An Investigation of Creative College Students Using Two Measures of Flexibility

Roberts

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AN INVESTIGATION OF
CREATIVE COLLEGE STUDENTS
USING TWO MEASURES OF FLEXIBILITY

By
John L. Roberts

A thesis presented to the
Faculty of the School of Graduate
Studies in partial fulfillment
of the
Degree of Master of Arts

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The author wishes to express his gratitude to Dr. Frank Fatzinger and Dr. E. J. Asher for their advice and guidance in the research and preparation of this thesis.

Acknowledgments are also due to those students who so willingly participated in this study.
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AN INVESTIGATION OF CREATIVE COLLEGE
STUDENTS USING TWO MEASURES OF FLEXIBILITY

During the early decades of this century few efforts were made to determine the basic characteristics of creative individuals. One indication of the lack of interest in this area has been the absence of studies concerning creativity. Guilford (1950) reported that less than two-tenths of one per cent of the books and articles indexed in the Psychological Abstracts for approximately the past quarter century were directly related to the subject of creativity.

During the past decade, however, various approaches have been tried to determine the characteristics of creative individuals (Stein and Heinze, 1960). In general these approaches have been concerned with anything that might be regarded as important in a study of the individual: his heredity, his personality, et cetera. For the most part, these approaches have failed.

A number of authors have focused their studies on the relationship between creativity and particular aspects of mental flexibility. Some writers have speculated that a creative individual is a flexible thinker (e.g. I.A. Taylor, 1959; Stein, 1953; C.W. Taylor, 1956). Other authors who are concerned with mental flexibility and its relationship to creativity have done objective studies of creative thinking (e.g. Guilford, 1950, 1957, 1959; Drevdahl, 1954). The theory underlying these approaches to creativity has been that a creative individual has the ability to break away from old habits of...
thinking and then strike out in new directions. This individual is not rigid in a way that would make him adhere to or repeatedly return to wrong ideas or poor solutions.

Mental flexibility in the creative process has been examined in different ways by some investigators. In an article devoted to a discussion of the different stages in the creative process, I.A. Taylor (1959) stated the need for freedom from stereotyping in Wallas's (1926) labeling of the four stages of the creative processes (preparation, incubation, illumination, verification).

During the preparation stage, Taylor stressed the need to absorb many of life's experiences without conscious awareness of how useful they might be and without a need to categorize each experience. The need for the freedom from stereotyping was again stressed by Taylor in discussing the incubation stage, when "experiences mill and flow freely about," the illumination stage, when "new categories must emerge," and the verification stage, when the "creative experience must be tested against reality and communicated."

In discussing the psychological characteristics of the creative individual, Stein (1953) stated, in reference to the stage in which the problem is investigated, that this stage is not a haphazard nor a rigid process. It is a flexible one that is often characterized by either implicit or explicit direction.

C.W. Taylor's (1956) article explored the ways in which the expressive aspects of the communication process reflect the extent of creative ability. With respect to expression fluency, Taylor observed two aspects of critical-mindedness that help determine the
quality and quantity of ideas: (1) the flexibility of critical-mindedness, and (2) the typical level of critical-mindedness. Taylor suggested, "the creative individual may be a person who can produce sheer quantity of ideas upon command and who also has sufficient flexibility of critical-mindedness to produce only high quality responses in a different test with that emphasis."

The contention that nonconformity or the ability of the creative individual to escape from the conventional was discussed in Stein's (1953) paper on creativity. Stein stated that the ability to avoid the conventional varies in its degree of significance and in its area of application. This point of variability in nonconformity was emphasized when Stein observed that in an area such as physics, greater flexibility in the intellectual sphere varies with the nature of the work that is undertaken. While in any other area such as art, greater flexibility in the emotional sphere varies with the nature of the work.

Since the early fifties, Guilford and his associates have been connected with a factor-analytic study of creative thinking. Before these factor analysis studies were undertaken, Guilford (1950) hypothesized a list of factors that may contribute to creative efforts of certain types of creative people, e.g. the scientist and the technologist. One of these hypothesized factors concerns an individual's flexibility of mind. Guilford explained this factor in terms of the ease with which an individual changes mental set.

The studies conducted by Guilford (1957) indicated that the original factor of flexibility could be divided into two subfactors: spontaneous flexibility and adaptive flexibility.
Spontaneous flexibility (the first subfactor) appeared in tests in which there was considerable freedom of response, as in a word fluency test. This subfactor may serve as the basis for a fanciful, creative imagination such as is found in the work of an artist. Adaptive flexibility (the second subfactor) occurred in tests in which there was problem solving and in which the type of solution changed radically from problem to problem. An individual bound to old habits will have a difficult time complying with these requirements (Guilford, 1957).

