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An empirical study of personality variables related to efficiency of problem solving

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AN EMPIRICAL STUDY OF PERSONALITY VARIABLES RELATED
TO EFFICIENCY OF PROBLEM SOLVING

by

Sylvia G. Dickerson

A dissertation submitted in partial fulfillment of
the requirements for the degree of Master of
Arts, in the Department of Psychology,
in the Graduate School of the
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CHAPTER I

INTRODUCTION

During the last few years there has been an increasing interest in problem solving behavior (2, 16) and closely related area such as concept formation, decision making and creative thinking. This can be seen by the large number of papers published within the last few years. Taylor and McNemar in the 1955 Annual Review (18) state that between 1949 and 1953, in the United States only, 125 relevant doctoral dissertations have been written and about 60 papers presented at the A. P. A. meetings besides the books written on the subject by Bruner (4), Vinacke (19), Humphrey (10), Rapaport (15). Despite the amount of work which has been done in this area, there are still many unanswered questions.

The essence of most current definitions of concept formation and problem solving seems to involve three stages: 1. exposure to changing patterns of stimuli during which certain responses are reinforced by some kind of cue, 2. development of a principle or rule acquired from the exposure to the problem situation by abstracting some common characteristics of the reinforced responses, and 3. application of this principle or rule to obtain the correct response in a similar situation in the future. The critical difference between this

kind of learning task and other learning tasks is that the stimulus situation changes from time to time whereas on other tasks it remains the same (e.g., maze learning).

It is generally assumed that intelligence plays a very important part in concept formation or problem solving behavior.¹ As a matter of fact, concept formation tasks are sometimes included in intelligence tests (A. C. E.) and, hence, are considered as related to intelligence by definition. In addition, there is some evidence, discussed below, of non-intellective variables in concept-formation. These variables are of the type which are customarily called personality variables.

A great deal of recent research has been done in the area known as the experimental study of personality. This type of research involves the classification of Ss by personality characteristics and the study of differential performance on experimental tasks. The Minnesota Multiphasic Personality Inventory (MMPI) (9) and the Taylor Scale of Manifest Anxiety (17) which was derived from the MMPI are among the most widely used devices. These two instruments have been studied in relationship to efficiency in learning (7), intelligence (3), school

1. No distinction is made in this study between problem solving and concept formation.

achievement (5, 11, 13) and many other variables and tasks.

Considering that so much attention has been given to the experimental study of personality and also to concept formation and problem solving, it is surprising that so few attempts have been made to bring them together. A careful search of the recent literature disclosed only two studies of this type. One of these (6) was not accessible to the writer and from the available abstract did not seem to be particularly relevant. The second study was conducted by Wesley (20) and deals with the relationship of personality variables to performance on a concept formation task. She constructed her own scale of rigidity and compared the performance of rigid, anxious and normal groups on a card sorting task. The normal group scored below the median on both the Wesley Rigidity scale and Taylor Anxiety scale. The rigid group scored in the upper decile of the Rigidity scale and below the 60th percentile on the Anxiety scale, and the anxious group scored in the upper decile on the Anxiety scale and below the median on the Rigidity scale.

The problem situation consisted of four series of multiple-attribute cards and a box containing four card sorting compartments into which the cards were sorted on the basis of cue cards placed above each compartment. A green light was flashed when S placed the right card in

the right compartment. A red light was flashed when the card was placed in the wrong compartment. The accepted criterion was to achieve ten consecutive correct sortings.

This study shows that the three groups did not differ significantly in terms of number of trials to learn the first series. For the next three series, the rigid group took more trials than the normal group, which took more trials than the anxious group. Thus it can be seen that the rigid group took longer to "shift concepts" from series to series while the anxious group shifted quicker than either rigid or normal group. From this study it can be concluded that there are personality variables which influence performance on this concept formation task.

A few years ago a new personality measure was developed, known as the Edwards Personal Preference Schedule (PPS) (8). The statements in the PPS have their origin in the list of needs given by H. A. Murray in his book, Explorations in Personality (14). The PPS provides a measure of 15 personality variables: Achievement, Deference, Order, Exhibition, Autonomy, Affiliation, Intraception, Succorance, Dominance, Abasement, Nurturance, Change, Endurance, Heterosexuality, Aggression. An inspection of the content a priori of these scales

suggested that certain ones might have a relationship to efficiency of problem solving. The scales selected for study, with brief definitions based on item content, will follow.

Achievement: To do one's best, to be successful, to accomplish tasks requiring skill and effort, etc.

Order: To have written work neat and organized, to make plans before starting on a difficult task, to have things organized, etc.

Autonomy: To be able to come and go as desired, to say what one thinks about things, to be independent of others in making decision, etc.

Change: To do new and different things, to travel, to meet new people, etc.

Endurance: To keep at a job until it is finished, to complete any job undertaken, to work hard at a task, etc.

Statement of the problem.

The primary purpose of this study was to investigate the relationship of personality variables to efficiency of problem solving. In order to do this, college women were given the Taylor Manifest Anxiety scale and the PPS in group testing sessions. Subjects later performed on a problem solving task and this performance was studied

in relationship to Anxiety scores and the Achievement, Order, Autonomy, Change and Endurance scales of the PPS.

CHAPTER II

PROCEDURE

Subjects.

The Ss in this study were women from Westhampton College enrolled in three sections of the general psychology course. The majority of Ss were either sophomores or juniors plus some few seniors.

Group Session.

At the beginning of the 1956 term all the students in general psychology classes were given a True-False test which included the Taylor Manifest Anxiety scale, and the K and L scales from the MMPI (Appendix A).

During the second semester the same groups were given the PPS. This test consisted of a set of 225 statements relating to the 15 personality variables which are to be answered by a forced choice technique. If S believes the statement as characteristic of himself, his response will be "yes," if not, the answer is "no." Items from each scale of the 15 personality variables are paired twice with items from each of the other variables. Therefore the highest possible score for each variable is 28. In order to obtain a score of zero for any variable, S would regard the statements for this particular variable as being less characteristic of himself in all the 28

comparisons in which it appears. According to the PPS manual, the 15 variables that are measured are relatively independent. (8)

On the basis of the group administered tests, PPS scores were available on 79 women. All of these women were administered the problem solving task. Anxiety scores were available on 67 of the total 79.

Apparatus and Materials.

The problem solving device known as the Corder box is an oblong, black, metal box with a base measurement of 8 by 18 inches. The front panel is sloped and has 15 green lights which are disposed lengthwise. Under each light there are numbers which run from 1 to 15 successively. Underneath the numbers there are small buttons which are pushed by S during the experiment. Above the green lights in the middle of the sloped face there is a yellow light with the word, "correct," underneath. (See Photograph I, Appendix B)

On E's side of the box there are necessary devices to turn on and off the lights on S's side and also regulate the yellow light. (See Photograph II, Appendix B)

The Corder box was placed on a table and a large screen separated S and E who sat on opposite sides

of the table. (See Photograph III, Appendix B)

Procedure.

The problem solving task was administered individually to 79 Ss by the writer and another graduate student. The experimenters were unaware of Ss personality test scores at the time of the problem-solving task administration.²

After S was seated facing the box, E took his seat and read the preliminary instructions which were identical for all Ss (See Appendix C). The instructions emphasized that S is to look for a rule which will tell him which light would be the correct one in any particular display. The two first displays of the first problem were used for examples.

Each S was given a chance to ask questions after the instructions were read. No questions were answered once S had started to work. Two problems were given to each S. The rule for the first problem was to push the button, the number of which was the sum of the numbers of the two smallest numbered lights in the display. For the second problem, the rule was half of

2. Due to the interrelation of this study and another study in progress at the same time, High and Low Anxious Ss were run first and Middle Anxious Ss were run later. It is assumed that this had no appreciable affect on results.

of the highest even number in the display.

The criterion for the solution of the problem was four consecutive errorless trials. When the criterion was reached, or when the first problem was not solved in 30 displays, E started S on the second problem.

After each S had finished his task according to the adopted criterion, he was thanked for his cooperation and asked not to discuss the task with other students. No results were given to S.

CHAPTER III

RESULTS

Ss were divided into Low (L), Middle (M), and High (H) groups for each of the PFS variables and the A scale on the basis of the frequency distribution of scores obtained by Ss. An attempt was made to have 25% of Ss in the L group, 25 % in the H group, and 50% in the M group. The different cutting points for the variables are presented in Table I.

