# PERSONALITY VARIABLES IN PROBLEM SOLVING

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## ABSTRACT

### PERSONALITY VARIABLES IN PROBLEM SOLVING

**by Hannah Lerman**

This study was designed primarily to explore the relationships between personality variables which include a wide range of the aspects of "normal" psychological functioning and problem-solving behavior on three problem tasks: the Luchins Water Jar Problems, the Cowen Alphabet Mazes and the Wisconsin Card Sorting Test. The California Personality Inventory was the personality instrument utilized. It yields eighteen scores covering a variety of personality factors. Forty-eight students in the introductory psychology course at Michigan State University served as subjects. The effect of the sex of the subjects and the order of presentation of the tasks were also studied.

Few if any of the relationships that are suggested by the results could be confidently stated to represent real rather than chance relationships. Since, however, a few statistically significant results were obtained, this study cannot be said to have shown that there are no relationships between personality and test variables. Replication of the study would be necessary before this could be ascertained. Possible meanings for those relationships which were found were discussed.

Sex differences in problem solving were found only in the time to solution for the "set" problems on the LWJ and on no other of the various measures derived from the problem-solving tasks. The order of the presentation of the tasks did not affect the results significantly.

# PERSONALITY VARIABLES IN PROBLEM SOLVING

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# INTRODUCTION

## Problem Solving and Rigidity

Many attempts have been made to relate success or failure in one type of problem-solving situation to performance in other situations by investigating the possibility of the existence of a generalised personality trait of rigidity (Applesweig, 1954; Cattell, 1946; Cowen and Thompson, 1951; Cowen, Wiener and Hess, 1953; Fisher, 1950; Forster, Vinacke and Digman, 1955; Pitcher and Stacy, 1954; Rokeach, 1948; Schmidt, Fonda and Wesley, 1954). Due to procedural differences among the studies, the various kinds of problem situations used and the different ways of defining rigidity, the results of these investigations are difficult to analyse (Applesweig, 1954).

Out of them, however, vigorous proponents of the two opposing viewpoints have emerged. Rokeach (1948, 1949, 1950) believes that rigidity is not an isolated phenomenon when it appears, but is an aspect of a general factor which will manifest itself in the solution of any problem. Billings (1934) had earlier found problem-solving ability in one field to be related to an individual's ability to deal with problems in other areas. Cowen and Thompson (1951) and Schmidt, Fonda and Wesley (1954) are also in accord with this view.

On the negative side, factor-analytic studies have failed to find a generalised rigidity or flexibility factor when the interrelationships of various problem tasks have been studied (Guilford, Frick, Christensen and Merrifield, 1957; Jasper, 1931; Kleemeier and Dudek, 1950; Notcutt, 1943).

Shevach (1937) suggested that perseveration, seemingly an aspect of problem-solving ability similar if not identical to rigidity, exists as a functional unity for some individuals while this unity is weak or non-existent for other individuals and the different populations used in the various studies might explain the contradictory results received.

Forster, Vinacke and Digman (1955) suggest the use of more restricted terms than flexibility-rigidity, terms which can be more closely tied to the specific task. Chown (1959), after an extensive review of the literature, offers a similar suggestion.

## Problem Solving and Personality Variables Other than Rigidity

While there has been a widespread interest in rigidity as it is related to problem-solving behavior, few attempts have been made to investigate other personality variables as they are manifested in problem tasks. Almost all of the current personality theories postulate that the internal consistency of the individual personality should reveal itself in consistency of some observable sort among the various behaviors each individual manifests under differing circumstances (Fenichel, 1945; Goldstein, 1939; Murphy, 1947; Rogers, 1951). The situation is complicated by the fact that the theorists seem to mean consistency of the meaning of each item of behavior as it applies to a specific individual rather than a more objective and easily observable consistency. Nevertheless, despite the fact that the existence of personality consistency is accepted almost axiomatically, few empirical investigations have been made in which attempts have been made to relate it to observable behaviors such as performance on problem-solving tasks.

Where variables other than rigidity were studied, personality measures have been sought which would differentiate subjects who were judged rigid or flexible in terms of their behavior on problem tasks (Applezweig, 1954; Cowen, 1954; Cowen and Thompson, 1951; Maltzman, Fox and Morrisett, 1953; Pitcher and Stacy, 1954; Schmidt, Fonda and Wesley, 1954). The hypotheses, even in these studies, concerned the validity of the problem-solving situation as a rigidity measure, the personality measure serving as a criterion by means of which validity could be ascertained.

A few studies do relate rigidity or perseveration to other personality traits. Pinard (1932) found the perseverator to be nervous, sensitive, effeminate and sentimental while the nonperseverator was inconsiderate, tactless and critical. Moderate perseverators were considerate, harmonious, reflective, and moderate nonperseverators were courageous, jovial and good mixers. Guilford, Christensen, Frick and Merrifield (1957) found that these individuals who were highly tolerant of ambiguity also scored high on the ability factors of associational fluency, originality and verbal comprehension; i.e., non-rigid individuals were tolerant of ambiguity.

There have been only a few studies in which problem solution was investigated in relation to personality variables other than rigidity or equivalent traits (Gaier, 1952; Nakamura, 1958). These dealt primarily with one or two relatively isolated variables and were not concerned with the range of personality factors that might be related to an individual's level of problem-solving ability.

## Statement of Problem

The present study explores the heretofore neglected possibility that personality variables other than rigidity might be related to

problem-solving ability. While it would be possible to make predictions about how personality variables are related to problem-solving behavior from within the framework of any number of theories, the expectations according to the different theories would not necessarily coincide. Because of the lack of theoretical consensus as to what relationships could be expected and the paucity of previous empirical investigation of personality in its relationship to problem-solving ability, no specific hypotheses have been formulated.

Three problem tasks were used so as to make it possible to discuss the generality of any relationships between problem performance and personality factors which might be obtained:

The Luchins Water Jar problems (LWJ) (Luchins, 1942) have been extensively studied in connection with the investigation of rigidity of personality as it relates to Einstellung phenomena (Applesweig, 1954; Bakan, 1955; Brown, 1953; Cowen, 1952; Cowen and Thompson, 1951; Cowen, Wiener and Hess, 1953; Forster, Vinacke and Digman, 1955; Goodstein, 1953; Luchins, 1951a, 1951b; Maltzman, Fox and Morrissett, 1953; Rokeach, 1948, 1950). The first problems of the series can only be solved by a two step arithmetic procedure. These are "Set" problems, so labeled because the subject is expected to build up a set or Einstellung for solving problems via this method. Subsequent problems (called "Ambiguous" in this study and "Critical" by some other investigators) can be solved by the long method used in the "Set" problems or by a shorter procedure (Other studies have also included "Extinction" problems which can only be solved by the short method and in which the long method cannot be made to work. This third type of problem is not included in the present study). Subjects who solve the "Ambiguous" problems or the long or "Set" method have often been called "rigid" and their responses on other

instruments have been contrasted with the "non-rigid" individuals, those who used the short method where it was appropriate. The LWJ has rarely been used to study characteristics of behavior other than "Set" and rigidity.

The second task involved here, the Cowen Alphabet Mazes (CAM) (Bakan, 1955; Cowen, Wiener and Hess, 1953) was designed to be a verbal parallel to the LWJ problems, and contains both "Set" and "Ambiguous" problems.

The Wisconsin Card Sorting Test (WCST) is, however, of a different type. The sorting task from which it was developed was introduced by Weigl (1941) who studied the differential performance of children, normal adults and adults with cerebral damage. Studies involving this instrument, however, have primarily aimed at exploration of situational influences upon performance (Berg, 1948; Grant, 1951; Grant and Berg, 1948; Grant, Jones and Tallantis, 1949; Jones and Grant, 1948; Ross, Rupel and Grant, 1952; Wohlwill, 1957).