Guilford (1959) reported that spontaneous and adaptive flexibility seem clearly to be the opposite to two forms of rigidity of thinking (perseverance and persistence). Spontaneous flexibility in thinking appeared to be independent of perseverance, one form of rigidity. Adaptive flexibility appeared to be a freedom from persistence in using previously learned futile methods of solution, another form of rigidity.

Some evidence concerning the predictive validity of the subfactor, adaptive flexibility, has been reported by Guilford (1959). He stated that adaptive flexibility has consistently shown some small relationship to performance in mathematics and in one instance to achievement in physics. Among aircraft engineers scores for adaptive flexibility correlated .31 with the criterion of rate of increase in pay. Quantitative thinking that involved relatively novel problems seems generally to be related to adaptive flexibility (Guilford, 1959).

In a study using graduate and advanced undergraduate students from several science and art departments at the University of Nebraska,
Dreverdahl (1954) found no significant differences between the creative of spontaneous and adaptive flexibility. However, Dreverdahl reported a low, but significant (beyond the .05 level) relationship between creativity classification and higher scores on the subfactor of adaptive flexibility.

The purpose of the present study was to determine if measures of perceptual flexibility would significantly discriminate between a creative and a noncreative group.

In Part One of the present study, figure reversal-reaction time was selected as a measure. The amount of time in the interval between the presentation of each reversible figure and the onset of the subject's change in response to each figure was measured. No relationship between creativity and figure reversal-reaction time to the five figures used in Part One had been reported at the time of the study. The rational behind the use of this measure was that a flexible individual might be more adept in changing his perception in an ambiguous stimulus situation. Use of this measure was exploratory since no previous direct evidence of relationship was reported.

Indirect evidence for the use of the reversible figures was provided by Witkin (1954) and Frenkel-Brunswik (1948, 1949). Witkin (1945) reported that because individuals do have characteristic ways of perceiving, there is greater possibility for individual variation in the manner of organizing perceptual experiences. His studies involving normal adult college students, demonstrated that, within limits, individuals differ from one another in the extent of adherence
to the pattern of a prevailing field. Other studies by Witkin (1954) demonstrated that with a poorly structured field each individual organizes the field in a characteristic manner. Frenkel-Brunswik (1948, 1949) has reported that children who had more "rigid" personalities were more likely to insist on clarity in their perceptions rather than be tolerant of an ambiguous perception. Although the studies of Witkin and Frenkel-Brunswik did not relate directly to creativity, they did provide support for the contention that individual differences could be obtained from response to different perceptual situations.

The hypothesis for Part One of the present study stated: The creative group's mean reaction time score to the five figures would be significantly lower than the noncreative group's mean reaction time score to the five figures.

In Part Two of the present study, flexibility in mental set was measured by Luchins' (1942) Water-Jar Test.

Investigators associated with Wertheimer in Berlin in the 1920's invented the Water-Jar Problems. Studies by Luchins (1942, 1951) have been concerned with the operation of set in problem solving where set is defined as the continued attempt to use a previously successful method in problems where the method is no longer adequate. To obtain a "flexible" score, the subject must attend to the immediate problem. A "rigid" score is obtained when the subject is unable to restructure the field in which there are alternative solutions to a problem.
Luchins (1951) has distinguished two types of behavioral rigidity in his test. The first of these concerns the use of the indirect method in place of the simpler direct method in solving problems 6, 7, 9 and 10. The second type of behavioral rigidity results in problem 8 where failure to use the direct method results in failure to solve the problem.

The hypothesis for Part Two of the present study stated: The creative group would attend to the immediate problem and, as a result, a significant difference would be obtained between the mean performance of the creative and noncreative groups on problems 6 through 10.
Method

Subjects:

One-hundred and one Western Michigan University undergraduate students were used in this study. Every professor at Western Michigan University received a letter which asked him to choose (by using his own definition of creativity or by using the definition of creativity supplied in the letter) one or two of his most creative undergraduate students. From the fifty-six per cent of the letters returned by the professors, Williams (1962) selected 29 males and 23 females as the creative group. The matched noncreative group consisted of 27 males and 22 females. The unequal number of Ss was a result of the mechanics of testing. The matching procedure consisted of matching each creative student with another noncreative student for sex, curriculum, and grade point average. The two groups were also found to be very similar in intelligence, grade level, and sex ratio in each curriculum. For specific details concerning the selecting and matching of the two groups, consult Williams (1962).