Table I

Cutting points for the L, M, H groups on the PFS variables and the A scale

| | <u>L</u> | <u>M</u> | <u>H</u> |
|---------------|----------------|-----------------|-----------------|
| Order | 2-6 (N:21) | 7-12 (N:36) | 13-22 (N:22) |
| Autonomy | 2-8 (N:25) | 9-13 (N:31) | 14-26 (N:23) |
| Endurance | 3-10 (N:23) | 11-15 (N:36) | 16-25 (N:20) |
| Change | 4-12 (N:22) | 13-20 (N:37) | 21-27 (N:20) |
| Achievement | 5-11 (N:25) | 12-16 (N:31) | 17-23 (N:23) |
| Anxiety scale | 0-11 (N:20) | 12-17 (N:26) | 18-34 (N:21) |

The data for analysis consisted of two, reasonably independent, criterion measures of efficiency of problem solving, namely, number of displays and average errors per display for each of the two problems separately. For the purpose of consistency, the performance on both problems was analyzed starting with the third display since the first two displays of the first problem were used as examples during the instructions.

The data for Ss who solved the problems and those who did not were analyzed together. Any error produced by this procedure would be of a conservative nature, i.e., would tend to diminish differences between personality groups due to the "discarding" of the differences which would have been found beyond 30 trials had all so been run until the problem was solved. The procedure has the advantage of having a larger number of Ss available for analysis and, hence, a more precise evaluation of the effects being studied.

The number of displays measured consisted of total number of displays starting with the third display and concluding after the four consecutive errorless trials which constituted the criterion of successful solution. The second criterion measure, average errors per display, consisted of the ratio of the total number of incorrect

buttons pushed by S, starting with the third display, to the total number of displays.

For each of the six personality variables, the two criterion measures were analyzed with regard to three factors: 1. interaction between the personality variable and the problems (A x B); 2. personality variable (B effect); 3. the problems (A effect). This data is summarized in the tables that follow.³

A. Order variable.

1. Mean of number of displays

The mean of number of displays for the L, M, and H Order groups are seen in Table II. These results suggest

Table II

Mean Number of Displays for L, M, H Order Groups

| | <u>L</u> | <u>M</u> | <u>H</u> | <u>Total</u> |
|------------|----------|----------|----------|--------------|
| Problem I | 17.85 | 13.97 | 11.59 | 14.34 |
| Problem II | 15.95 | 17.78 | 17.40 | 17.18 |
| Total | 16.90 | 15.80 | 14.50 | 15.74 |

that group H performs most efficiently on the first problem, but becomes less efficient when shifting from the

3. For the analysis of variance the Type I design from Lindquist's Design and Analysis of Experiments (12) was used. Although the distribution of scores departed somewhat from normality, the departure was judged to be within acceptable limits as indicated by the Norton Study. (12)

first problem to the second. Group M shows something of the same effect. Group L is least efficient on the first problem, but becomes most efficient on Problem II. The analysis of variance for the Order variable is summarized in Table I, Appendix D. This analysis revealed a significant interaction ($<.05$) between Order and problems. T tests were run between the various pairs of means and revealed that the difference for group M and group H on both problems was statistically significant ($<.05$). The difference between group L and group H on the first problem also approached statistical significance at .05 level. No other differences approached significance.

2. Mean of average errors per display

The means of average errors per display for L, M, H Order groups are seen in Table III. The inspection

Table III

Mean Average Errors per Display for L, M, H Order Groups

| | <u>L</u> | <u>M</u> | <u>H</u> | <u>Total</u> |
|------------|----------|----------|----------|--------------|
| Problem I | 1.06 | .85 | .61 | .84 |
| Problem II | .68 | .85 | .82 | .79 |
| Total | .87 | .85 | .71 | .81 |

of these means indicates some similarity to the results

seen in Table II. In this case, however, the analysis of variance, seen in Table II, Appendix D, revealed no significant effects. The A B effect (interaction) had a probability value of $<.10$.

B. Autonomy variable

1. Mean of number of displays

The mean number of displays for L, M, H Autonomy groups is seen in Table IV. These means suggest that the

Table IV

Mean Number of Displays for L, M, H Autonomy Groups

| | <u>L</u> | <u>M</u> | <u>H</u> | <u>Total</u> |
|------------|----------|----------|----------|--------------|
| Problem I | 15.56 | 14.16 | 13.26 | 14.34 |
| Problem II | 21.36 | 13.61 | 17.48 | 17.18 |
| Total | 18.46 | 13.88 | 15.36 | 15.74 |

L and H groups dropped in efficiency when shifting to the second problem; whereas the M group did not. However, the analysis of variance indicates that this interaction was not significant (Table III, Appendix D). The main effect of Autonomy approached significance ($<.10$). The problems effect was significant ($<.05$) which provides

verification of the assumption that the second problem was, in general, more difficult than the first problem.

2. Mean of average errors per display

The mean average errors per display for L, M, H Autonomy groups are seen in Table V. These results

Table V

Mean Average Errors per Display for L, M, H Autonomy Groups

| | <u>L</u> | <u>M</u> | <u>H</u> | <u>Total</u> |
|------------|-------------|------------|------------|--------------|
| Problem I | <u>.94</u> | <u>.83</u> | <u>.75</u> | <u>.84</u> |
| Problem II | <u>1.04</u> | <u>.55</u> | <u>.87</u> | <u>.79</u> |
| Total | .99 | .68 | .81 | .81 |

seem to follow rather closely the results obtained in Table IV. In this case, the main effect of Autonomy was significant ($<.05$) (Table IV, Appendix D). Tests (t) were run between the three column means seen in Table V. The results showed that the difference between L and M Autonomy groups had a probability value of $<.10$; while the differences between L and H, and M and H were not statistically significant.

C. Endurance variable

The mean number of displays and the mean of

average errors per display for L, M, H Endurance groups are seen in Tables VI and VII respectively. From the

Table VI

Mean Number Displays for L, M, H Endurance Groups

| | <u>L</u> | <u>M</u> | <u>H</u> | <u>Total</u> |
|------------|----------|----------|----------|--------------|
| Problem I | 15.43 | 14.67 | 12.50 | 14.34 |
| Problem II | 17.48 | 16.83 | 17.50 | 17.18 |
| Total | 16.45 | 15.75 | 15.00 | 15.74 |

analysis of variance only the problem effect was statistically significant ($<.05$) (Table V, Appendix D).

Table VII

Mean Average Errors per Display for L, M, H Endurance Groups

| | <u>L</u> | <u>M</u> | <u>H</u> | <u>Total</u> |
|------------|----------|----------|----------|--------------|
| Problem I | .89 | .86 | .74 | .84 |
| Problem II | .84 | .79 | .77 | .79 |
| Total | .86 | .82 | .75 | .81 |

No significant differences were found. (Table VI, Appendix D)

D. Achievement variable

The mean number of displays and the mean average errors per display for L, M, H Achievement groups are seen in Tables VIII and IX respectively. From the

Table VIII

Mean Number of Displays for L, M, H Achievement Groups

| | <u>L</u> | <u>M</u> | <u>H</u> | <u>Total</u> |
|------------|----------|----------|----------|--------------|
| Problem I | 14.36 | 14.03 | 14.73 | 14.34 |
| Problem II | 16.08 | 16.61 | 19.17 | 17.18 |
| Total | 15.22 | 15.32 | 16.95 | 15.74 |

analysis of variance only the problem effect was statistically significant at $< .05$. (Table VII, Appendix D)

Table IX

Mean Average Errors per Display for L, M, H Achievement Groups

| | <u>L</u> | <u>M</u> | <u>H</u> | <u>Total</u> |
|------------|----------|----------|----------|--------------|
| Problem I | .85 | .87 | .79 | .84 |
| Problem II | .66 | .81 | .93 | .79 |
| Total | .75 | .84 | .86 | .81 |

There were no statistically significant differences. (Table VIII, Appendix D)

E. Change variable

The mean of number of displays and the mean of average errors per display for L, M, H Change groups are seen in Tables X and XI respectively.

Table X

Mean Number of Displays for L, M, H Change Groups

| | <u>L</u> | <u>M</u> | <u>H</u> | <u>Total</u> |
|------------|----------|----------|----------|--------------|
| Problem I | 14.27 | 13.43 | 16.10 | 14.34 |
| Problem II | 16.63 | 18.67 | 15.05 | 17.18 |
| Total | 15.45 | 16.05 | 15.57 | 15.74 |

Aside from the problem effect ($<.05$), no other statistically significant differences were found. (Table IX, Appendix D)

Table XI

Mean Average Errors per Display for L, M, H
Change Groups

| | <u>L</u> | <u>M</u> | <u>H</u> | <u>Total</u> |
|------------|------------|------------|-------------|--------------|
| Problem I | <u>.84</u> | <u>.71</u> | <u>1.08</u> | <u>.84</u> |
| Problem II | <u>.87</u> | <u>.81</u> | <u>.69</u> | <u>.79</u> |
| Total | .85 | .76 | .89 | .81 |

There were no statistically significant differences.

