p.339).

Much of the work concerning the relationships between various personality "traits," "types," or "temperaments" and perceptual, motor, or "objective" test performance has utilized factor-analysis. The most important names here are Spearman (37), Eysenck (11), Cattell (7, 8),

and Thurstone (40). One method has consisted largely of correlating various perceptual tasks with "paper and pencil" personality tests, interest, and social scales, items taken therefrom, or original items similar thereto. From an analysis of the items, areas which are saturated with a particular "factor" are obtained (40). One of the perceptual items which crops up time and again in these studies is the Gottschaldt figures.

Jay (22), who did a re-analysis of part of Thurstone's work (40), reports that the ability to "see" many of the Gottschaldt figures is related significantly to an interest in "theoretical" activities as measured on the Allport-Vernon "Study of Values." Gehlman (15), likewise, reports a significant relationship between the Gottschaldt figures and an interest in physical science. Pemberton (33) reports that a longer form of the Gottschaldt figures produces a heavy loading on a factor, C_2 , which she designates "flexibility of closure"—Thurstone's Factor A. She remarks (33, p.164):

The tests with loadings on C_2 seem to require several . . . of these modes of behavior . . . 7, namely, the ability to abstract common properties, to hold in mind simultaneously various aspects, to break up a given whole into parts, to plan ahead ideationally, and to shift from one aspect of a situation to another.

This description of Pemberton's C_2 factor suggests two areas of possible relationship, to one of which she refers, viz., (33, p. 154):

Klein and Schlesinger have expressed the opinion that perceptual organization is the counterpart of personality organization and have mentioned the possibility of introducing Thurstone's closure factors among their explanatory principles.

Briefly, it is suggested that performance on a perceptual task such as the Gottschaldt figures may reflect an "organizing principle,"

"integrating mechanism," (25), or consistent "hypothesis" (3) which is akin to personality organization and behavior. If such is the case, and we have evidence to indicate that individuals do reflect some type of consistent organization in their perceptual performance (25, 13, 44), might not this same "organizing principle" occur in other behavior areas, e.g., learning? If such a pervasive organization does occur, is it reflected in the rate and approach to learning situations, i.e., is there a "learned set" present in perceptual performance which is also reflected in learning and responding in new-learning situations? Pemberton's description of factor C_2 certainly suggests that performance on perceptual tasks saturated in C_2 may be related to learning performance.

As previously mentioned in the quotation from Hovland (21), few attempts to discover sources of variability and/or consistency in human learning have been made apart from those on sex, age, and mental abilities. Bruner (3) has spoken of perceptual theory in much the same manner that Hovland has regarded human learning. Bruner states (3, p. 123):

Above all, such a theory of perception should account systematically for individual differences in the perceptual process and not assign them to random error In future research, we must, I think, seek to maximize the constant errors and, what is more, cease calling them by the old-fashioned statistical name of errors.

The recognition of variability is noted in both human learning and perceptual performance by Bruner and Hovland. Further, the suggestion is offered by Bruner that individual differences in perceptual performance should become the experimental variable themselves rather than assigning them to the category of "errors."

Klein (25), May (29), and Silverstein (36) have since tried the type of approach which Bruner proposed, namely, maximizing individual differences by taking those individuals who fall at the extremes of performance on a perceptual task and treating them as separate groups rather than as "deviates" from a common "group" norm. It was in this sense that May and Silverstein sought to elicit personality differences from "extremist" performance on various selector tasks. The question of attempting to account for those "variable" or "extremist" individuals who fall on each side of the "typical learning curve" in the group becomes immediately apparent.

It is well known that task complexity, distribution of practice trials, age, intelligence, sex, aptitudes, etc. will affect the rate of approach to asymptote; is it possible that certain individuals consistently fall on either side of the representative curve so that the curve never represents their actual performance but is, in effect, masked by the cancelling contributions of each of the extreme groups of individuals?

Klein in regard to his sharpening-leveling dimension states (25, p. 341):

. . . perceptual attitudes offer starting points for considering the meaning of individual differences elsewhere and for approaching the central directives which control all of a person's adaptive behavior . . . /this possibility/ . . . leads to . . . /consideration/ . . . of leveling and sharpening in other functions--in motor or expressive behavior, in learning, in concept formation, etc. Consistencies of a person in each of these spheres is a major research problem for the future.

Pemberton (33, p. 172) speaks of a hypothetical problem which, in actuality, has since been studied by Klein in an indirect fashion. She

Suggests that her high C_1 group, Thurstone's "speed of closure" factor, might tend to maintain its original interpretation of a stimulus for a longer time than the high C_2 , "flexibility of closure," group even when the stimulus was gradually being changed on succeeding trials. Pemberton's high C_2 group is closely akin to Klein's "sharpeners" in that both reflect high performance on Gottschaldt figures. Klein's description of his low Gottschaldt performers or "levelers" also resembles Pemberton's high C_1 group or at least there is considerable similarity from behavioral and performance descriptions of these individuals by each investigator. If this is the case, Klein has demonstrated that his "levelers", Pemberton's C_1 group, tended to judge a series of squares as the same size as in original trials although the size was increased on successive trials! Klein remarks (25, p. 336): "The extent of this 'adaptive lag' in some was such that at the close of the experiment they were judging a square of 13 inches to be only 4 inches!" On the other hand, the sharpeners, high C_2 , were making adequate judgments on the squares, having shifted their judgments as the size of the squares increased.

It has been suggested that the ability to distinguish familiar Gestalts which are hidden in a more complex figure—the embedded figures of Gottschaldt—might well represent an ability which is closely related to the usually measured psychometric intelligence. May (29) found a positive correlation of .56 between available ACE scores of eighteen of his male ss and Gottschaldt performance. Conversely, he found a correlation of -.25 between available ACE scores of fourteen female ss

and Gottschaldt performances. The correlations are not only separately significant but significant in terms of the direction between the sexes.

May refers to Thurstone's Factor E (40) as having loadings on both reasoning tests and the Gottschaldt figures which raises the question of whether the "leveling-sharpening [dimension]" might not really be an aspect of psychometric intelligence or visa-versa (29), p. 72)." This finding not only suggests that intelligence is a factor in perception but that there are extreme sex differences as well at least in regard to the Gottschaldt figures. From Witkin's (44, 20) findings of major sex differences in perception, May (29) and Silverstein's (36) corroboration and further suggestions of a correlational factor with intelligence (40, p. 111), it is clearly indicated that sex and intelligence are factors which should be either controlled or utilized as independent variables in future studies on perceptual choice. In spite of Witkin's report of significant sex differences on Gottschaldt performance, Klein (26) does not mention such a distinction nor does he report any attempt at control of such a variable.

May (30), in a personal communication, reports a correlation of .74 between accuracy of Bender-Gestalt reproduction and Gottschaldt performance for all 53 of his male ss. Such a significant correlation suggests that these tasks are measuring some common aspect of visual-motor performance. This finding may be akin to Pemberton's (33, p. 162) report of a correlation of .70 between her version of the Gottschaldt designs (concealed figures) and a copying test.

The status of perceptual performance and personality correlates remains, unfortunately, a rather unclear picture although it poses highly interesting experimental problems and the work of Eysenck and Cattell continue to provide evidence that personality traits do exist. Perhaps an answer may come from the relationship of learning and perceptual performances as Klein has suggested.

2. Learning and Individual Differences

The occurrence of individual differences in human learning are as old as the study of learning itself. While note has always been made of individual differences and some studies have utilized aspects of the differences themselves as experimental variables--notably sex, age, and intelligence differences--learning curves and performance have been presented in terms of group averages. This resulted in rather good prediction for performance of the group as a whole but allowed relatively little prediction for any particular individual, the best estimate being the group mean. The reader is referred to an excellent review of individual differences in learning in regard to sex, age, and intellectual ability by McGeoch and Irion (28, pp. 516-568). A less extensive coverage of the problem is also given by Deese (10, pp. 293-301).

Thurstone suggested the possibility of increased variability with practice as early as 1918 (39). There followed a great interest in the study of variability and the effects of practice and/or short series of learning trials. Kincaid (23) summarized the experiments in this area through 1924. The review indicated that individual differences increase,

decrease, or show unclear changes with practice and different types of learning activities. Kjerstad (24) noted individual differences in the shapes of learning curves for memory and found some of his SS reaching a mastery criterion three times faster than others. While there were large individual differences, Kjerstad noted a similarity in form of the curves which varied when the portions of the curves were divided into various fractions of total trials.

Woodworth mentions the question of variability and individual differences through a series of learning trials thus (48, p. 174):

Are individuals made more alike or more unlike by equal training in a performance? That is a question regarding group variability, and it is a question of importance in relation to the problem of heredity and environment. For if training makes individuals more alike, the individual differences that appear in advance of special training must be due to differences in previous opportunity; but if training makes individuals more unlike, there must be inherent differences between them. One would expect a straightforward answer from a good practice experiment, except that we do not know what variability to measure.

What Woodworth pointed out in 1938 is still unanswered today.

Another factor which is known to affect learning performance, especially learning rates, is age. The now classic study of learning in adults by Thorndike, et al. (38, p. 335) suggested that adults twenty-five to forty-five learn at nearly the same rate and in nearly the same manner as they would have learned the same thing at fifteen to twenty. It is not until the mid-fifties that a significant decline became apparent in the tasks utilized.

Tyler (41) remarks that learning ability is not synonymous with intelligence. She states (41, p. 179), "Our intelligence tests measure

learning ability for only complex, abstract sorts of material and recent work indicates that they do not predict very well the rate at which even this type of material will be learned." While correlations between learning and intelligence have been reported ranging from practically zero to .39 (14, 47), the consistent positive relationships are enough to warrant the precaution of control in comparing differences between groups who are differentiated on a single variable such as perceptual performance.

Numerous factor analyses have indicated that Spearman's g factor and the reasoning factor which appears in tests of reasoning, deduction, and problem solving are quite similar if not identical in view of the disappearance of the reasoning factor into the Spearman g factor with quite high loadings (45, p. 33). Although identity between a general factor and the reasoning factor is not established, the presence of considerable common variance between "reasoning" learning tasks and the g factor is at least indicated. There remains the question which was asked at the beginning of this paper, namely, is there some pervasive "organizing principle" which occurs in several types of tasks such as perceptual, memory, and reasoning. There is nothing to indicate that the existence of such an "organizing principle" would be identical to a general factor such as Spearman's, but the possibility exists that another kind of factor—a learned behavior "set"—might be expressed in perceptual performance and found in learning performance.

3. Perception and Learning

While the learning of perceptions has received much attention

(3, 4, 16, 19, 20, 27, 35), relatively little has been done in investigating the effects of perceptual performance on learning behavior although this is of paramount importance, particularly in clinical psychology. Much of the clinical literature is filled with behavioral responses to the perceptions of visual stimuli but little is found in regard to the learning performance of individuals with particular perceptual responses, e.g., the learning in psychotherapy of a person who gives many whole responses or many detail responses on the Rorschach. Clinical experience clearly indicates such an implied differentiation whenever a prognosis is stated.

The learning literature is filled with evidence concerning "learning to learn" experiments, learned "sets", transfer phenomenon, and the perceptual changes wrought by learning but a survey of the literature reveals little or nothing about what effects a learned "perceptual set" might have on future learning. The factor analyses on learning, intelligence, personality, and perception have provided evidence of the existence of certain factors or "traits." None of these trait studies, however, have related perceptual abilities and learning. Thurstone (40), has published a monograph on perceptual functions but none of the perceptual traits themselves have been related to learning abilities.

In a recent paper Gibson & Gibson (17) discuss the two alternatives, human perception as a learned phenomenon versus human learning as a perceptual phenomenon. In citing Bruner, Postman, Hebb, and others they state (17, p. 33), "what all these theorists seem to be saying is that the organization process and the learning process are not

inconsistent after all." Gibson & Gibson then pose the question of whether perception is a creative or a discriminative process and conclude that there is nothing to indicate that an accurate percept is one which is enriched by past experience. They conclude by saying (17, p. 40), "Repetition or practice is necessary for development of the improved percept, but there is no proof that it incorporates memories Perhaps the ability to summon up memories is merely incidental to perceptual learning and the ability to differentiate stimuli is basic."

No work thus far in the fields of personality, perception, or learning has attempted to relate particular perceptual traits with a mode or type of learning ability although note has been made of individual differences in learning curves (24). Tyler refers to the lack of investigation in this area (41, p. 372):

There is clear evidence for separate factors for things like speed and strength of closure, susceptibility to optical illusions, and rate of alternation of ambiguous figures. So far, evidence is lacking as to what these special perceptual abilities are related to in personality or behavior

Whether the Gottschaldt and Bender-Gestalt figures are considered as purely visual-perceptive-motor tasks or correlate with particular personality "traits" or Anschauungen is not clearly established. There is evidence indicating that such correlations occur but many experimental questions remain to be tested (7, 15, 22, 25, 26, 32, 34, 40, 43). Thus, if it should happen that differences in learning occur between two groups which have been maximally differentiated on the basis of such a perceptual task when age, sex, and intelligence--known to affect a learning curve--are controlled, it would seem to indicate that more extensive research on

personality and/or perceptual factors affecting the rate and type of learning should be undertaken.

4. Statement of Problem

The purpose of the present study was to investigate the relationship between certain learning phenomena and perceptual tasks which purportedly measure flexibility of closure and accuracy. Age, sex, and intelligence were controlled. The extreme scorers on the perceptual tasks were then to be subjected to three learning situations involving motor, associative, and conceptual learning respectively. Measures of the rate of learning were determined for all tasks and a curve fitted for each individual's performance on each of three tasks. Measures of variability were also determined for each individual on each task as was the asymptotic rate. The measures of variability and learning curves between the two experimental groups were compared in order to test whether consistent differences might be found when the independent variable was high or low performance on a perceptual task. The asymptote measures provided a test for speed of learning to criteria.

The general hypotheses advanced were the expectations of differences between the experimental groups on their individual slopes on each learning task and also on individual variability on each task. It was expected that those individuals who were able to perceive the embedded figures in the Gottschaldt designs would prove superior in their rate of learning ability on the more "verbal" and "conceptual" tasks than those SS who had difficulty in perceiving the embedded designs, and this

superiority would be apparent in the faster learning to criteria of the high perceptual performance group.

Little significant differentiation was expected between the groups on motor performance but such a task was included not only because of the known occurrence of individual differences on the task but also to provide a "base-line" of learning abilities in the overall behavioral picture. No expectation of variability differences could be set forth because of the ambiguity of the indirect evidence in this area. Furthermore, the author could conceivably offer "reasons" for greater variability occurring in either group. On the one hand, a group which showed greater learning rate and accomplishment would also have greater opportunity for larger fluctuation on succeeding trials. On the other hand, a group which might have difficulty in establishing consistently correct behavioral responses might tend to show greater variability over a series of trials. There was no evidence for assuming that differentiation on the perceptual task would also differentiate significantly different groups in terms of variability, but this is part of the experimental question.

As this study is exploratory in a relatively virgin area, the foregoing expectations were examined for indications of future research in this area.

CHAPTER II

METHOD

Two experiments were conducted in this study. The procedure in the second experiment was identical with that in the first and should be considered, therefore, a replication.

A. Subjects

In Experiment I, 136 undergraduate males in two sections of a general psychology class at the University of Tennessee made up the population from which Ss for the experiment proper were selected. In Experiment II, 62 undergraduate males of one section of a general psychology class at the University of Tennessee composed the population from which the experimental Ss were drawn. Both populations from which the experimental Ss were drawn were similar in age range, class, and college. All Ss selected for the experiment were required to serve in it. The means, standard deviations, and range on the selector tasks for the total sample and experimental Ss in each experiment are reported in Table I. Only male Ss were utilized in this study because of sex differences in perceptual performance. Although age differences in learning have been reported by Thorndike (38), such differences did not appear until the mid-fifties at which time significant declines began to occur. The Ss in this experiment ranged in age from 17-30 and such a difference was not considered to be significant.

TABLE I

MEANS AND STANDARD DEVIATIONS OF TOTAL SAMPLE AND
EXPERIMENTAL GROUPS ON SELECTOR TASKS FOR
EXPERIMENTS I AND II

<u>Total Sample</u>								
	<u>Experiment I</u>		<u>Experiment II</u>					
	Wonderlic	Gottschaldt	Wonderlic	Gottschaldt				
N	136	136	62	62				
$\bar{X}$	29.37	14.51	29.70	14.82				
	4.81	6.02	5.08	5.36				
Range	26	27	22	25				
r		.35		.21				
p		.01		.05				
<u>Experimental Subjects</u>								
	Wonderlic		Gottschaldt		Wonderlic		Gottschaldt	
	High	Low	High	Low	High	Low	High	Low
N	15	15	15	15	6	6	6	6
$\bar{X}$	29.87	29.60	22.53	6.33	30.00	30.16	23.50	6.00
Range	17	17	7	11	7	7	6	7

In both experiments, the lowest and highest performers on the perceptual task were selected from the total sample and those of each extreme who could be matched with each other on the intelligence test were used as Ss. The mean of the ages in each group was relatively similar. The perceptual scores, ages, and intelligence test scores for both groups in each experiment are presented in Appendix B. As can be seen, fifteen pairs which met the above criteria were obtained from the first population and six pairs were obtained for Experiment II.

It was originally intended to use three subgroups of five pairs each in Experiment I. However, because of a decision to replicate, it was decided to combine the three subgroups of Experiment I into one total group. The means, medians, range, and probabilities on these separate subgroups are presented in Appendix B. It will be noted that these data confirm the direction of results found in the body of this study even though they are not statistically conclusive.

B. Selector Tasks

The selector tasks administered to the total population in both experiments were the Wonderlic Personnel Test, Form A (46), the Bender-Gestalt Test, and the Gottschaldt Figures as used by May and Silverstein (29, 36). An information sheet containing the name, age, major, class, date, and a code number was attached to the other three tests and all materials were paper-clipped together and passed out face down to the Ss. No names appeared on any of the materials other than the face sheet.

