Creativity Quotient: A Statistical Instrument For Combining Cognitive And Personality Components Of Creative Thinking

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(ABSTRACT)

Creative thinking is a multi-facted trait. It encompasses a constellation of intellectual abilities and personality characteristics. In this study cognitive and personality components of creative thinking were included in an instrument. From the relevant literature the most important cognitive components in order of importance were problem finding, original problem solving, general problem solving, knowledge, and attentiveness to detail. Lack of conformity was suggested to be the most important personality component. Measures of these components of creative thinking were developed. Data were obtained by interviewing 110 third-grade children (M = 8.9 yrs), from which 80 sets were randomly selected to develop a scoring scheme. The scoring scheme was utilized to derive a statistical equation to quantify creative thinking for each individual. To ascertain the reliability and consistency of the developed scoring scheme, the author and two graduate students independently scored the remaining data (30 sets). The coefficient of variability for the three groups of scores were computed by means of pooled estimate of variance. This quantity was found to be .02 which is remarkably small.

The relative contribution of each component to creative thinking and the interrelationship between them have been discussed. Whether problem finding and problem solving are two separate cognitive procrsses was also discussed.

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INTRODUCTION

Creativity has been a topic of empirical research for at least half a century. Although we now have a better understanding of this human quality it is still considered an elusive trait (Khatena, 1982). Much confusion about creativity stems from defining it as the production of something that is unusual and good or useful (Halpern, 1984). Based on such a definition, an act or an idea has to be judged by someone or some group as unusual and good or useful before it can be labeled as creative. However, adjectives such as "unusual," "good," and "useful" involve judgment and people often disagree on the quality of these attributes. To clarify some of the ambiguity that surrounds the term "creativity," two points must be taken into consideration. First, creativity is a human trait just as intelligence and morality are. Second, creativity is a multi-faceted trait. As a human trait, creativity varies along a continuum and all individuals have it to various degrees. However, a creative person is a unique individual who possesses a sufficient degree of this trait to be qualitatively different from most other individuals. The relationship between creativity and the creative person is analogous to that between intelligence and the intelligent person. It is generally agreed that everybody possesses some intelligence and that different degrees of intelligence exist. Nonetheless, we refer to the intelligent person as a qualitatively different individual whose score on an IQ test is at the upper end of the distribution of scores for the general population (Ausubel, 1978). Up to this point no standardized test of creativity has existed as it has for intelligence. Such a test is needed for understanding the dynamics of this human quality. In the present study the first step has been taken toward developing a standardized test of creative thinking.

As a multi-faceted trait, creative thinking encompasses a constellation of intellectual abilities and personality characteristics. Thus far, creative thinking has been thought of as a unified cluster of either intellectual abilities or personality characteristics. The latter view has resulted in the development of psychometric measures such as Guilford's Tests of Divergent Production (Guilford, 1967), Torrance Tests of Creative thinking (Torrance 1962), and Wallach and Kogan's battery (1965). In these divergent thinking (DT) tests, verbal and visual stimuli are employed to pose questions demanding multiple answers. Subjects are asked to generate as many answers as possible to a given stimulus, thereby demonstrating fluency, flexibility, and originality. These tests which are very similar in structure and scoring have been subject to several criticisms. First, they have been demonstrated primarily to be measures of ideational fluency, the mere number of responses produced (Hocevar, 1979; Wallach, 1970). Therefore, the question of whether DT tests measure abilities involved in creative thinking remains unanswered. Second, very little is known about their predictive validity (Anastasi, 1976). Third, divergent thinking alone cannot explain the thought processes involved in the production of new ideas. According to Barron and Harrington (1981) "divergent thinking goes hand in glove with convergent thinking" to produce a new idea. Finally, scores on DT tests reflect the influence of such contaminating factors as test instructions and test scoring procedures (Datta, 1963; Harrington, 1975; Vernon, 1971). Although much of the research efforts have been focused on measures of divergent thinking, some measures of non-divergent tests of creativity also exist. Among these are the Remote Association Test by Mednick and Mednick (1967) and the Barron-Welsh Art Scale (Barron & Welsh, 1952). These tests, however, are not without their problems. For example, the relationship between divergent and non-divergent tests is obscure (e.g., Barron, 1953; Cropley, 1967; Hargreaves & Bolton, 1972). Furthermore, as with DT tests, the non-divergent tests are also focused on a single dimension of creative thinking (Bolton, 1972). Despite all criticisms, these tests are used for various purposes ranging from research to educational program placement. However, Anastasi (1976) warned against widespread use of these tests as valid indicators of creative potential.

The efforts of those who believe that differences in creativity are more related to non-cognitive than to cognitive factors have resulted in the emergence of a set of "core" personality characteristics thought to be associated with creative achievement. Based on these personality characteristics, several creative personality scales have been developed such as the Adjective Check List (Gough, 1979) or the 16 PF Equation (Cattell, Eber, & Tatsuoka, 1970). However, the overall findings of research in this area indicate that considerable variation exists among groups of creative people. This is due in part to the utilization of different methods by different researchers. Additionally, it is not known which of these core personality characteristics (e.g., attraction to complexity, autonomy, self-confidence, independence of judgment, etc.)

facilitate creative behavior and which are by-products of creative achievement and social recognition (Barron & Harrington, 1981; Brody, 1972).

In conclusion, aside from the existing criticisms against each of the two approachs, taking a purely cognitive or a personality approach toward the identification of creative potential seems to limit progress in terms of understanding of this human quality. A more promising approach appears to involve considering both personality and cognition in determining creative potential. The purpose of the present study was to isolate the most important cognitive and personality components thought to be associated with creative achievement and to include them in an instrument for measuring creative thinking. From the literature, six cognitive and personality components consistently were found to be related to creative achievements of eminent people. They included problem finding, original problem solving, general problem solving, information or knowledge, attentiveness to the details of the environment, and lack of conformity.