The California Personality Inventory (CPI) (Gough, 1957) was the personality measured used. It includes many scales which are designed to assess a variety of areas of functioning in the normal individual. It was standardized on young adults, many of whom were of college age, thus making it especially appropriate for use with the college population sampled in this study.

## METHOD OF INVESTIGATION

Fifty-seven students enrolled in Psychology 201 at Michigan State University during Winter Quarter 1960 were the subjects used in this experiment. Of these, data from nine subjects was discarded and not used in computing statistics because of experimental errors or omissions. The final sample of forty-nine included twenty-seven males and twenty-one females whose range in age was from eighteen to twenty-six years.

The scores on the college entrance tests that the subjects had taken were obtained from the Office of Evaluation Services. In addition, the students' cumulative grade-point averages were also obtained. The subjects took the California Personality Inventory during class sessions and then were seen individually. The individual testing sessions consisted of administration of the Luchins Water Jar problems, the Wisconsin Card Sorting Test and the Cowen Alphabet Mazes. The students were told only that they would be taking part in a problem-solving experiment. They were requested to give two hours of time to the experiment. Most, however, completed the three tasks within thirty to fifty minutes.

### California Personality Inventory

The CPI was administered according to instructions given in the manual (Gough, 1957) during regular class periods to two class sections of Psychology 201. Most of the eighty-nine class members completed the test in less than one and one-half hours. Later, volunteers were solicited from these sections for participation in individual testing sessions.

The CPI is an untimed test consisting of 468 statements. The subject replies to each of the numbered statements by indicating which are "true" about himself and which are "false." The test contains eighteen scales which represent aspects of personality functioning. These are as follows:

Group I - Measures of Poise, Ascendency and Self-Assurance

1- Dominance (Do)
2- Capacity for Status (Cs)
3- Sociability (Sy)
4- Social Presence (Sp)
5- Self-Acceptance (Sa)
6- Sense of Well-Being (Wb)

Group II - Measures of Socialization, Maturity and Responsibility

7- Responsibility (Re)
8- Socialization (So)
9- Self-Control (Sc)
10- Tolerance (To)
11- Good Impression (Gi)
12- Communality (Cm)

Group III - Measures of Achievement Potential and Intellectual Efficiency

13- Achievement via Conformance (Ac)
14- Achievement via Independence (Ai)
15- Intellectual Efficiency (Ie)

Group IV - Measures of Intellectual and Interest Modes

16- Psychological-Mindedness (Py)
17- Flexibility (Fx)
18- Femininity (Fe)

Detailed descriptions of the various scales are available in Gough (1957). Their significance will also be discussed below where it is relevant to the results obtained.

## Luchins Water Jar Problems

This task consisted of sixteen arithmetic problems, of which the first two were practice problems. The LWJ and CAM problems were alternated so that the LWJ problems were the first task administered to even-numbered subjects and the last given to odd-numbered subjects, while the reverse was true for the CAM problems.

The problems were printed on separate sheets of 8½" x 11" paper which the experimenter handed to the subject. If a subject took longer than two minutes on either of the two practice problems or indicated that he was unable to solve the problem, the experimenter demonstrated the appropriate method of solution. No help was furnished to the subject on subsequent problems. For each problem attempted by each subject, the experimenter recorded the subject's time to completion. If a subject failed to work a problem, the time recorded was the time until the subject indicated that he wished to go on to the next problem. The first time a subject spent over three minutes working on a given problem, the experimenter said, "You may go on to the next one if you wish" but did not press the subject further if he chose to continue.

Problems 1-6 were "Set" problems soluble by the B-A-2C method alone. Problems 7-14 were "Ambiguous" problems soluble both by the B-A-2C method and either A+C or A-C. In addition, problem 11 was soluble by C alone. Most of the problems were taken from Luchins (1951a, 1951b) and R. Bakan (1955). The problems used may be found in Appendix 1.

The scores derived from this test included: S, the number of "Set" problems solved; As, the number of "Ambiguous" problems solved in the "set" manner; TT, the total time for solution of all

problems; T/14, the average time for solution of the total problem set; T/S, the average time for solution of the "Set" problems; T/A, the average time for solution of the "Ambiguous" problems.

## Cowen Alphabet Mazes

This task involved finding pathways through mazes of letters of the alphabet arranged in 6 x 6 grids so that combining the letters as they were found along this path would yield meaningful words or phrases. The problems were arranged so that their sequence paralleled the sequence of the LWJ problems. They were given as the first task to odd-numbered subjects and last to even-numbered subjects. As in the LWJ task, there were sixteen problems, of which the first two were practice problems. Problems 1-6 were "Set" problems whose solution was via an indirect path. Problems 7-14 were comparable to the "Ambiguous" problems of the LWJ task. Each of these could be solved via either a direct or an indirect path through the maze. The problems used may be found in Appendix 2.

The problems were printed on separate sheets approximately 8½" x 5½" in size which the experimenter handed to the subject. As the experimenter gave a subject the first practice problem, she instructed the subject as follows, pointing out appropriate sections on the grid as she spoke:

"This experiment involved working out mazes. In each of these mazes, the idea is to move from the upper right-hand corner to the lower left-hand corner, spelling out words as you go. You are allowed to move one box at a time in any direction, just as long as the move you make helps to spell out a word. The solutions are either meaningful words or phrases. In case there is more than one path

that will take you from start to finish, the correct solution is the path that used the fewest number of boxes. This one is practice; try it." With subsequent problems, the only instructions were "Try this one."

If the subject took longer than two minutes on either of the two practice problems or indicated that he was unable to solve the problem, the experimenter indicated the path through the maze, repeating the instructions in an informal way as she did so. No help was provided on the other problems. For each problem attempted by a subject, the experimenter recorded the subject's time to completion. If a subject failed to work a problem, the time recorded was the time until the subject indicated a wish to proceed to the next problem. The first time a subject spent over three minutes working on a given problem, the experimenter indicated "You may go on to the next one if you wish" but did not press the subject further if he chose to continue. The scores derived from this test are equivalent to those derived from the LWJ problems.

## Wisconsin Card Sorting Test

The WCST was the second problem task for all subjects. It involved sorting a pack of sixty-four cards. The cards were 3" x 3" squares of white coated cardboard upon which figures had been painted. The figures on these cards could be stars, crosses, triangles or circles. A card could contain one to four identical figures in one of the following four colors: red, yellow, blue or green. The pack thus contained one each of all combinations of the four figures, four colors and four numbers that could be devised under the restriction that only one color and one type of figure could appear on a given card.

In addition to the sixty-four Response cards, there were four Stimulus cards which were placed before the subject. These were: one red triangle, two green stars, three yellow crosses and four blue circles (Cards containing these figures were also included within the pack of Response cards). It was thus possible to sort the Response cards according to their color, or the number or type of figures they contained.

Where a single figure appeared on a card, it was centered with the 3" x 3" square. Where two figures appeared on a card, they were always placed so that one was in the upper left-hand quarter of the card and the other in the lower right-hand quarter. Three figures were always placed so that there was one each in the lower left and right-hand quarters and one figure centered above them in the upper half of the card so that the three together formed a triangle. When a card contained four figures, there was one in each quarter of the card, thus forming a square. This placement of figures is the same as that given by Grant, Jones and Tallantis (1949).

The cards were given to all subjects in a standard order. They were arranged so that neither the same figure, color nor number of figures appears on any two consecutive cards in the pack. The order in which the cards were used as well as the configuration which appeared on each is available in Appendix 3.

The four Stimulus cards were placed from left to right, in the order in which they were mentioned above, before the subject. The subject was given the pack of sixty-four Response cards with the following instructions:

"I want you to put these cards into four groups beneath the ones on the table. I will tell you whether you are right or wrong." If the subject asked any questions about the task, the experimenter only

repeated: "I will tell you whether you are right or wrong." The instructions are essentially those used by Berg (1948).