A code number on each of the tests and the same number on the face sheet enabled the examiner to identify those Ss who were selected to form the experimental groups. The examiner had an associate pick the names associated with the numbers so that he would not know which group an S was in during the individual testing.

1. Wonderlic Personnel Test, Form A

It was necessary to secure a relatively reliable measure of intelligence for each S so that later matching could be accomplished. Because all of the initial selection data had to be collected in a one-hour class period, only the Wonderlic Test was satisfactory in regard to both time of administration and reliability of measurement. The Wonderlic Test (46) is similar to the Otis Self-Administering Intelligence Tests, and the items are of the same nature. It is also self-administering and consists of fifty items to be answered in a twelve-minute time limit. No S was able to complete all items in the time limit. A normal distribution of scores was secured from the test, and it closely approximated the distribution found on other intelligence tests. For a more complete description and critique of the Wonderlic Test, the reader is referred to *Buros Mental Measurements Handbook, Third Year* (5, pp. 347-350).

2. Gottschaldt Figures

The version of the Gottschaldt figures used in this study was exactly that of May and Silverstein (29, 36). They used an adaptation of the Gottschaldt figures which are reproduced in Thurstone (40). The twenty-seven figures were reproduced on three sheets of paper which were

stapled together to form a booklet. Each S was to outline in pencil one of the two simple figures which appeared at the top of each page in the more complex figures found below (Appendix A). The time limits were those used by May and Silverstein and found to be maximally discriminating. These times were: three minutes for page one, four minutes for page two, four minutes for page three. The score on this test was the total number of correct designs outlined in the complex figures within the above time limits.

The finding that Thurstone's Factor E is heavily saturated by both tests of reasoning and Gottschaldt performance (40, p. 111) as well as May's corroboration of such a relationship (29, p. 71) has implied that Gottschaldt performance may be reflective of some function of intelligence. In this study, a correlation of .34, significant at less than the .01 level, was found between Wonderlic Intelligence scores and Gottschaldt performance in the sample for Experiment I and a correlation of .21, not significant at the .05 level, was obtained for the sample of Experiment II. This again confirms the positive relationship between such a perceptual task and intelligence test items. Although such correlations are rather low, they support the necessity for matching individuals on intelligence who display extreme differences on the perceptual task. Such a matching would ultimately be necessary for the learning tasks in any case because of the known effect of intelligence on certain learning tests.

3. Bender-Gestalt Designs

The Bender-Gestalt designs (32) were included in the selector devices because of a logical assumption that they were measuring similar areas of perceptual behavior as the Gottschaldt figures. It was felt that the ability to maintain a Gestalt against distraction and outline it in a more complex design as on the Gottschaldt might also be reflected in the accuracy of reproduction of Bender-Gestalt designs.

Pemberton (33) had reported a correlation of .70 between Gottschaldt performance and a copying test (not the Bender-Gestalt), which gave support to the notion that the "copying" of the Bender-Gestalt designs would likewise correlate highly with Gottschaldt performance. Further, May (29) reported that the most significant relationships between his selector task (Gottschaldt figures) and his personality measures were found in the accuracy of reproduction of the Bender-Gestalt designs. In a personal communication, May (30) reports a correlation of .74 between Gottschaldt performance by 54 males and accuracy ratings of their performance on the Bender-Gestalt. It was hoped to refine the perceptual selection by utilizing both tasks but this study did not find a correlation even approaching the magnitude of May's.

Two raters* were asked to rate the Bender-Gestalt figures on a seven point scale of most accurate to least accurate using such measures

*The writer is indebted to his wife, Sue G. Rosecrans, and Martha J. Thorne for judging the Bender-Gestalt reproductions.

The writer rated the same Bender-Gestalt designs independently and obtained a correlation of .36 between Gottschaldt and Bender-Gestalt which supports the other finding.

as size, accuracy of angles, use of guide lines, etc. A between-rater correlation of .56 was obtained which is significant at better than the .01 level. However, a correlation between Gottschaldt scores and the mean-rater rank of the Bender-Gestalt designs was only .35 which, although significant at better than the .01 level of probability, is a very low correlation for explaining common variance. The coefficient of non-determination in such a case would indicate that better than eighty-eight per cent of the variance in one of the tests is independent of changes in the other. In view of such a low correlation, the Bender-Gestalt designs were omitted from the selection procedure and Gottschaldt performance only was used for differentiation of the total sample into the two experimental groups.

C. Learning Tasks

The tasks chosen were believed to represent different aspects of human learning ranging from motor activity through verbal association to problem solving-conceptualization. In order for a task to be used in this study, it was necessary that it lend itself to the measurement of increments of learning over a series of trials.

The Koerth Pursuit-Rotor was deemed an acceptable task for motor learning over a number of trials. The method of paired-associates was included as an "in between" learning activity in that it was more verbal than the pursuit-rotor but not yet at a problem solving or conceptual level. It also provides for an increment of learning over a series of

trials. The third learning task chosen was an adaptation of the cross puzzle used by Cook (9, 42).

Several other conceptual and/or problem solving tests were considered but rejected because they proved too difficult for solution except under rather intense motivation by the S, did not meet the criterion of incremental measurements over a series of trials, or lacked an objective basis for scoring. The cross problem met the requirement of a problem solving-conceptualization task which provided increments of scores over a series of trials and it could be scored objectively.

The literature is in general agreement that there are differences in learning rate between massed and distributed trials. As this is not an issue in this study and the Ss were not available for lengthy periods of distributed learning trials, it was decided to give each S massed performance trials on each task. While this might affect the learning rate and shape of the learning curve, such effects would be consistent for each S and any differences between the rates should be a function of the S and not of the massing.

1. Motor Task

The Koerth Pursuit-Rotor was included in the learning tasks as a measure of motor learning. Because of the standardization and the ease of obtaining increments of learning efficiency, the pursuit-rotor was used to sample motor learning. A pilot study revealed optimal times for trials and rest periods and asymptote levels which were twelve one-minute trials separated by one-minute rest intervals. The Koerth

Pursuit-Rotor (Lafayette Company Model) was of standard design with a brass target of five-eighths of an inch placed flush with the bakelite turntable which rotated at sixty revolutions per minute. The usual flexible stylus was utilized. The pursuit-rotor was placed in a circuit through an electronic recycling timer which automatically started and stopped the pursuit-rotor and recording clock. Scores were measured in terms of seconds contact per trial.

2. Paired Associates Task

The method of paired associates was employed as a measure of verbal association learning. Many of the paired associate learning experiments have utilized the Ebbinghaus method of nonsense syllable association, the association of English and foreign words, the association of symbols, or the association of multi-syllable adjectives. As motivation in this, as in all learning studies, is a factor which is uncertainly controlled, it was felt that the learning tasks should be such that they would give maximum information about learning rate without being so difficult as to lower the motivation or "desire to accomplish." For this reason, ten pairs of common three-letter nouns were employed. They were arranged so that little or no association between the pairs of words was discernible to the author and another judge.

In order to control serial learning effects, the pairs were presented in a pre-arranged random order so that each presentation of the ten pairs was in a different order from that preceding. The pairs and orders are presented in Table II. A standard memory drum was used

TABLE II

PRE-ARRANGED RANDOM ORDER OF WORDS IN
THE PAIRED ASSOCIATES LEARNING TASK

P Denotes the First Trial of Practice on
the Pairs. The Order of Presentation
was 1, 2, 3, 4, 2, 1, 4, 3, etc.

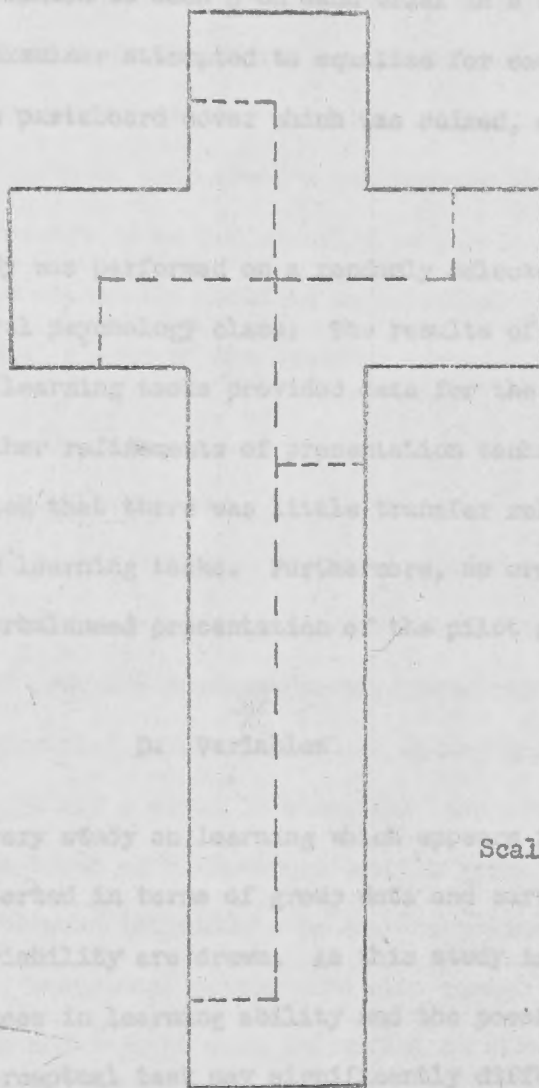
		Order							
P		1		2		3		4	
POT	BAR	INK	LEG	CUP	NET	SUN	LAP	AIR	LID
SUN	LAP	CAR	ANT	KEY	RAT	PAN	MOB	MAT	OAR
MAT	OAR	PAN	MOB	POT	BAR	POT	BAR	TEA	BED
AIR	LID	MAT	OAR	CAR	ANT	CUP	NET	PAN	MOB
PAN	MOB	AIR	LID	SUN	LAP	INK	LEG	KEY	RAT
CUP	NET	SUN	LAP	PAN	MOB	MAT	OAR	POT	BAR
KEY	RAT	KEY	RAT	AIR	LID	TEA	BED	CAR	ANT
INK	LEG	CUP	NET	INK	LEG	CAR	ANT	SUN	LAP
CAR	ANT	POT	BAR	TEA	BED	AIR	LID	CUP	NET
TEA	BED	TEA	BED	MAT	OAR	KEY	RAT	INK	LEG

to present the words at the rate of one every two seconds. Each S was given an initial presentation of all ten pairs of words, after which the test trials consisted of the presentation of a stimulus word for two seconds followed by the stimulus word paired with its associate for two seconds. The words were typed in capital letters, elite type. A complete trial required sixty seconds, forty seconds for the presentation of the pairs by themselves and with their associates and a twenty second delay between trials.

3. Problem Solving Task

As previously mentioned, many tasks were considered and discarded for failure to meet certain requirements of the experiment. An adaptation of a cross puzzle used by Cook (9, p. 342) was decided upon as it provided a measure of problem solving and conceptual activity, increments of score over a series of trials, and was not so difficult as to lower each S's motivation for the task. The task is similar to a jig-saw puzzle and requires five pieces of plywood to be fitted together to form a cross (Figure 1). There is an extensive drop in time during the first few trials, generally between the first and second which is similar to the "insight" curve. Thereafter, there is a much slower drop in time scores but variability differs among individuals.

Although Cook utilized the task in studying massed and distributed learning, the results he obtained in his massed group with the puzzle appeared to satisfy the demands of this study for such a problem solving device. Because of the extreme range in time scores on this task, all



Scale: $\frac{1}{2}'' = 1''$

Figure 1

CROSS PUZZLE LEARNING TASK

scores were converted to logarithms times ten for statistical treatment. The pieces were presented to each S on each trial in a randomly arranged pattern which the examiner attempted to equalize for each S. The pieces were covered with a pasteboard cover which was raised, starting the trial.

4. Pilot Study

A pilot study was performed on a randomly selected group of students in a general psychology class. The results of this group's performance on the learning tasks provided data for the number of trials to asymptote and other refinements of presentation technique. The pilot study indicated that there was little transfer relationship between any of the selected learning tasks. Furthermore, no order effects were noted in the counterbalanced presentation of the pilot group.

D. Variables

In almost every study on learning which appears in the literature, the results are reported in terms of group data and curves representing group means and variability are drawn. As this study is concerned with individual differences in learning ability and the possibility that performance on a perceptual task may significantly differentiate subgroups from a total sample when age, sex, and intelligence are equated, it was necessary to fit a curve for each individual on each task. This would not only prevent the masking of individual differences in learning ability, but would also make it possible to ascertain if individuals in one group revealed significantly different slopes in their learning

curves when compared with the other. A measure of variability was also indicated in that one of the experimental questions posed was whether the experimental groups might differ significantly in their variability either individually or group-wise. Another variable to be studied was the differences in the means of each group's performance on each learning task. Finally, a measure of an individual's performance in terms of his ranking on each task within the combined experimental groups was made on both the individual slopes of the learning curves and the variability on each task.

1. Slopes of Individual Curves

The slopes of each individual on each learning task were obtained by a statistical procedure which will be discussed under ANALYSIS. Individual curves of learning performance were obtained because of the usual masking of individual performance which occurs whenever a "representative" curve for a group is computed. Comparisons between the group was not on the basis of differences between group curves but rather paired differences between individuals in each experimental group. As mentioned above, the individual curves were also ranked and correlations obtained between the rankings of each individual on each task when the subgroups were combined into a total sample.

2. Variability of Individual Performances

Variability of each individual on each task was also obtained and will be discussed in greater detail under ANALYSIS. As with slope differences, variability between paired individuals in each subgroup was

compared on each learning task. The individual variabilities were ranked and correlations were obtained between the rankings of each individual on each task with the subgroups combined into a total sample.

3. Mean Differences in Performance

Differences between the means of "thirds" of the total performance trials on each task on each pair of Ss were obtained and statistically analyzed. The method of obtaining the "thirds" for each individual is discussed under ANALYSIS. In addition to obtaining mean differences between the individuals in the subgroups on the thirds of performance, mean differences were also obtained between the individuals in each subgroup on the criterion trial of the paired associates task. Finally, the percentage of correct associations to total associations given to the paired associates were obtained for each pair of individuals in the subgroups and the differences analyzed.

E. Procedure

Upon determining the matched pairs of extreme scorers on the Gottschaldt figures, an appointment was made with each S for individual testing on each of the three learning tasks. As previously mentioned, the Bender-Gestalt test was not employed in determining the experimental groups because of low correlation with the Gottschaldt. The testing was divided into two sessions per individual with the second session following the first by approximately one week. The first session generally occupied from forty-five to sixty minutes during which time the Ss were given the

paired associates task and the pursuit-rotor respectively. At the conclusion of the first session a second appointment time was made with each S after which the examiner explained the functions and nature of the two tasks on which they had worked.

The author felt that by telling the Ss of the tasks in a general way, motivation could be enhanced as well as a continuance of a cooperative return for the second session. That this was apparently successful is attested not only by the author's impressions of the Ss' feelings but by the failure of only two Ss to miss appointments which they spontaneously remedied by coming to the examiner's office. In short, motivation of each S for cooperation and effort on the tasks appeared to be very good for all Ss. At the second session, each S was given the cross puzzle which took from twenty to forty minutes following which the examiner explained the basis for selection of the Ss, the nature of the learning tasks, and a general summary of the experimental problem.

Although a pilot study had indicated that there were no significant relationships between the tasks and especially no order effects, the precaution of a progressive expansion of differences between the two subgroups over the series of tasks from "lowest" (pursuit-rotor) to "highest" (cross puzzle) was controlled by administering the paired associates as the first task followed by pursuit-rotor and, a week later, the cross problem. This precaution was taken to insure that any progressive differences would be a product of differences in selection of the two groups on the perceptual device and not due to any subtle order effects.

In the initial session, the Ss were seated at a table in front of a memory drum. Instructions were read to them on the procedure (Appendix C) and the pairs were consecutively presented on the first trial. The test trials were then begun with presentation of a stimulus word for two seconds followed by the stimulus word and its pair for two seconds, the next stimulus word for two seconds, etc. Each trial consumed forty seconds and a twenty second delay between trials resulted in a sixty second interval for each trial. Trials were continued until a criterion of one successful anticipatory repetition of all ten pairs was obtained.

Following the paired associates, the Ss were given twelve one-minute trials on the pursuit-rotor separated by one-minute rest intervals. Prior to the task, instructions were read to each S and a brief demonstration of pursuing the target was given by the examiner (Appendix C). The score was the number of seconds contact with the target on each trial. Results of the pilot study indicated that asymptotic performance occurred on the tenth to eleventh trials and therefore, twelve trials were given each S in this study. Following the pursuit-rotor task, each S was given an explanation of each of the devices and what they measured. Each S was then given a re-appointment for the second session.

In the second testing session, each S was seated at a table with a screen in front of him. The instruction were read to him and a scaled figure (without dotted lines, Figure 1) of the design to be put together from the pieces was shown him briefly. On each trial, the screen was removed and the cover lifted from the randomly arranged pieces

of the puzzle to start the trial. The clock was started for timing the trials just as the cover was lifted. The score for each trial was the number of seconds to solution. Immediately upon solution the screen was placed in front of the puzzle in order to prevent the S becoming too familiar with the correct arrangement. The pilot study indicated that a relatively large drop in time for solution occurred between the first and second trials for Ss in general. However, individual variability was rather large and continued for twelve to fourteen trials with a gradual decrement in time scores. For this reason, the Ss were given fifteen trials in this experiment.

Upon completion of the problem solving task, each S was informed of the basis for his selection, the purpose of the study, and the general expectations. Most of the Ss appeared interested and expressed a desire to participate in future psychological experiments.