Problem finding has been suggested to be the first crucial step in the birth of any creative act (Bolton, 1972; Dillon, 1982; Getzels & Csikszentmihaly, 1976; Smilansky, 1984). Perceiving and formulating new problems to solve is a separate and more important stage of the creative process than finding useful solutions to problems that have already been identified (Buhl, 1960; Mackworth, 1965;). In this regard, Albert Einstein said, "The formulation of a problem is often more essential than its solution, which may be merely a function of mathematical or experimental skill." (Einstein & Infeld, 1938, p. 92). However, becoming aware of an unidentified problem does not insure that the problem will be solved creatively or even solved at all (Mackinnon, 1970). Thus, the next important stage of the creative process is not only being able to solve the problem, but rather solving it creatively. The determinant of solving a perceived problem is the availability of a certain amount of knowledge or information. Obviously, the absence of sufficient information impedes or obviates the attainment of a solution to a problem (Buttimer, 1983; Mackinnon, 1970). Furthermore, the extent of one's willingness to attend to the details of the environment influences one's sensitivity to unidentified problems (Gardner, 1961; Schachtel, 1959; Thompson & Clark, 1981; Ward, 1969). Undoubtedly, if the process of creativity consisted of nothing other than perceiving problems and devising solutions, it would be a very private act. But then it could be a private act committed by many (Gruber, 1983). Thus, an essential component of the actualization of any creative process is the courage of communicating new and unusual ideas without the fear of being unconventional or nonconforming. Indeed, Crutchfield (1962) and others (e.g., Barron, 1958; Bolton, 1972; Mackinnon, 1970; Moustakas, 1967) have produced ample evidence in favor of lack of conformity as a strong personality correlate of creative productions. However, it would be unrealistic to think that if one becomes nonconforming and unconventional one becomes highly creative.

In this study measures of the six cognitive and personality components of creative thinking were devised to develop an instrument by means of which to derive an equation to quantify creative thinking. Through the derivation of such an equation creative thinking can be defined in terms of its components. Furthermore, the relative contribution of each component can be identified.

Method

Subjects

One hundred and ten third-grade children, with equal number of boys and girls, from three elementary public schools in a southeastern community participated. These third graders had a mean age of 8.9 years.

Stimulus Materials

Two different stimuli were used in this study. A "What's Wrong" feature from the back cover of the November 1983 issue of Highlights For Children, hereafter called Picture Task, and the Information subtest of Wechsler Intelligence Scale for children-R (Wechsler, 1974). The Picture Task was employed because measures of five of the variables of interest to this study could be derived from it. This picture depicts a scene with scrambled content and at least 34 oddities. Recognition of these oddities was employed as a measure of attentiveness to detail.

To develop a measure of conformity, the thirty-four identified oddities were classified into two types: (1) logical oddities, those which violate the laws of physics or laws of nature; and (2) normative oddities, those which violate the laws or norms of culture. To ascertain the validity of this classification scheme, 30 college students were presented with the Picture Task and a list of oddities and were asked to judge them accordingly. Ten of these oddities: mismatched kitchen drape, apron worn backward, tennis racket hanging on the wall with pots and pans, saw being used to cut a turkey, bowling pin used to roll cooking dough, tennis ball mixed with apples on a table, cat wearing collar and necktie, teddy bear with mismatched ears, boy wearing a shirt with mismatched sleeves, and a baby with one shoe on and one shoe off were judged by more than 90% of the students as normative oddities. These oddities were employed to measure level of conformity.

Four of the identified oddities (drawer used as a fish tank, a chair with a missing leg standing balanced, light bulb placed in a candle holder with two candles, and a cloth hat used as plant pot) which had potential for causing a number of different problems were selected to measure problem finding. These same four oddities were formulated into the following problems to measure problem solving and original problem solving variables.

1. Drawer as fish tank: Suppose a person comes to you and tells you "I want to put my fish in a drawer just like these people in the picture have done. But I have a problem. The problem is that water leaks out of the drawer. I don't know what to do about it. Please tell me what to do to stop the water from leaking out."

2. Chair with missing leg: Suppose these people in the picture come to you and tell you "Each time we sit in this chair we fall. We really want to use the chair and sit in it without falling down. But we don't know what to do. Please tell us what we can do about it."

3. Light bulb: See this candle holder with no cord attached to it! Suppose this man comes to you and says "If I don't light this light bulb I will be in trouble. I don't know how to do it. Please tell me how to light the bulb so I won't be in trouble."

4. Hat like flower pot: A first-grade student is asked by the teacher to plant some seeds in a hat-like plant pot. This first-grade student goes home and gets his dad's hat and plants some seeds in it. Unfortunately, after few days the hat rots and dirt

> falls out. Now this first-grade student is very sad and doesn't know how to complete his assignment. He comes to you to solve his problem. What can he do to complete his assignment?

The information subtest of the WISC-R was employed to measure the level of knowledge.

Procedure

Each child was tested individually in a school room in one session lasting as long as the child wished. In a pilot study the use of a tape-recorder for coding of responses proved to be distractive and threatening for this study. Thus, data sheets were used to code responses. Testing proceeded only after the children felt relaxed and comfortable about expressing their ideas. The stimulus materials were administered in the following order:

Phase 1: Experimenter presented the Picture Task to the child and said "Look at this picture and tell me all the unusual things you see in this picture, such as the fish in the drawer."

Phase 2: A card with three choices written on it was given to the child. Then experimenter explained "I am going to ask you some questions. I want you to pick your best choice from these three choices each time to answer each question." After a short practice, an appropriate question (e.g., Would you wear a shirt with mismatched sleeves?) was asked about each of the ten oddities selected for this phase. The choices were: (1) Yes, I would do this; (2) Maybe, I would do this; and (3) No, I would not do this.

Phase 3: Each child's attention was called to each of the four oddities selected to measure the problem finding variable. Then the child was asked "Could this _____ (e.g., chair) cause any problem?" If the child said "Yes" then the child was encouraged to state all the problems that the child could think of. If the child said "No" then he/she was asked to explain why not, in order to insure that the child did not perceive a problem.

Phase 4: Each of the four previously mentioned problems was explained to each child individually. The child's understanding of each was elicited by asking the child to tell the experimenter what the problem was. Then the child was encouraged to solve each problem in as many different ways as possible.