Initially, the experimenter responded to a subject's sorting by using color as the basis for determining whether a placement was correct. When a subject had placed five consecutive cards correctly, the experimenter shifted to using number as the basis of her responses to the subject. After the subject achieved five successive successes with number as the correct category, the experimenter shifted again, this time using type of figure (hereafter spoken of as form) as correct. These categories were used again in the same order, making a total of six categories. Each subject sorted the cards until he had completed the six categories or had sorted all sixty-four cards. The time that was spent by the subject on the entire task was recorded. After the cards had been sorted, each subject was asked: "What were you trying to do or what did you think you were supposed to do?" and his response noted.

Scores derived from this test included Total Correct Responses (TCR) made by the subject, Total Errors (TE) which were further divided into Perseverative Errors (PE) and Non-Perseverative Errors (NPE) according to whether the response classified as an error would have been correct for the immediately preceding category, Total Time (TT) for completion of six categories or sorting sixty-four cards, Average Time per card sorted (T/Card), Average Time per category completed (T/Cate.), Number of Categories completed (#Cate.), and Number of Cards used in completing six categories (#Card). Where the subject did not complete six categories, 64 + was considered to be the Number of Cards used.

## Intellectual Measures

Prior to 1958, Michigan State University had administered the American College Examination (ACE) to all incoming freshmen and transfer students. Beginning in that year, however, the College Qualification Test (CQT) was used in the entrance examinations.

Of the students in this experiment, thirty had entered Michigan State University in 1958 or later and had taken the CQT. This group consisted of sixteen females and fourteen males. Eighteen others had entered Michigan State University between 1953 and 1957 and had been tested with the ACE. This group contained five females and thirteen males. These scores along with the subjects' grade-point averages were used as measures of intellectual functioning.

The ACE yields two part scores and a total score. The scores are L, a score on the verbal or linguistic section, and Q, a quantitative score. The CQT, on the other hand, yields three part scores and a total. Its parts are V, vocabulary, I, information, and N, numerical. V was considered equivalent to L of the ACE on the basis of published correlations between the two, and N was used as the equivalent of Q on the same basis. The total scores of the ACE and the CQT were also considered as comparable (Juola, 1960). The I score of the CQT was not used since a score on this variable was available for only a portion of the subjects in the experiment.

Prior to 1959, published scores were available from the Office of Evaluation Services in the form of ranks of 1 through 10 which had been derived from the percentile rating of all the students who had taken the test at a given time. In 1959, however, the publication listed the scores directly as percentile ratings. On the basis of the information available on the method previously used to obtain "derived scores,"

the percentile ratings of the fifteen subjects who taken the entrance examinations in Fall 1959 or later were converted into such "derived scores." A table illustrating the conversion method is available in Appendix 4.

The comparability of the scores of the ACE and the CQT, and the conversion method used were both suggested by Dr. A. E. Juola of the Office of Evaluation Services at Michigan State University to whom the experimenter wishes to express her appreciation for his kind assistance.

## RESULTS AND DISCUSSION

### Effects of the Sex of Subjects and the Order of Test Presentation

Since half of the subjects received LWJ first and the others worked on CAM first, the question of the effect of the order of the test has to be considered. This is especially pertinent because of the difference in the level of difficulty of the two tests. Thirty-one subjects (thirteen females, eighteen males) correctly solved all the "Set" problems of the LWJ, while only fourteen subjects (five females, nine males) solved all the "Set" problems of the CAM. Seventeen individuals solved all the "Ambiguous" LWJ problems in a direct manner while only one person accomplished this on the CAM. Is there an effect of solving the less difficult problems upon later performance of the more difficult ones? Is the second problem set easier if the more difficult one came first?

Along with the possibility of test order affecting performance, the possibility of differences in the performance of males and females also has to be considered. Billings (1934), Crutchfield (1960), Nakamura (1958) and Sweeney (1953) have reported sex differences in various kinds of problem solving situations including numerical and arithmetic reasoning tests. Guetzkow (1951) reported sex differences favoring males in extinction problems of the LWJ (this type is not included in the present study), and no sex differences in the critical problems (called "Ambiguous" in the present study). There is no published information with regard to sex differences in performance on either the CAM or the WCST.

Table 1. The Significance of F Tests of the Sex and Order Effects on Five Scores Obtained from the Luchins Water Jar Problems and the Cowen Alphabet Mazes.

| Score | Effect | LWJ | CAM |
|---|---|---|---|
| S | | | |
| | sex | -* | - |
| | order | 1.0 | 1.93 |
| | int'n | - | - |
| As | | | |
| | sex | 2.26 | - |
| | order | - | - |
| | int'n | 2.75 | - |
| T/14 | | | |
| | sex | 8.15** | - |
| | order | - | 2.07 |
| | int'n | - | - |
| T/S | | | |
| | sex | 7.87** | - |
| | order | - | 2.09 |
| | int'n | - | - |
| T/A | | | |
| | sex | - | - |
| | order | - | - |
| | int'n | - | - |

*Dashes represent cases where $F < 1$

**Significant beyond .01 level of confidence

Table 1 shows the results of significance tests of the effects of the sex of the subject and the order in which the LWJ and CAM were administered. These analyses were computed according to Walker and Lev (1953) who suggest the use of an approximate test for an analysis of variance where the Ns in the cells are unequal. Tests of

heterogeneity of variance had been computed previous to these analyses. In those, the statistical test used initially was the $F_{max}$ test, tested with df from 10 to 15. Where the results changed in significance level within these df, Bartlett's test was performed. The only cases in which these tests reached significant levels were T/14 and T/S of the LWJ. These were significant at .01 (B = 13.66) and .05 (F = 10.21) respectively.

Neither sex nor order variables seem to affect performance significantly on the CAM. The order of administration also does not have an important effect upon LWJ. Males and females, however, are significantly different from each other on LWJ in their mean Times to Solution for the "Set" problems as well as of the total group of problems. The mean time for females is significantly longer than the mean time for the males, and the females in the sample also show themselves to be significantly more variable in their average times; i.e., while some worked as fast as the males, others took much longer times to solve the problems. This difference in variability and average time does not appear in the time scores for the "Ambiguous" problems. It seem likely that the significant result on sex differences in T/14 is due primarily to the large difference in the means and variance of the time to solution of the "Set" problems.

Chown (1959) indicated that the number of problems solved on LWJ had not proven to be valuable in the study of rigidity and suggested that time scores might be more helpful. The females in the sample managed to solve the same number of problems as the men, but, as a group, did their problems more slowly. This perhaps indicates that they experienced greater difficulty with the "Set" problems. This hypothesis is in accord with the information available, i.e. women do less well than men on quantitative tasks (Billings,1934). If, going

beyond available data, we wish to consider longer time scores as indicative also of greater "Set" and rigidity, it is necessary to note that the difference in time scores between men and women does not appear in the "Ambiguous" problems on which "Set" or Einstellung is customarily measured. Since the "Set" problems alone merely represent a series of numerical problems that happen to have a common method of solution and in which no measure of Einstellung is included, it seems more parsimonious to consider the time difference between the sexes, since they occur on the "Set" problems alone, as being due to differences in facility of dealing with quantitative problems. If there is a difference in numerical ability between the sexes, the question arises as to why there were not time differences on the "Ambiguous" problems as well.

A possible answer to this question lies in the influence of practice on previous problems on subsequent problem-solving behavior. Time scores on the first "Set" problems were generally longer than on later problems. As subjects became aware that there was a common method, their times to solution decreased. When the "Ambiguous" problems were presented, those individuals who used the "Set" method continued to decrease their solution times as they gained further practice with this method. Those individuals who changed from using the indirect "Set" method of solution to using the more direct method of solution also worked faster on the "Ambiguous" problems, the direct solution involving fewer steps and therefore taking less time than the "Set" method.