F. Analysis of Results

As previously mentioned, an individual curve was fitted for each S on each task. The method of averages was used for this fitting and as each curve was parabolic in function, the method appeared to give good results.* The function obtained by the method of averages is from the following equation:

$$y = a + bx + cx^2$$

*The writer is indebted to Dr. E. E. Cureton for providing the formula for the method of averages as well as furnishing him with the statistical method for solving the individual curves.

where a represents the point of intersection of the curve on y when x is zero, b represents the slope of the curve and c is the amount of positive or negative curvature. The x term is obtained by dividing the curve into "thirds" which best represent the form of the curve and securing the mean value of each "third." For each third there is a mean value which represents x at that point which requires that the three values of x on each curve must be placed in the above equation and the resulting three equations solved simultaneously. For ease in computations the difference from the mean of the first "third" of trials to the mean of the second "third" of the trials, must equal the distance of the mean of the second "third" of trials to the mean of the third "third" of trials. Graphically, this produces equidistance between the first and second points and the second and third points.

Thirds of trials were used because an examination of the curves revealed a general negative trend for all curves except for the paired associates in which the statistical procedure resulted in a cumulative effect and a resultant positive curvature. For the paired associates which were converted to trials to successive criteria (42, p. 394) producing a range of ten trials, the thirds were divided into the first three trials, the second four trials, and the final three trials. The pursuit-rotor involved twelve trials and was divided equally, four trials in each third. The cross puzzle involved fifteen trials but was divided into four trials for the first third, seven trials for the second, and four trials for the third third. Dr. E. E. Cureton* suggested that these

*Dr. E. E. Cureton, personal communication.

divisions would best represent the curves and would result in no middle number of trials being larger than the combined first and third numbers of trials.

There are many measures of variability which might be employed on the data obtained in this study. Some appeared unsuitable while others appeared to be too cumbersome and detailed for the quantity of data in this exploratory study. As previously mentioned, the method employed here was to measure the variability which occurred in the trial-by-trial differences on each task after the curve had reached a relatively stable plane. If the curve has passed the point of inflection and is relatively flat for most of the ss, any great degree of fluctuation will reflect variability of performance rather than acquisition. Differences between successive trials were computed for all individual trials on the paired associates. The trials to successive criteria measure used in computing the rate of learning did not allow for an inflection point for all individuals.

The trial-by-trial differences from trial four through fifteen were used on the cross puzzle and the trial-by-trial differences from trial six through twelve were employed on the pursuit-rotor. These differences were individually squared, summed, and divided by the total number of differences for the particular task and might be termed the variability of the trial-by-trial differences. The formula is:

$$\frac{\sum d^2}{n} = \sigma_d^2$$

where d is the difference between each trial and n is the total number of differences.

A test for mean differences for paired individuals in the subgroups was run between the previously obtained means of the "thirds" on each task, the criterion trial on the paired associates, and the percentage of correct connections of paired associates on that task. The percentage of correct connections was obtained by dividing the total right associations minus the wrong associations by the total right associations plus wrong associations.

A Wilcoxon Rank Test was done on the slopes of the curves between the paired individuals in each experimental group on all three tasks. All the individuals were then lumped into a total group and a rank order correlation run between rankings on one task and that on another. This was done to test the possibility of consistent slope ranking for each individual on each task.

A Rank Test was also done on the variability ranking between the individuals in the two experimental groups. All the subjects were again lumped into a total group and a rank order correlation computed between each two of the tasks in order to determine if an individual's ranking on variability in the total group was consistent from task to task.

One measure which was obtained only in Experiment II resulted from the examiner's observations of different approaches to solution on the cross puzzle. Because the high and low groups of Experiment I did not differ significantly in their time-performance scores, it was felt that a difference in approach to the problem in terms of whole-part, efficient-inefficient, rigid-loose, and trial-and-error--conceptual ratings might yield some qualitative differences. Accordingly, the SS of Experiment II

were rated on a five point scale on each of the above dimensions with a value of 3 being the mean, values less than 3 tending towards the first term of each of the above dimensions, and values more than 3 tending toward performance more akin to the latter end of each dimension. Judgments were made without the examiner knowing to which group an S belonged.

The above techniques were utilized to test the previously mentioned hypotheses regarding variability, performance, and slope of the learning curves between two experimental groups who were divided on the basis of extreme differences of performance on a perceptual task.

of this study. Following the completion of the first experiment, it was decided to conduct a replication of Experiment I, a replication was attempted. In general, the large degree of variability found in this study indicated that something other than age, sex, and intelligence are responsible for large individual differences.

Inspection of the slopes of the curves between the two experimental groups of Experiment I revealed no perceptually significant differences either in direction or magnitude. A Wilcoxon Rank Test for paired replicates was run on the ranked slopes of each learning task. The lowest total rank sum on the slopes of paired association, three points, and word-to-letter were not significant at the .05 level of probability. (Note the only eleven pairs of gs were used in the word-to-letter results because four of the gs had had previous practice on the task in another experiment). The results of the ranking on the slopes of the curves

CHAPTER III

RESULTS

Consistent trends indicating performance differences between the two groups, particularly on paired associates, were found in both experiments. Originally, there were three subgroups of five pairs each in Experiment I and data on all the measures for these subgroups are given in the appendices. In Experiment I, these subgroups are combined into a total group and data for the total group are reported in the body of this study. Owing to some ambiguity but also the presence of definite trends in Experiment I, a replication was attempted. In general, the large degree of variability found in this study indicates that something other than sex, age, and intelligence are producing large individual differences.

A. Slopes

Inspection of the slopes of the curves between the two experimental groups of Experiment I revealed no acceptably significant differences either in direction or magnitude. A Wilcoxon Rank Test for paired replicates was run on the ranked slopes of each learning task. The lowest total rank sum on the slopes of paired associates, cross puzzle, and pursuit-rotor were not significant at the .05 level of probability. (Data for only eleven pairs of Ss were used in the pursuit-rotor results because four of the Ss have had previous practice on the task in another experiment). The results of the ranking on the slopes of the curves

on each task are summarized in Table III.

The hypothesis that there would be no significant correlations between an individual's ranking on the various learning tasks when all the Gs of both groups in Experiment I are combined into a total group was tested. Such a test revealed that there was no relationship between the ranking of a particular individual's slope on one task and his slope ranking on another task. The rank order correlation of the slopes between paired associates and pursuit-rotor yielded a rho of $-.019$. A rho of $.068$ resulted from the correlation of paired associate and cross puzzle slopes. Pursuit-rotor and cross puzzle ranked slopes yielded a rho of $-.147$. None of the above correlations approach acceptable significance. Because of the lack of significance or trends on the slopes between the groups in Experiment I, these measures were not computed in Experiment II.

B. Variability

It will be recalled that variability was determined by the trial-by-trial differences squared and divided by the number of these differences. Table IV presents the data on variability in both experiments. As can be easily seen, none of the rank tests were significant between the groups on any of the tasks in Experiment I. Differences significant at the $.05$ level also did not occur in Experiment II although it will be noted that the lowest rank sum on the paired associates and cross puzzle in each experiment was obtained by the H group. This would indicate that there might possibly be less variability in that group.

TABLE III

SLOPES IN EXPERIMENT I

	Pursuit-Rotor		Paired Associates		Cross Puzzle	
	High	Low	High	Low	High	Low
N	11	11	15	15	15	15
$\bar{X}$	3.74	4.06	.038	.390	2.11	2.24
Md	3.41	4.33	.184	.236	2.14	2.22
Range	9.21	7.00	2.82	3.11	3.79	4.08
Wilcoxon Rank T (lowest sum)	22		45		45	
P	>.10		>.10		>.10	

TABLE IV

VARIABILITY IN EXPERIMENTS I AND II

	Pursuit-Rotor		Paired Associates		Cross Puzzle	
	Experiment I					
	High	Low	High	Low	High	Low
N	11	11	15	15	15	15
$\bar{X}_{d^2}$	17.18	14.08	2.96	3.79	6.59	9.34
Md_{d^2}	13.64	10.44	2.22	2.56	3.18	5.21
Range	33.92	20.33	11.67	14.22	24.17	29.50
Wilcoxon Rank T (lowest sum)	36.5		49			28
P	>.10		>.10			.07
	Experiment II					
N	6	6	6	6	6	6
$\bar{X}_{d^2}$	9.79	28.06	2.70	13.89	5.45	6.25
Md_{d^2}	9.34	16.43	2.67	6.22	4.49	1.88
Range	8.90	81.98	4.78	33.89	11.09	21.94
Wilcoxon Rank T (lowest sum)	1		9		4	
P	.075		>.10		>.10	

A rank order correlation of variability of each individual in the combined groups of Experiment I was computed on each task to test the hypothesis of consistency of variability of an individual's rank on the three learning tasks. A rho of $-.045$ resulted between the pursuit-rotor and paired associates data. A correlation of $.194$ was found between cross puzzle and pursuit-rotor data. Neither of the above correlations is even close to acceptable significance. A rank order correlation of $.340$ resulted between the cross puzzle and paired associates which is just under the $.05$ level of confidence ($P .05 = .355$). In Experiment II the two variables gave a rho of $.339$ ($P .05 = .55$).

These correlations are low but suggested a relationship between variability on the paired associates and cross puzzle. To afford a check on what each of the subgroups in each experiment contribute toward the above correlations, rank correlations were computed separately for the high and low group in each experiment. In Experiment I, the high group had a correlation of $.55$ ($P < .05$) and the low group yielded a rho of $.01$. A reversal of direction occurred in Experiment II with the high group producing an r of $.14$ and the low group yielding an r of $.88$ ($P < .01$).

C. Mean Differences

In Experiment I, the differences of the means of the "thirds" of the trials for each pair of SS on each task indicated varying degrees of positive trends in favor of the high group, but there was a general lack of statistical significance. The method of obtaining the "thirds" was

described in Chapter II. The series of trials on each task for each S were divided into thirds which best described the shape of the curve. The differences in the means of these thirds between each pair of Ss were then statistically analyzed for matched pairs. The resulting t-tests were run on each third of each task for all matched pairs as well as on the criterion trial of the paired associates. The data are reported in Tables V and VI respectively for Experiments I and II.

Experiment II resulted in essential confirmation of the trends indicated in Experiment I except that the use of a one-tailed probability gave slightly greater significance levels, particularly on paired associates.

Although it was expected prior to the experiment that the high Gottschaldt performance group would excel the low group on the paired associates and cross puzzle tasks, no such expectation was advanced for the pursuit-rotor task. In view of such expectations, one might consider utilizing a one-tailed test of significance but it was felt that in Experiment I in this relatively unexplored area it would be more justified to use a two-tailed level of significance in spite of any expectations.

That the t-tests on the thirds and criterion trials between the groups of Experiment I resulted in relatively high P's is seen in Table VII. Only one of the t-tests is significant at better than the .05 level and that is for the final third on the paired associates task. However, the middle third and criterion trial differences on the same task also approach accepted significance levels on a two-tailed test and strengthen our confidence in the only t-test significant at the .05 level. Furthermore,

TABLE V

MEANS, MEDIANS, AND RANGE OF THIRDS OF TRIALS IN
THE H AND L CONDITIONS OF EXPERIMENT I

		High			Low		
		Thirds			Thirds		
		First	Middle	Last	First	Middle	Last
Seconds on Target							
PURSUIT- ROTOR	$\bar{X}$	12.93	23.29	30.35	12.04	22.11	27.40
	Md	11.6	20.6	29.0	12.5	24.9	28.2
	Range	17.9	24.6	22.2	12.4	20.2	23.2
N = 11							
Trials to Successive Criteria							
PAIRED ASSOCIATES	$\bar{X}$	1.49	3.60	7.40	1.80	5.27	10.71
	Md	1.00	3.25	7.00	1.33	5.25	8.67
	Range	4.00	7.00	9.00	2.33	9.25	18.00
N = 15							
Log Seconds x 10							
CROSS PUZZLE	$\bar{X}$	16.67	10.02	8.53	17.54	10.46	9.09
	Md	17.04	9.32	7.88	17.27	10.35	8.52
	Range	7.68	5.91	6.06	5.76	5.65	5.41
N = 15							

only three out of fifteen of the low group achieved lower trials to criteria on the final third than their partner in the high group ($P = .017$, one). Nothing approaching accepted significance occurred on the other two learning tasks except for the last third on the pursuit-rotor and the first third on the cross puzzle.

At first glance, it would appear that little if anything was indicated by such results. However, an examination of the t-tests reveals that in every case the high group was superior to the low group even if not at a high significance level. In other words, all of the ten t-tests which were run are in the direction of high group superiority. Such an occurrence would happen less than once in a hundred times by chance. It is not completely valid to consider all ten events as independent, however, because each third on each task is correlated with the other thirds of that task. From another point of view, each task considered independently indicates that the high group was superior to the low group on three tasks out of three which, while not significant, does suggest that more than chance is operating here in favor of the high group's superiority of performance.

The same t-tests were obtained on the groups in Experiment II. The overall results approximate those of the first study except for a slightly greater effect on the paired associates and cross puzzle due chiefly to the poor performance of two Ss in the low group on each task. The extreme performance by these Ss also increased the variability of the differences between the two groups to such an extent that even though there were no reversals on the paired associates task (all six members of the high group

required less trials than their mates, $P = .016$, one tail), only two of the measures on this task were clearly significant at the .05 level of confidence for a one-tailed test although the other two measures closely approached it. The t 's and probabilities on the means of the thirds on each task are reported in Table VII for Experiment II. It will be noted that the probabilities are for a one-tailed test because of the direction of the results in Experiment I.

The combined probabilities on the differences in thirds in both experiments are also reported in Table VII and indicate that the paired associates task is the only task which significantly differentiated the experimental groups. None of the measures on the other tasks approach significance except for the first third on the cross puzzle. It is possible that this is an artifact because although the first third approached significance in Experiment I, the second third was the measure which most nearly approached acceptable significance in Experiment II. If we accept the combined level of significance on the first third for the cross puzzle then it seems wise to be cautious about differences between the two groups on this task.

As predicted and expected, significant differences between the two groups on the pursuit-rotor did not occur. It is of interest to note that although significance was found chiefly in the paired associates task, the high group on all three tasks in both studies was superior in terms of faster learning time or shorter learning period. A finding of six differences out of six in the same direction in favor of the high group is significant at the .016 level at one tail. This latter finding may

TABLE VII

SEPARATE AND COMBINED PROBABILITIES (FISHER'S METHOD, 12, 18)
OF t-TESTS BETWEEN MEANS OF EXPERIMENTAL GROUPS

All Twenty t-Tests are in Direction of
H Group Being Superior

Task	Measure	Experiment I		Experiment II		Combined
		<u>t</u>	P (two)	<u>t</u>	P (one)	P (one)
PURSUIT- ROTOR	last third	1.27	.23	.36	.37	.10
	middle third	.40	.70	.03	.48	.25
	first third	.32	.77	.77	.24	.25
PAIRED ASSOCIATES	criterion trial	2.02	.07	2.07	.05	.01
	last third	2.33	.04	2.06	.05	.005
	middle third	1.91	.08	1.86	.06	.01
	first third	1.06	.33	1.99	.05	.025
CROSS PUZZLE	last third	.84	.44	1.38	.12	.10
	middle third	.73	.50	1.56	.09	.10
	first third	1.58	.14	1.19	.14	.05

suggest that there is some relationship between the selector task used in this study and some other measure which consistently though not always significantly differentiates the two experimental groups.

The hypothesis that the high group would make a higher percentage of correct associations out of their total associations on the paired associates task was tested. A paired t-test in the first experiment yielded a probability of .04 in favor of the high group but the results of Experiment II not only did not confirm such significance but, in fact, reversed the direction. A probability of less than .70 in favor of the low group occurred in Experiment II. This reversal of direction in the second experiment is enough to seriously question if not disregard the finding suggested in Experiment I.

There was some overlap among Ss in the two groups of both experiments. This occurred on both variability and means of "thirds" of performance. Although the presence of an individual with an exceptionally high score on a particular task would tend to affect the group's mean on each trial of the task, it was, nevertheless, decided to depict the performances of the two groups on each task in terms of the mean of each group's scores on each trial. The resulting curves for Experiment I are presented in Figures 2, 3, and 4. Inspection of these curves reveals very little difference between the two groups on the pursuit-rotor task although there is a slight separation in the last three trials which most probably is a chance occurrence. The small effects obtained are in line with the stated expectancy.