Phase 5: The information subtest of the WISC-R was administered according to the standard procedure as detailed in the manual for this test.

Results

Out of 110 sets of data, eighty were randomly selected in order to develop a scoring scheme and to derive a model equation to define creative thinking in terms of its components and to compute the level of creative thinking for each child. The remaining data (30 sets) were retained to assess the reliability and consistency of the scoring scheme.

Scoring Scheme

Attentiveness to detail: The oddities identified by each child were compared to the previously developed list of thirty-four oddities. All the ones that were among those on the list were counted and the sums were used as the overall score (M = 20.81, SD = 4.74).

Conformity: A score of three was given to choice 1, two to choice 2 and one to choice 3. The child's scores on each of the ten questions were summed and used as score for the extent of conformity (M = 13.06, SD = 3.05).

Problem finding: Problem finding was defined as the ability to use relevant information and to pose problems requiring multiple solutions. Using this operational definition, two general types of problems were identified based on the data: plausible and implausible. Three classes of implausible problems for all the four problem finding situations were identified:

1. Appearance problems are those reflecting a lack of conformity with general cultural norms or a lack of concern about the impression made on others, such as looking weird.
2. Generalizable problems are those which could exist in normal situations, such as running out of food for fish.
3. Hypothetical problems are those the occurrence of which is conditional upon the existence of some other factors, such as if you drop somthing on the candle holder, the light bulb might burst.

Different classes of plausible problems were identified from the data for each of the four problem finding situations.

Six different classes of problems were identified for the first problem situation (using drawer as fish tank).

1. Water will leak out
2. Drawer will be damaged
3. Fish will die
4. Drawer cannot be used for normal purposes
5. There will be a mess and bad smell in the house

6. Things will fall into the water from the top of the drawer

Six classes of problems were identified for the second problem situation (chair with missing leg).

1. Chair cannot be used
2. Chair will fall and break even more
3. Chair has to be fixed (time and effort)
4. Cost for repair
5. Chair has the potential to inflict some danger on others
6. Feeling sad about the chair being broken

Three classes of problems were identified for the third problem situation (light bulb in the candle holder):

1. Light bulb not lighting up due to the candle holder not being connected to a power source
2. There won't be as much light with two candles as with three
3. Light bulb does not belong to candle holder, thus may fall off and break

Six classes of problems were identified for the fourth problem situation (cloth hat being used as plant pot):

1. Hat gets ruined, which will be waste of money
2. Water soaks through the hat
3. Hat cannot be used any more if needed

4. Plant might die as a result of being placed in a hat
5. There will be a mess to clean up

Children received a score of one for each plausible problem given. No credit was given to repetition of any problem phrased differently. The number of plausible problems given were counted to yield an overall problem finding score (M = 7.32, SD = 2.44).

Problem solving and Original problem solving: Problem solving in this study was operationalized as the ability to find a pertinent and logical, but not necessarily effectual, solution which meets the specific requirements of a given problem. Using this operational definition, different classes of solutions were derived from the data for each of the four problems. Those classes of solutions that were given by more than 5% of the sample were considered popular classes; those that were given by 5% or less of the sample were considered original classes of solutions.

Solution 1: For using a drawer as fish tank three classes of popular and one class of original solutions were derived from the data.

A. Popular classes
   1. Fix or seal the cracks
   2. Use a water-proof drawer made of other materials, such as glass or metal

3. Line the inside of the drawer with sheets of water proof-materials

B. Original class: Carve a one-piece drawer

Solution 2: For using the chair without falling down, four classes of popular and two classes of original solutions were derived from the data. These include the following:

A. Popular classes

1. Fix the chair
2. Prop the chair up by placing some kind of object such as a stack of books under the place where the leg is missing
3. Have some one to hold it up
4. Lean it against a support such as corner of a wall

B. Original classes

1. Cut off the other three legs to make it level
2. Adjust its center of gravity by distributing weight on the other three legs

Solution 3: For lighting the light bulb in the candle holder, three classes of popular and five classes of original solutions were obtained.

A. Popular classes

1. Connect electricity to candle holder
2. Use a battery system

3. Put something inside the bulb

B. Original classes

1. Produce electricity by means of an electromagnetic field
2. Cover the light bulb with wax
3. Use a candle shaped like the bulb
4. Use remote control
5. Fill it with fire flies

Solution 4: To solve the hat-like plant pot problem, four classes of popular and two classes of original solutions were obtained from the data.

A. Popular classes

1. Use a hat-like plant pot
2. Use hat already made of other materials (e.g., army hat)
3. Disguise an ordinary plant pot as a hat

B. Original classes

1. Use another container shaped like a hat (e.g., round brass bowl with brim)
2. Make a hat-like plant pot by using raw materials (e.g., clay soil)

The number of popular solutions was summed to obtain an overall problem solving score for each child (M = 3.86, SD = 1.78). By the same method, original problem solving scores were computed (M = .25, SD = .63). Children received credit for classes of solutions and not instances of each class. Those solutions that are not found in this study should be considered original solutions and scored accordingly only if they satisfy the conditions stated in the operational definition.

Knowledge: Children's performances on the Information subtest of WISC-R were scored according to prescribed procedure. These scores were used as measure of children's level of knowledge (M = 11.11, SD = 2.69).