Instruments and Apparatus:

Five reversible figures were used in Part One of the present study (See Figures 1-5). Figures 1 and 3 were taken from Patty and Johnson (1953). Figure 2 was taken from Morgan (1956). Figures 4 and 5 were taken from Kimble (1956).
Figures 1-5. Five Reversible Figures Used to Obtain a Measure of Figure Reversal Reaction Time.
Each figure was outlined in black ink on a sheet of 8 1/2" x 11" white paper. Each figure was approximately six inches square. The figures were attached to specially devised manila cards (9" x 12") that could be manipulated to show only one figure at a time.

An electric timing device was used to measure the amount of time each S took in reacting to each figure. At the presentation of each figure the E would switch the timer on and at the moment the S reported a complete change or reverse in the figure the S would stop the timer by throwing his switch. This procedure was replicated for each of the five figures.

Lucins's (1942) series of Water-Jar Problems were used to obtain a measure of mental flexibility in Part Two of the present study (See Figure 6). Ten problems, placed on ten 5" x 8" cards were presented, one at a time, to each S. In each problem, the task was to explain how a stipulated quantity of water could be obtained by using jars of given sizes, e.g. given an empty 14 quart jar, an empty 36 quart jar and an empty 8 quart jar, measure 6 quarts of water. Problems 1 to 5 could be solved in the same way; first fill the second jar, then subtract from it the amount necessary to fill the first jar once and the third jar twice (the indirect method). Problems 6, 7, 9 and 10 also could be solved by using the indirect method or, more directly, in one step which did not involve the second jar (the direct method). Problem 8 could be solved only by the direct method. A maximum of four minutes was allowed for each problem.
Figure 6

Ten Water-Jar Problems Used to Obtain a Measure of Flexibility in Mental Set

<table>
<thead>
<tr>
<th>Problem</th>
<th>Size of Jars</th>
<th>Get</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>21</td>
<td>127</td>
</tr>
<tr>
<td>2.</td>
<td>17</td>
<td>37</td>
</tr>
<tr>
<td>3.</td>
<td>15</td>
<td>144</td>
</tr>
<tr>
<td>4.</td>
<td>7</td>
<td>160</td>
</tr>
<tr>
<td>5.</td>
<td>50</td>
<td>120</td>
</tr>
<tr>
<td>6.</td>
<td>39</td>
<td>84</td>
</tr>
<tr>
<td>7.</td>
<td>24</td>
<td>72</td>
</tr>
<tr>
<td>8.</td>
<td>28</td>
<td>76</td>
</tr>
<tr>
<td>9.</td>
<td>18</td>
<td>48</td>
</tr>
<tr>
<td>10.</td>
<td>14</td>
<td>36</td>
</tr>
</tbody>
</table>
Procedure:

The two tests (figure reversal-reaction time test and water jar test) were a part of a larger creativity study. Six other graduate students in psychology administered tests which dealt with other aspects of creativity during the same testing sessions.

The administrative procedure for the figure reversal-reaction time test in Part One was as follows: Each S was seated directly in line with the cards which were placed on the back of a chair. The bottom of the card was two and a half feet above the floor and five feet from the subject. When the S was seated, the E handed the switch to the S and asked the S to throw the switch a few times in order to get the "feel" of the switch. After the directions were read aloud, the E released (by using the right hand) the first card, and at the same time (by using the left hand) the E threw the switch to start the timer. After each trial the E recorded the amount of time (in whole seconds) the S took in responding to the figure. This procedure was followed throughout the study.

The directions that were read to the S were as follows:

"When you are in position, I will display, one at a time, a series of five cards. You have a possibility of seeing two figures on each card. Upon looking at each card you will be able to distinguish one of the two figures on the card. If you do see the other figure, please indicate to me (by throwing your switch) the exact moment you visualize a completed change in the figure. After each card you will be asked to tell what you have seen, so try to be exact."
The administrative procedure for Luchins Water-Jar Problems in Part Two was as follows: After completing the reaction time test the S was asked to pick up a pencil and a piece of paper, which was placed nearby. The E then presented the first problem and read the following directions:

"This experiment is designed to see how well you can work simple arithmetic problems without making mistakes. Imagine that you are standing beside a lake which has lots of water. In the first problem you are given three empty jars. The first empty jar has a capacity of 21 quarts of water. The second empty jar has a capacity of 127 quarts of water. The third empty jar has a capacity of 3 quarts of water. Write down on your paper how you would go about getting exactly 100 quarts of water. Do the problem the easiest possible way. Remember you may not have to use all of the three jars in order to solve the problem."