(Table X, Appendix D)

F. Anxiety scale

The mean number of displays and the mean average errors per display for L, M, H Anxiety groups are seen in Tables XII and XIII respectively.

Table XII

Mean Number of Displays for L, M, H Anxiety
Groups

| | <u>L</u> | <u>M</u> | <u>H</u> | <u>Total</u> |
|------------|--------------|--------------|--------------|--------------|
| Problem I | <u>13.55</u> | <u>13.57</u> | <u>18.81</u> | <u>15.31</u> |
| Problem II | <u>18.65</u> | <u>16.11</u> | <u>18.29</u> | <u>17.35</u> |
| Total | 16.10 | 14.89 | 18.50 | 16.33 |

Aside from the problem effect ($<.05$) no other statistically significant differences were found.

(Table XI, Appendix D)

Table XIII

Mean Average Errors per Display for L, M, H Anxiety Groups

| | <u>L</u> | <u>M</u> | <u>H</u> | <u>Total</u> |
|------------|----------|----------|----------|--------------|
| Problem I | .89 | .69 | 1.20 | .90 |
| Problem II | .88 | .75 | .88 | .83 |
| Total | .88 | .72 | 1.04 | .86 |

There were no statistically significant differences.

(Table XII, Appendix D)

G. A. C. E. scores

As a check on the relationship of intellectual ability to efficiency of problem solving, Ss were subdivided on the basis of total A. C. E. scores obtained from the records of the Freshman Testing Program. The groups were divided on the basis of frequency distribution of scores obtained by the 64 Ss. The cutting points were: Low (N:21) 59-99; Middle (N:26) 100-119; High (N:17) 120-141. The mean number of displays and the mean average errors per trial for L, M, H, A. C. E. groups are seen in Tables XIV and XV respectively.

Table XIV

Mean Number of Displays for L, M, H, A. C. E. Groups

| | <u>L</u> | <u>M</u> | <u>H</u> | <u>Total</u> |
|------------|--------------|--------------|--------------|--------------|
| Problem I | <u>16.38</u> | <u>13.57</u> | <u>14.77</u> | <u>14.81</u> |
| Problem II | <u>18.76</u> | <u>15.65</u> | <u>16.94</u> | <u>17.01</u> |
| Total | 17.57 | 14.61 | 15.85 | 15.94 |

There are no statistically significant differences.

(Table XII, Appendix D)

Table XV

Mean Average Errors per Display for L, M, H, A. C. E. Groups

| | <u>L</u> | <u>M</u> | <u>H</u> | <u>Total</u> |
|------------|------------|------------|------------|--------------|
| Problem I | <u>.99</u> | <u>.79</u> | <u>.88</u> | <u>.87</u> |
| Problem II | <u>.97</u> | <u>.63</u> | <u>.84</u> | <u>.80</u> |
| Total | .98 | .71 | .86 | .84 |

There were no statistically significant differences.

(Table XIV, Appendix D)

H. Intercorrelations of Personality Scales and A. C. E.

After the above analyses were completed, correlation coefficients were computed among the PFS scales which had

shown the greatest relationship to problem solving efficiency. Intercorrelations with A scale and A. C. E. scores were also computed. These are seen in Table XVI.

Table XVI

Product - Moment Correlation Coefficients
between the PPS variables, A scale, and A. C. E. scores.

| | <u>A scale</u> | <u>Order</u> | <u>Endurance</u> | <u>Autonomy</u> |
|-----------|----------------|--------------|------------------|-----------------|
| A. C. E. | -.30** | .10 | .25* | -.03 |
| A scale | | -.13 | -.34** | .15 |
| Order | | | .39** | -.13 |
| Endurance | | | | -.12 |

** p < .01
* p < .05

An inspection of this table indicates that while some small significant relationships exist, the variables studied are largely independent of one another.

CHAPTER IV

DISCUSSION

The results obtained in this study provide some additional confirmation to the Wesley study which indicated that efficiency on problem solving is a function of certain personality variables. As the following discussion is presented, the writer has in mind the operational definitions of the personality variables as they are presented in the respective manuals. (8, 17)

It can be concluded that Order as defined in PPS has two effects upon efficiency in problem solving. The first effect is on the initial performance and the second effect is on shifting from the initial problem situation to a second, more difficult situation. Persons who are high on Order are most efficient on initial performance, but least efficient when shifting to a more difficult situation. On the other hand, persons who are low on Order are least efficient on the initial performance, but most efficient when shifting to a more difficult problem situation.

The Order variable suggests in its definition some type of organized mode of attack which the person uses in the problem situation. It might be speculated that

the high person on Order is more organized in his mode of attack and therefore solves the initial problem more efficiently. However, when the same person has to deal with a second more difficult situation, his well organized approach for the first problem still persists and the performance on the new situation is less efficient. By the same reasoning, the person who is low on Order is less organized in his mode of attack, therefore more flexible. His efficiency on the first task is poor, but when he approaches another situation, he is able to change his mode of attack with less difficulty. Thus, for the Order variable, one cannot talk about problem solving efficiency in general, but must separate the two effects: efficiency on initial performance and efficiency on shifting to new problems.

From the results in this study, it can be stated that Autonomy is a personality variable which has a more general influence on problem solving behavior. The person who obtained a medium score on Autonomy was the most efficient problem solver on both problems.

An inspection of the items of the Autonomy scale suggests dependent - independent characteristics. It might be speculated that the person low on Autonomy is accustomed to relying on others for guidance in attacking

new situations and is less efficient in dealing with the unfamiliar problem solving task. On the other hand, the person high on Autonomy may be independent to the degree of being "scattered" or inconsistent in approaching new situations. The person with a medium score on Autonomy is the best problem solver because he represents a balance between excessive dependence and excessive independence.

An inspection of the results for Order and Autonomy suggests that the effects of high Autonomy and low Order and low Autonomy and high Order are diametrically opposed. This is in spite of the absence of any significant correlation between the two scales.

While no significant effects were found for the Endurance and Anxiety scales, the observed difference in the means provides some basis for speculation. As to the Endurance variable, it seems that the person high on this scale is most efficient on the initial performance and least efficient when shifting to a second more difficult task. An inspection of the results on the A scale suggests that the person medium on Anxiety is most efficient on problem solving.

An interesting observation can be made with regard to the problem solving performance of A. C. E.

groups. Scores on this test are recognized as measures of intelligence and therefore it would be expected that the high group on A. C. E. would perform most efficiently on the problem solving task as noted above. The analysis of variance revealed no statistically significant differences. The small, observed differences favored the middle A. C. E. group.

The present study suggests that there are two aspects of efficiency on problem solving. The first is a matter of initial performance and the second concerns shifting to a second more difficult task. This study also suggests that the personality characteristics associated with these two types of efficiency are different. An inspection of the results indicates that the ideal problem solver in terms of initial performance would be high on Order, Autonomy, and Endurance, and medium on Change, Achievement, and A scale. The ideal problem solver on shifting to a second more difficult task would be high on Change and A scale, and medium on Autonomy; low on Achievement, Order, and Endurance.

CHAPTER V

SUMMARY

The purpose of this paper was to study the relationship of personality variables to efficiency of problem solving. For this purpose five scales - Order, Autonomy, Endurance, Achievement, Change - from the Edwards PPS and the Taylor A scale were studied in relationship to performance on a problem solving task.

Ss for this study were women from Westhampton College, enrolled in General Psychology classes. Ss were divided into Low, Middle, and High groups for each variable on the basis of the frequency distribution of scores obtained by Ss. The problem solving task was then administered to each S individually. Each S was given two problems. The criterion for the solution of each problem was four consecutive errorless trials. If the first problem was not solved in 30 displays, E started S on the second problem. The measure of efficiency for problem solving, which was reasonably independent, was two-fold: 1. number of displays; 2. average errors per display.

The major findings were as follows:

1. There was a significant ($<.05$) interaction between Order and problems on the number of displays

criterion and an interaction approaching significance ($\leq .10$) on the average errors per display criterion. There was a statistically significant difference on both problems on the number of displays criterion for the M and H Order groups ($\leq .05$). The difference between L and H Order groups approached statistical significance ($.05$).