Derivation of Model Equation

The principles of modeling (Gilchrist, 1984) were used to develop an equation for computing creativity quotient. Accordingly, the six predictor variables of interest- problem finding (PF), original problem solving (OPS), problem solving (PS), knowledge (K), conformity (C), and attentiveness to detail (A)- were ordered in terms of their likely importance, as indicated in the literature. Relative weights were assigned to each of these predictor variables by considering the relationships between them and the constraints on their values. The constraints took the following form:

$\beta_1(PF) > \beta_2(OPS) > \beta_3(PS) = \beta_4(K) = \beta_5(C) > \beta_6(A)$. A reasonable set of coefficients (β_i) for the predictor variables was judged to be 3, 2, 1, 1, and .5. In order to compensate for differences in the variability of each variable, raw scores were transformed into standard scores. Thus, a comparable set of coefficients (γ_i) was obtained by dividing the relative weights by the respective standard deviations. The resultant prediction equation was found to be:

$Y = \Sigma_{i=1}^{6} (\beta_i / S_i)X_i = \Sigma_{i=1}^{6} \gamma_i X_i = 1.23(PF) + 3.19(OPS) + .56(PS) + .37(K) + .33(C) + .10(A)$

The intercept term (constant α) is absent in this equation in order to ensure that no Y_i (creative thinking score) would have a negative value. To standardize scores one usually subtracts means from the raw scores and divides by respective standard deviations. If this procedure had been utilized for this study the Y_i would be equal to:

$$\Sigma_{i=1}^{6} \gamma_i X_i - \Sigma_{i=1}^{6} \gamma_i X_i$$

As can be seen, a constant ($\alpha = \Sigma_{i=1}^{6} \gamma_i X_i$) would be subtracted from each subject's creative thinking score (Y_i) which results in negative scores for some subjects (those whose scores falls below the mean). In order to make all the values (Y_i) positive we would have to add a constant to all scores. However, if one doesn't add the constant ($\alpha = \Sigma_{i=1}^{6}$ (γ_i X_i) one doesn't subtract the constant. Additionally, the derived equation can be used with raw scores by interested users with no further need to standardize scores.

Reliability

To assess the reliability of the scoring scheme, the author and two graduate students independently scored the data not used in the derivation of the equation (30 sets). Each of the scorers was provided with stimulus materials and written instructions for scoring. The scorers were instructed to credit any responses not included in their scoring instructions only if they satisfied the conditions of operational definitions of the predictor variables.

The pooled estimate of variance for creative thinking scores (Y_i's) reported by the three independent scores for each of the 30 children were obtained by using the following formula.

$$sp = \Sigma_{i=1}^{30} S_i^2 / 30$$

with $S_i^2 = (\Sigma_{j=1}^{3} X_{ij}^2 - (\Sigma_{j=1}^{3} (X_{ij})^2 / 3)) / 2.$

This parameter, which was found to be equal to .5 (very small) was needed for computation of the coefficient of variability for the three groups of scores. The pooled estimate of variance was divided by the overall mean (sp / ($\Sigma^{30}_{i=1}$ $\Sigma^{3}_{j=1}$ X_{ij} / 90) to yield the coefficient of variability. This quantity was found to be equal to .02 which is remarkably small, especially since it includes experimental error as well, such as error in summing scores.

Discussion

The analysis of the coefficient of variation for the three groups of scores obtained from three independent scorers yielded an almost perfect scorer reliability. This coefficient, which was .02, is very small and indicates that 2% or less (contains experimental error as well) of an individual score is due to scorer variance. Thus, the scoring scheme is highly objective.

The overall findings of this study indicate that the instrument is an objective one with standardized procedures for administration and scoring. Furthermore, this instrument contains elements of both divergent and convergent productions. Even though the problem finding and problem solving aspects of this instrument demand that the subject's thought be converging upon a plausible response, the subject is, at the same time, encouraged to generate as many responses as possible, thereby allowing fluency, flexibility, and originality.

The Pearson Product-Moment Correlation procedure was employed to investigate the relationships among the six predictor variables. As can be seen in Figure 1., lack of conformity and original problem solving were found to be significantly related to each other ($r = .58$, $p < .0001$). Knowledge, problem finding, and general problem solving were also found to be significantly related to original problem solving ($r_{OPS,K} = .49$, $p < .0001$; $r_{OPS,PF} = r_{OPS,PS} = .48$, $p < .0001$). Attentiveness to detail and original problem solving were not significantly related ($r = .07$, $p < .5$). Problem finding was found to be significantly related to general problem solving ($r = .72$, $p < .0001$), knowledge ($r = .54$ $p < .0001$), and attentiveness to detail ($r = .55$, $p < .0001$). Knowledge was significantly related to general problem solving ($r = .50$, $p < .0001$), attentiveness to detail, and lack of conformity ($r_{K,A} = r_{k,C} = .43$, $p < .0001$). The remaining correlation coefficients, as shown in Figure 1., were either nonsignificant or the size of r was less than .40.

Insert Figure 1. here

The question of whether problem finding is a different cognitive process distinct from the problem solving process has recently captured some attention and interest among researchers. Even though very little is known in this area, some illuminating information has started to emerge. The present lack of knowledge can be attributed to several factors. First, very few empirical studies of problem finding exist. Second, those who have investigated problem finding (Allender, 1969; Getzels & Jackson, 1962; Getzels & Smilansky, 1983; Ivany, 1969; Shulman, 1965; Suchman, 1966) have utilized different materials such as assorted and unrelated objects which of themselves constitute no problem, "in-basket" containing relatively hidden or embedded problem-elements, or discrepant events which clearly depict problems. As a result, no conclusive statement can be made about the nature of processes involved in problem finding. Finally, in addition to the present study, apparently only two other researchers have investigated the relationship between problem finding and problem solving. Smilansky (1984) first presented high school students with the Raven (1958) Progressive Matrices Test and then provided them with a skeleton matrix page to create a new and most difficult item that they could think of. He found a small, though statistically significant, correlation between students'