Therefore, the initial differences in time scores between males and females, which implies differences in quantitative ability, lessened with each problem regardless of the method used; i.e. there were no differences between the two groups in their ability to benefit

from practice on the problems and their awareness of a communality in method among the problems despite a difference in facility with quantitative tasks.

Table 2. The Significance of Sex Differences on Seven Scores Obtained from the Wisconsin Card Sorting Test

| Score | t betw. means[1] | variance ratios[2] |
|---|---|---|
| TCR | .52 | B = 1.76 |
| TT | .003 | 1.31 |
| T/Card | .36 (df=1) | 4.27** |
| T/Cate. | .44 | 1.92 |
| TE | .64 | 1.42 |
| PE | .20 | 1.09 |
| NPE | 1.35 | 2.07 |

**Significant beyond .01 level of confidence

[1]Except where indicated, df for the t tests = 46. In the case where $s^2 \neq s^2$, the correction for df suggested by Walker and Lev (1953) was made and df 1.

[2]The statistical test used was the $F_{max}$ test, using both df = 21 and df = 28. Where the results were in doubt, Bartlett's test was performed and this result appears in lieu of the result of the $F_{max}$ test.

Table 2 shows the results of tests of the difference between males and females with respect to their performance on the WCST. Neither the variances nor the means differ significantly between males and females except for the variance on T/Card. The females were more variable than the males were but as a group were not slower. Tests of sex differences on #Cards and #Cate. do not appear in the table because the assumptions of normality required for using t,

which applied to the other WCST variables, could not be justified for these two measures because of their skewed distributions. A non-parametric substitute for t, the Mann-Whitney U test with the appropriate correction for tied ranks were employed instead (Siegel, 1956). The results for both variables also support the hypothesis of no differences between the sexes.

## Intellectual Variables

Table 3 shows the results of the effects due to the subjects' sex and the entrance examination taken. It reveals that males and females do not perform in a significantly different manner on these examinations. Only with regard to the measurement of arithmetic abilities do the two tests differ. The CQT for both males and females yields lower scores for this aspect of academic functioning than does the ACE.

Table 3. The Significance of F tests of the Effects of Sex and Test on Entrance Scores

| Test | Means | | | Variance† |
|---|---|---|---|---|
| | Sex | Test | Interaction | |
| Linguistic or Verbal | -* | - | - | 2.45 |
| Quantitative or Numerical | - | 4.90** | - | 1.56 |
| Total | - | - | - | 2.44 |

†$F_{max}$ test used

*Dashes represent cases where $F < 1$

** Significant beyong .05 level of confidence

The possibility of sex differences in Grade-Point average in our sample was also investigated. The average GPA for males was 2.46 and the average was 2.53 for females. These were not significantly different from one another ($t$ = .43).

Table 4 shows the correlations for the total sample between the intellectual measures and various measures derived from the problem-solving tasks. The corresponding correlations for males and females separately may be found in Appendix 5.

Table 4. The Significance of Correlations Between Intellectual Measures and Thirteen Measures Derived from the Problem-Solving Tasks (Total Sample)

| Test | Score | L or V | Q or N | T | GPA |
|---|---|---|---|---|---|
| LWJ | | | | | |
| | T/S | -.238 | -.324* | -.405** | -.261 |
| | T/A | -.069 | -.474** | -.299 | -.070 |
| | T/14 | -.232 | -.413** | -.432** | -.259 |
| CAM | | | | | |
| | T/S | -.093 | -.018 | -.103 | -.029 |
| | T/A | -.274 | -.037 | -.208 | -.166 |
| | T/14 | -.194 | -.017 | -.154 | -.120 |
| WCST | | | | | |
| | TT | -.234 | -.197 | -.255 | -.328* |
| | T/Card | -.152 | -.209 | -.202 | -.241 |
| | T/Cate. | -.242 | -.010 | -.104 | -.130 |
| | TCR | .208 | .165 | .257 | .214 |
| | TE | -.260 | -.182 | -.288* | -.352* |
| | PE | .038 | -.211 | -.120 | -.244 |
| | NPE | -.421** | -.054 | -.304* | -.273 |

*Significant beyond .05 level of confidence
**Significant beyond .01 level of confidence

All the measures shown, with the exception of TCR, are time or error scores for which high scores represent long times or a large number of errors. Negative relationships with the intellectual measures would therefore be expected if intellectual ability is related to performance on problem-solving tasks. For TCR, however, high scores are indicative of the total number of correct responses made by the subjects. It therefore should show positive relationships with the intellectual measures. Except for the correlation between PE and L or V which is a positive one, the correlations are all in the expected direction.

It is interesting to note that none of the CAM variables show significant relationships to the intellectual measures. Considering the nature of the task, it is surprising that there is no significant relationship to L or V. It must be noted, however, these CAM measures are the time scores and not the number of "Set" or "Ambiguous" problems and that the number of problems solved might well show relationships with L or V or other of the measures. Unfortunately, these correlations were not computed.

The LWJ variables, however, show significant relationships to the Q or N and T scores of the entrance examinations. Numerical ability therefore is a contributing factor to the speed of performance on these problems. Grade-Point average is not significantly related to any of the LWJ variables.

Grade-Point average is significantly correlated with TT and TE, two variables derived from the WCST. Scholastic ability as measured by GPA is significantly related to the total time taken by the subjects on the WCST. Speed of concept-formation can be considered as having some relationship to the ability to comprehend concepts which, presumably, is one factor of academic performance.

TE which is significantly related to GPA is also significantly correlated with the T score on the entrance examinations. The WCST is set up so that the subject is immediately aware of the correctness of his responses. Continuing to make errors, as is implied in a high score on TE, shows an inability to benefit from past mistakes. This type of difficulty is presumably penalised in an academic setting and on academic tests.

The same reasoning perhaps can be used in explaining the significant relationships between NPE and the L or V and T scores of the entrance examinations. It could be more easily applied if PE showed significant relationships instead of NPE, as PE is a perseverative measure. However, non-perseverative errors were rare in our sample. They usually occurred where the subject did not complete any categories or perhaps completed only one. His responses could not be classified as perseverative errors according to the customary usage of that term on the WCST, but he nevertheless persisted in making the same kinds of errors time after time and demonstrated an inability to profit from previous mistakes.

## The California Personality Inventory and Problem-Solving Variables

### Time Scores

The distributions of the personality scores from the CPI and of the total time scores from the three problem tasks separately and combined were each dicotomised at their median and $X^2$ computed. Table 5 shows the relationship between the eighteen scales of the CPI and the time scores on the problem-solving tasks. LWJ, CAM and the combined total time scores demonstrate no significant relationship

Table 5. The Significance of Chi Square Relationships Between Scores on the California Personality Inventory and Total Time Scores

| CPI Score | LWJ | CAM | WCST | Combined Times |
|---|---|---|---|---|
| Do | 1.40 | .084 | .084 | 1.29 |
| Cs | .091 | 1.34 | .334 | .774 |
| Sy | .334 | .083 | .75 | 0 |
| Sp | 2.06 | .334 | 1.34 | .077 |
| Sa | .365 | .755 | 2.10 | .365 |
| Wb | .701 | .339 | 3.05 | .828 |
| Re | .365 | 2.10 | .765 | 2.94 |
| So | 2.13 | .334 | 5.34* | .732 |
| Sc | .334 | .083 | 4.08* | 0 |
| To | .774 | 3.01 | 1.34 | 2.06 |
| Gi | .334 | .084 | 2.08 | .334 |
| Cm | .309 | .755 | .084 | 1.29 |
| Ac | .334 | .083 | 2.08 | .334 |
| Ai | 2.94 | .755 | .755 | .365 |
| Ie | 1.72 | 0 | 1.334 | .091 |
| Py | .001 | .084 | 6.797** | .001 |
| Fx | .732 | .334 | 0 | .774 |
| Fe | 2.94 | .084 | 6.797** | .001 |

*Significant beyond .05 level of confidence
**Significant beyond .01 level of confidence

to any of the personality variables. The relationship between the CPI scores and the total time scores on the WCST, however, reached a significant level with four of the personality scores. The chance expectations for a statistic to be significant at the .05 level when eighteen independent statistics are computed is one. The variables listed are not independent; the effect of this on the probability of the occurrence of significance is unknown. We may assume that one or two of the significant results here represent real differences in the population. It is more likely that the real differences occurred where

the level of confidence is beyond .01. These were Py, Psychological-Mindedness, and Fe, Femininity. In both cases, the longer time scores were associated with low scores on the personality variables, both of which are classified as intellectual and interest modes (Gough, 1957).