2. The main effect for Autonomy was significant ($\leq .05$) for the average errors per display criterion and approached significance at $.10$ level for the number of displays criterion. The difference between L and M Autonomy groups had a probability value which measured $\leq .10$.

3. The problems effect was significant by the number of displays measure ($\leq .05$). Problem II was more difficult than Problem I.

With reference to these results, the following conclusions were reached:

1. Persons high in Order appear to be most efficient on initial performance on problem solving. Persons low in Order appear to be most efficient when shifting from the initial task to a second, more difficult task.

2. Degree of Autonomy influences problem solving behavior in general. Persons middle in Autonomy

appear to be most efficient on problem solving tasks.

3. The variables of Endurance, Achievement, Change, Anxiety scale do not influence problem solving behavior significantly.

4. Intellectual ability as measured by A. C. E. scores does not influence problem solving behavior significantly.

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APPENDIX A

TRUE- FALSE TEST

Number _____

The statements below represent experiences, ways of doing things, or beliefs or preferences that are true of some people but are not true of others. Read each statement and decide whether or not it is true with respect to yourself. If it is true or mostly true print T in the space provided in front of the question. If the statement is not usually true or is not true at all print F in the space provided in front of the question. Answer each statement as carefully and honestly as you can. There are no correct or wrong answers. We are interested in the way you work and in the things you believe. Answer each statement as you come to it. Be sure to answer each one.

- | | |
|---|--|
| <u>T</u> 1. I am often sick to my stomach. | _____ 16. I find it hard to make talk when I meet new people. |
| _____ 2. I think a great many people exaggerate their misfortunes in order to gain the sympathy and help of others. | <u>F</u> 17. I blush as often as others. |
| <u>F</u> 3. I do not tire quickly. | <u>T</u> 18. Once in a while I put off until tomorrow what I ought to do today. |
| _____ 4. I have had very few quarrels with members of my family. | _____ 19. I have nightmares every few nights. |
| <u>F</u> 5. I am about as nervous as other people. | _____ 20. People often disappoint me. |
| _____ 6. I would rather win than lose in a game. | <u>T</u> 21. I worry quite a bit over possible troubles. |
| <u>F</u> 7. I have very few headaches. | _____ 22. It makes me impatient to have people ask my advice or otherwise interrupt me when I am working on something important. |
| <u>T</u> 8. I worry over money and business. | <u>F</u> 23. I practically never blush. |
| <u>T</u> 9. I work under a great deal of strain. | _____ 24. I like to know some important people because it makes me feel important. |
| _____ 10. I think nearly anyone would tell a lie to keep out of trouble. | <u>T</u> 25. I am often afraid that I am going to blush. |
| <u>T</u> 11. I cannot keep my mind on one thing. | _____ 26. It takes a lot of argument to convince most people of the truth. |
| _____ 12. I do not like everyone I know. | <u>F</u> 27. My hands and feet are usually warm enough. |
| <u>T</u> 13. I have diarrhea ("the runs") once a month or more. | <u>T</u> 28. I often find myself worrying about something. |
| _____ 14. I am against giving money to beggars. | <u>T</u> 29. I sweat very easily even on cool days. |
| <u>T</u> 15. I frequently notice my hand shakes when I try to do something. | _____ 30. My table manners are not quite as good at home as when I am out in company. |

- T 31. When embarrassed I often break out in a sweat which is very annoying.
- ___ 32. I find it hard to set aside a ~~task~~ that I have undertaken, even for a short time.
- F 33. I do not often notice my heart pounding and I am seldom short of breath.
- ___ 34. It makes me uncomfortable to put on a stunt at a party even when others are doing the same sort of thing.
- T 35. I feel hungry almost all the time.
- ___ 36. If I could get into a movie without paying and be sure I was not seen I would probably do it.
- T 37. Often my bowels don't move for several days at a time.
- ___ 38. At times I feel like swearing.
- T 39. I have a great deal of stomach trouble.
- ___ 40. At time I am full of energy.
- T 41. At times I lose sleep over worry.
- ___ 42. I do not read every editorial in the newspaper every day.
- T 43. My sleep is restless and disturbed.
- ___ 44. Criticism or scolding hurts me terribly.
- T 45. I often dream about things I don't like to tell other people.
- T 46. I have often felt that I faced so many difficulties I could not overcome them.
- T 47. I am easily embarrssed.
- ___ 48. Sometimes when I am not feeling well I am cross.
- T 49. My feelings are hurt easier than most people.
- ___ 50. I often think " I wish I were a child again".
- T 51. I wish I could be as happy as others.
- ___ 52. Often I can't understand why I have been so cross and grouchy.
- T 53. I am usually calm and not easily upset.
- ___ 54. At times I feel like swearing.
- T 55. I cry easily.
- T 56. I certainly feel useless at times.
- T 57. I feel anxious about something or someone almost all of the time.
- ___ 58. At times I feel like smashing things.
- F 59. I am happy most of the time.
- ___ 60. Once in a while I laugh at a dirty joke.
- T 61. It makes me nervous to have to wait.
- ___ 62. At periods my mind seems to work more slowly than usual.
- T 63. At times I am so restless that I cannot sit in a chair for very long.
- ___ 64. Most people will use somewhat unfair means to gain profit or an advatage rather than to lose.
- T 65. Sometimes I become so excited that I find it hard to get to sleep.
- ___ 66. I do not always tell the truth.
- T 67. At times I have been worried beyond reason about something that really did not matter.
- ___ 68. I have often met people who were supposed to be experts who were no better than I.

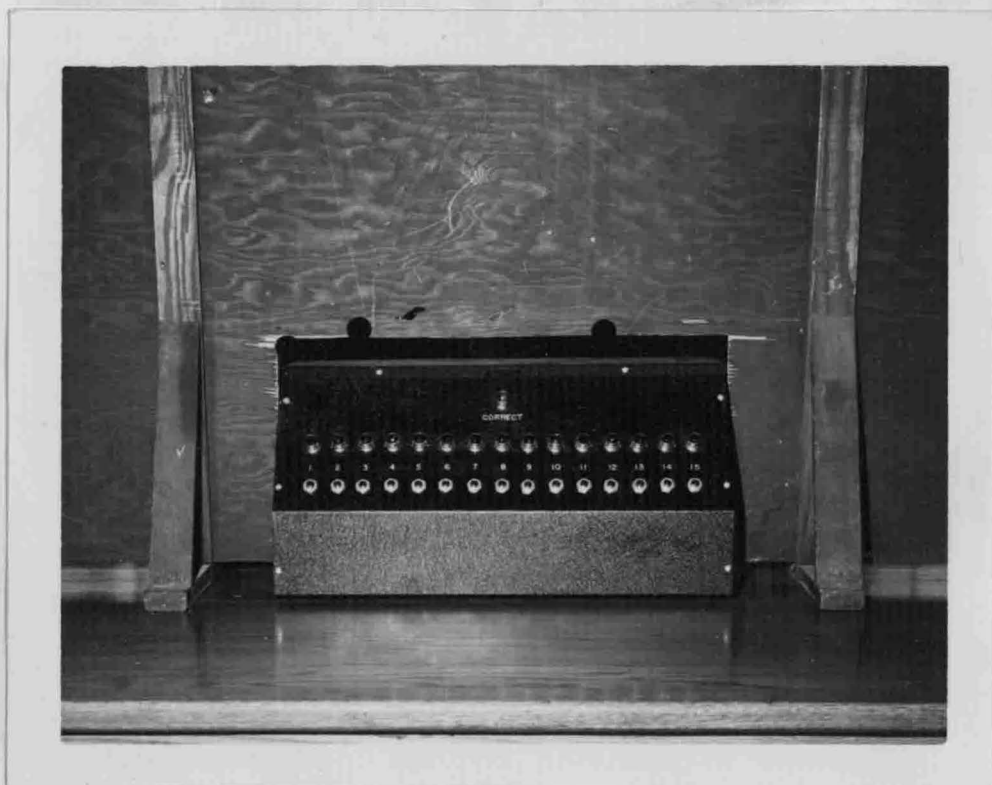
- F 69. I do not have as many fears as my friends.
- ___ 70. What others think of me does not bother me.
- T 71. I have been afraid of things or people that I knew could not hurt me.
- ___ 72. I get angry sometimes.
- T 73. I find it hard to keep my mind on a task or job.
- ___ 74. I have never felt better in my life than I do now.
- T 75. I am more self-conscious than most people.
- ___ 76. I like to let people know where I stand on things.
- T 77. I am the kind of person who Takes things hard.
- ___ 78. I gossip a little at times.
- T 79. I am a very nervous person.
- ___ 80. When in a group of people I have trouble thinking of the right things to talk about.
- T 81. Life is often a strain for me.
- ___ 82. I get mad easily and get over it soon.
- T 83. At times I think I am no good at all.
- ___ 84. Once in a while I think of things too bad to talk about.
- T 85. I am not at all confident of myself.
- ___ 86. I have periods in which I feel unusually cheerful without any special reason.
- T 87. At times I feel that I am going to crack up.
- ___ 88. At times my thoughts have raced ahead faster than I could speak them.
- T 89. I don't like to face a difficulty or make an important decision.
- ___ 90. Sometimes at elections I vote for men about whom I know very little.
- F 91. I am very confident of myself.