The curves of the groups of Experiment I on the paired associates

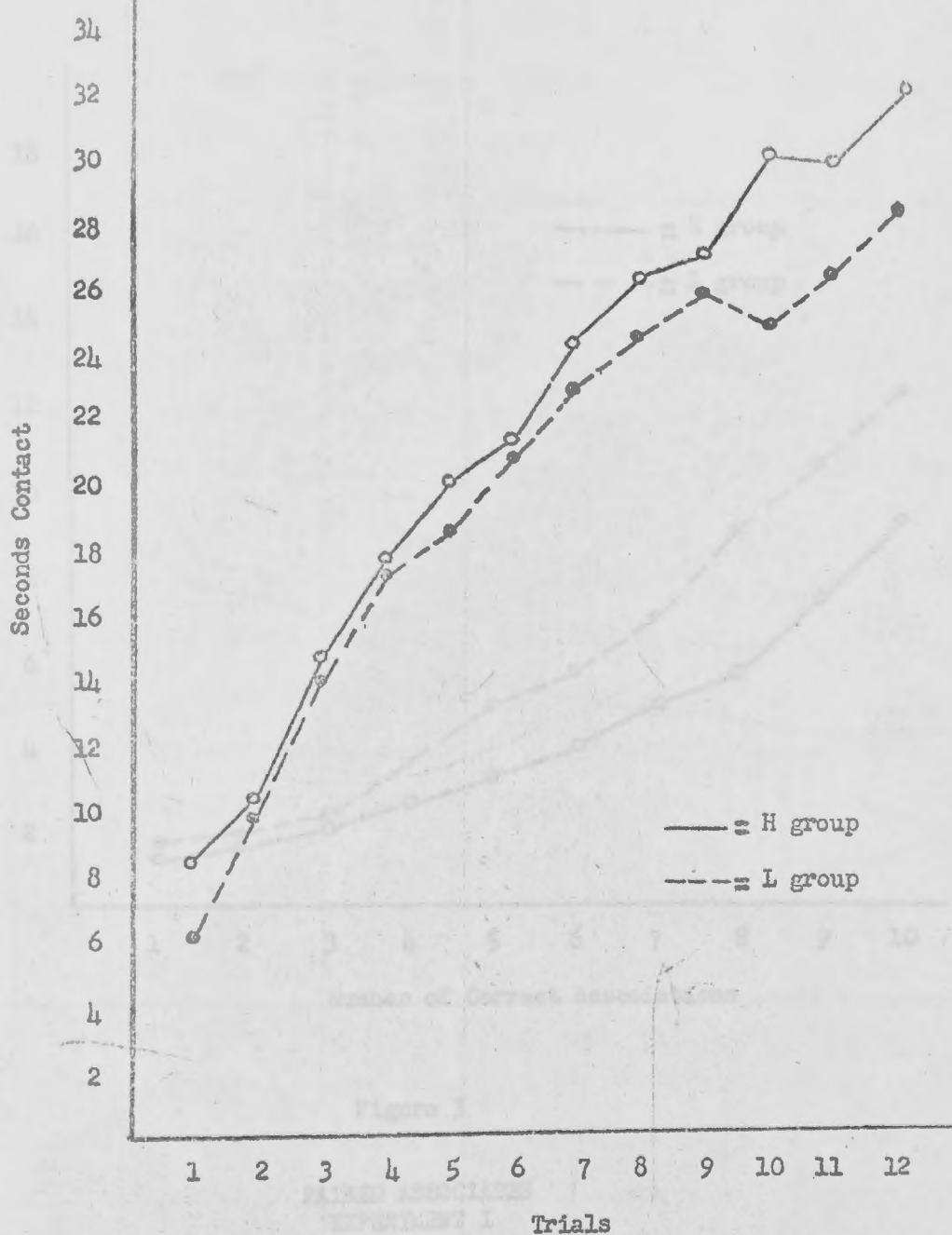


Figure 2

PURSUIT-ROTOR
EXPERIMENT I

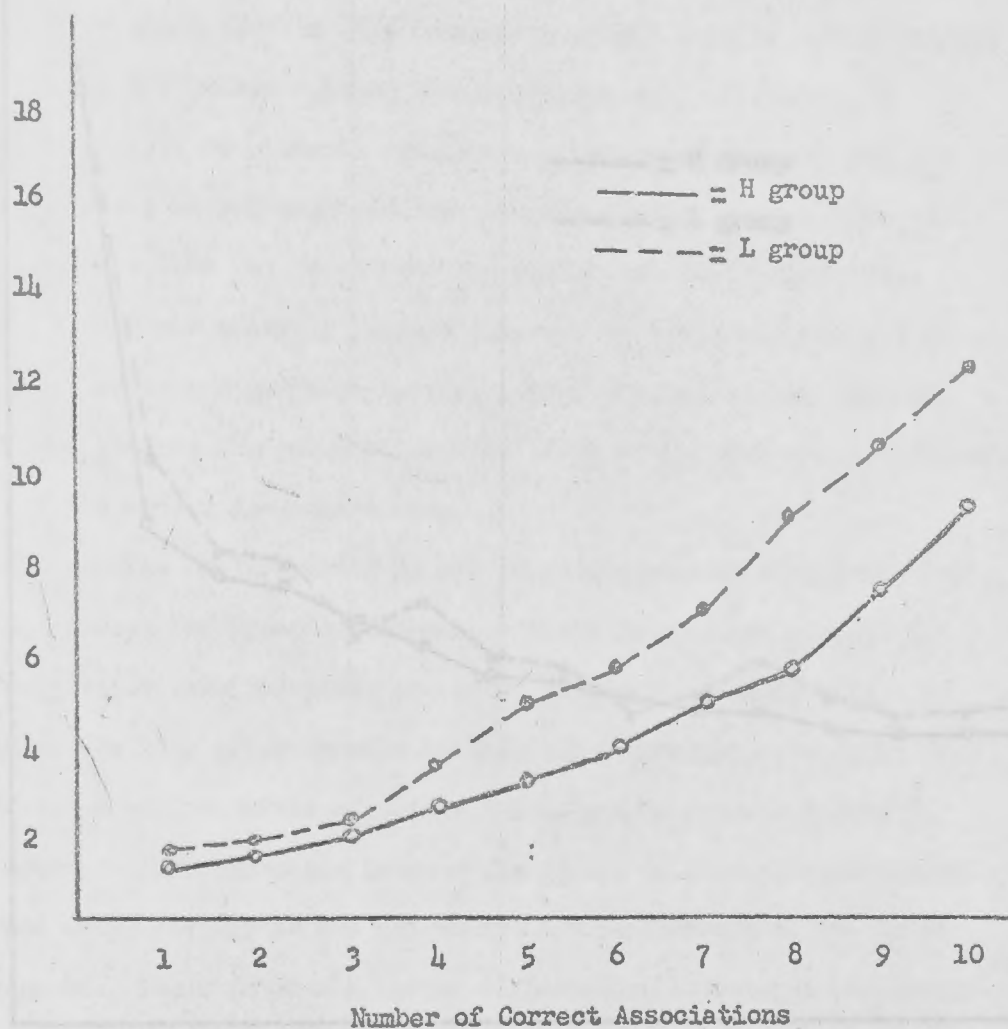


Figure 3

PAIRED ASSOCIATES
EXPERIMENT I

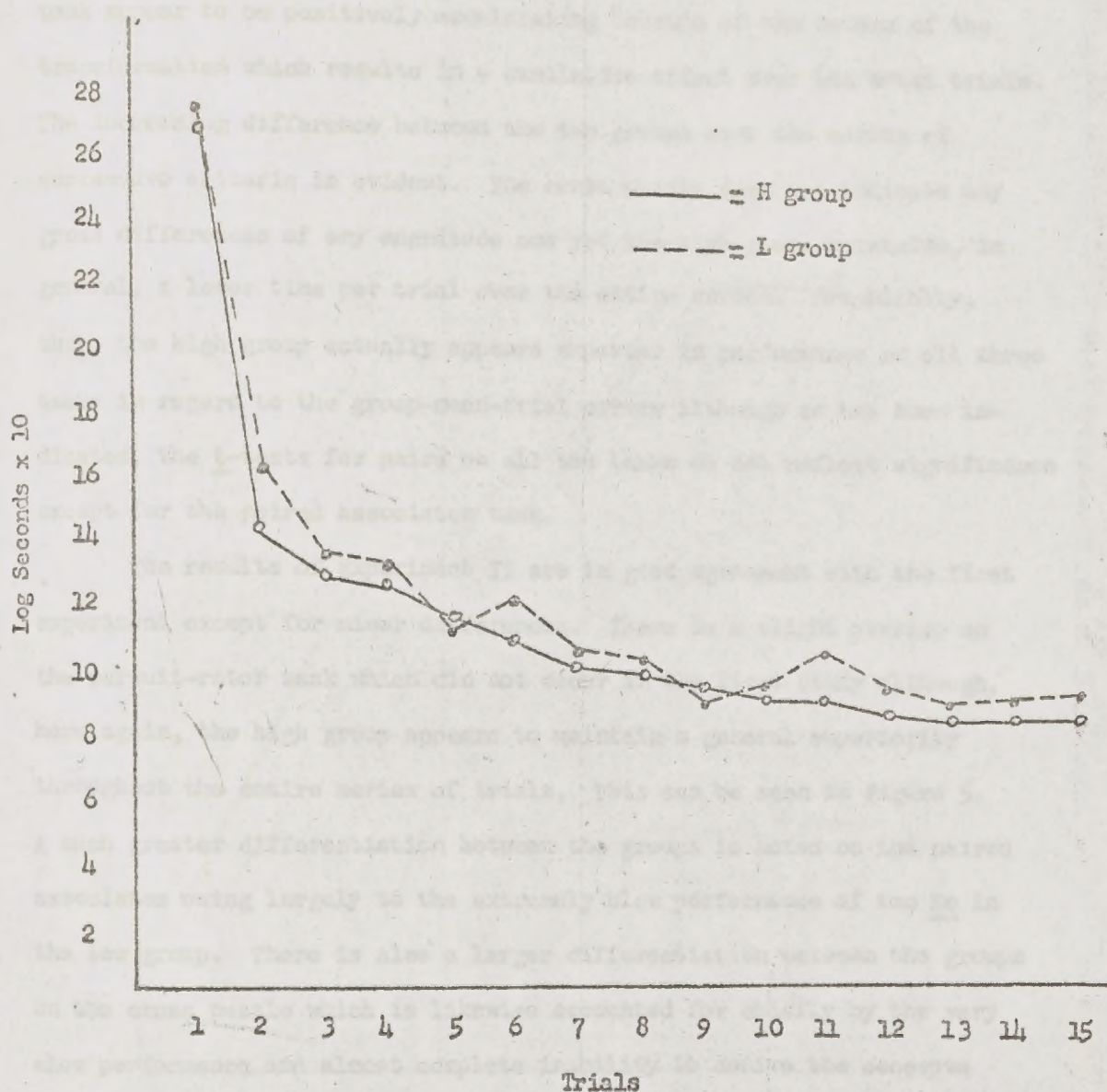


Figure 4

CROSS PUZZLE EXPERIMENT I

task appear to be positively accelerating because of the nature of the transformation which results in a cumulative effect over the total trials. The increasing difference between the two groups over the series of successive criteria is evident. The cross puzzle does not indicate any gross differences of any magnitude and yet the high group maintains, in general, a lower time per trial over the entire series. Graphically, then, the high group actually appears superior in performance on all three tasks in regard to the group-mean-trial curves although as has been indicated, the t-tests for pairs on all the tasks do not reflect significance except for the paired associates task.

The results of Experiment II are in good agreement with the first experiment except for minor differences. There is a slight overlap on the pursuit-rotor task which did not occur in the first study although, here again, the high group appears to maintain a general superiority throughout the entire series of trials. This can be seen in Figure 5. A much greater differentiation between the groups is noted on the paired associates owing largely to the extremely slow performance of two Ss in the low group. There is also a larger differentiation between the groups on the cross puzzle which is likewise accounted for chiefly by the very slow performance and almost complete inability to derive the concepts necessary for fast solution by one of the Ss in the low group. These results are shown in Figures 6 and 7. It might be argued that the differences between the two groups occurred because of one or two exceptionally slow performers in the low group and were simply sampling errors. If such were the case, we would expect as great a likelihood that