Py is described as measuring "the degree to which the individual is interested in, and responsive to, the inner needs, motives, and experiences of others." Those who score low on this variable are described as "apathetic, serious and unassuming; slow and deliberate in tempo; overly conforming and conventional." This description of the low scorer might well predict our result; that he would be slow performing a task for which one requirement is sufficient alertness and awareness to perceive that the task demands have been shifted by the experimenter.

Fe is a measure of the masculinity or femininity of interests, with low scores indicating more masculine interests. The low scorer here is described as "hard-headed, ambitious, masculine, active, robust and restless, manipulative and opportunistic in dealing with others; blunt and direct in thinking and action; impatient with delay, indecision, and reflection." This description could easily go with results opposite to the one obtained here. The association of this description with long time scores on the WCST is not easy to explain. Hopefully, it represents a relationship based on chance alone.

Number of Problems Solved

Because S and As yielded narrow ranges of possible scores (S = 0 to 6; As = 0 to 8) on both LWJ and CAM, it was decided that S for LWJ and CAM be combined so as to widen the possible range of distribution of scores and facilitate comparisons with CPI, and that

the same procedure be followed with As. These comparisons, $X^2$ performed in 2 x 2 tables with both variables dicotomized at their medians, are shown in Table 6. Only three results reached a significant level out of the thirty-six statistics computed. This does not appear to be different from what the expectations according to chance would be.

Table 6. The Significance of Chi-Square Relationships Between Scores on the California Personality Inventory and the Number of "Set" and "Ambiguous" Problems Solved on the Luchins Water Jar Problems and the Cowen Alphabet Mazes Combined

| CPI Score | S | As |
|---|---|---|
| Do | .26 | .084 |
| Cs | .11 | 1.34 |
| Sy | .34 | .75 |
| Sp | 2.23 | 8.35** |
| Sa | .26 | .084 |
| Wb | 2.48 | .33 |
| Re | 2.82 | .084 |
| So | 1.95 | 1.34 |
| Sc | 3.05 | 2.08 |
| To | 6.68** | .504 |
| Gi | .34 | .084 |
| Cm | 8.10** | 2.10 |
| Ac | 0 | .084 |
| Ai | 3.33 | 2.10 |
| Ie | 2.02 | .504 |
| Py | 1.54 | .084 |
| Fx | .107 | .33 |
| Fe | 3.33 | .084 |

**Significant beyond .01 level of confidence

If the relationship between Sp and As is not accidental, it could be easily accounted for on the basis of Gough's information about these test scores (Gough, 1957) and information about the tasks. Those who scored high on Sp received low scores on As. High scorers on Sp are described by Gough as: "clever, enthusiastic, imaginative, quick, informal, spontaneous, active and vigorous." Low scorers on As, which represents the number of "Ambiguous" problems solved in the "Set" manner, were those individuals who solved more of these problems via the short method. They can be considered to be less "rigid" or more "flexible" in their performance than the others were. The description of the high scorers on Sp can readily be considered as descriptive of these individuals.

The significant relationships between S and Cm and To could be less easily explained. The relationship is in the same direction for both; high scorers on the personality variables obtained lower scores on S. S is the measure of the number of "Set" problems solved and is therefore a measure of numerical skill. Below are Gough's descriptions of high scorers on To and Cm:

> high on To, Tolerance - "enterprising, informal, quick, tolerant, clear-thinking, resourceful; intellectually able; having broad and varied interests."
>
> high on Cm, Communality - "moderate, tactful, reliable, sincere, patient, steady and realistic; honest and conscientious; having common sense and good judgment."

It is difficult to see how these descriptions can be related to low scores on S. From the description of high scorers on To, one would expect them to possess good numerical ability rather than the reverse while the description of high scorers on Cm does not clearly suggest either good or poor numerical skills.

## Awareness of Shifts

All subjects were questioned after they completed the WCST as to their perception of the task which had been required of them. They were classified as Aware or Not Aware of the shifting nature of the criteria which the experimenter had used to determine what were correct responses. The groups were compared by $X^2$ on their personality scores. These results appear in Table 7. Only two of the eighteen statistics reach the .05 level of significance, and therefore it is most probable that these represent chance relationships.

Table 7. The Significance of Chi Square Relationships Between Scores on the California Personality Inventory and the Subjects' Awareness of Shifts on the Wisconsin Card Sorting Test.

| CPI Score | $X^2$ |
|---|---|
| Do | 2.26 |
| Cs | .001 |
| Sy | .084 |
| Sp | 1.40 |
| Sa | .678 |
| Wb | .26 |
| Re | .85 |
| So | 5.49* |
| Sc | 2.10 |
| To | 1.40 |
| Gi | .084 |
| Cm | .85 |
| Ac | .76 |
| Ai | 6.59* |
| Ie | .001 |
| Py | 1.97 |
| Fx | 2.94 |
| Fe | .059 |

*Significant beyond .05 level of confidence

If these represent more than chance relationships, the relationship between Ai and awareness of the shift could be explained more easily than that between So and awareness of shifts. In both cases, the high scorers on the personality variables were more likely to be aware of the shifting nature of the criteria for correctness than were the low scorers. High scorers on Ai, which is a measure of Achievement Via Independence, are described by Gough as: "mature, forceful, dominant, demanding and foresighted; independent and self-reliant; having superior intellectual ability and judgment." Insofar as these individuals rely upon their judgment regardless of whether their judgments accord with the usual or yield information requiring them to respond in some unusual manner, they might be expected to do well on such a task as the WCST. The WCST has a "trick" in it; the experimenter shifts criteria. This is unusual and not in accord with students' expectations. High scorers on Ai were sufficiently self-reliant and presumably non-anxious to perceive this.

High scorers on So are described as "honest, industrious, obliging, sincere, modest, steady, conscientious, and responsible; self-denying and conforming." Contrary to our results, one would not expect such individuals to be willing or able to perceive unusual changes in the experimental task.

## Correlations

Before the results shown in Tables 5 and 6 were computed, correlations were computed with Pearson's r between all the variables derived from the problem-solving tasks and the personality scores of the CPI. This was done separately for males and females and for the entire sample. It was felt that these results would be even more

difficult to discuss than the $X^2$ results without replication of the experiment to determine which results represented real relationships and which had occurred on the basis of chance alone. These correlations can be found in Appendix 6.

## SUMMARY

This study was designed primarily to explore the relationships between personality variables which include a wide range of the aspects of "normal" psychological functioning and problem-solving behavior on three problem tasks: the Luchins Water Jar Problems, the Cowen Alphabet Mazes and the Wisconsin Card Sorting Test. The California Personality Inventory was the personality instrument utilized. It yields eighteen scores covering a variety of personality factors. Forty-eight students in the introductory psychology course at Michigan State University served as subjects. The effect of the sex of the subjects and the order of presentation of the tasks were also studied.