APPENDIX B

Photographs of the Corder box

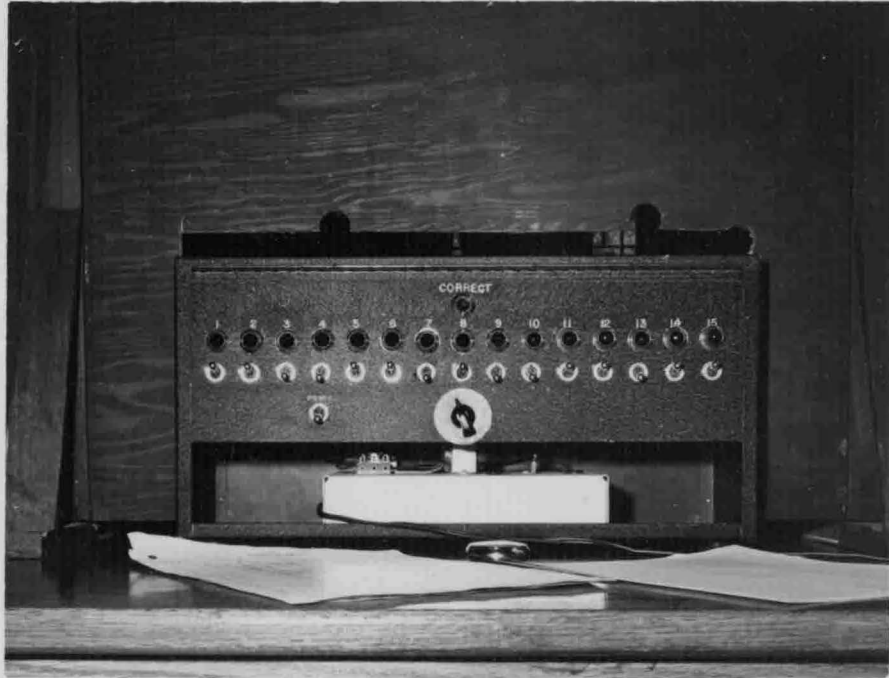
I

Subject's side



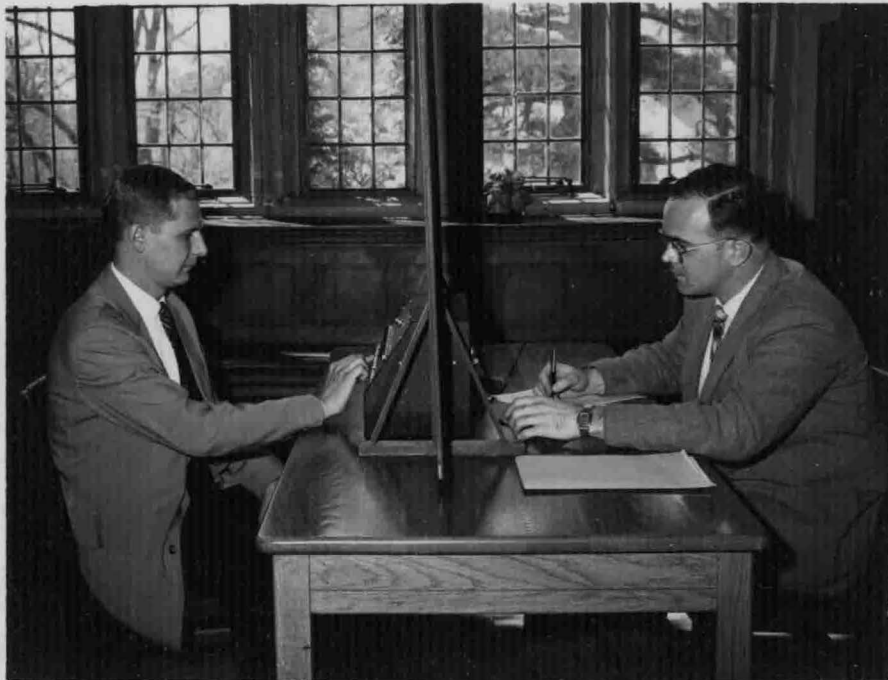
II

Experimenter's side



III

Subject and Experimenter



APPENDIX C

FINAL INSTRUCTIONS AND PROBLEMS USED IN PROBLEM SOLVING
STUDY: SPRING 1957

(Corder-Williams-Grigorowitsch)

- * Keep display on for 30 sec. after correct R is made.
- * Use only Problems #1 and #2.
- * Ask S not to discuss experiment with friends.

We are interested in how people perform on this task. This is what we call a problem-solving task. In front of you there are 15 green lights which you will notice are numbered. At the start, several of these lights will come on. You should pay attention only to the lights that are lit. Your job is to discover a rule so that you will know which numbered light (and button) is the correct one. The first time, of course, you will have to guess. When you have found the correct button, the yellow light in the center will come on. Then all the lights will go off. After a moment, the lights will come on again. Again you must find the correct button. This will continue a number of times. The point is there is a rule involved ... and as soon as you discover the rule, you will know which light is correct.

Here is an example. (Display on) Which number is the correct one? Select the number you think might be

correct. Push the button under this number and see if the yellow light comes on. (Wait) Find which one of the numbers is the "correct" one. (Wait until the "correct" is found.) Why do you think that light No. 5 is correct? Tell me all the reasons you can think of which might make No. 5 the correct one. (Pause.) Yes (or) you may have to pay attention to the numerical values in finding the rule.

(Do not go on until a numerical hypothesis is offered.)

(Display off)

(Display on)

Which number is correct this time? Take your time. Each incorrect choice will count as an error. Remember to look for the rule which will tell you which number is correct. The same rule holds each time the lights come on. (After correct light is found) What number was correct this time? Does this confirm any of the reasons you thought of last time? Does this eliminate any of them? Can you think of any other rules which might apply?

(Display off)

You are still working on the first problem. When you can push the correct button each time without trying any of the others, you have learned the problem. When

you do this four times in a row, we shall go on to the next problem.

Now I want you to think about the task for a moment and see if you have any questions. After the lights come on again, I cannot answer any questions at all.

(Wait just a moment for questions and then go on.)

(Answer questions)

(Display on, etc., until problem 1 is learned)

THIS IS A NEW PROBLEM: NUMBER 2. Try to discover the rule for this problem. (Display, etc., no comments by E.)

THIS IS A NEW PROBLEM: NUMBER 3.

(Note: If subject does not reach criterion in thirty displays, stop subjects and go on to next problem.)

(Exception: if evidence of solution, continue for one or two more.)