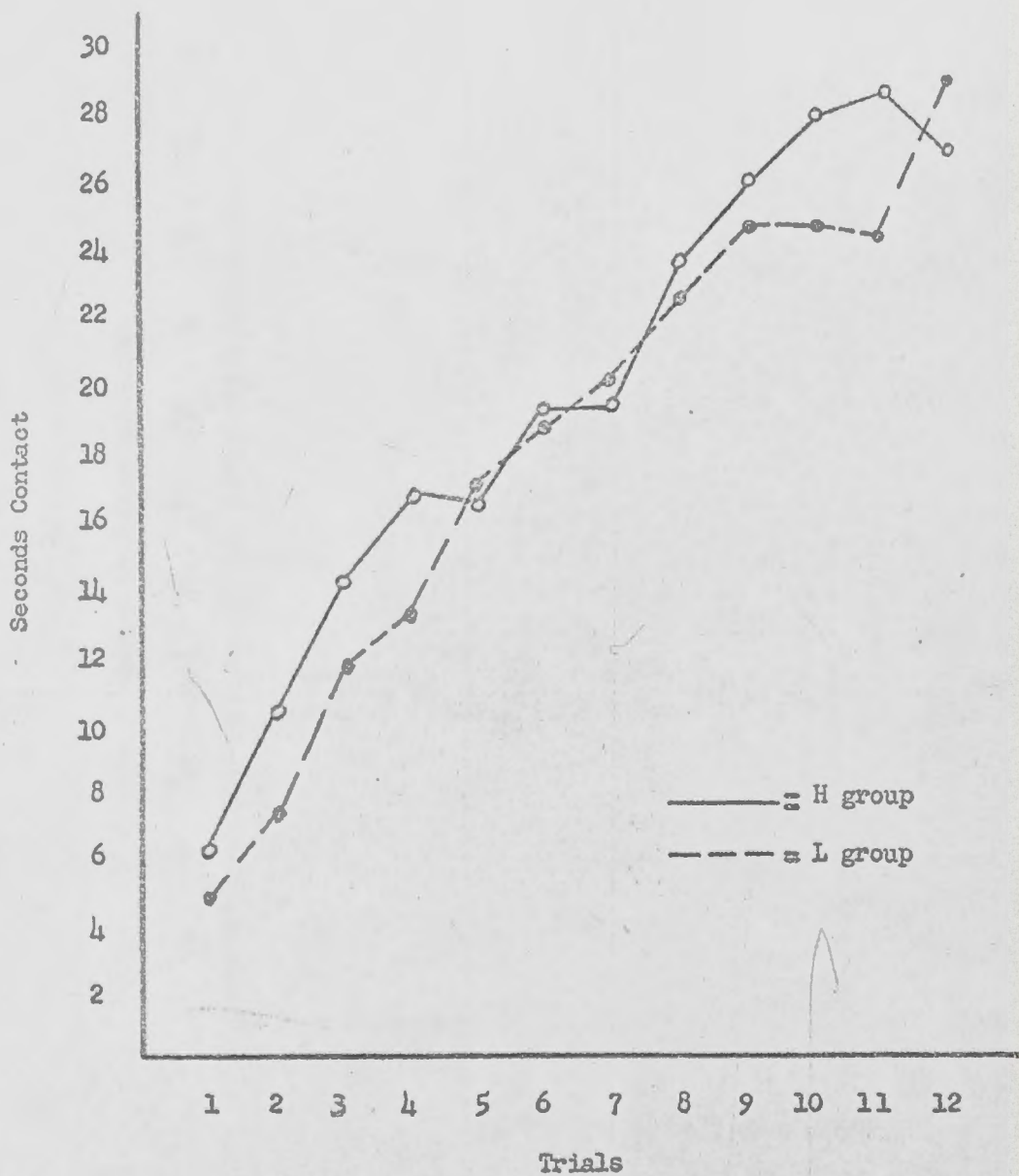


Figure 5

PURSUIT-ROTOR
EXPERIMENT II

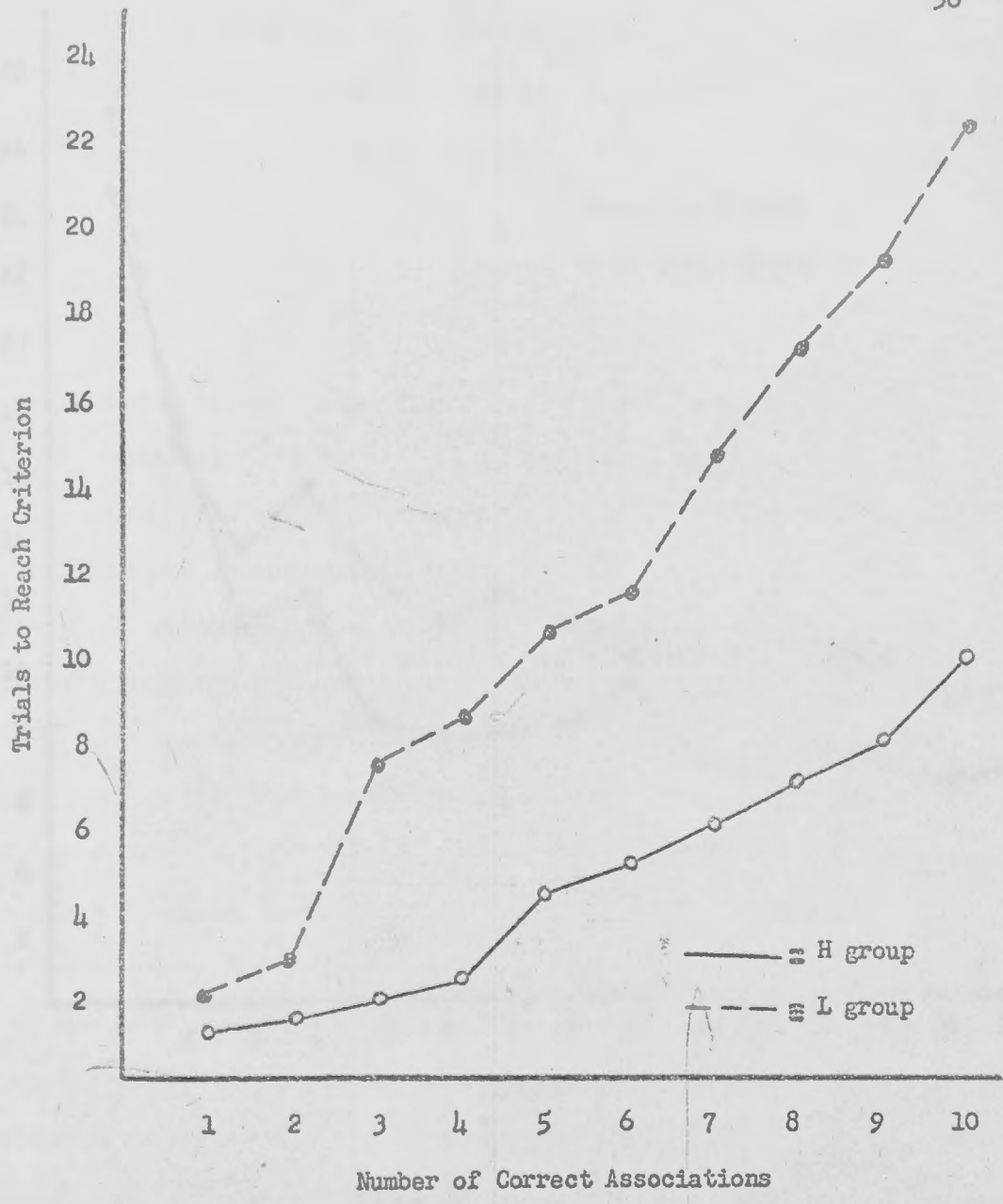


Figure 6

PAIRED ASSOCIATES
EXPERIMENT II

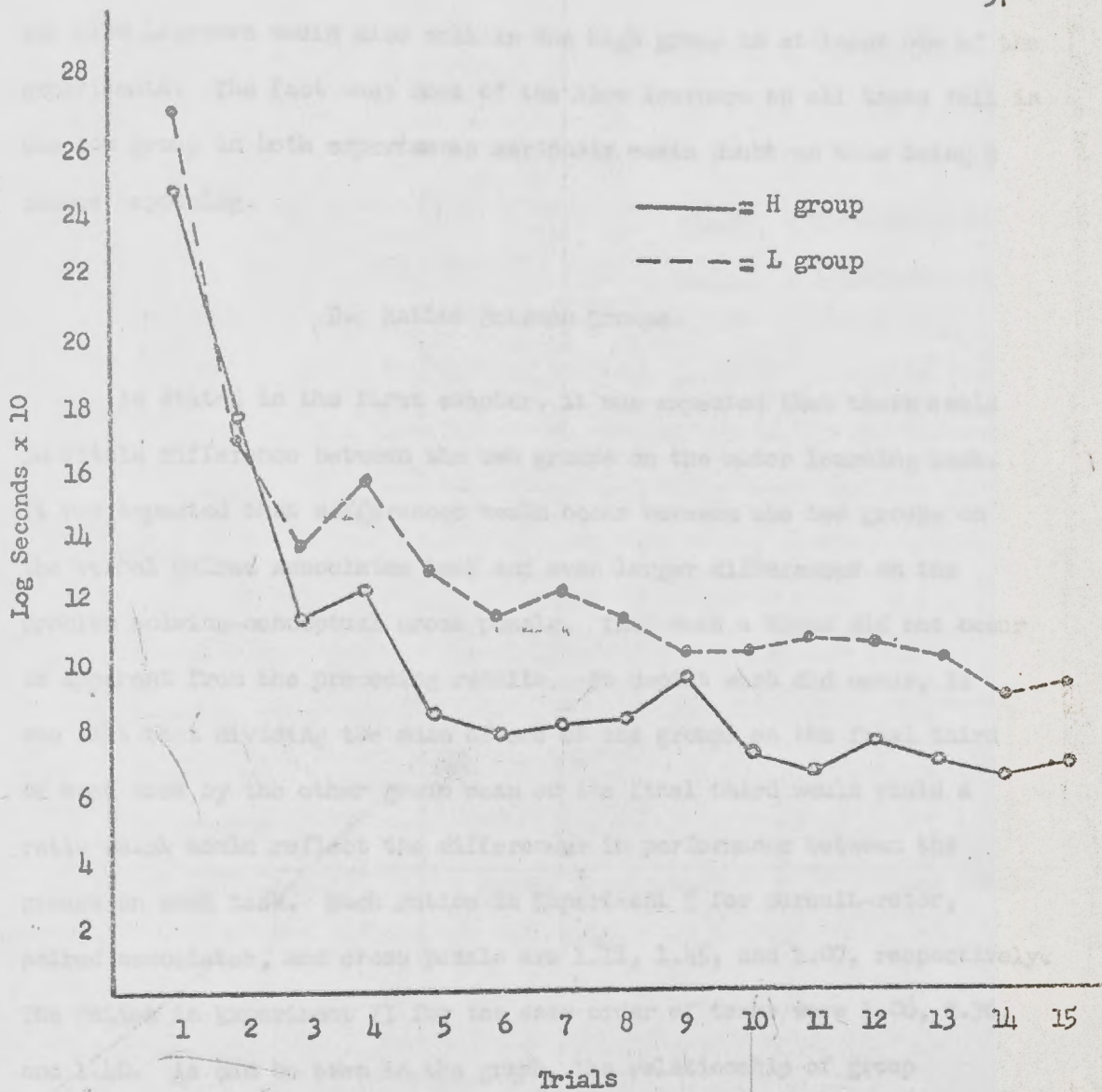


Figure 7

CROSS PUZZLE
EXPERIMENT II

the slow learners would also fall in the high group in at least one of the experiments. The fact that most of the slow learners on all tasks fell in the low group in both experiments seriously casts doubt on this being a chance happening.

D. Ratios Between Groups

As stated in the first chapter, it was expected that there would be little difference between the two groups on the motor learning task. It was expected that differences would occur between the two groups on the verbal paired associates task and even larger differences on the problem solving-conceptual cross puzzle. That such a trend did not occur is apparent from the preceding results. To depict what did occur, it was felt that dividing the mean of one of the groups on the final third of each task by the other group mean on the final third would yield a ratio which would reflect the differences in performance between the groups on each task. Such ratios in Experiment I for pursuit-rotor, paired associates, and cross puzzle are 1.11, 1.45, and 1.07, respectively. The ratios in Experiment II for the same order of tasks were 1.06, 2.36, and 1.40. As can be seen in the graph, the relationship of group performance differences on the final third ratios of each task is parabolic rather than increasing. The differences between the groups on pursuit-rotor and cross puzzle in each experiment tend to approximate each other while performance on the paired associates produces the maximum differentiation. The findings of the second experiment again indicate

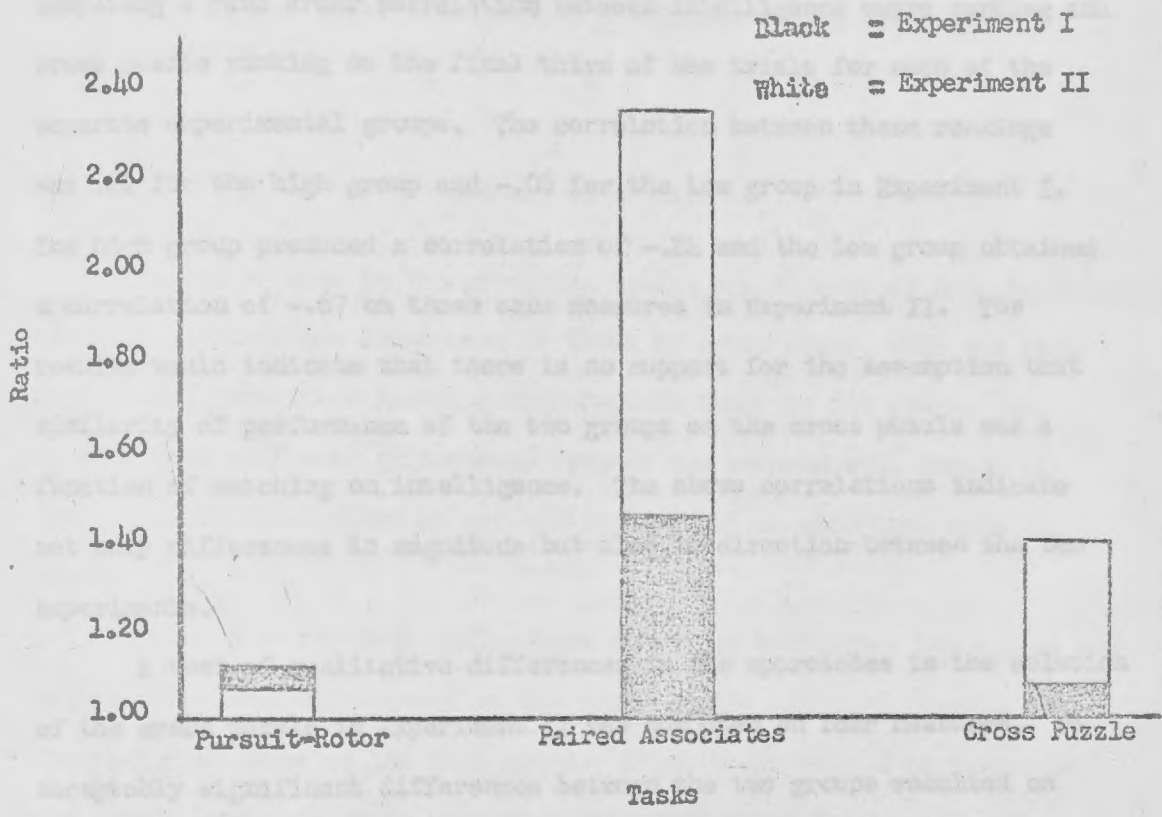


Figure 8

BETWEEN-GROUP RATIOS OF TASKS
EXPERIMENTS I AND II

this parabolic relationship in even greater degree than does Experiment I.

The hypothesis that the similarity of performance of the two groups on the cross puzzle resulted from matching on intelligence was tested by computing a rank order correlation between intelligence score ranking and cross puzzle ranking on the final third of the trials for each of the separate experimental groups. The correlation between these rankings was .22 for the high group and $-.08$ for the low group in Experiment I. The high group produced a correlation of $-.24$ and the low group obtained a correlation of $-.67$ on these same measures in Experiment II. The results would indicate that there is no support for the assumption that similarity of performance of the two groups on the cross puzzle was a function of matching on intelligence. The above correlations indicate not only differences in magnitude but also in direction between the two experiments.

A test of qualitative differences in the approaches to the solution of the cross puzzle in Experiment II was computed on four measures. No acceptably significant differences between the two groups resulted on the rigid-loose dimension. A t-test for matched pairs on the whole-parts dimension yielded a t of 3.80, $P .013$, in favor of the high group using a more "whole" approach. The same test yielded a t of 3.14, $P .025$, in favor of the high group being more "efficient" in their approach to solution of the task. Finally, the high group tended to use a more conceptual rather than a trial-and-error approach on the task with a t of 2.97, $P .03$. All the probabilities are for two tails. Although these t tests were computed on only the six pairs of Experiment II, they suggest

that there may be qualitative differences in performance on the cross puzzle task even though no quantitative differences of high significance occurred. The significant ratings made by the examiner when he had no knowledge as to which experimental group a particular S belonged strengthens this possibility.

E. Summary of Results

As can be seen in the preceding tables and figures of both experiments, the major differences found were in terms of group means, with the high Gottschaldt performers learning more rapidly than the low group. No acceptably significant differences between the experimental groups in terms of individual slope or variability ranking on each task were obtained.

While only the mean differences on paired associates had a P of .05 or less, the mean differences on the cross puzzle and pursuit-rotor were invariably in favor of the high group. Since there were altogether six such comparisons, it would seem that this difference is probably not ascribable to chance ($P = .016$, one tail).

On paired associates in both experiments, only three Ss out of twenty-one in the low group were superior to their high partner (P less than .01).

CHAPTER IV

DISCUSSION AND CONCLUSIONS

As was seen in the previous chapter, the perceptual selector device used in this study is not associated with different learning curve slopes. There are, likewise, no highly significant differences in variability either between the experimental groups or in the consistency of an individual's variability across the three tasks.

The major findings of the two experiments in this study lie in the shorter learning trials required for the high Gottschaldt group on the three learning tasks, the consistency with which high Ss exceeded their low partners, and the parabolic relationship of the group mean ratios on the three learning tasks. This latter finding is contrary to the pre-experimental expectation as it will be recalled that an increasing differentiation between the experimental groups was expected throughout the range of learning tasks--motor, paired associates, and problem solving, respectively.

The lack of a significant difference between the high and low groups on the pursuit-rotor task is not surprising as there is little in the literature or on the basis of a priori assumptions which would suggest that this kind of motor performance would be different for individuals who perform differently on perceptual Gestalt designs. A difference between the experimental groups on the problem solving task was expected largely on the assumption that this task involved analytical reasoning, conceptualization, and integration, factors which the literature had suggested were correlated

with high performance on the perceptual selector device employed in this study.

In actuality, the groups not only did not draw farther apart on the cross puzzle than they did on the paired associates task, their performance closely resembled that found on the pursuit-rotor. The results yielded, therefore, a parabolic relationship on relative differences on the three tasks as it was graphically presented in the previous chapter. Another suggestive finding from both experiments is the consistent slight-to-large superiority of the high group over the low group in group-mean-trial differences on all tasks. This superiority was in favor of the high group in six out of six comparisons.

The lack of more significant differences between the high and low groups on the cross puzzle warrants an analysis. There are numerous studies in the literature which purport to show relationships between performance on the perceptual task used in this study and various personality attributes, reasoning ability, analytic ability, and theoretical activity (3, 11, 15, 22, 25, 26, 33, 34, 40, 43). It will be recalled that the two groups were matched extremely closely on intelligence obtained from a test which is quite verbal in nature and requires a considerable amount of problem solving ability.

McGeoch (36), Thorndike (42), Thurstone (12), and many others have noted the relationship between problem solving and intelligence. Thurstone, for example, has noted that intelligence and reasoning ability have heavy loadings on a common factor. It will also be recalled that the reasoning factor has been found to disappear into Spearman's g factor with a high

loading. In view of this, the implication is that the similarity of results in both groups on the problem solving task may be reflecting this matching on intelligence. However, it should be noted that the rank order correlations between intelligence and cross puzzle for each separate experimental group in both experiments were low. Not only were all correlations low but the directions were also different in each experiment. In addition, the range of intelligence scores in the experimental groups was wide and closely approximated the distribution of the population from which the groups were drawn.

Thus, we are left with the conclusion that psychometric intelligence is not related to performance on the cross puzzle. Such a conclusion is contrary to the findings of previous workers. This suggests that either previous studies have used problem solving or conceptual tasks which measure different abilities than does the task used in this study or an individual's particular preference for reasoning and analytical activities does not greatly reflect his superior ability of performance on such tasks. At any rate, the present study did not produce highly significant differences between the perceptual groups performances on such a problem solving task when they had been matched on psychometric intelligence. Furthermore, the inconsistent and low correlations between performance and intelligence do not enable us to state that matching on intelligence produced the similarity of performance between the experimental groups.

The significant difference between the two groups on learning of the paired associates implies that the perceptual selector device is related in some manner to this type of learning. However, consideration

should be given to the fact that even though order effects were not noted in a pilot study, the method of presentation in both experiments utilized the paired associates task first, the pursuit-rotor second, and the cross puzzle at a later test session, third. If the presentation of the first task differentiated the groups and later tasks reflected test-attitude learning (practice effects of general learning attitudes) which spread from the first through the last task, the effect might produce results similar to the differences obtained in this study. While this may be a possibility, it does not appear to detract from the finding of differences between the groups on paired associates. Instead, it would tend to mask differences between the groups on the other tasks by making them more alike.

It will be recalled that a rating scale of approach to solution of the cross puzzle was established for Experiment II to test whether the examiner could ascertain qualitative differences in performance when he did not know to which group a particular S belonged. As noted in the preceding chapter, significant differences in qualitative performance on this task resulted from such ratings. These significant qualitative differences are obtained even when the performance-time criteria do not differentiate the groups at an acceptable level of significance.

Briefly, the high group appears to solve the task more efficiently, with a "whole" approach as contrasted to a "parts" approach, and with a more conceptual approach than "trail and error." There were no differences between the groups on their ratings of being "rigid" or "loose" in choice of solution pattern although all Ss tended to continue using a pattern with which they achieved initial success on solution. This pattern varied

considerably from S to S with some individuals persisting in a somewhat inefficient or "awkward" approach with which they had initially succeeded on the task even though another pattern might be faster or more efficient. This suggests that there may be qualitative differences between the experimental groups on the cross puzzle task which is not evidenced in the quantitative solution criteria.

It is tempting to conclude that performance on the perceptual tasks used in this study differentiates individuals with different memory abilities, particularly of an immediate recall or rote type. Wolfe (45, p. 31) in a review of factor analysis to 1940 lists memory as the fourth most frequently reported factor and states that it is best tested by paired association or recognition tests of recently learned material. He expresses the feeling that the factor might best be named rote learning or immediate memory.

The perceptual factor involved in the Gottschaldt task has been discussed at length in Chapter I and nothing in the literature has suggested either a common loading of this perceptual task and memory tasks with each other or on another common factor. To the contrary, the Gottschaldt is related to separate perceptual factors which Thurstone has named perceptual speed and flexibility of closure both of which he identified in tests which involve "a facility in perceiving detail that is imbedded in irrelevant material (45, p. 32)." Perhaps the relationship between such a perceptual factor (which is loaded heavily by the task used in this study) and an immediate memory factor is best understood in terms of discriminability as pointed out by Gibson & Gibson (17). The

latter authors feel that the ability to differentiate stimuli is basic to perceptual learning and that instead of past experience enriching an accurate percept, what is really acquired with practice is increased differentiation of the perceptual stimuli.

Possibly it was the ability of the high group to clearly differentiate the Gestalts of the imbedded figures from the irrelevant material which is also being reflected in the "differentiation" of certain paired associates (correct) from other possible associations (incorrect). Thus, faster differentiation of the correct pairs led to the shorter numbers of trials in the high group and might be akin to the larger number of "seen" imbedded figures.

It is reasonable to draw such a conclusion except that one might expect such "speedy" differentiation by the high group might also produce faster learning performance on the cross puzzle. While the high group was superior to the low group on this task in both experiments, they did not differentiate to the same magnitude as occurred on the paired associates. Nevertheless, the memory factor can hardly be excluded from either of these tasks, particularly the paired associates, and it is strongly suggested that perceptual performance on the task used in this study is in some way related to immediate memory.