Few if any of the relationships that are suggested by the results could be confidently stated to represent real rather than chance relationships. Since, however, a few statistically significant results were obtained, this study cannot be said to have shown that there are no relationships between personality and test variables. Replication of the study would be necessary before this could be ascertained. Possible meanings for those relationships which were found were discussed.

Sex differences in problem solving were found only in the time to solution for the "Set" problems on the LWJ and on no other of the various measures derived from the problem-solving tasks. The order of presentation of the tasks did not affect the results significantly.

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# APPENDICES

## APPENDIX 1

### LWJ Problems

| | given | | | get | solution |
|---|---|---|---|---|---|
| | A | B | C | | |
| practice 1 | 29 qt. | | 3 | 20 | A - 2C |
| practice 2 | 39 | | 4 | 31 | A - 2C |
| 1- set | 21 | 127 | 3 | 100 | B-A-2C |
| 2- set | 12 | 32 | 3 | 14 | B-A-2C |
| 3- set | 22 | 89 | 4 | 59 | B-A-2C |
| 4- set | 14 | 163 | 25 | 99 | B-A-2C |
| 5- set | 18 | 38 | 7 | 6 | B-A-2C |
| 6- set | 14 | 59 | 10 | 25 | B-A-2C |
| 7- ambiguous | 18 | 48 | 4 | 22 | B-A-2C or A+C |
| 8- ambiguous | 9 | 36 | 6 | 15 | B-A-2C or A+C |
| 9- ambiguous | 23 | 49 | 3 | 20 | B-A-2C or A-C |
| 10- ambiguous | 20 | 47 | 7 | 13 | B-A-2C or A-C |
| 11- ambiguous | 34 | 85 | 17 | 17 | B-A-2C or A-C or C |
| 12- ambiguous | 18 | 39 | 3 | 15 | B-A-2C or A-C |
| 13- ambiguous | 14 | 36 | 8 | 6 | B-A-2C or A-C |
| 14- ambiguous | 15 | 39 | 3 | 18 | B-A-2C or A+C |

APPENDIX 2

## CAM Problems

**practice 1**

N E V E S
F P M L X
I G K Q T
S U O S Z
H E Y V R

**practice 2**

S K L N W
E B I K H
C W Y Z O
S F J I X
T I S G Q

**1- set**

Z R A J A N
Y L I C O K
P Z R T Q Y
S I B X O U
L M P L U H
D U O L T P

**2- set**

N B I X D M
L O P M E F
S C J N Q I
H U K J A J
Y Z W Q R B
D L O B E S

**3- set**

L S O K N R
E Z M Q U C
H E O N Y B
Z J N Z A U
M P X Q N X
E D I H D A

**4- set**

E N B R O W
B O S X I U
H L G N Q C
P B V Z F G
D Z Y K O L
M E H T R M

**5- set**

G M S D S F
Q I T M I K
I S U X Y C
R E M X T R
G B Q J H V
T A O B E I

**6- set**

O L B R I B
N U C V U H
W X J Y F D
T F X Q T M
Y L N Z H F
E K A C E O

**7- ambiguous**

Y F N G E Y
N A Y H O R
B R H U W C
N V S Z M V
G A S O A D
W A R D Y R

**8- ambiguous**

G M O E Y L
Z T U K E S
Q S H T Q E
A V T C H F
B E F Z I C
R A E H M R

**9- ambiguous**

E P M H L T
K Q S T R X
G Q K Y S Z
R S N U T O
E O V I H F
W E T S E N

**10- ambiguous**

S E D M P T
L O Y D W A
U P V O M F
X P D Z P B
I G O Z E X
S T A C T C

**11- ambiguous**

Q C R B L F
A V T M I V
L P J E N Q
K M D Q I K
C A L B U V
Y T I L A Z

**12- ambiguous**

P W R L R N
L Z V P O K
V X M T Q H
O K I Z F V
W C Y X O Q
E R U S R S

**13- ambiguous**

I O B C L H
M N T Q E Z
H G F R Z O
D V H Y R J
X A G Q E V
T I U S D W

**14- ambiguous**

S G C A R Y
F R H E O B
D N A U Z N
X P S K C G
N E J E A F
E M O C N W

## APPENDIX 3

### WCST Cards

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1- | 2 R C | 17- | 2 Y S | 33- | 3 R C | 49- | 3 B O |
| 2- | 1 G T | 18- | 4 G C | 34- | 4 B S | 50- | 2 G C |
| 3- | 4 Y S | 19- | 1 R T | 35- | 2 Y O | 51- | 1 Y O |
| 4- | 1 B O | 20- | 3 G S | 36- | 3 G C | 52- | 3 B S |
| 5- | 3 Y S | 21- | 4 B O | 37- | 2 B S | 53- | 1 Y T |
| 6- | 1 G C | 22- | 3 G T | 38- | 1 G O | 54- | 4 G S |
| 7- | 4 Y O | 23- | 1 R S | 39- | 2 R S | 55- | 1 B T |
| 8- | 3 B C | 24- | 2 B O | 40- | 4 G T | 56- | 4 R C |
| 9- | 4 G O | 25- | 4 Y T | 41- | 1 B S | 57- | 2 G S |
| 10- | 3 R T | 26- | 3 R S | 42- | 3 G O | 58- | 4 R T |
| 11- | 2 G O | 27- | 2 G T | 43- | 2 Y C | 59- | 1 Y C |
| 12- | 4 R S | 28- | 3 Y O | 44- | 4 R O | 60- | 4 B T |
| 13- | 3 B T | 29- | 1 B C | 45- | 2 Y T | 61- | 3 R O |
| 14- | 1 G S | 30- | 2 R O | 46- | 4 B C | 62- | 2 B C |
| 15- | 3 Y C | 31- | 4 Y C | 47- | 2 R T | 63- | 3 Y T |
| 16- | 1 R O | 32- | 2 B T | 48- | 1 Y S | 64- | 1 R C |

### Code

1, 2, 3, 4 refer to the number of figures on the card.
R = red; G = green; Y = yellow; B = blue.
T = triangle; S = star; C = cross; O = circle.

## APPENDIX 4

### Conversion Table for Entrance Examination Scores

| Derived score | Percentage taking test who scored higher than a given score | Percentage receiving a given score | Percentage taking test who scored lower than a given score |
|---|---|---|---|
| 10 | 0 | 1 | 99 |
| 9 | 1 | 3 | 96 |
| 8 | 4 | 8 | 88 |
| 7 | 12 | 16 | 72 |
| 6 | 28 | 22 | 50 |
| 5 | 50 | 22 | 28 |
| 4 | 72 | 16 | 12 |
| 3 | 88 | 8 | 4 |
| 2 | 96 | 3 | 1 |
| 1 | 99 | 1 | 0 |