DISPLAY

PROBLEM 1

43

| | | | | | | |
|----|---|---|-----------|-----------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 | 8 | |
| 2 | 4 | 5 | 6 | 7 | 8 | 9 |
| 3 | 1 | 3 | <u>4</u> | 5 | 9 | 10 |
| 4 | 3 | 5 | 6 | <u>8</u> | 10 | 12 |
| 5 | 1 | 2 | <u>3</u> | 8 | 9 | 10 |
| 6 | 1 | 5 | <u>6</u> | 9 | 10 | |
| 7 | 3 | 4 | 6 | <u>7</u> | 13 | 14 |
| 8 | 6 | 7 | 10 | 12 | <u>13</u> | |
| 9 | 2 | 4 | 5 | <u>6</u> | 9 | |
| 10 | 3 | 7 | 8 | 9 | <u>10</u> | |
| 11 | 4 | 5 | <u>2</u> | 11 | 13 | |
| 12 | 2 | 6 | 7 | <u>8</u> | 12 | 15 |
| 13 | 1 | 5 | <u>6</u> | 8 | 14 | |
| 14 | 1 | 8 | <u>2</u> | 12 | 13 | |
| 15 | 5 | 9 | 11 | 12 | 13 | <u>14</u> |
| 16 | 1 | 4 | <u>5</u> | 6 | 8 | |
| 17 | 4 | 8 | 9 | 11 | <u>12</u> | 13 |
| 18 | 3 | 6 | 8 | <u>2</u> | 11 | |
| 19 | 7 | 8 | 9 | 12 | <u>15</u> | |
| 20 | 1 | 7 | <u>8</u> | <u>13</u> | 14 | |
| 21 | 5 | 8 | 9 | 10 | 12 | <u>13</u> |
| 22 | 2 | 8 | 9 | <u>10</u> | 11 | 14 |
| 23 | 2 | 5 | 6 | <u>7</u> | 8 | |
| 24 | 5 | 7 | 8 | 10 | <u>12</u> | |
| 25 | 3 | 8 | 9 | 10 | <u>11</u> | 12 |
| 26 | 6 | 8 | 10 | 12 | <u>14</u> | |
| 27 | 3 | 7 | <u>10</u> | 12 | 15 | |
| 28 | 1 | 6 | <u>7</u> | 8 | 12 | |
| 29 | 6 | 9 | 10 | 11 | 14 | <u>15</u> |
| 30 | 5 | 6 | 8 | 9 | 10 | <u>11</u> |

DISPLAY

| | | | | | | |
|----|----------|----------|----------|----------|----------|----|
| 1 | 1 | 3 | <u>4</u> | 6 | 8 | |
| 2 | 2 | <u>5</u> | 6 | 7 | 10 | 11 |
| 3 | <u>7</u> | 8 | 9 | 10 | 11 | 14 |
| 4 | 2 | <u>6</u> | 9 | 10 | 12 | |
| 5 | 1 | 2 | <u>3</u> | 4 | 5 | 6 |
| 6 | 3 | <u>4</u> | 8 | 9 | 11 | |
| 7 | <u>2</u> | 4 | 5 | 7 | 9 | |
| 8 | <u>6</u> | 7 | 8 | 12 | 15 | |
| 9 | 6 | <u>7</u> | 11 | 13 | 14 | |
| 10 | 3 | <u>5</u> | 8 | 9 | 10 | |
| 11 | 2 | <u>3</u> | 4 | 5 | 6 | 9 |
| 12 | <u>4</u> | 5 | 6 | 8 | 11 | 13 |
| 13 | 5 | <u>7</u> | 9 | 10 | 11 | 14 |
| 14 | 1 | <u>2</u> | 3 | 4 | 9 | |
| 15 | <u>1</u> | 2 | 3 | 5 | 7 | 9 |
| 16 | 1 | 2 | 5 | <u>6</u> | 11 | 12 |
| 17 | <u>5</u> | 6 | 7 | 9 | 10 | |
| 18 | 3 | <u>6</u> | 9 | 12 | 15 | |
| 19 | <u>2</u> | 3 | 4 | 11 | 13 | 15 |
| 20 | 2 | 5 | 6 | <u>7</u> | 11 | 14 |
| 21 | <u>2</u> | 3 | 4 | 11 | 13 | 15 |
| 22 | 3 | 4 | <u>5</u> | 7 | 10 | |
| 23 | <u>6</u> | 7 | 9 | 11 | 12 | |
| 24 | 1 | <u>3</u> | 6 | 13 | 15 | |
| 25 | 2 | 3 | 4 | 6 | <u>7</u> | 14 |
| 26 | 1 | 2 | 3 | <u>4</u> | 8 | |
| 27 | 4 | <u>5</u> | 8 | 9 | 10 | |
| 28 | 2 | 4 | <u>6</u> | 8 | 10 | 12 |
| 29 | 2 | 6 | 7 | 12 | 14 | 15 |
| 30 | <u>2</u> | 3 | 4 | 9 | 11 | |

APPENDIX D

Table I

Summary of analysis of variance of the Order variable on the number of displays criterion.

| Source | df | SS | MS | F | P |
|-----------------|-----|---------|--------|------|------|
| Between Ss | 78 | 8085.50 | | | |
| (B) Personality | 2 | 125 | 62.50 | <1 | >.20 |
| error (b) | 76 | 7960.50 | 104.74 | | |
| Within Ss | 79 | 5132.50 | | | |
| A (Problems) | 1 | 320 | 320 | 5.84 | <.05 |
| AB | 2 | 351 | 175.50 | 3.21 | <.05 |
| error (w) | 76 | 4161.50 | 54.75 | | |
| Total | 157 | | | | |

Table II

Summary of analysis of variance of the Order variable on the number of average errors per display criterion.

| Source | df | SS | MS | F | P |
|-----------------|-----|---------|-------|------|------|
| Between Ss | 78 | 33.2405 | | | |
| (B) Personality | 2 | .7087 | .3543 | <1 | >.20 |
| error (b) | 76 | 32.5318 | .4280 | | |
| Within Ss | 79 | 25.8237 | | | |
| A (Problems) | 1 | .0714 | .0714 | <1 | >.20 |
| AB | 2 | 1.9122 | .9561 | 3.05 | <.10 |
| error (w) | 76 | 23.8401 | .3137 | | |
| Total | 157 | | | | |

Table III

Summary of analysis of variance of the Autonomy variable on the number of displays criterion.

| Source | df | SS | MS | F | P |
|--------------|-----|---------|--------|------|------|
| Between Ss | 78 | 8085.50 | | | |
| B (Autonomy) | 2 | 588 | 294.00 | 2.98 | <.10 |
| error (b) | 76 | 7497.50 | 98.65 | | |
| Within Ss | 79 | 5132.50 | | | |
| A (Problems) | 1 | 320 | 320 | 5.40 | <.05 |
| AB | 2 | 310.25 | 155.12 | 2.62 | <.10 |
| error (w) | 76 | 4502.25 | 59.24 | | |
| Total | 157 | | | | |

Table IV

Summary of analysis of variance of the Autonomy variable on the number of average errors per display criterion.

| Source | df | SS | MS | F | P |
|--------------|-----|---------|--------|------|------|
| Between Ss | 78 | 33.2405 | | | |
| B (Autonomy) | 2 | 2.5315 | 1.2658 | 3.13 | <.05 |
| error (b) | 76 | 30.7090 | .4040 | | |
| Within Ss | 79 | 25.8237 | | | |
| A (Problems) | 1 | .0714 | .0714 | <1 | >.20 |
| AB | 2 | 1.4067 | .7038 | 2.19 | <.20 |
| error (w) | 76 | 24.3456 | .3203 | | |
| Total | 157 | | | | |

Table V

Summary of analysis of variance of the Endurance variable on the number of displays criterion.

| Source | df | SS | MS | F | P |
|---------------|-----|---------|--------|------|------|
| Between Ss | 78 | 8085.50 | | | |
| B (Endurance) | 2 | 44 | 22 | <1 | >.20 |
| error (b) | 76 | 8041.50 | 105.81 | | |
| Within Ss | 79 | 5132.50 | | | |
| A (Problems) | 1 | 320 | 320 | 5.47 | <.05 |
| AB | 2 | 63.61 | 31.80 | <1 | >.20 |
| error (w) | 76 | 4448.89 | 58.54 | | |
| Total | 157 | | | | |

Table VI

Summary of analysis of variance of the Endurance variable on the number of average errors per display criterion.

| Source | df | SS | MS | F | P |
|---------------|-----|---------|-------|----|------|
| Between Ss | 78 | 33.2405 | | | |
| B (Endurance) | 2 | .2606 | .1303 | <1 | >.20 |
| error (b) | 76 | 32.9799 | .4339 | | |
| Within Ss | 79 | 25.8237 | | | |
| A (Problems) | 1 | .0714 | .0714 | <1 | >.20 |
| AB | 2 | .0650 | .0325 | <1 | >.20 |
| error (w) | 76 | 25.6873 | .3379 | | |
| Total | 157 | | | | |

Table VII

Summary of analysis of variance of the Achievement variable on the number of displays criterion.

| Source | df | SS | MS | F | P |
|-----------------|-----|---------|--------|------|------|
| Between Ss | 78 | 8085.50 | | | |
| B (Achievement) | 2 | 91 | 45.50 | <1 | >.20 |
| error (b) | 76 | 7994.50 | 105.19 | | |
| Within Ss | 79 | 5132.50 | | | |
| A (Problems) | 1 | 320 | 320 | 5.10 | <.05 |
| AB | 2 | 47 | 23.50 | <1 | >.20 |
| error (w) | 76 | 4765.50 | 62.70 | | |
| Total | 157 | | | | |