The overall results suggest that the perceptual device used in this study will differentiate two groups of individuals who display different rates of learning. This is most apparent in learning which requires immediate memory but is also suggested in tasks involving motor patterns and problem solving abilities with the high perceptual performers

also being superior on all learning tasks. The degree of differentiation between the two experimental groups varies with the type of learning task and does not appear to be a "huge" effect even in the task which resulted in the most significant differentiation. However, the consistency of this effect cannot be ignored and indicates that at least some type of perceptual (and possibly personality) factor is accounting for differences in learning rates when sex, age, and psychometric intelligence are controlled.

The results, then, appear to support the original intent of this study, *viz.*, to investigate possible sources of individual differences in learning when sex, age, and intelligence were controlled. The demonstration of differences between the two groups when these factors are controlled is enough to warrant consideration of perceptual and/or personality differences as sources of individual differences in learning. That performance on the perceptual task used in this study is not the only nor even major source of individual differences is readily attested to by the fact that with sex, age, and intelligence controlled and the experimental groups divided into high and low performers, considerable individual differences and reversals of effect were noticeable on all tasks.

In general, the magnitude of effect in this study suggests that

(1) the effect of perceptual differences on learning used in this study is rather limited, or (2) the perceptual task used in this study is itself correlated moderately with some other more differentiating measure, thus producing consistent (though not large) differences and significances between the groups.

IMPLICATIONS FOR FUTURE RESEARCH

Relative little work has been done in determining the sources of variability in human learning. It is well known that individual differences--intra-individual and inter-individual--are the major sources of such variability. Even the areas of sex, mental abilities, and age have received little consideration in the last decade.

With the rapid rise of applied psychology, individual prediction has become a matter of pressing necessity. In a hospital or clinic setting, for example, a "correct" diagnosis or prediction even as high as eighty per cent still leaves much to be desired. Prediction of an individual's learning or behavior from a group mean is only as "good" as the regimen of that mean. The complexity of human behavior presents a challenge to dormant typological psychology. If refinement of prediction can be abetted by discovering particular traits which affect learning then individual differences as uncontrolled variables will be lessened and individual prediction will be enhanced. While factor analytic studies are the major approaches attempting to clarify this area, there are many functional-type experiments which could aid in this task. The present study was an attempt in this direction.

Among the many factors which remain to be studied as sources of variability in human learning are personality traits, conceptual abilities, memory abilities, etc. A particular perceptual task was employed in this study although the literature has inconclusively suggested that performance on this task is also related to personality traits. A major question which should be undertaken is that of determining differences, if any, in learning

ability among individuals separated on certain personality attributes. Hysterical versus compulsive attributes offer one source of division. Clinical experience readily verifies the fact that individuals of the same age, sex, and psychometric intelligence often respond with widely different degrees of time in regard to therapeutic learning. Differences in personality structure as a source of this disparity in therapeutic learning immediately suggests the experimental variable.

An equally interesting hypothesis which might be tested is the relationship of performance in laboratory learning tasks with therapeutic learning performance. Individuals would be matched on sex, age, and intelligence and the speed of therapeutic learning compared to the speed of learning laboratory tasks. Such laboratory tasks would encompass the area of which therapeutic learning is chiefly composed, i.e., verbal, conceptual, symbolic, and abstract.

SUMMARY

The present study was an attempt to discover a possible source of variability in human learning when the factors of age, sex, and psychometric intelligence were controlled. The populations from which experimental groups were drawn were male undergraduates in a general psychology class. One hundred and thirty-six males composed the population of Experiment I from which fifteen matched pairs were drawn. Six matched pairs were drawn from a population of sixty-two males in the replication, Experiment II. The pairs in both experiments were matched on the three

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factors mentioned above. The populations and experimental groups in both experiments were similar. Group intelligence and perceptual tests were administered to the populations.

The experimental subjects were selected from the highest and lowest performers on the perceptual device and only those Ss in the high group who could be matched on psychometric intelligence and age with corresponding Ss in the low group were used. All experimental Ss were then required to serve in the experiment and individually administered three learning tasks in two one-hour sessions. These tasks were: pursuit-rotor, paired associates, and a problem solving cross puzzle.

No acceptably significant differences in individual learning curve slopes or individual task-to-task variability were obtained between the experimental groups. Major differences in terms of group means were found with the high Gottschaldt performers learning more rapidly than the low group. While only the mean differences on paired associates had a P of .05 or less, the mean differences on the cross puzzle and pursuit-rotor in both experiments were in favor of the high group. Since there were altogether six such comparisons, yielding differences favoring the high group, it would seem that this difference is probably not ascribable to chance.

It was concluded that perceptual performance as reflected by the Gottschaldt figures is one source of individual differences (and, thus, group variability) in human learning when the factors of sex, age, and psychometric intelligence are controlled.

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APPENDICES

INSTRUCTIONS FOR STUDENT TASKS

Today we are conducting an experiment in which we will use only the girls in the class who are excused for this class period. All of you have parallel? If not, please ask one of us for one when you get the material. You are now having some materials passed out to you which I want you to place on your desk with the class information sheet on top. Please do not go through any of the material until I give you directions for each part. Some of these items which you are going to perform will be used in any way in regard to grades, tests, or school performance. So just ask that you do your best on them. If at any time you have a question, please raise your hand and one of us will come to you to answer it.

Fill out the first sheet which asks for your name, age, class (high, jr., etc.) college (liberal arts, etc.), major, the date 1955 and section . . . Please do not write your name on any of the other materials. Now, slip the sheet you have filled out, out of the clip and place it under your seat. You now have a small booklet in front of you. Do not turn it over until I tell you to do so. Keep them face down until I tell you to turn them over.

Instructions for Group in Worksheet

APPENDIX A

(After 195 and Silverstein)

On these sheets you will find two figures at the top of each page and your other, more complicated ones, down below. You are asked to find one of the two simple figures from the top of each of the pages, more complex figures. This means that each complicated figure contains only one of the two simple figures. Outline the simple figure in each of the complicated ones. (A pale example of figure and solution on board). Here is an example worked out on the board. Here all the simple figure marked out on the more complex one. The same instructions that I have just read to you are found at the top of each page. We want you to work as fast as possible. Don't spend too much time with any one. Then you select only. Work on each page until we tell you to stop. If you finish a page before I give you the signal, do not go on to the next page. Do as early as you can and raise your hand if you have any questions. Now turn your booklet over and go ahead. (I allow for 3 minutes on the first page and 4 minutes on the other two pages).

Stop! Please place the booklet under your seat. That was a rather difficult task and so one was expected to finish all of it.

INSTRUCTIONS FOR SELECTOR TASKS

Today we are conducting an experiment in which we will use males only; the girls in the class may be excused for this class period. Do all of you have pencils? If not, please ask one of us for one when you get the material. You are now having some materials passed out to you which I want you to place on your desk with the blue information sheet on top. Please do not go through any of the material until I give you directions for each part. None of these tasks which you are going to perform will be used in any way in regard to grades, tests, or school performance. We just ask that you do your best on them. If at any time you have a question, please raise your hand and one of us will come to you to answer it.

Fill out the first sheet which asks for your name, age, class (soph., jr., etc.) college (liberal arts, etc.), major, the date 1955 and section _____. Please do not write your name on any of the other materials. Now, slip the sheet you have filled out, out of the clip and place it under your seat. You now have a small booklet in front of you. Do not turn it over until I tell you to do so. Keep them face down until I tell you to turn them over.

Instructions for Group Gottschaldt
Figures Administration

(After May and Silverstein)

On these sheets you will find two figures at the top of each page and some other, more complicated ones, down below. You are asked to find one of the two simple figures from the top in each of the lower, more complex figures. This means that each complicated figure contains only one of the two simple figures. Outline the simple figure in each of the complicated ones. (E. puts example of figure and solution on board). Here is an example worked out on the board. Here is the simple figure marked out in the more complex one. The same instructions that I have just read to you are found at the top of each page. We want you to work as fast as possible. Don't spend too much time with any one item you cannot solve. Work on each page until we tell you to stop. If you finish a page before I give you the signal, do not go on to the next page. Do as many as you can and raise your hand if you have any questions. Now turn your booklet over and go ahead. (E. allows 3 minutes on the first page and 4 minutes on the other two pages).

Stop! Please place the booklet under your seats. That was a rather difficult task and no one was expected to finish all of it.

You now have before you a larger booklet entitled Personnel Test. Read with me as I read the directions on the front. Do not open it until I say begin.

Instructions for Wonderlic Personnel Test,
Form A Administration

This is a test of problem solving ability. It contains various types of questions. This test contains 50 questions. It is unlikely that you will finish all of them, but do your best. After the examiner tells you to begin, you will be given exactly 12 minutes to work as many as you can. Do not go so fast that you make mistakes since you must try to get as many right as possible. The questions become increasingly difficult, so do not skip about. Do not spend too much time on any one problem. The examiner will not answer any questions after the test begins. Ready? Begin.

Stop! Please place the booklet under your seats.

You now have two sheets of paper before you with a set of cards which are clipped together underneath them. Lay the cards on the desk where you can see this design (show on board) on it. Unclip the cards and lay the clip aside.

Instructions for Group Bender-Gestalt Administration

(After May and Silverstein)

You have before you on your armrest a series of designs. Copy them one after another on one of the sheets of paper as best you can. Hold your paper this way (E. holds up a blank sheet of paper in prescribed manner). Do not turn the designs sideways or upside down, but copy them as they are. The circle should be at the left on the first design. You have about 12 minutes to copy all the designs. Begin now. (After 10 minutes, E. informs the Ss that they have two more minutes to finish the task).

Stop! Please clip the cards back together with paperclip in the proper order (E. shows). Now please take the material from under your seat and clip it together including the design cards just as you received it with the information sheet on top. Thank you. Leave the material on your desk. Thank you.

TABLE VIII

SELECTION DATA FOR HIGH AND LOW
GROUPS OF PARTHENS I

High					Low				
Age	Class	Wt.	Color		Age	Class	Wt.	Color	
136	19	104	23	21	137	18	7	25	8
137	19	80	31	22	138	19	4	30	1
138	20	5	40	24	139	19	7	10	1
139	20	5	32	25	140	20	1	30	3
140	21	44	30	26	141	21	22	22	5
Y	20.2		32.2	24.1		21.2		31.2	2.2
142	20	50	26	23	142	21	22	27	5
143	20	5	26	23	143	20	20	25	6
144	20	40	23	22	144	20	20	23	7
145	20	40	27	22	145	20	20	27	7
146	21	40	30	23	146	20	7	30	8
Y	22.0		27.6	21.5		20.0		26.6	6.6
147	20	8	26	22	147	19	1	28	9
148	20	7	30	24	148	20	1	30	10
149	20	7	34	22	149	20	7	34	10
150	20	5	32	19	150	20	1	32	11
Y	21.2		30	19	151	18		30	11
Y	21.6		30.8	20.1		20.6		31.2	10.7

APPENDIX B

TABLE VIII

SELECTION DATA FOR HIGH AND LOW
GROUPS OF EXPERIMENT I

High					Low				
S	Age	Class	Won.	Gott.	S	Age	Class	Won.	Gott.
136	19	So.	28	21	83	18	F	28	0
3	19	So.	31	225	36	20	J	30	1
71	20	J	40	24	40	26	F	40	2
66	20	J	32	26	6	20	J	32	3
106	23	So.	30	26	11	22	So.	29	5
$\bar{X}$	20.2		32.2	24.4		21.2		31.8	2.2
79	20	So.	26	23	26	21	So.	27	5
46	19	J	26	23	85	18	So.	26	6
123	25	So.	23	21	27	20	So.	23	7
4	25	Sr.	27	24	33	18	So.	27	7
117	21	Sr.	31	23	69	23	F	30	8
$\bar{X}$	22.0		26.6	22.8		20.0		26.6	6.6
104	26	F	28	22	54	19	J	28	9
53	24	F	30	20	61	20	J	30	10
113	22	F	34	22	96	26	F	34	10
56	20	J	32	19	91	20	J	33	11
9	21	F	30	19	125	18	F	30	11
$\bar{X}$	22.6		30.8	20.4		20.6		31.0	10.2

TABLE IX

SELECTION DATA FOR HIGH AND LOW
GROUPS OF EXPERIMENT II

High					Low				
S	Age	Class	Won.	Gott.	S	Age	Class	Won.	Gott.
148	20	J	33	27	183	19	F	33	9
197	19	F	33	24	198	18	F	33	2
156	19	So.	32	23	157	20	So.	31	7
166	21	J	29	21	155	30	Sr.	30	6
139	19	So.	27	22	179	23	F	28	6
182	21	So.	26	24	153	27	J	26	6
$\bar{X}$	19.8		30.00	23.5		22.8		30.16	6

TABLE IX

SELECTION DATA FOR HIGH AND LOW
GROUPS OF EXPERIMENT II

High					Low				
<u>S</u>	Age	Class	Won.	Cott.	<u>S</u>	Age	Class	Won.	Cott.
148	20.	J	33	27	183	19	F	33	9
197	19	F	33	24	198	18	F	33	2
156	19	So.	32	23	157	20	So.	31	7
166	21	J	29	21	155	30	Sr.	30	6
139	19	So.	27	22	179	23	F	28	6
182	21	So.	26	24	153	27	J	26	6
$\bar{X}$	19.8		30.00	23.5		22.8		30.16	6

TABLE X

INDIVIDUAL EQUATION CONSTANTS ON THE PURSUIT-ROTOR
 IN EXPERIMENT I: a IS THE VALUE OF y WHEN x IS
 0; b IS THE SLOPE OF THE CURVE; c IS THE
 AMOUNT OF POSITIVE OR NEGATIVE
 CURVATURE

High Group				Low Group			
<u>S</u>	<u>a</u>	<u>b</u>	<u>c</u>	<u>S</u>	<u>a</u>	<u>b</u>	<u>c</u>
3	1.00	2.71	-.013	36	3.27	.41	.113
71**				40*			
66	19.94	1.58	.016	6	1.80	3.69	-.163
106*				11**			
136	5.57	3.41	-.113	83	5.46	4.33	-.206
123	-4.68	4.64	-.116	27	7.19	2.13	.000
46	1.60	2.10	-.022	85	4.68	5.46	-.263
4	14.56	1.60	-.025	33	2.14	3.40	-.150
79	18.94	-1.18	.175	26	6.95	4.44	-.216
117	-4.19	4.51	-.109	69	1.77	5.50	-.275
104	9.62	6.60	-.322	54	-5.70	6.59	-.363
9	-4.34	4.79	-.166	125	5.92	5.06	-.188
53	-5.65	8.03	-.450	61	-.71	3.68	-.206
113*				96**			
56*				91**			
$\bar{X}$	4.76	3.74	-.117		2.98	4.06	-.174

* Previous practice on this task.

** Excluded, partner had previous practice.

TABLE XI

INDIVIDUAL EQUATION CONSTANTS ON THE PAIRED ASSOCIATES
 IN EXPERIMENT I: $\underline{a}$ IS THE VALUE OF $\underline{y}$ WHEN $\underline{x}$ IS
 0; $\underline{b}$ IS THE SLOPE OF THE CURVE; $\underline{c}$ IS THE
 AMOUNT OF POSITIVE OR NEGATIVE
 CURVATURE

High Group				Low Group			
<u>S</u>	<u>a</u>	<u>b</u>	<u>c</u>	<u>S</u>	<u>a</u>	<u>b</u>	<u>c</u>
3	2.16	-.92	.170	36	-2.50	1.97	-.028
71	-.52	.86	.048	40	.14	.14	.143
66	1.75	-.51	.068	6	1.07	-.07	.102
106	.02	.64	.007	11	.25	.76	.061
136	-.94	1.28	.014	83	1.84	-.65	.116
123	.21	1.64	-.041	27	-1.25	1.54	-.041
46	.43	.29	.000	85	-.33	.57	.048
4	.01	.47	.014	33	-.86	.91	.095
79	2.66	-1.18	.177	26	.37	.96	.177
117	1.29	-.43	.143	69	2.77	.13	.075
104	4.39	.18	.061	54	2.78	-.02	.149
9	.19	.40	.004	125	-1.29	1.38	-.034
53	1.96	-.92	.218	61	2.71	-.84	.163
113	1.33	-.33	.082	96	2.53	-1.14	.191
56	2.28	-.90	.129	91	2.01	.24	.048
$\bar{X}$	1.15	.04	.067		.68	.39	.084

TABLE XII

INDIVIDUAL EQUATION CONSTANTS ON THE CROSS PUZZLE
 IN EXPERIMENT I: a IS THE VALUE OF y WHEN x IS
 0; b IS THE SLOPE OF THE CURVE; c IS THE
 AMOUNT OF POSITIVE OR NEGATIVE
 CURVATURE

High Group				Low Group			
<u>S</u>	<u>a</u>	<u>b</u>	<u>c</u>	<u>S</u>	<u>a</u>	<u>b</u>	<u>c</u>
3	11.78	3.14	-.133	36	13.75	1.55	-.056
71	11.76	2.36	-.092	40	16.19	2.02	-.082
66	10.26	2.14	-.089	6	10.49	2.22	-.095
106	10.42	2.10	-.090	11	11.79	3.08	-.132
136	9.09	2.02	-.086	83	13.19	.95	-.028
123	12.12	3.20	-.134	27	12.09	3.13	-.148
46	10.63	.96	-.012	85	10.92	2.36	-.099
4	11.70	3.23	-.145	33	15.27	2.58	-.093
79	13.73	1.74	-.054	26	10.55	2.32	-.110
117	10.98	2.51	-.116	69	11.17	2.20	-.088
104	15.47	.60	.013	54	13.72	1.98	-.064
9	13.42	.85	-.025	125	10.79	2.05	-.088
53	15.54	1.83	-.078	61	11.32	2.48	-.106
113	11.18	2.92	-.134	96	12.93	2.73	-.111
56	10.02	2.39	-.104	91	13.56	1.97	-.080
$\bar{x}$	11.87	2.11	-.085		12.52	2.24	-.092

TABLE XIII

TRIAL-BY-TRIAL VARIABILITY OF HIGH AND LOW GROUPS
ON PURSUIT-ROTOR (P.R.), PAIRED ASSOCIATES
(P.A.), AND CROSS PUZZLE (C.P.) IN
EXPERIMENT I

High Group				Low Group			
S	P.R.	P.A.	C.P.	S	P.R.	P.A.	C.P.
3	34.13	1.67	5.12	36	9.90	3.89	2.63
71	**	2.44	3.18	40	*	2.89	29.68
66	14.54	.56	.79	6	10.44	2.00	5.21
106	*	1.44	1.24	11	**	4.78	2.10
136	13.64	2.22	.99	83	18.48	1.22	28.89
123	19.65	2.22	4.14	27	14.70	2.11	30.15
46	16.87	.44	10.34	85	9.19	1.78	2.17
4	12.38	.89	1.74	33	10.42	7.11	4.87
79	11.80	4.89	9.10	26	20.23	15.44	8.59
117	9.69	3.00	1.40	69	21.32	1.89	.65
104	12.7	2.67	16.69	54	26.43	5.11	7.01
9	15.3	5.11	24.60	125	7.67	2.00	1.68
53	33.3	12.11	17.68	61	6.10	2.56	1.43
113	*	1.56	.43	96	**	2.56	6.38
56	*	1.00	1.39	91	**	1.44	8.69

* Previous practice on task.