## APPENDIX 5

**Correlations Between Intellectual Measures and Measures Derived from the Problem-Solving Tasks**

| | Males | | | | Females | | | |
|---|---|---|---|---|---|---|---|---|
| | L or V | Q or N | T | GPA | L or V | Q or N | T | GPA |
| **LWJ** | | | | | | | | |
| T/S | -.506** | -.163 | -.481* | -.211 | -.306 | -.309 | -.400 | -.373 |
| T/A | -.132 | -.321 | -.281 | .099 | -.054 | -.567** | -.260 | -.214 |
| T/14 | -.452* | -.218 | -.458* | -.126 | -.305 | -.438* | -.448* | -.410 |
| **CAM** | | | | | | | | |
| T/S | -.102 | .031 | -.069 | .075 | -.121 | -.025 | -.126 | -.143 |
| T/A | -.167 | -.036 | -.135 | -.033 | -.464* | -.096 | -.345 | -.331 |
| T/14 | -.146 | .039 | -.089 | .049 | -.306 | -.084 | -.248 | -.339 |
| **WCST** | | | | | | | | |
| TT | -.231 | .081 | -.060 | -.128 | -.278 | -.394 | -.409 | -.461* |
| T/Card | -.266 | .140 | -.090 | -.135 | -.116 | -.389 | -.275 | -.308 |
| T/Cate. | -.232 | .189 | .050 | .008 | -.244 | -.352 | -.382 | -.329 |
| TCR | .222 | -.038 | .122 | .301 | .177 | .398 | .412 | .132 |
| TE | -.139 | -.087 | -.060 | -.210 | -.420 | -.331 | -.551** | -.473* |
| PE | .204 | -.073 | .174 | -.055 | -.262 | -.370 | -.480* | -.455* |
| NPE | -.358 | -.040 | -.234 | -.208 | -.520* | -.204 | -.508* | -.383 |

*Significant beyond .05 level of confidence
**Significant beyond .01 level of confidence

## APPENDIX 6

### Correlations Between Problem-Solving Scores and Personality Variables

Total Sample

| CPI | LWJ | | | | CAM | | | | Wisconsin Card Sorting Test | | | | | | | | Intellectual Measures | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Score | S | As | T/S | T/A | S | As | T/S | T/A | TCR | TT | T/Card | T/Cate | TE | PE | NPE | #Cate's | L or V | Q or N | T | GPA |
| Do | .130 | -.011 | -.181 | -.199 | .138 | -.071 | -.026 | .220 | -.122 | -.074 | -.104 | .169 | .068 | -.050 | .151 | .016 | -.006 | .140 | .075 | .230 |
| Cs | -.010 | -.028 | .078 | -.154 | .126 | -.076 | -.053 | .243 | -.205 | .100 | .038 | .197 | .197 | .068 | .222 | -.152 | -.046 | -.002 | .074 | -.024 |
| Sy | .131 | .042 | -.129 | -.057 | .063 | -.042 | -.011 | .182 | -.129 | .068 | .057 | .109 | .069 | -.006 | .108 | .108 | -.018 | .078 | .025 | .129 |
| Sp | .114 | -.194 | .100 | -.268 | -.004 | -.029 | .045 | .344* | -.188 | .251 | .234 | .309 | .126 | -.080 | .266 | -.029 | -.194 | .139 | -.047 | -.040 |
| Sa | .179 | -.104 | .252 | -.252 | -.004 | -.041 | .153 | .361* | -.063 | .184 | .143 | .188 | .152 | .084 | .136 | -.133 | .022 | .122 | .047 | .033 |
| Wb | .429** | .149 | .260 | .163 | .198 | -.031 | .056 | .152 | -.068 | -.020 | .060 | -.110 | -.234 | -.297* | -.045 | .381** | -.189 | -.081 | -.207 | .022 |
| Re | -.213 | .136 | .216 | .136 | .068 | -.130 | .073 | -.130 | .116 | -.088 | -.067 | -.178 | -.151 | -.141 | -.080 | -.090 | .218 | -.084 | .061 | .110 |
| So | -.285 | .212 | .233 | .185 | .050 | .145 | .043 | -.088 | -.033 | -.131 | -.094 | -.056 | -.167 | -.218 | -.026 | .200 | .048 | -.094 | -.059 | .110 |
| Sc | -.436** | .208 | .256 | .281 | .070 | -.035 | -.012 | -.113 | -.043 | -.224 | -.154 | -.230 | -.240 | -.208 | -.141 | .267 | -.121 | -.132 | -.191 | .081 |
| To | -.373** | -.014 | .189 | .034 | .014 | .016 | .050 | -.017 | -.042 | -.143 | -.112 | -.147 | -.101 | -.118 | -.029 | .176 | -.028 | -.106 | -.128 | -.012 |
| Gi | -.393** | .279 | .197 | .247 | .163 | .082 | .041 | -.023 | -.149 | -.183 | -.145 | -.096 | -.082 | -.095 | -.025 | .120 | -.282 | -.151 | -.287 | -.098 |
| Cm | -.199 | -.054 | .111 | -.144 | -.064 | -.115 | .140 | .154 | .111 | .038 | -.029 | -.134 | .010 | .153 | -.140 | .150 | .005 | -.049 | -.021 | -.092 |
| Ac | -.234 | .277 | .166 | .189 | .365* | -.065 | -.084 | -.036 | -.038 | -.076 | -.020 | .005 | -.180 | -.225 | -.037 | .224 | .112 | -.082 | -.026 | .239 |
| Ai | -.345* | -.167 | .292 | -.013 | .028 | -.126 | .079 | .032 | .067 | -.043 | .031 | -.177 | -.199 | -.131 | -.160 | .156 | .104 | -.035 | .017 | .128 |
| Ie | -.083 | .060 | .025 | -.093 | -.029 | -.177 | .055 | .028 | .064 | .0002 | .034 | -.137 | -.177 | -.047 | -.213 | .264 | .022 | .008 | -.026 | .079 |
| Py | -.145 | .091 | .061 | -.011 | .191 | .079 | -.053 | .127 | -.108 | -.318* | -.224 | -.166 | -.241 | -.244 | -.110 | .030 | .045 | .056 | .060 | .248 |
| Fx | .044 | -.090 | -.098 | .066 | -.076 | .064 | -.059 | .118 | .097 | .103 | .124 | -.079 | -.045 | .076 | -.143 | -.017 | .118 | -.002 | .081 | -.129 |
| Fe | -.036 | -.013 | .274 | .028 | -.189 | .011 | .074 | -.098 | .142 | -.077 | -.070 | -.060 | -.126 | .317* | -.218 | -.066 | .308* | -.121 | .083 | .271 |