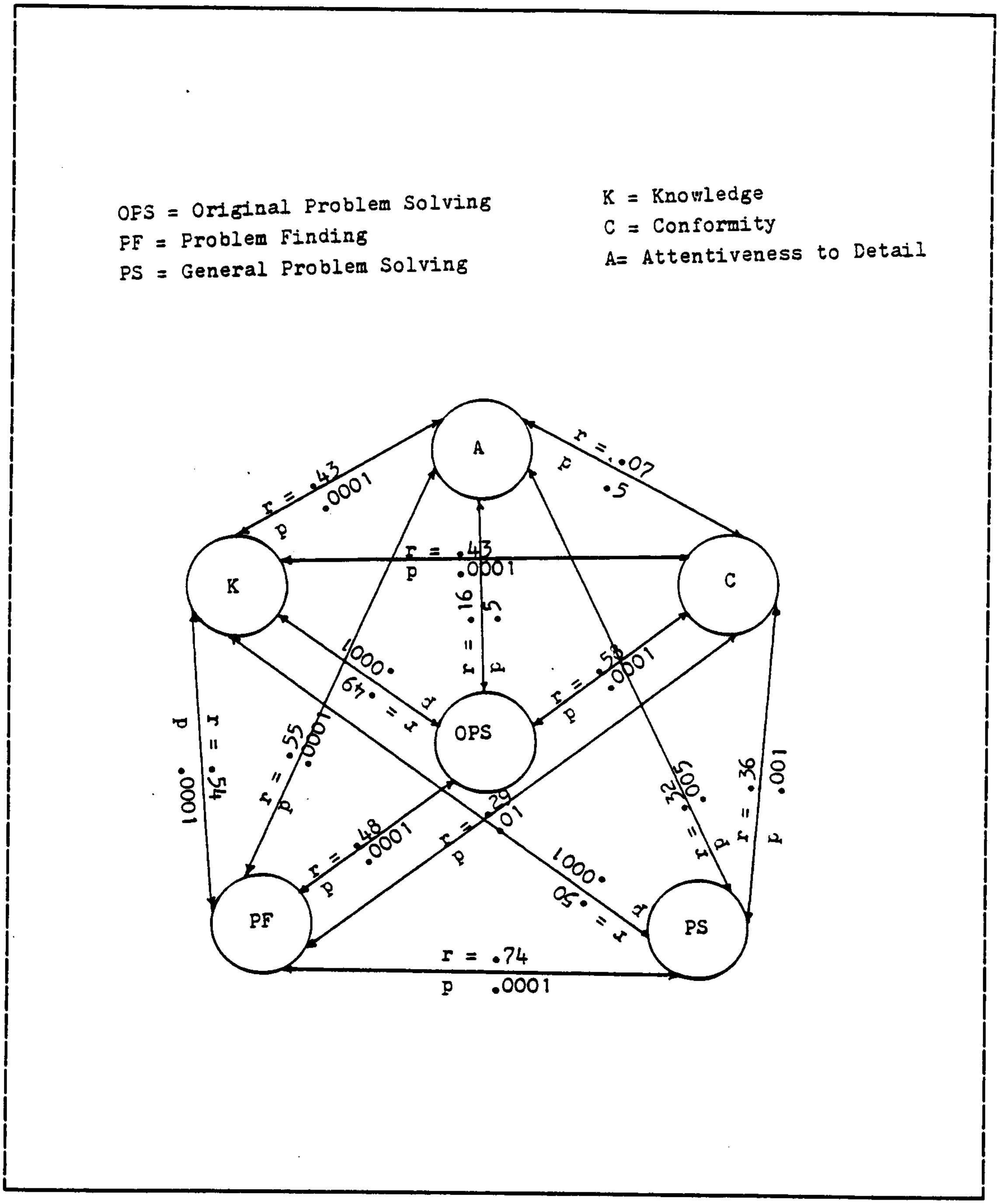

Figure 1: Pearson Correlation Coefficients between six predictor variables

problem solving and problem creating scores (r =.16 for one group and r = .18 for a different group). A point of consideration about Smilansky's study is that the students were not required to find a problem but rather they were first presented with problems to solve and then were asked to create a new variant of the same problem.

A milestone study in this area was conducted by Getzels and Csikszentmihalyi (1976). They presented 31 art students with an array of assorted objects from which they would select and arrange a still-life to paint. These researchers found a significant correlation of .54 between "discovery-oriented behavior" (manipulating and exploring the objects) and rated originality of their paintings. This finding has been interpreted as demonstrating a fairly close relationship between problem finding and problem solving processes (Dillon, 1982). The findings of the present study also support this notion. The correlation between problem finding and problem solving scores of the subjects in the present study was r = .72, suggesting that those who find more problems are also capable of solving more.

From the findings of the present study and that of Getzels and Csikszentmihalyi, it appears that, in order to uncover the nature of the problem finding and problem solving relationship, a distinction must be made between solving an assigned problem and formulating a problem from a troublesome situation where no apparent problem exists (Dewey, 1933). In the latter case no cognitive disequilibrium is felt. The only necessary mental operation is the transformation of the previously learned principles to fit the demand of a designated goal--to solve an assigned problem (Ausubel & Sullivan, 1976). The process of generating a solution to an assigned problem does not involve a change in one's current state of cognition. Rather, the solution is a mere reflection of one's ability to transfer or to apply the relevant established principles to an analogous new situation. Thus, after solving an assigned problem, no qualitatively new information is added to the existing body of knowledge. Furthermore, in solving an assigned problem one's behavior is elicited by an external agent. A student completing a physics assignment or a geometrician solving new variants of the same problems are two examples of this process.

The activities or behaviors of one who finds a problem previouly undetected stand in sharp contrast with those who are assigned problems to solve. Contrary to the process of solving an assigned problem, in the problem finding situation one's behavior is the result of a transaction between an individual and the environment. Prior to finding or discovering a problem through a transaction with the environment one experiences an event or a phenomenon which leads to the recognition of some discrepancy or incongruity in one's mental world (Dewey, 1933). As a result, one feels a cognitive disequilibrium. In order to reestablish the state of equilibrium, the first step in the process is to find the problem. Once the recognition of the problem is achieved one engages in a series of activities in search of finding some materials to solve the problem. In this process which has proven to be long in most cases (Gruber, 1981) often one's perception of the original problem undergoes a number of revisions. In order to solve the found problem one has to discover new laws and principles in addition to applying the established principles. Thus, after solution of a discovered problem an advancement in science and knowledge occurs. Contributions of individuals like Einstein, Newton, or Louis Pasteur are a few examples of this case. From such a perspective, problem finding and problem solving processes appear to be continuous and inseparable.

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Appendix A

PICTURE TASK

Appendix B

LIST OF ODDITIES

Please place L for logical oddities and N for normative oddities in the parentheses.