** Excluded, partner had previous practice.

TABLE XIV

TRIAL-BY-TRIAL VARIABILITY OF HIGH AND LOW GROUPS
ON PURSUIT-ROTOR (P.R.), PAIRED ASSOCIATES
(P.A.), AND CROSS PUZZLE (C.P.) IN
EXPERIMENT II

High Group				Low Group			
<u>S</u>	P.R.	P.A.	C.P.	<u>S</u>	P.R.	P.A.	C.P.
148	9.43	1.44	1.25	183	88.97	3.78	2.58
197	11.35	3.33	7.70	198	18.35	6.11	1.05
156	5.99	2.00	3.88	157	6.99	1.44	.92
166	14.89	.44	5.10	155	14.51	30.33	8.92
139	7.83	3.78	2.41	179	31.57	6.33	1.17
182	9.25	5.22	12.34	153	7.94	35.33	22.86

TABLE XV

MEANS OF THIRDS OF LEARNING TRIALS
ON PURSUIT-ROTOR IN EXPERIMENT I

Seconds on Target							
High Group				Low Group			
<u>S</u>	1	2	3	<u>S</u>	1	2	3
3	7.7	18.1	28.1	36	5.0	10.7	20.0
71**				40*			
66	24.0	30.9	38.5	6	9.9	18.8	22.5
106*				11**			
136	13.4	23.0	29.0	83	15.0	24.9	28.2
123	6.2	20.6	31.3	27	12.5	21.0	29.5
46	6.7	14.3	21.2	85	16.7	29.1	33.1
4	18.4	23.9	28.6	33	9.7	17.9	21.3
79	17.1	18.7	25.9	26	16.7	26.7	29.8
117	6.4	20.5	31.1	69	13.8	25.9	29.2
104	24.1	38.9	43.4	54	8.5	21.8	23.5
9	6.6	19.8	27.7	125	17.4	30.9	38.4
53	11.6	27.5	29.0	61	7.2	14.5	15.2
113*				96**			
56*				91**			
$\bar{X}$	12.93	23.29	30.35		12.04	22.11	27.40

* Previous practice on task.

** Excluded, partner had previous practice.

TABLE XVI

MEANS OF THIRDS OF LEARNING TRIALS
ON PAIRED ASSOCIATES IN
EXPERIMENT I

Number of Correct Associations							
<u>High Group</u>				<u>Low Group</u>			
<u>S</u>	1	2	3	<u>S</u>	1	2	3
3	1.00	2.25	7.67	36	1.33	7.50	11.67
71	1.00	5.25	8.33	40	1.00	4.25	11.00
66	1.00	1.00	2.67	6	1.33	3.75	8.67
106	1.33	3.75	6.33	11	2.00	6.25	12.00
136	1.67	6.50	11.67	83	1.00	1.75	5.33
123	3.33	8.00	11.67	27	1.67	6.00	9.33
46	1.00	2.00	3.00	85	1.00	4.25	8.67
4	1.00	3.00	5.33	33	1.33	7.00	15.00
79	1.00	1.50	6.33	26	3.00	11.00	23.33
117	1.00	3.25	9.00	69	3.33	5.75	10.00
104	5.00	7.25	11.00	54	3.33	6.50	13.33
9	1.00	3.50	7.00	125	1.33	5.25	8.33
53	1.00	3.50	11.33	61	1.67	3.00	8.33
113	1.00	2.00	5.00	96	1.00	2.00	7.67
56	1.00	1.25	4.67	91	2.67	4.75	8.00
$\bar{X}$	1.49	3.60	7.40		1.80	5.27	10.71

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TABLE XVII

MEANS OF THIRDS OF LEARNING TRIALS
ON CROSS PUZZLE IN EXPERIMENT I

Log Seconds x 10							
High Group				Low Group			
S	1	2	3	S	1	2	3
3	18.81	9.20	7.63	36	17.27	12.00	10.14
71	17.08	9.44	7.39	40	20.73	14.34	12.90
66	15.05	8.43	7.20	6	15.46	8.69	7.64
106	15.11	8.75	7.83	11	18.66	9.36	8.05
136	14.60	8.46	7.51	83	15.38	11.81	9.96
123	19.28	9.43	7.71	27	18.98	10.35	10.70
46	11.95	9.56	7.88	85	16.21	8.93	7.64
4	18.86	9.48	8.87	33	21.13	12.31	9.10
79	17.74	11.31	8.16	26	15.67	9.23	9.43
117	16.53	9.44	9.39	69	16.11	9.13	7.49
104	17.04	13.03	8.26	54	18.26	11.10	7.83
9	15.38	12.17	10.48	125	15.37	9.14	8.21
53	19.63	14.08	13.26	61	16.85	9.35	8.26
113	17.64	9.32	9.09	96	19.06	10.44	8.52
56	15.36	8.17	7.24	91	17.99	11.78	10.42
$\bar{X}$	16.67	10.02	8.53		17.54	10.46	9.09

TABLE XVIII

MEANS OF THIRDS OF LEARNING TRIALS
ON ALL TASKS IN EXPERIMENT II

Pursuit-Rotor

Seconds on Target

<u>High Group</u>				<u>Low Group</u>			
<u>S</u>	1	2	3	<u>S</u>	1	2	3
148	14.80	22.02	31.50	183	13.98	24.93	29.18
197	9.25	12.15	21.45	198	9.80	19.15	28.63
156	12.83	20.80	29.88	157	.90	4.30	10.75
166	13.23	23.05	28.73	155	4.55	16.35	19.53
139	6.15	16.80	24.08	179	16.03	28.43	37.03
182	14.93	23.98	29.97	153	11.43	25.02	30.47
$\bar{X}$	11.87	19.80	27.60		9.45	19.70	25.93

Paired Associates

Number of Correct Associations

148	1.00	2.50	7.00	183	2.00	8.00	13.33
197	1.67	3.75	7.33	198	1.00	2.75	9.00
156	1.00	3.75	7.67	157	2.33	3.50	8.00
166	1.00	3.00	4.33	155	8.00	24.00	37.67
139	1.00	3.00	7.67	179	1.67	4.00	11.33
182	3.00	9.50	16.33	153	8.67	25.50	39.33
$\bar{X}$	1.45	4.25	8.39		3.95	11.29	19.78

TABLE XVIII

MEANS OF THIRDS OF LEARNING TRIALS
ON ALL TASKS IN EXPERIMENT II
(CONTINUED)

Cross Puzzle

Log Seconds x 10

High Group				Low Group			
S	1	2	3	S	1	2	3
148	16.90	8.40	7.39	183	16.99	9.01	6.78
197	14.08	8.18	7.04	198	17.13	8.58	8.09
156	18.56	8.03	6.96	157	15.05	8.64	8.81
166	18.12	7.59	6.05	155	25.91	21.31	19.30
139	15.00	7.96	7.13	179	17.31	10.13	8.68
182	17.06	9.83	9.01	153	18.19	12.04	9.35
$\bar{X}$	16.62	8.33	7.26		18.43	11.62	10.17

TABLE XIX

PURSUIT-ROTOR

Experiment I

Seconds on Target						
<u>S</u>	1	2	3	4	5	6
High Group						
3	5.5	7.2	9.4	8.8	10.9	17.7
71**						
66	20.8	20.7	24.6	29.7	28.2	28.9
106*						
136	6.3	11.6	13.8	21.9	20.9	22.3
123	3.2	4.0	7.3	10.3	17.5	15.6
46	2.6	5.0	10.3	9.0	12.0	13.4
4	11.0	18.3	21.2	22.9	22.9	22.2
79	18.1	14.2	17.8	18.1	17.9	19.7
117	4.0	4.5	8.6	8.6	16.5	17.7
104	16.0	18.6	27.6	34.0	36.8	34.8
9	1.7	4.6	7.5	12.6	13.5	19.8
53	4.4	6.0	14.8	21.0	23.6	23.4
113*						
56*						
$\bar{X}$	8.5	10.4	14.8	17.9	20.2	21.4

TABLE XIX

PURSUIT-ROTOR (CONTINUED)

Experiment I

Seconds on Target

S	7	8	9	10	11	12
High Group						
3	23.4	20.3	28.7	24.5	31.4	27.6
71**						
66	31.4	34.9	36.4	41.4	36.2	40.0
106*						
136	25.0	23.6	24.6	31.7	28.3	31.4
123	22.6	26.7	29.4	27.5	33.9	34.4
46	14.5	17.1	15.0	23.8	21.6	24.2
4	24.1	26.5	31.7	28.6	25.1	29.1
79	16.5	20.8	20.6	24.6	27.0	31.5
117	20.8	27.0	28.7	30.3	32.4	32.9
104	39.8	42.1	41.0	44.1	43.8	44.7
9	21.6	24.1	24.5	28.8	26.7	30.9
53	31.4	31.4	22.8	31.0	28.2	33.9
113*						
56*						
$\bar{X}$	24.6	26.8	27.6	30.6	30.4	32.8

* Previous practice on task.

**Excluded, partner had previous practice on task.

TABLE XX

PURSUIT-ROTOR

Experiment I

Seconds on Target						
S	1	2	3	4	5	6
Low Group						
36	2.6	4.3	5.4	7.5	7.2	9.1
40*						
6	5.4	8.7	13.4	12.1	15.5	20.1
11**						
83	4.9	13.8	19.6	21.8	21.6	29.2
27	7.7	12.0	15.3	15.0	16.8	20.4
85	11.0	14.0	18.7	23.1	27.9	26.2
33	4.9	7.8	13.9	12.1	17.3	16.9
26	7.6	14.8	18.6	25.6	22.8	25.8
69	7.3	9.7	14.9	23.4	21.3	20.7
54	4.3	6.0	9.0	14.7	16.5	21.3
125	10.3	13.9	20.9	24.5	27.5	29.4
61	1.5	6.5	5.9	14.9	12.7	14.2
96**						
91**						
$\bar{X}$	6.1	10.1	14.1	17.7	18.8	21.2

TABLE XX

PURSUIT-ROTOR (CONTINUED)

Experiment I

Seconds on Target						
S	7	8	9	10	11	12
Low Group						
36	14.0	12.4	16.9	19.1	20.8	23.0
40*						
6	17.7	21.7	25.0	20.1	21.5	23.5
11**						
33	22.0	26.7	28.4	24.7	28.8	30.7
27	21.0	25.9	30.4	25.7	29.6	32.1
85	31.3	30.9	33.9	35.2	31.1	32.3
33	20.5	16.8	22.4	20.4	21.1	21.2
26	29.3	28.8	26.8	34.4	32.2	25.7
69	30.1	31.5	28.0	26.3	31.0	31.6
54	21.8	27.7	22.3	18.6	27.4	25.6
125	34.1	32.7	36.7	39.1	38.7	38.9
61	13.1	17.8	17.6	14.1	14.8	14.1
96**						
71**						
$\bar{X}$	23.2	24.8	26.2	25.2	27.0	27.2

* Previous practice on task.

** Excluded, partner had previous practice on task.

TABLE XXI

PURSUIT-ROTOR

Experiment II

Seconds on Target						
S	1	2	3	4	5	6
High Group						
148	8.3	12.2	17.3	21.4	18.7	22.4
197	6.0	6.5	10.7	13.8	10.2	13.7
156	6.1	10.9	19.0	15.3	17.4	20.6
166	6.1	11.9	16.0	18.9	22.6	21.1
139	2.6	4.5	7.2	10.3	11.2	16.2
182	9.2	15.4	14.8	20.3	19.3	21.9
$\bar{X}$	6.38	10.23	14.16	16.66	16.57	19.32
Low Group						
183	7.8	12.2	19.6	16.3	19.4	28.0
198	6.4	8.0	10.8	14.0	14.0	17.0
157	.6	1.0	.7	1.3	3.0	5.6
155	.3	3.1	3.1	9.0	21.5	16.4
179	8.5	13.0	20.4	22.2	22.5	24.6
153	6.1	6.9	16.1	16.6	21.0	22.9
$\bar{X}$	4.95	7.37	11.78	13.23	16.90	19.08

TABLE XXI

PURSUIT-MOTOR (CONTINUED)

Experiment II

Seconds on Target						
S	7	8	9	10	11	12
High Group						
148	20.7	26.3	28.6	32.4	33.2	31.8
197	11.8	12.9	20.3	21.7	23.0	20.8
156	21.7	23.5	26.8	31.3	30.7	30.7
166	20.1	28.4	26.3	30.1	29.5	29.0
139	18.5	21.3	23.4	24.6	26.6	21.7
182	24.5	30.2	31.6	28.6	30.5	29.2
$\bar{x}$	19.55	23.77	26.17	28.12	28.92	27.20
Low Group						
183	21.6	30.7	25.2	32.7	22.0	36.8
198	17.7	27.9	27.2	27.5	29.7	30.1
157	3.8	4.8	7.9	8.7	10.8	15.6
155	14.1	13.4	21.0	18.2	17.5	21.4
179	35.6	31.0	36.1	34.3	37.4	40.3
153	27.3	28.9	31.7	28.3	30.8	31.1
$\bar{x}$	20.01	22.78	24.85	24.95	24.70	29.21

TABLE XXII

PAIRED ASSOCIATES

High Group
Experiment I

S	Correct Associations Per Trial									
	1	2	3	4	5	6	7	8	9	10
3	1	1	1	1	1	3	4	7	8	8
71	1	1	1	5	5	5	6	8	8	9
66	1	1	1	1	1	1	1	1	3	4
106	1	1	2	3	4	4	4	4	7	8
136	1	1	3	4	6	7	9	10	12	13
123	3	3	4	7	7	8	10	11	11	13
46	1	1	1	1	1	3	3	3	3	3
4	1	1	1	2	3	3	4	4	5	7
79	1	1	1	1	1	1	3	3	5	11
117	1	1	1	1	4	4	4	7	10	10
104	3	6	6	6	6	8	9	10	10	13
9	1	1	1	2	2	5	5	5	5	11
53	1	1	1	3	3	4	4	4	14	16
113	1	1	1	1	1	2	4	4	4	7
56	1	1	1	1	1	1	2	4	4	6
Y	1.27	1.47	1.73	2.60	3.07	3.93	4.80	5.67	7.27	9.27

TABLE XXII

PAIRED ASSOCIATES (CONTINUED)

Low Group
Experiment I

S	Correct Associations Per Trial									
	1	2	3	4	5	6	7	8	9	10
36	1	1	2	6	6	8	10	10	11	14
40	1	1	1	1	3	6	7	9	11	13
6	1	1	2	3	3	4	5	6	9	11
11	1	1	4	4	7	7	7	12	12	12
83	1	1	1	1	2	2	2	5	5	6
27	1	2	2	5	5	7	7	9	9	10
85	1	1	1	3	4	5	5	8	9	9
33	1	1	2	3	7	7	11	12	14	19
26	3	3	3	7	10	10	17	18	26	26
69	3	3	4	4	5	6	8	9	9	12
54	2	4	4	4	7	7	8	12	12	16
125	1	1	2	2	5	7	7	7	9	9
61	1	2	2	3	3	3	3	7	8	10
96	1	1	1	2	2	2	2	5	8	10
91	2	3	3	4	4	5	6	6	9	9
$\bar{X}$	1.40	1.73	2.27	3.47	4.87	5.73	7.00	9.00	10.73	12.40

TABLE XXIII

PAIRED ASSOCIATES

High Group
Experiment II

S	Correct Associations Per Trial									
	1	2	3	4	5	6	7	8	9	10
148	1	1	1	2	3	3	6	6	7	8
197	1	2	2	3	4	4	4	5	6	11
156	1	1	1	1	4	4	6	6	8	9
166	1	1	1	2	3	3	4	4	4	5
139	1	1	1	1	3	4	4	6	6	11
182	2	2	5	5	9	12	12	15	17	17
$\bar{X}$	1.17	1.33	1.83	2.33	4.33	5.00	6.00	7.00	8.00	10.16

Low Group
Experiment II

183	2	2	2	5	8	9	10	11	13	16
198	1	1	1	1	1	4	5	5	8	14
157	2	2	3	3	3	4	4	7	8	9
155	1	6	17	19	24	24	29	35	36	42
179	1	1	3	3	3	3	7	7	13	14
153	4	4	18	20	24	25	33	39	39	40
$\bar{X}$	1.83	2.67	7.33	8.50	10.50	11.50	14.67	17.33	19.50	22.50