*Significant beyond .05 level of confidence

**Significant beyond .01 level of confidence

## Males

| CPI Score | LWJ S | LWJ As | LWJ T/S | LWJ T/A | CAM S | CAM As | CAM T/S | CAM T/A | Wisconsin Card Sorting Test TCR | TT | T/Card | T/Cate | TE | PE | NPE | #Cate's | Intellectual Measures L or V | Q or N | T | GPA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Do | .213 | .211 | -.132 | .027 | .148 | .039 | .041 | .242 | .099 | .079 | .061 | .180 | -.044 | -.064 | .004 | .069 | .057 | -.084 | .068 | .251 |
| Cs | .105 | .032 | .002 | -.075 | .219 | .191 | -.212 | .214 | -.098 | .194 | .185 | .158 | .092 | .002 | .111 | .128 | .041 | .090 | .109 | .034 |
| Sy | .190 | .194 | -.198 | .023 | .053 | -.043 | .021 | .231 | .161 | .290 | .249 | .117 | .019 | .060 | -.032 | .093 | -.020 | .006 | .060 | .110 |
| Sp | .221 | -.018 | -.131 | -.285 | .216 | .165 | -.120 | .348 | -.071 | .500** | .478* | .390* | .184 | .030 | .199 | -.112 | -.249 | .041 | -.114 | -.245 |
| Sa | .201 | -.033 | -.282 | .309 | .146 | -.099 | .172 | .535** | .145 | .381* | .289 | .190 | .134 | .177 | .001 | -.081 | .048 | .002 | .064 | -.014 |
| Wb | -.361 | .329 | .200 | .306 | .183 | .134 | .045 | .089 | .000 | -.109 | .106 | -.127 | -.447* | -.375 | -.205 | .435* | -.093 | -.037 | -.117 | .037 |
| Re | -.009 | .088 | .049 | .197 | .233 | -.314 | -.100 | -.184 | .010 | -.233 | -.169 | -.121 | -.240 | -.220 | -.093 | .192 | .388* | .004 | .296 | .315 |
| So | -.216 | .240 | .108 | .348 | .199 | .316 | -.040 | -.157 | -.341 | -.233 | -.678** | .043 | -.186 | -.209 | .055 | .141 | .073 | -.120 | -.039 | .029 |
| Sc | -.458* | .345 | .448* | .509** | .010 | .099 | .051 | -.240 | -.082 | -.471* | -.254 | -.310 | -.477* | -.433* | -.189 | .386* | -.076 | -.016 | -.131 | .212 |
| To | -.428* | .146 | .378 | .290 | .182 | .168 | -.235 | -.153 | .056 | -.270 | -.126 | -.281 | -.344 | -.250 | -.194 | .311 | .070 | -.162 | -.061 | .045 |
| Gi | -.447* | .386* | .428* | .567** | -.019 | .131 | .126 | -.110 | -.137 | -.447* | -.270 | -.220 | -.373 | -.334 | -.152 | .311 | -.226 | -.076 | -.244 | .078 |
| Cm | -.041 | .023 | -.497** | -.231 | .149 | -.279 | -.107 | .156 | .171 | .024 | -.010 | -.140 | -.011 | .302 | -.292 | .121 | .135 | .011 | .177 | -.094 |
| Ac | -.099 | .401* | .024 | .258 | .399* | -.012 | -.114 | -.075 | -.041 | -.108 | -.050 | .091 | -.190 | -.238 | -.015 | .168 | .136 | -.008 | .076 | .255 |
| Ai | -.417* | -.099 | .441* | .076 | .177 | -.036 | -.092 | -.164 | .142 | -.344 | -.262 | -.313 | -.299 | -.089 | -.286 | .167 | .167 | -.058 | .046 | .160 |
| Ie | -.241 | .184 | .235 | .066 | .157 | -.027 | -.079 | -.117 | .156 | -.180 | -.059 | -.237 | -.355 | -.057 | -.385* | .374 | .058 | -.046 | .012 | .139 |
| Py | -.073 | .385* | .159 | .246 | .311 | .246 | -.068 | .157 | .090 | -.410* | -.234 | -.285 | -.459* | -.286 | -.302 | .420* | .064 | -.049 | -.053 | -.074 |
| Fx | -.004 | -.091 | .257 | .017 | .286 | .039 | -.268 | .038 | -.125 | -.078 | -.104 | -.117 | .136 | .284 | -.094 | -.078 | .138 | -.082 | -.025 | -.284 |
| Fe | -.174 | -.318 | -.012 | .054 | -.274 | -.053 | .191 | -.075 | .118 | -.087 | -.108 | -.046 | -.041 | .047 | -.094 | -.198 | .273 | -.019 | -.174 | .427* |

*Significant beyond .05 level of confidence

**Significant beyond .01 level of confidence

## Females

| CPI Score | LWJ S | LWJ As | LWJ T/S | LWJ T/A | CAM S | CAM As | CAM T/S | CAM T/A |
|---|---|---|---|---|---|---|---|---|
| Do | -.013 | -.232 | -.170 | -.434* | .100 | -.236 | -.096 | .152 |
| Cs | -.142 | -.089 | .143 | -.229 | .054 | -.389 | .137 | .291 |
| Sy | .029 | -.118 | -.066 | -.132 | .055 | -.043 | -.044 | .065 |
| Sp | .088 | -.287 | .061 | -.209 | -.256 | -.262 | .294 | .320 |
| Sa | .142 | -.139 | -.237 | -.186 | -.145 | .022 | .151 | .109 |
| Wb | -.506* | -.016 | .354 | .049 | .215 | -.211 | .070 | .244 |
| Re | -.571* | .011 | .264 | .010 | .006 | -.063 | .322 | .030 |
| So | -.353 | .028 | .115 | -.067 | .037 | -.060 | .086 | .107 |
| Sc | -.386 | .016 | .110 | .024 | .159 | -.194 | -.128 | .130 |
| To | -.317 | -.181 | .108 | -.174 | -.084 | -.131 | .323 | .163 |
| Gi | -.345 | .211 | .164 | -.017 | .194 | .026 | -.049 | .093 |
| Cm | -.408 | -.189 | .479* | -.078 | -.261 | .117 | .487* | .170 |
| Ac | -.363 | .081 | .148 | .085 | .421 | -.127 | -.090 | .061 |
| Ai | -.246 | -.296 | .243 | -.127 | -.083 | -.243 | .290 | .376 |
| Ie | -.109 | -.087 | -.089 | -.268 | -.211 | -.384 | .245 | .284 |
| Py | .223 | -.179 | .038 | -.219 | .165 | -.046 | -.035 | .090 |
| Fx | .096 | -.063 | -.275 | .134 | -.304 | -.068 | .219 | .235 |
| Fe | .462* | -.228 | -.112 | -.383 | .068 | .172 | -.293 | .001 |

| CPI Score | Wisconsin Card Sorting Test TCR | TT | T/Card | T/Cate | TE | PE | NPE | #Cate's | Intellectual Measures Lor V | Qor N | T | GPA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Do | -.389 | -.228 | -.234 | .123 | .192 | -.018 | .413 | -.048 | -.063 | .361 | .053 | .241 |
| Cs | -.314 | -.030 | -.044 | .273 | .309 | .152 | .434* | -.183 | -.191 | -.099 | -.282 | -.079 |
| Sy | -.515* | -.148 | -.071 | .077 | .125 | -.110 | .393 | -.021 | .028 | .147 | -.047 | .175 |
| Sp | -.284 | .086 | .144 | .164 | .024 | -.211 | .314 | .113 | -.028 | .127 | -.030 | .186 |
| Sa | -.255 | .047 | .080 | .185 | .157 | -.014 | .335 | -.188 | .023 | .201 | .012 | .087 |
| Wb | -.133 | .045 | -.039 | -.092 | -.024 | -.206 | .211 | .322 | -.341 | -.132 | -.305 | .009 |
| Re | .099 | .046 | -.025 | -.284 | .016 | -.024 | .062 | .216 | -.241 | -.092 | -.247 | -.184 |
| So | .265 | -.079 | -.180 | -.192 | -.092 | -.151 | .004 | .260 | -.169 | .139 | -.003 | .171 |
| Sc | -.027 | -.035 | -.126 | -.066 | .065 | .089 | .019 | .098 | -.284 | -.187 | -.237 | -.076 |
| To | -.133 | -.064 | -.115 | .036 | .125 | .015 | .235 | .029 | -.181 | -.037 | -.182 | -.064 |
| Gi | -.155 | .012 | -.081 | .096 | .212 | .205 | .170 | -.115 | -.368 | -.259 | -.346 | -.259 |
| Cm | .028 | .054 | -.053 | -.113 | .052 | -.081 | .209 | .190 | -.270 | -.091 | -.273 | -.103 |
| Ac | -.069 | -.061 | -.024 | -.107 | -.139 | -.233 | .013 | .281 | .003 | -.061 | -.100 | .212 |
| Ai | -.029 | .210 | .219 | .088 | -.071 | -.202 | .112 | .130 | -.033 | .030 | -.001 | .088 |
| Ie | -.046 | .164 | .105 | .060 | .043 | -.032 | -.128 | .097 | -.043 | .072 | -.077 | .013 |
| Py | -.291 | -.259 | -.231 | .003 | -.035 | -.196 | .178 | .090 | .025 | .150 | .173 | .532* |
| Fx | .355 | .260 | .291 | -.025 | -.267 | -.206 | -.281 | .202 | .120 | .049 | .195 | .038 |
| Fe | .157 | -.211 | -.284 | .055 | -.160 | -.043 | -.269 | -.103 | .334 | .331 | .395 | .278 |

*Significant beyond .05 level of confidence

**Significant beyond .01 level of confidence