Table VIII

Summary of analysis of variance of the Achievement variable on the number average errors per display criterion.

| Source | df | SS | MS | F | P |
|-----------------|-----|---------|-------|----|------|
| Between Ss | 78 | 33.2405 | | | |
| B (Achievement) | 2 | .3153 | .1527 | <1 | >.20 |
| error (b) | 76 | 32.9252 | .4332 | | |
| Within Ss | 79 | 25.8237 | | | |
| A (Problems) | 1 | .0714 | | | |
| AB | 2 | .6622 | .3311 | <1 | >.20 |
| error (w) | 76 | 25.0901 | .3313 | <1 | >.20 |
| Total | 157 | | | | |

Table IX

Summary of analysis of variance of the Change variable on the number of displays criterion.

| Source | df | SS | MS | F | P |
|--------------|-----|---------|--------|------|------|
| Between Ss | 78 | 8085.50 | | | |
| B (Change) | 2 | 11 | 5.50 | <1 | >.20 |
| error (b) | 76 | 8074.50 | 106.24 | | |
| Within Ss | 79 | 5132.50 | | | |
| A (Problems) | 1 | 320 | 320 | 5.84 | <.05 |
| AB | 2 | 261 | 135.50 | 2.31 | <.20 |
| error (w) | 76 | 4451.50 | 58.57 | | |
| Total | 157 | | | | |

Table X

Summary of analysis of variance of the Change variable on the number average error per display criterion.

| Source | df | SS | MS | F | P |
|--------------|-----|---------|--------|------|------|
| Between Ss | 78 | 33.2405 | | | |
| B (Change) | 2 | 2.2240 | 1.1120 | <1 | >.20 |
| error (b) | 76 | 32.7568 | 4.3101 | | |
| Within Ss | 79 | 25.8237 | | | |
| A (Problems) | 1 | .0714 | .0714 | | |
| AB | 2 | 1.6689 | .8345 | <1 | >.20 |
| error (w) | 76 | 24.0834 | .3168 | 2.63 | <.20 |
| Total | 157 | | | | |

Table XI

Summary of analysis of variance of the A scale variable on the number of displays criterion.

| Source | df | SS | MS | F | P |
|--------------|-----|---------|--------|------|------|
| Between Ss | 66 | 7126.50 | | | |
| B (A scale) | 2 | 322 | 161.00 | 1.51 | >.20 |
| error (b) | 64 | 6804.50 | 106.32 | | |
| Within Ss | 67 | 7826.50 | | | |
| A (Problems) | 1 | 184 | 184 | 3.08 | <.05 |
| AB | 2 | 63.97 | 31.99 | <1 | >.20 |
| error (w) | 64 | 3817.53 | 59.65 | | |
| Total | 133 | | | | |

Table XII

Summary of analysis of variance of the A scale variable on the number average error per display criterion.

| Source | df | SS | MS | F | P |
|--------------|-----|---------|--------|------|------|
| Between Ss | 66 | 35.4636 | | | |
| B (A scale) | 2 | 2.4053 | 1.2026 | <1 | >.20 |
| error (b) | 64 | 33.0583 | .5165 | | |
| Within Ss | 67 | 12.7716 | | | |
| A (Problems) | 1 | .2397 | .2397 | 1.30 | >.20 |
| AB | 2 | .7707 | .3853 | 2.09 | >.20 |
| error (w) | 64 | 11.7612 | .1837 | | |
| Total | 133 | | | | |

Table XIII

Summary of analysis of variance of the A. C. E. scale variable on the number of displays criterion.

| Source | df | SS | MS | F | P |
|--------------------|-----|---------|--------|------|------|
| Between Ss | 63 | 7742.50 | | | |
| B (A. C. E. scale) | 2 | 203 | 101.50 | < 1 | >.20 |
| error (b) | 61 | 7540.50 | 147.85 | | |
| Within Ss | 64 | 2741.50 | | | |
| A (Problems) | 1 | 155 | 155 | 3.18 | <.05 |
| AB | 2 | .99 | .48 | < 1 | >.20 |
| error (w) | 61 | 2585.51 | 42.38 | | |
| Total | 127 | | | | |

Table XIV

Summary of analysis of variance of the A. C. E. scale variable on the number of average error per display criterion.

| Source | df | SS | MS | F | P |
|--------------------|-----|---------|-------|------|------|
| Between Ss | 63 | 26.5873 | | | |
| B (A. C. E. scale) | 2 | 1.6797 | .8399 | 2.05 | <.20 |
| error (b) | 61 | 24.9076 | .4083 | | |
| Within Ss | 64 | 21.6224 | | | |
| A (Problems) | 1 | .1922 | .1922 | < 1 | >.20 |
| AB | 2 | .1352 | .0676 | < 1 | >.20 |
| error (w) | 61 | 21.2950 | .3490 | | |
| Total | 127 | | | | |

APPENDIX E

RAW DATA

| S u b j e c t s | A c h i e v e m e n t | O r d e r | A u t o n o m y | C h a n g e | E n d u r a n c e | A s c a l e | A. C. E. | Number Displays | | | | Average Error per Display | |
|--------------------------------------|---|-----------------------|--------------------------------------|----------------------------|---|----------------------------|----------|--------------------|----|------|------|------------------------------------|----|
| | | | | | | | | 1. | 2. | 1. | 2. | 1. | 2. |
| 1 | 8 | 10 | 7 | 20 | 4 | 14 | 117 | 12 | 6 | .83 | .33 | | |
| 2 | 12 | 16 | 14 | 9 | 20 | 14 | 140 | 6 | 7 | .0 | .71 | | |
| 3 | 21 | 6 | 13 | 8 | 10 | 16 | 107 | 30 | 30 | 1.90 | 1.17 | | |
| 4 | 18 | 4 | 14 | 21 | 13 | 13 | 114 | 8 | 10 | .62 | .80 | | |
| 5 | 19 | 3 | 9 | 22 | 15 | 13 | 131 | 30 | 5 | 1.37 | .0 | | |
| 6 | 18 | 11 | 14 | 10 | 9 | 13 | - | 7 | 6 | 0 | 0 | | |
| 7 | 17 | 15 | 6 | 21 | 11 | 12 | 120 | 7 | 22 | .71 | 1.40 | | |
| 8 | 20 | 18 | 10 | 13 | 25 | 12 | - | 6 | 30 | 0 | 1.10 | | |
| 9 | 12 | 22 | 9 | 5 | 14 | - | 118 | 12 | 6 | .75 | 0 | | |
| 10 | 16 | 4 | 11 | 21 | 16 | 14 | - | 30 | 30 | 1.87 | 1.50 | | |
| 11 | 12 | 7 | 3 | 20 | 9 | 14 | - | 23 | 8 | 1.35 | .12 | | |
| 12 | 23 | 11 | 12 | 11 | 17 | 15 | 131 | 16 | 12 | 1.06 | .58 | | |
| 13 | 14 | 15 | 4 | 17 | 11 | 14 | - | 13 | 10 | .54 | .20 | | |
| 14 | 19 | 13 | 3 | 14 | 13 | 17 | 108 | 23 | 24 | .78 | 1.20 | | |
| 15 | 9 | 7 | 13 | 14 | 12 | - | - | 7 | 4 | .28 | 0 | | |
| 16 | 14 | 5 | 26 | 17 | 4 | 32 | 122 | 13 | 30 | 1.15 | 1.47 | | |
| 17 | 13 | 7 | 17 | 16 | 3 | 17 | 94 | 6 | 22 | 0 | 1.36 | | |
| 18 | 11 | 6 | 17 | 18 | 12 | - | 128 | 6 | 6 | 0 | 0 | | |