A maximum of four minutes was allowed. The E then told the S to stop solving problem 1. The E then explained to the S (regardless of whether problem 1 was solved correctly or incorrectly) how to solve problem 1. When the S indicated to the E that problem 1 was understood, the E presented the remaining nine problems (one at a time) to the S. Before the start of the second problem, the E again reminded the S that all three jars or numbers may not have to be used to solve the problems. During the succeeding eight problems no other directions were given to the S. A limit of four minutes was used for all remaining problems.

Knowledge of which students belonged to the creative or non-creative groups was not obtained by the E until after all the papers
were scored. This procedure was enforced to remove the possibility of scoring bias throughout the study.
Results

The results of the figure reversal-reaction time test are presented in Table 1. Only the reaction times to four figures were used in analyzing the data because only four Ss correctly responded to the fifth figure (My wife and my mother-in-law figure, Kimble, 1956, b). All Ss in both groups distinguished "My wife" as the first figure on the fifth card. Two Ss in the noncreative group reported the young lady changed to an animal with a tail. Two others reported the change was to a bird. Five Ss in the creative group reported the same figure changed to an animal with a tail. Other creative Ss reported the figure changed to a bird, cat, portion of landscape, vase, foot, face on a white veil.

According to the results in Table 1, no significant difference was found between the means of the creative and the noncreative groups. The "t" value was .91.

The results of the Water-Jar Problems are presented in Tables 2, 3, and 4. Table 2 shows that no significant difference was found between the means of the creative and the noncreative groups and on problems 1 through 5. Therefore, it may be assumed that both groups were equally able to solve problems 1 through 5. The "t" of 1.65 was not significant. Table 3 shows that no significant difference was found between the means of the creative and the noncreative groups on problems 6 to 10. The "t" of .53 was not significant. Therefore, the experimental hypothesis was not supported.
Table 4 shows the percentage of Ss in both groups solving problems 6 and 7, 9 and 10 by using the indirect method. Forty-seven per cent of the creative group and fifty-six per cent of the noncreative group solved problems 6 and 7 by using the indirect method. Sixteen per cent of the creative group and twenty-two per cent of the noncreative group solved problems 9 and 10 by using the indirect method.
Table 1

Figure Reversal Reaction Time Test in Seconds
for the Creative and Noncreative Groups

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>S.E.</th>
<th>&quot;t&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creative Group</td>
<td>20.57</td>
<td>22.50</td>
<td>9.73</td>
<td></td>
</tr>
<tr>
<td>Noncreative Group</td>
<td>16.31</td>
<td>24.43</td>
<td>12.18</td>
<td>.91</td>
</tr>
</tbody>
</table>
Table 2

Correct Solutions to Water-Jar Problems, 1 through 5, for the Creative and Noncreative Groups.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>S.E.</th>
<th>&quot;t&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creative Group</td>
<td>4.08</td>
<td>1.1</td>
<td>.15</td>
<td></td>
</tr>
<tr>
<td>Noncreative Group</td>
<td>3.70</td>
<td>1.1</td>
<td>.16</td>
<td>1.65</td>
</tr>
</tbody>
</table>
Table 3

Direct Solutions to Water-Jar Problems, 6 through 10, for the Creative and Noncreative Groups

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>S.E.</th>
<th>&quot;t&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creative Group</td>
<td>2.92</td>
<td>1.8</td>
<td>.25</td>
<td>.53</td>
</tr>
<tr>
<td>Noncreative Group</td>
<td>2.73</td>
<td>1.7</td>
<td>.24</td>
<td></td>
</tr>
</tbody>
</table>
Table 4

Percentage of Ss in the Creative and Noncreative Groups Solving Problems 6 and 7, 9 and 10, by using the Indirect Method

<table>
<thead>
<tr>
<th></th>
<th>Problems 6 &amp; 7</th>
<th>Problems 9 &amp; 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creative Group</td>
<td>47%</td>
<td>16%</td>
</tr>
<tr>
<td>Noncreative Group</td>
<td>56%</td>
<td>22%</td>
</tr>
</tbody>
</table>
Discussion

The hypothesis of Part One that the creative group's mean reaction time to the five figures would be significantly lower than the noncreative group's mean reaction time score was not supported.

The results of studies (Brown, 1955; Donahue and Griffitts, 1931; Hochberg and McAlester, 1953) dealing with the rate of apparent change in reversible figures suggest that the nature of reversible figures may lead to difficulty in interpreting the results in Part One. Brown (1955) reported that ambiguous figures give rise to more than two different perceptions. The variety of S's responses to figure 5 (My wife and my mother-in-law) supported this conclusion. The Ss reporting these responses indicated that the exact moment of apparent change was not always clear and at times one part of the figure had one appearance while another part had another appearance.