( ) Giraffe

( ) Kitchen drape

( ) Hat flower pot

( ) Fallen plant on the window sill

( ) Tennis racket on the wall

( ) Candlestick

( ) Bike wheel

( ) Apron on backwards

( ) Baseball glove as pot holder

( ) Saw as knife

( ) Peeling apple with scissors

( ) Peeling apple in the pie crust

( ) Bowling pin as dough roller

( ) Spade for mixing dough

( ) Upside-down shaker

( ) Colored egg

( ) Jack-O-lantern in the pie

( ) Tennis ball by apples

( ) Dog eating apple

( ) Dog wearing bib

( ) Dog sitting at the table to eat

( ) Upside down pitcher

( ) Cat eyeing the fish

( ) Fish in the drawer

( ) Fish's head out of water

( ) Broken chair

( ) Cat with necktie

( ) Cat with bushy tail

( ) Teddy bear's mismatched ears

( ) Little boy's sleeve

( ) Mismatched tile on the floor

( ) Prairie dog

( ) Baby's bare foot

( ) Cat has no whiskers

Appendix C

PARENT CONSENT FORM

Dear Parent:

Creativity is a highly valued human quality, one to which the present state of civilization and the highly technological societies owe a great deal. Yet, very little is known about certain aspects of the creative process. In the creative thinking project at Virginia Tech, we are interested in creative thinking among third graders. We would like to invite your child to participate in this project.

Children who participate in this project will be shown pictures of objects and people working together and are asked to answer a question about each. Children's general knowledge will be assessed by asking them to answer several questions.

Participation is strictly voluntary and no child will be asked to participate against his or her will. However, based on our experience, children really enjoy participating in projects such as this. It would require about 30 minutes of their time.

Please return the enclosed form to your child's teacher within two days so that we know whether or not you would like for your child to be included in the project.

We will be more than happy to share our results with you upon completion of the project. If you have any questions, please do not hesitate to call Maryam Sobhany at 552-3412 after 6:00 p.m, and Cosby Rogers at 961-4793 or 951-2657 before 6:00 p.m.

Cosby S. Rogers, Ph.D.

Project Director

Maryam S. Sobhany

Project Coordinator

Permission Form

Please check one:

___I do grant permission for my child to participate in the creative thinking project

___I do not grant permission for my child to participate in the creative thinking project

Child's name:____

Child's birth date:______________________________________

Parent (Guardian)'s Signature:___________________________

Date:____

Telephone Number:_______________________________________

Appendix D

HIGHLIGHTS FOR CHILDREN'S CONSENT

Highlights for Children
803 Church Street
Honesdale, Pennsylvania 18431
Telephone (717) 253-1080

March 8, 1985

Dear Ms. Sobhany:

We have received your letter of February 18th, requesting permission to reproduce the "What's Wrong" feature from the back cover of the November 1983 issue of HIGHLIGHTS. As I understand your purpose, this picture will be used in your doctoral dissertation, which focuses on children's thought processes.

We would be delighted to grant you this permission. We ask only that you run the following credit line, indicating that this material belongs to HIGHLIGHTS and is used with our permission:

Used by permission. HIGHLIGHTS FOR CHILDREN, INC.
Columbus, Ohio.

Thank you for your interest in HIGHLIGHTS, and best wishes for success with your dissertation.

Sincerely,

WALTER B. BARBE, Ph.D.
Editor-in-Chief

WBB/jro'k

Appendix E

CREATIVE THINKING TEST: THE INSTRUMENT

CREATIVE THINKING TEST (CTT)

CTT is an instrument composed of six verbal tests. These tests must be administered in the order explained in this booklet. Before administering the test items, the examiner must establish rapport throughout the testing session and make smooth transitions between the test items. Examination should begin with some general statement about what the subject may expect.

During the course of the examination, some subjects may ask whether a particular response was correct. In such case, the examiner should reassure the subject and refrain from indicating whether the response was right or wrong.

The examination must be conducted at a table with convenient working height for both the examiner and subject. The testing room must be reasonably comfortable and free from distraction.

DIRECTIONS FOR ADMINISTRATION AND SCORING

I. Attention to detail

Tell the subject "I have a picture which I want to show you." Present the Picture Task and say " This is my picture. I want you to look at it and tell me the unusual things that you see, such as the fish in the drawer."

Record subject's verbal responses on the Record Form.

Scoring: 1 point for each identified oddity. A list of acceptable oddities are given below

Maximum Score = 34

<u>Acceptable oddities</u>

Giraffe

Kitchen drape

Hat flower pot

Fallen plant on the window sill

Tennis racket on the wall

Candlestick

Bike wheel

Apron on backwards

Baseball glove as pot holder

Saw as knife

Peeling apple with scissors

Peeling apple in the pie crust

Bowling pin as dough roller

Spade for mixing dough

Upside down shaker

Colored egg

Jack-O-lantern in the pie

Tennis ball by apples

Dog eating apple

Dog wearing bib

Dog sitting at the table to eat

Upside-down pitcher

Cat eyeing the fish

Fish in the drawer

Fish's head out of water

Broken chair

Cat with necktie

Cat with bushy tail

Teddy bear's mismatched ears

Little boy's sleeve

Mismatched tile on the floor

Prairie dog

Baby's bare foot

Cat has no whiskers

II. Conformity

Direction: Say "I am going to ask you some questions. You have three choices to choose from each time to answer each question." Present the choice card and read out loud each of the choices.

Choice 1: Yes, I would do this

Choice 2: Maybe, I would do this

Choice 3: No, I would not do this

Before administering the test items the examiner must make sure that subject understands the procedure.

Record the subject's choices on the Record Form.

Scoring: 3 points for choice 1, 2 points for choice 2, and 1 point for choice 3.

Maximum Score = 30 points

Test Questions: Point to the particular part of the picture before asking each of the questions (e.g., look at the man cutting turkey with a saw!)

1- Would you use a clean saw to cut turkey or meat?

2- Would you use a clean bowling pin to roll out dough?

3- Would you have a teddy bear like this (point to the picture) with mismatched ears?

4- Would you wear a shirt with mismatched sleeves, like this (point to the picture)?