TABLE XXIV

CROSS PUZZLE

High Group
Experiment I

Log Seconds x 10								
S	1	2	3	4	5	6	7	8
3	27.96	21.08	14.42	11.79	8.75	8.57	11.67	7.63
71	23.83	15.21	18.41	10.86	10.09	9.14	12.86	9.08
66	27.85	13.01	9.24	10.09	8.86	8.26	9.91	9.08
106	24.87	15.92	10.41	9.24	8.57	8.69	9.19	8.39
136	24.71	12.70	11.00	10.00	8.81	9.73	9.14	8.81
123	28.13	10.83	22.59	15.55	10.90	9.40	10.09	7.56
46	15.16	12.04	9.64	10.97	7.63	11.30	7.71	9.35
4	30.42	18.85	13.14	13.01	9.82	9.96	11.04	8.63
79	27.26	11.40	14.52	17.78	12.94	13.48	9.08	14.91
117	29.36	11.73	12.23	12.81	9.96	10.61	9.68	9.35
104	29.25	16.33	11.85	10.72	16.80	16.73	10.45	16.83
9	22.87	11.30	12.65	14.70	23.74	10.49	11.52	9.68
53	30.53	17.68	13.10	17.21	14.25	19.89	11.37	13.56
113	31.70	18.31	9.64	10.90	10.21	9.29	8.57	8.51
56	29.29	9.40	10.00	12.74	10.86	8.33	8.39	8.45
$\bar{x}$	26.88	14.39	12.86	12.56	11.48	10.92	10.04	9.99

TABLE XXIV

CROSS PUZZLE (CONTINUED)

High Group
Experiment I

Log Seconds x 10							
S	9	10	11	12	13	14	15
3	7.40	11.24	9.14	8.57	7.63	6.90	7.40
71	9.14	8.13	7.63	7.92	8.57	7.16	5.91
66	8.33	7.56	6.99	7.40	8.13	7.48	5.80
106	7.99	9.54	8.86	8.92	7.16	6.43	8.81
136	8.51	6.72	7.48	6.99	8.57	7.32	7.16
123	9.68	10.76	7.63	8.39	7.56	7.63	7.24
46	9.73	9.14	12.07	6.81	6.33	11.07	7.32
4	8.81	8.63	9.44	8.92	8.92	8.39	9.24
79	10.90	9.96	7.92	8.86	7.85	7.92	7.99
117	9.91	7.85	8.69	8.69	9.87	9.87	9.14
104	9.35	11.40	9.64	9.82	8.57	8.69	9.96
9	9.49	10.04	10.04	11.90	9.73	10.25	10.04
53	14.64	10.93	13.91	10.09	13.71	12.23	17.01
113	9.35	9.78	9.49	8.92	9.78	9.19	8.45
56	7.92	6.43	6.81	7.32	7.78	6.53	7.32
$\bar{x}$	9.41	9.21	9.05	8.63	8.67	8.47	8.59

TABLE XXV

CROSS PUZZLE

Low Group
Experiment I

Log Seconds x 10								
S	1	2	3	4	5	6	7	8
36	29.02	14.55	13.24	12.28	13.64	14.59	11.14	10.97
40	28.40	12.70	25.75	16.07	11.90	21.49	16.68	11.96
6	22.66	12.07	12.65	14.47	8.51	8.33	10.21	7.92
11	29.30	22.30	12.83	10.21	12.41	11.14	9.64	8.57
83	30.98	10.64	9.91	10.00	9.49	22.80	12.15	12.79
27	26.18	28.33	10.97	10.45	10.61	6.99	8.75	12.46
85	27.26	15.69	10.76	11.14	13.22	10.09	7.32	7.99
33	28.73	20.36	17.41	18.01	15.45	11.61	15.07	14.89
26	28.43	11.30	9.08	13.87	8.75	7.32	9.87	9.29
69	28.51	11.93	13.65	10.33	9.40	10.09	8.81	9.24
54	26.52	15.17	13.08	18.16	12.07	12.67	14.74	9.87
125	22.09	12.81	13.26	13.30	10.00	8.98	7.99	8.63
61	28.60	17.02	12.15	9.64	9.24	9.96	8.75	9.19
96	23.02	22.05	14.70	16.47	15.33	9.91	8.45	10.49
91	27.91	16.79	12.53	14.73	12.23	17.44	10.49	10.45
7	27.37	16.24	13.46	13.27	11.21	12.23	10.67	10.31

TABLE XXV

CROSS PUZZLE (CONTINUED)

Low Group
Experiment I

Log Seconds x 10							
S	9	10	11	12	13	14	15
36	10.29	12.79	10.57	9.35	9.68	10.49	11.04
40	6.72	16.64	15.00	14.36	9.03	13.91	14.31
6	9.24	7.63	8.98	6.81	8.13	7.63	7.99
11	8.81	8.20	6.72	8.57	7.63	6.81	9.19
83	9.59	7.85	7.99	10.68	10.37	8.57	10.21
27	5.68	7.71	20.22	11.46	10.90	12.23	8.20
85	8.20	7.71	8.06	8.06	6.99	7.24	8.26
33	11.07	9.49	8.57	9.49	8.63	9.35	8.92
26	8.20	7.40	13.77	9.91	10.09	8.69	9.03
69	9.14	8.39	8.86	7.56	8.20	7.48	6.72
54	10.33	10.04	7.99	7.40	7.63	6.90	9.40
125	10.04	9.24	9.08	8.26	8.33	7.56	8.69
61	9.91	8.51	9.91	8.33	9.40	7.24	8.06
96	8.98	8.20	11.73	8.57	8.33	9.78	7.40
91	10.83	11.07	9.96	11.37	8.75	10.64	10.90
$\bar{x}$	9.14	9.39	10.49	9.35	8.81	8.96	9.22

TABLE XXVI
CROSS PUZZLE
Experiment II

Log Seconds x 10								
S	1	2	3	4	5	6	7	8
High Group								
148	26.42	16.26	13.26	11.67	9.35	8.75	7.85	8.33
197	17.43	15.88	8.39	14.62	8.75	8.45	11.99	6.90
156	21.19	28.79	12.15	12.12	8.51	7.32	7.56	10.45
166	29.30	18.19	12.88	12.12	7.85	6.81	7.24	7.92
139	24.73	12.25	10.13	12.88	8.33	8.98	7.56	8.51
182	29.34	14.35	13.64	10.90	9.68	8.13	7.99	9.35
$\bar{x}$	24.74	17.62	11.74	12.39	8.75	8.07	8.37	8.58
Low Group								
183	26.56	14.52	17.80	9.08	9.35	11.24	8.06	6.99
198	31.37	12.15	12.65	12.36	10.04	8.69	8.06	8.20
157	20.00	18.85	11.27	10.09	9.40	8.57	9.40	8.13
155	31.58	27.08	20.91	24.07	21.28	20.92	19.52	24.56
179	27.07	18.95	11.46	11.76	10.41	10.00	11.78	9.91
153	25.64	10.41	9.24	27.45	17.44	11.21	18.28	12.20
$\bar{x}$	27.04	16.99	13.89	15.80	12.99	11.77	12.52	11.67

TABLE XXVI

CROSS PUZZLE (CONTINUED)

Experiment II

Log Seconds x 10							
S	9	10	11	12	13	14	15
High Group							
148	7.63	9.24	7.63	7.92	7.16	7.56	6.90
197	8.69	6.23	6.23	7.63	7.08	6.63	6.81
156	8.13	6.33	7.92	7.16	7.32	5.56	7.78
166	11.21	6.33	5.80	6.53	6.33	6.02	5.31
139	7.24	7.40	7.71	7.48	6.99	6.72	7.32
182	16.76	9.35	7.56	10.86	8.39	8.45	8.33
$\bar{x}$	9.94	7.48	7.14	7.93	7.21	6.82	7.08
Low Group							
183	8.63	8.81	10.00	8.26	6.81	5.31	6.72
198	8.06	8.33	8.69	7.99	7.24	8.81	8.33
157	7.56	7.85	9.54	10.09	8.86	7.78	8.51
155	20.10	21.32	21.48	20.40	22.76	16.88	17.17
179	8.98	10.00	9.82	9.59	8.57	7.85	8.69
153	10.37	7.63	7.16	10.41	8.57	8.92	9.49
$\bar{x}$	10.62	10.66	11.12	11.12	10.47	9.26	9.82

TABLE XXVII

MEANS, MEDIANS, AND RANGE OF THREE SUBGROUPS IN THE
H AND L CONDITIONS ON SLOPE FUNCTIONS OF CURVES
FOR ALL LEARNING TASKS IN EXPERIMENT I

	Subgroups					
	I		II		III	
	High	Low	High	Low	High	Low
Pursuit-Rotor						
N	3	3	5	5	3	3
$\bar{X}$	2.57	2.81	2.80	4.19	6.47	5.11
Med	2.71	3.69	2.10	4.44	6.60	5.06
Range	1.83	3.92	5.82	3.37	3.24	2.91
Paired Associates						
N	5	5	5	5	5	5
$\bar{X}$	.269	.428	.157	.822	-.312	-.396
Med	.642	.143	.286	.907	-.327	-.021
Range	2.20	2.62	2.82	1.41	1.32	2.52
Cross Puzzle						
N	5	5	5	5	5	5
$\bar{X}$	2.35	1.96	2.25	2.52	1.72	2.24
Med	2.14	2.02	2.51	2.36	1.83	2.05
Range	1.12	2.13	2.67	.93	2.32	.76

TABLE XXVIII

MEANS, MEDIANS, AND RANGE OF THREE SUBGROUPS IN
THE H AND L CONDITIONS ON TRIAL-BY-TRIAL
VARIABILITY FOR ALL LEARNING
TASKS IN EXPERIMENT I

	Subgroups					
	I		II		III	
	High	Low	High	Low	High	Low
Pursuit-Rotor						
N	3	3	5	5	3	3
$\bar{X}$	20.77	12.94	14.08	15.17	18.76	13.40
Med	14.54	10.44	12.38	14.70	8.37	7.67
Range	20.49	8.58	9.96	12.13	33.92	18.75
Paired Associates						
N	5	5	5	5	5	5
$\bar{X}$	1.66	2.96	2.29	5.67	4.49	2.73
Med	2.22	2.89	2.22	2.11	2.67	2.56
Range	1.88	3.56	4.45	13.66	11.11	3.67
Cross Puzzle						
N	5	5	5	5	5	5
$\bar{X}$	2.26	13.70	5.34	9.29	12.16	5.04
Med	1.24	5.21	4.14	4.87	16.69	6.38
Range	4.33	27.58	8.94	29.50	24.17	7.26

TABLE XXIX

MEANS, MEDIANS, AND RANGE OF SECONDS CONTACT BY THIRDS
OF TRIALS FOR THREE SUBGROUPS IN THE H AND L
CONDITIONS OF EXPERIMENT I ON PURSUIT ROTOR

Subgroup I (N = 3)

	High			Low		
	First	Thirde Middle	Last	First	Thirde Middle	Last
$\bar{X}$	15.0	24.0	31.9	10.0	18.1	23.6
Med	13.4	23.0	29.0	9.9	18.8	22.5
Range	16.3	12.8	10.4	10.0	14.2	8.2
t^*	1.33	1.75	2.32			
P	>.30	<.30	<.20			

Subgroup II (N = 5)

$\bar{X}$	11.0	19.6	27.6	13.9	24.3	30.7
Med	6.7	20.5	28.6	13.8	25.9	29.5
Range	12.2	9.6	10.1	7.0	11.2	11.8
t^*				<.97	1.44	.26
P				<.40	<.30	<.90

Subgroup III (N = 3)

$\bar{X}$	14.1	28.7	33.4	11.0	22.4	25.7
Med	11.6	27.5	29.0	8.5	21.8	23.5
Range	17.5	19.1	15.7	10.2	16.4	23.2
t^*	.49	.88	1.00			
P	<.70	<.50	<.45			

*ts are under the group which was directionally superior on that third.

TABLE XXX

MEANS, MEDIAN, AND RANGE OF TRIALS TO CRITERIA BY THIRDS
OF TRIALS FOR THREE SUBGROUPS IN THE H AND L CONDITIONS
OF EXPERIMENT I ON PAIRED ASSOCIATES

Subgroup I (N = 5)						
	High			Low		
	First	Thirds Middle	Last	First	Thirds Middle	Last
$\bar{X}$	1.20	3.75	7.33	1.33	4.70	9.73
Md	1.00	3.75	7.67	1.33	4.25	11.00
Range	.67	5.50	9.00	1.00	5.75	6.67
t^*	.59	.55	1.06			
P	<.60	<.70	<.40			
Subgroup II (N = 5)						
$\bar{X}$	1.47	3.55	7.07	2.07	6.80	13.27
Md	1.00	3.00	6.33	1.67	6.00	10.00
Range	2.33	6.50	8.67	2.33	6.75	14.67
t^*	.83	1.75	1.83			
P	<.50	<.20	<.20			
Subgroup III (N = 5)						
$\bar{X}$	1.80	3.50	7.80	2.00	4.30	9.13
Md	1.00	3.50	7.00	1.67	4.75	8.33
Range	4.00	6.00	6.67	2.33	4.50	5.67
t^*	.37	1.00	1.18			
P	<.80	<.40	<.40			

* t s are under the group which was directionally superior on that third.

TABLE XXXI

MEANS, MEDIANS, AND RANGE OF LOG SECONDS X 10 BY THIRDS
OF TRIALS FOR THREE SUBGROUPS IN THE H AND L
CONDITIONS OF EXPERIMENT I ON CROSS PUZZLE

Subgroup I (N = 5)						
High				Low		
	First	Thirde Middle	Last	First	Thirde Middle	Last
$\bar{X}$	16.13	8.86	7.51	17.50	11.04	9.74
Med	15.11	8.75	7.51	17.27	11.81	9.96
Range	4.21	1.01	.63	5.35	5.65	5.26
t^*	1.38	2.74	2.34			
P	<.30	<.10	<.10			
Subgroup II (N = 5)						
$\bar{X}$	16.87	9.84	8.40	17.62	9.99	8.87
Med	17.74	9.48	8.16	16.21	9.23	9.10
Range	7.33	1.88	1.68	5.46	3.38	3.21
t^*	.79	.18	.58			
P	<.50	<.90	<.60			
Subgroup III (N = 5)						
$\bar{X}$	17.01	11.35	9.67	17.51	10.36	8.65
Med	17.04	12.17	9.09	17.99	10.44	8.52
Range	4.27	5.91	6.02	3.69	2.64	2.21
t^*	.54				.66	.76
P	<.70				<.60	<.50

* t 's are under the group which was directionally superior on that third.

INSTRUCTIONS FOR HANDLING TARGETS

Parquet-Target

1. Not going to give you this handle with the flexible handle on
it. I want you to try to keep the end of the handle on this handle
as long as possible. The little target will receive in a
few seconds a contact signal. (2. Uninterrupted proper holding of handle
of target of target). You will have 12 trials of 1 minute each
interrupted by a 1 minute rest period between trials. Any questions?
(3. Please a brief trial to get you acquainted with the work and
using the handle. (2. allow 12 seconds rest). All right. Begin.

Parquet Association

You will be given a set of words. First word is paired with
second word. Study these pairs so that when one of the words is shown
you, you can recall what word went with it. Do not try to learn these
words in any particular order because the order will be changed each
time. The object is to associate a particular word with one word and
not to learn words.

APPENDIX C

After presentation of words you will be shown a word of
which you must recall the word with which it was associated.
You will receive 12 trials of 1 minute each. The first trial is the word that is
associated with the presentation of the word. It is changed after that.
You will be presented with the word and the associate to check the
accuracy of your response. Do not respond until you recall what
was associated with the pair. It is all right to guess even if you are
wrong. The word and the try to learn what word goes with what. Remember
to keep the words with the target. Any questions? Ready?

Cross Pairs

You are to give five pairs together to form a cross which looks
like this. (2. show pattern of cross upon on piece of paper). Then
I will give you a trial of putting the pieces together to form a cross. The
pieces will not look like this as they are given to you. (2. little cover
which makes placed pieces of puzzle). To be sure you get out. Any
questions? Begin this after listening order for trial.

INSTRUCTIONS FOR LEARNING TASKS

Pursuit-Rotor

I am going to give you this handle with the flexible stylus on it, and I want you to try to keep the end of the stylus on this little target as long as possible. The little brass target will revolve in a circle at a constant speed. (E. demonstrates proper holding of handle and pursuit of target). You will have 12 trials of 1 minute each separated by a 1 minute rest period between trials. Any Questions? Let us have a brief trial to get you acquainted with the task and holding the handle. (E. allows 10 seconds run). All right? Begin.

Paired Associates

You will be shown a group of words. Each word is paired with another word. Study these pairs so that when one of the pairs is shown alone, you can recall what word went with it. Do not try to learn these pairs in any particular order because the order will be changed each time. The point is to associate a particular word with the word with which it always appears.

After presentation of the words you will be shown a word by itself to see whether you remember the word with which it was associated. If you do remember it, speak it aloud. You must tell me the word that is associated with the presented word within 2 seconds because after that time you will be presented with the word and its associate to check the correctness of your response. We will continue until you recall every word associated with its pair. It is all right to guess even if you are not sure of a word but try to learn what word goes with what. Remember to speak it aloud within two seconds. Any questions? Ready?

Cross Puzzle

You are to put five pieces together to form a cross which looks like this. (E. shows outline of cross drawn on piece of paper). When you begin each trial of putting the pieces together to make a cross, the pieces will not look like this as they are given to you. (E. lifts cover to show randomly placed pieces of puzzle). Go as fast as you can. Any questions? (Begin time after lifting cover for trial).