| S u b j e c t s | A c h i e v e m e n t | O r d e r | A u t o n o m y | C h a n g e | E n d u r a n c e | A s c a l e | A. C. E. | Number Displays | | Average Error per Display | |
|--------------------------------------|---|-----------------------|--------------------------------------|----------------------------|---|----------------------------|----------|-----------------|-----------------|---------------------------|------------------|
| | | | | | | | | $\frac{1.}{6}$ | $\frac{2.}{10}$ | $\frac{1.}{0}$ | $\frac{2.}{.50}$ |
| 19 | 14 | 5 | 12 | 14 | 10 | - | 126 | $\frac{1.}{6}$ | $\frac{2.}{10}$ | $\frac{1.}{0}$ | $\frac{2.}{.50}$ |
| 20 | 17 | 4 | 7 | 13 | 7 | 14 | - | 7 | 30 | .14 | 1.93 |
| 21 | 9 | 11 | 5 | 13 | 18 | 13 | 114 | 8 | 30 | .12 | .83 |
| 22 | 12 | 15 | 12 | 12 | 17 | 15 | - | 13 | 9 | .61 | 1.11 |
| 23 | 9 | 3 | 15 | 26 | 12 | - | 119 | 14 | 9 | .93 | .11 |
| 24 | 18 | 3 | 8 | 15 | 11 | 13 | 119 | 30 | 30 | 1.77 | .93 |
| 25 | 17 | 6 | 16 | 7 | 12 | 26 | 130 | 10 | 5 | .30 | 0 |
| 26 | 6 | 17 | 12 | 16 | 10 | 20 | 78 | 6 | 30 | 0 | 1.13 |
| 27 | 13 | 12 | 10 | 25 | 16 | 14 | 119 | 9 | 5 | 1.11 | 0 |
| 28 | 12 | 9 | 18 | 22 | 15 | 16 | 133 | 6 | 12 | 0 | .50 |
| 29 | 11 | 11 | 7 | 7 | 20 | 13 | 124 | 15 | 30 | .47 | 1.60 |
| 30 | 9 | 12 | 10 | 15 | 9 | 17 | 115 | 9 | 7 | .67 | .14 |
| 31 | 13 | 10 | 5 | 14 | 12 | 16 | 119 | 6 | 12 | 0 | .66 |
| 32 | 6 | 11 | 16 | 16 | 9 | - | 62 | 9 | 23 | .55 | 1.22 |
| 33 | 18 | 19 | 23 | 11 | 23 | 22 | 88 | 6 | 23 | 0 | 1.48 |
| 34 | 17 | 13 | 11 | 21 | 11 | 19 | 105 | 7 | 30 | .42 | 1.50 |
| 35 | 15 | 3 | 15 | 13 | 13 | 13 | - | 6 | 11 | 0 | .45 |
| 36 | 14 | 10 | 8 | 12 | 12 | 14 | 91 | 8 | 11 | 1.00 | .82 |
| 37 | 9 | 13 | 12 | 20 | 11 | 28 | 99 | 18 | 6 | 1.17 | 0 |

| S u b j e c t s | A c h i e v e m e n t | O r d e r | A u t o n o m y | C h a n g e | E n d u r a n c e | A s c a l e | A. C. E. | Number Displays | | Average Error per Display | |
|--------------------------------------|---|-----------------------|--------------------------------------|----------------------------|---|----------------------------|----------|-----------------|-----------|---------------------------|------------|
| | | | | | | | | <u>1.</u> | <u>2.</u> | <u>1.</u> | <u>2.</u> |
| 38 | 7 | 8 | 10 | 11 | 20 | 15 | 114 | <u>19</u> | <u>10</u> | <u>1.00</u> | <u>.10</u> |
| 39 | 12 | 4 | 14 | 21 | 8 | 18 | 86 | 30 | 19 | 2.00 | .84 |
| 40 | 13 | 6 | 9 | 22 | 10 | 18 | 59 | 30 | 11 | 1.87 | 1.00 |
| 41 | 22 | 2 | 18 | 19 | 4 | 30 | 89 | 30 | 30 | 1.17 | 1.40 |
| 42 | 11 | 13 | 13 | 13 | 14 | 20 | 91 | 6 | 13 | 0 | .23 |
| 43 | 13 | 11 | 8 | 16 | 18 | 19 | 99 | 11 | 28 | .18 | .96 |
| 44 | 10 | 14 | 9 | 18 | 5 | 31 | 106 | 7 | 6 | .57 | 0 |
| 45 | 11 | 9 | 8 | 15 | 10 | 23 | 96 | 12 | 12 | 1.25 | .67 |
| 46 | 17 | 3 | 11 | 13 | 12 | 23 | 107 | 23 | 6 | 1.40 | 0 |
| 47 | 18 | 21 | 15 | 8 | 22 | 18 | - | 8 | 10 | .75 | .30 |
| 48 | 20 | 16 | 9 | 8 | 17 | 27 | 98 | 13 | 7 | .46 | .43 |
| 49 | 13 | 11 | 6 | 4 | 9 | 23 | 98 | 19 | 8 | 1.47 | .12 |
| 50 | 11 | 11 | 6 | 9 | 14 | 19 | 74 | 30 | 30 | 1.67 | 1.70 |
| 51 | 13 | 2 | 11 | 10 | 9 | 22 | - | 11 | 23 | .81 | .87 |
| 52 | 13 | 6 | 12 | 8 | 9 | 24 | 101 | 15 | 15 | 1.13 | .33 |
| 53 | 14 | 9 | 2 | 15 | 17 | 24 | - | 15 | 30 | 1.27 | 1.73 |
| 54 | 8 | 8 | 16 | 12 | 4 | 19 | 100 | 30 | 30 | 1.53 | 1.67 |
| 55 | 10 | 18 | 15 | 19 | 13 | 20 | 96 | 18 | 23 | 1.50 | 1.35 |
| 56 | 14 | 13 | 16 | 14 | 7 | 28 | 99 | 23 | 30 | 1.22 | 1.90 |

| S u b j e c t s | A c h i e v e m e n t | O r d e r | A u t o n o m y | C h a n g e | E n d u r a n c e | A s c a l e | A. C. E. | Number Displays | | Average Error per Display | |
|--------------------------------------|---|-----------------------|--------------------------------------|----------------------------|---|----------------------------|----------|-----------------|-----------|---------------------------|-----------|
| | | | | | | | | <u>1.</u> | <u>2.</u> | <u>1.</u> | <u>2.</u> |
| 57 | 16 | 10 | 6 | 21 | 13 | 26 | 129 | <u>18</u> | <u>12</u> | 1.77 | .66 |
| 58 | 13 | 8 | 4 | 20 | 14 | 34 | 87 | 16 | 29 | 1.25 | 1.62 |
| 59 | 11 | 3 | 9 | 22 | 12 | 18 | 130 | 30 | 12 | 1.93 | .75 |
| 60 | 15 | 11 | 9 | 24 | 12 | 8 | 100 | 6 | 11 | 0 | .64 |
| 61 | 10 | 11 | 17 | 25 | 15 | 0 | 128 | 15 | 26 | 1.40 | 1.27 |
| 62 | 7 | 12 | 11 | 19 | 16 | 7 | - | 14 | 9 | .71 | .11 |
| 63 | 13 | 19 | 7 | 20 | 14 | 3 | 119 | 6 | 20 | 0 | 1.00 |
| 64 | 5 | 12 | 8 | 8 | 15 | 11 | 116 | 7 | 30 | .43 | 1.73 |
| 65 | 10 | 12 | 11 | 18 | 13 | 1 | 91 | 10 | 6 | 1.30 | .17 |
| 66 | 19 | 9 | 12 | 12 | 10 | 9 | 76 | 13 | 10 | .85 | 1.10 |
| 67 | 12 | 6 | 22 | 21 | 16 | 7 | 119 | 9 | 7 | 1.78 | .28 |
| 68 | 19 | 7 | 4 | 18 | 11 | 7 | 141 | 17 | 15 | 1.00 | .40 |
| 69 | 14 | 12 | 17 | 16 | 13 | 9 | 115 | 23 | 30 | 1.13 | 1.70 |
| 70 | 18 | 8 | 12 | 20 | 13 | 8 | 118 | 6 | 23 | 0 | 1.26 |
| 71 | 11 | 10 | 8 | 27 | 15 | 10 | 123 | 30 | 30 | 1.50 | 1.27 |
| 72 | 16 | 15 | 4 | 14 | 15 | 10 | 97 | 30 | 23 | 1.83 | .87 |
| 73 | 19 | 6 | 12 | 25 | 3 | 11 | 103 | 7 | 6 | .14 | 0 |
| 74 | 18 | 20 | 8 | 10 | 14 | 7 | 134 | 18 | 30 | 1.50 | 1.97 |
| 75 | 9 | 9 | 10 | 24 | 22 | 7 | 111 | 21 | 10 | 1.52 | .10 |
| 76 | 18 | 12 | 5 | 7 | 14 | 9 | 127 | 8 | 24 | .75 | 1.29 |
| 77 | 8 | 13 | 18 | 23 | 18 | 6 | 111 | 6 | 4 | 0 | 0 |
| 78 | 23 | 14 | 19 | 16 | 19 | 3 | - | 16 | 29 | 1.19 | 1.21 |
| 79 | 12 | 11 | 13 | 24 | 18 | 10 | - | 9 | 30 | .78 | 1.27 |

VITA

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