Donahue and Griffitts (1931) reported that complexity as indicated by the number of lines or other units had a tendency to make the rate of change slower for some Ss. Donahue and Griffitts (1931) also reported that familiar objects fluctuate more rapidly than those representing less familiar objects. Because of the design of Part One an accurate appraisal of Donahue's and Griffitts's findings could not be obtained, but it is suggested that future studies take their findings into consideration in order to obtain a more reliable measure of responses to reversible figures.
Hochberg and McAlester (1953) suggested that key-pressing to indicate a reverse in a figure altered the percept. If this is the case, the throwing of a switch to indicate a reverse in a figure would seem to affect the reliability of some Ss' reactions to the figures.

Because of the apparent difficulty in interpreting the results in Part One, it is suggested that future studies concentrate on designs which measure the rate of change in reversible figures over a certain period of time. Perhaps these designs will provide a more reliable and discriminating measure than the measure used in Part One.

The hypothesis of Part Two that the creative group would attend to the immediate problem, and, as a result, a significant difference would be obtained between the mean performance of the creative and noncreative groups on problems 6 through 10 was rejected. If Luchins's test can be assumed to provide an adequate measure of mental rigidity and flexibility, then the results in Part Two provide no information about a possible relationship between creativity and mental flexibility and rigidity.

Perhaps a test in which the type of solution changes radically from problem to problem would provide a more discriminating measure of mental rigidity and flexibility than Luchins's test. Guilford's (1950) test for adaptive flexibility, requiring an individual to change set from problem to problem, seems to provide such a measure. However, Drevdahl (1954) reported that no significant difference was found between a creative and noncreative group when Guilford's test
of adaptive flexibility was used.

The nature of the results in Part Two does suggest the possibility that the selection of the creative group may have been heavily influenced by the high degree of educational success rather than the high degree of creative ability possessed by this group. The percentage of Ss in the creative group and in the matched noncreative group solving problems 6 and 7, 9 and 10 by using the indirect (poorer) method (i.e., employing all three jars in solving the problems instead of employing two of the three jars in solving the problems) was considerably lower than the percentage of Ss (college students) solving the same problems by using the indirect method in Luchins' studies.

In a study at Brooklyn College Luchins' (1942) reported that 82 per cent of the 79 juniors and seniors used the indirect method of solving problems 6 and 7. In another study at New York University using 275 teachers and administrators of elementary and secondary schools in New York City as Ss, Luchins (1942) reported that 87 per cent of the control group used the indirect method in solving problems 6 and 7. Table 4 shows that 47 per cent of the creative group and 56 per cent of the noncreative group used the indirect method in solving problems 6 and 7.

Concerning problems 9 and 10, Luchins (1942) reported that 55 per cent of the Ss in the Brooklyn College study and 71 per cent of the Ss in the New York University study used the indirect method in solving these problems. Table 4 shows that 16 per cent of the creative group and 22 per cent of the noncreative group used the indirect method in solving problems 9 and 10.
Although the difference in results between the Ss used in the present study and the Ss used in Luchins' studies seems large, there remains the possibility that certain factors in the present study may have influenced the Ss' performances. One of the influencing factors is the fact that both groups in the present study were performing under the assumption that they were creative. Operating under this assumption would at least provide an incentive to perform "creatively" on the problems.

Another influencing factor is the fact that the Ss in the present study were allowed a maximum of four minutes to solve each problem while Luchins' Ss were allowed a maximum of 2.5 minutes to solve each problem. Evidence that time is an important factor with respect to the type of solution to the Water-Jar Problems was reported by Rokeach (1950). He found that the longer the various groups were subjected to experimental variation in delay conditions the more the direct method of solution to problems 6 through 10 was employed.

Even if the difference in results between the Ss used in the present study and the Ss used in Luchins' studies could be accounted for by the factors of motivation and increased time to solve each problem, there still exists a further indication that the selection of the creative group may have been heavily influenced by the high degree of this educational success. This indication was obtained by comparing the creative and the matched groups grade-point average of 3.2 with the school grade-point average of 2.3.
If further studies are to be undertaken in the areas subjected to investigation in Parts One and Two of the present study, it is recommended that the above suggestions be taken into account in order to improve upon the accuracy of measurement. However, even with these recommendations taken into account, it seems highly unlikely that anything but minimal differences will result from employing these measures.
Summary

The purpose of the study was to determine if measures of flexibility would significantly discriminate between a creative and a matched noncreative group. Five reversible figures were used as a measure of figure reversal-reaction time. Luchins's (1942) Water-Jar Test was used as a measure of flexibility in mental set. Differences between the creative and matched noncreative groups were not significant for either of the two measures.
References