5- Would you put a necktie on a cat? If subject said, "I don't have a cat," ask him/her to pretend to have one.

6- Would you walk with one shoe on and one off?

7- Would you leave your ball on the table beside other things?

8- Would you put a smock on backwards?

Before asking the remaining two questions ask the subject to suppose he has a house all his own and he wants to decorate it in any way he wishes. Then ask the following questions:

9- Would you use a mismatched drape for the kitchen window?

10- Would you hang a tennis racket on kitchen wall with pots and pans?

III. Problem Finding

Direction: Say "I want you to find some problems."

1- Point to the drawer with fish and ask, "Could using a drawer as a fish tank cause any problem?"

2- Point to the chair with missing leg and ask, " Could this broken chair cause any problem?"

3- Point to the candle holder with light bulb in it and ask, "Could this candle holder cause any problem?"

4- Point to the hat flower pot and ask, "Could using a hat as flower pot cause any problem?"

For all the four problem finding cases, if the subject's answer is positive, encourage him/her to state as many problems as he can think of. If the subject's answer is negative, ask him to explain why.

Record, verbatim, subject's responses on the Record Form.

Scoring: Problem finding is operationalized as the ability to use relevant information and pose a problem permitting multiple solutions. Using this operational definition, two general types of problems are identified: plausible and implausible. The three classes of implausible problems for all the four problem finding situations are:

1. Appearance problems are those reflecting a lack of conformity with general cultural norms or a lack of concern about the impression made on others, such as:

   --looks funny

   --people think you are crazy

   --it is not nice

2. Generalizable problems are those which could exist in normal situations, such as:

   --you may run out of food for fish

   --candle holder can tip over and break

   --roots don't have room to grow

3. Hypothetical problems are those the occurrence of which is conditional upon the existence of some other factors, such as:

--if you drop somthing on the candle holder the light bulb might burst

--if you put papers in the drawer they'll get wet

--if some one wants to hide under the chair it will fall

--if you drop the candle holder, the bulb will break

--if plant grows too big hat can tip over

Different classes of plausible problems are identified for each of the four problem finding situations.

Classes of plausible problems identified for the first problem situation (using drawer as fish tank) are as follows:

1- Water will not stay in drawer. This class reflects the child's awareness that an ordinary drawer has cracks and is not water-proof. Some examples are as follows:

--water leaks

--it drips all over

--leaks out

2- Water damages wooden drawer. This class reflects the child's awareness that water soaks through wood and ruins it unless wood has received special treatment; or drawer has been made of special wood. Some examples are as follows:

--bottom will drop

--drawer gets ruined

--drawer gets wraped

3- Lack of space to keep usual stuff in the drawer. Examples of this class are as follows:

--you don't have room to put your silverware in

--where do you keep your towels?

--you couldn't use it for anything else

4- Fish will die. An ordinary drawer is not a good habitat for fish to live; as a result fish might die. Examples of the class are as follows:

--they won't live

--they die

--is not deep enough

--doesn't keep much water

--water is polluted because chemical is dissolved in it

--you may have left dust in it before putting water in

--there is no air pump in the drawer

--fish jump out

Excluded from this class is "If you shut the drawer fish will die." In other words, no credit will be given to this response.

5- Mess that has to be cleaned up as a result of having fish in a drawer. Examples of this class are as follows:

--you have a big mess to clean up

--you have to change the water too often

--water will be all over the floor

--it would be smelly

--wet drawer doesn't smell too good

--smells

--you'd have a smelly kitchen

Excluded from this class are "Fish splashes water all over," and "You have to take the dead fish out." Also excluded from this class are responses related to fish dying and smelling up the house.

6- Being fished out either by children or the cat. Examples of this class are as follows:

--cat can get them

--little kid can get on the chair and take them

Excluded from this class are responses related to dog or other people trying to take the fish out or trying to kill the fish.

7- Egg or other things rolling into the water from the top of drawer. Excluded from this class are the responses related to things other than the ones on the table falling into the water. Examples of this class are as follows:

--egg can roll into the water and crack open and the stuff inside goes into the water

--the sugar will roll in the water

Classes of plausible problems for the second problem finding situation (chair with messing leg):

1- Chair breaks even more. Examples of this class are as follows:

--breaks even worse

--the other parts may break too if it falls

--if anybody sat in it it might break

--it collapses

2- Chair cannot be used. Examples of this class are as follows:

--can't sit on it

--can't use it

--it would be in the way

--won't be very comfortable

--you won't have enough chair

3- Cost of fixing it or losing it. Examples of this class are as follows:

--you have to buy a new chair

--if it is an expensive chair, it is a waste of money

--it is cheaper because it doesn't have that much wood

--it costs you money to fix it

4- Repairing the chair. Examples of this class are as follows:

--it takes time to fix it

--you have to fix it

--when people sit in it and it breaks it will take forever to fix it.

5- Feeling sad about it. Examples of this class are as follows:

--you could have liked it and you'd be sad when it breaks

--it makes you feel bad when it breaks

6- People can get hurt on it. Excluded from this class are the responses related to cat or dog getting hurt on it. Examples of this class are as follows:

--hurts somebody

--you can break a neck or an arm

--it is dangerous

7- Losing balance and falling either by itself or by other external forces. Examples of this class are as follows:

--falls down

--if some one sits on it falls

--not sturdy

--it would wiggle

Classes of plausible problems for the third problem finding situation (candle holder with the light bulb in it):

1- Light bulb will not give out any light. Examples of this class are given below:

--it won't work

--no plug to light the bulb

--no electricity hooked up to it

--you can't put fire on the bulb like a candle

2- Light bulb taking the place of a candle. Therefore, the candlestick will not give as much light as with three candles. Examples of this class are as follows:

--with two candles, it is not as bright as with three candles

--if power went out with two candles you won't have enough light

--they won't get much light because the bulb won't light

3- Bulb rolls out. Because the light bulb does not belong to the candlestick,it won't fit properly. Examples of this class are given below:

--if you can't screw it,it might fall off and break and hurt somebody

--light bulb could come unscrewed

Classes of plausible problems for the fourth problem finding situation (cloth hat being used as plant pot)

1- Ruining the hat. Some examples of this class are:

--the hat gets dirty

--can't wear the hat

--if you need a hat there is soil and water in it

--person wouldn't have one hat

--water ruins the hat

--hat rots

--if you want to wear it you have to wash it

2- Cost. Examples are:

--I would not pay for the hat to use it as pot

--you have to buy another hat if you need one

--it is a waste of money

3- Water soaks through the hat. Some examples are:

--water leaks out

--water is going to get all over your turkey

--if you water the plant it sips through the hat

4- Plant will not live long because hat is not a good habitat for it. Some examples of this class are:

--plant might die

--if you water it, water will go through the hat and plant won't get that much food

--if you water it the felt, leather or coloring could come out and kill the plant

5- Hat is not strong enough to hold up. Some examples of this class are as follows:

--hat might break open

--hat is too soft

--it might burst open and make a big mess

6- Turkey goes to waste. Justification for this class is the way in which the picture is depicted.

Scoring: In all four problem finding situations, for each given plausible problem that falls under one of the classes the subject receives a score of one. Sometimes two or three problems are given as one problem such as "Water leaks out then fish will die" or "Water will leak out and you have a mess to clean up." In such instances the subject will receive a separate score for each problem. For example, the subject would receive a score of two for each of the above mentioned examples. However, the subject would not receive any score for the repetition of problems. Consider these examples: "Water will leak out and you have to clean the mess" or "Drawer will rot and fall out; then you have to clean the mess." The class "mess" has been repeated twice. Therefore, subject will be credited only once.

Notation 1:

In all four problem finding cases, sometimes children answered negatively when asked whether a particular situation could cause any problem, in which case they were asked to explain why. Their explanation should be judged as criteria for each of the four problem finding cases. In general, their explanations either reflect solutions or problems. Some examples are given below.

--the candlestick does not cause any problem with the exception of the bulb not working

--yes, you can plant seeds in a hat because hat is lined with plastic

Notation 2: Any future problem not mentioned in this booklet can be credited only if it satisfies the conditions of the operational definition and specific conditions of each situation.

IV. General Problem Solving and Original Problem Solving

Directions: Say, "I am going to give you some problem to solve. Remember each problems can be solved in different way. So think of as many different ways as you can to solve each problem." Subjects can be encouraged to state different solutions by saying, "Can you think of other ways?" Read each of the four problems very clearly to the subject and make sure he or she understands what the problem is. After reading each problem ask the subject "What is the problem?"

1. Problem 1, Drawer as fish tank: Suppose a person comes to you and tells you, "I want to put my fish in a drawer just like these people in the picture have done. But I have a problem. The problem is that water leaks out of the drawer. I don't know what to do about it. Please tell me what to do to stop the water from leaking out."
2. Problem 2, Chair with missing leg: Suppose these people in the picture come to you and tell you, "Each time we sit in this chair we fall. We really want to

use the chair and sit in it without falling down. But we don't know what to do. Please tell us what we can do about it."

3. Problem 3, Light bulb: See this candle holder with no cord attached to it! Suppose this man comes to you and says "If I don't light this light bulb I will be in trouble. I don't know how to do it. Please tell me how to light the bulb so I won't be in trouble."
4. Problem 4, Hat-like flower pot: A first-grade student is asked by the teacher to plant some seeds in a hat-like plant pot. This first-grade student goes home and gets his dad's hat and plants some seeds in it. Unfortunately, after few days the hat rots and dirt falls out. Now this first-grade student is very sad and doesn't know how to complete his assignment. He comes to you to solve his problem. What can he do to complete his assignment?

Record, verbatim, subject's responses on the Record Form.

Scoring: Problem solving is operationalized as the ability to find a pertinent and logical but not necessarily effectual solution which meets specific requirements of a given problem. In general, for each given acceptable solution, the subject will receive a score of one. Solutions for each problem have been classified into different classes. Each subject will receive a score for each given class and not instances within the same class, e.g., metal drawer, glass drawer, copper drawer are not taken as different solutions but rather as instances of the class called "use a drawer made of other material."

Solutions for each problem are classified into two general classes: popular and original. Therefore, each solution should be judged for its acceptabililtiy and its popularity or originality. The number of given popular solutions is summed across all four problems and is used as general problem solving score. The number of given original solutions is summed and is used as original problem solving score.

<u>Solutions to Problem 1</u>: The acceptable solutions must reflect the child's uderstanding of the fact that an ordinary wooden drawer will not solve the problem unless something is done to it. Therefore, getting a new drawer, trying another drawer, shape the drawer as gold fish tank, or use a thicker drawer will not qualify as solutions for this problem. Furthermore, solutions must be a statement of some action or some alternative that have some potential to stop the drawer from leaking. Therfore, putting the fish in some other container and then putting them in the drawer or putting a pan under the drawer will not qualify as solutions

for this problem. The following classes of solutions are identified. A. Classes of popular solutions:

1- Fix it or seal it. Some examples are given below.

--patch up the holes or fix the places that leak

--put a piece of board, metal, glass etc. under the drawer

--put something in the cracks, around the cracks, or in the corner

2- Use a drawer that won't leak. Examples of this class are:

--use a glass drawer

--make a metal drawer

--buy a water proof drawer

--build any drawer that doesn't have any cracks

3- Lining the drawer or frame the drawer with some materials. Examples of this class are:

--put plastic or wax in

--cover the drawer with glass

--get metal to put under the drawer and over its side so water won't go through them

--make the outside water proof

B. Classes of original solutions

1- Carve a one piece drawer

Solution to Problem 2:

Solutions to this problem should be a statement of some actions or some alternatives that make possible the use of chair for sitting on it. Therefore, getting rid of it, buying a new chair, or having a light person sit on it will not qualify as solutions for this problem. The following classes of solutions have been derived from the data.

A. Classes of popular solutions

1- Fix the chair. some examples are as follows:

--take it to a shop and have it fixed

--put the leg back on

--glue a piece of wood in there

--find a leg for it

--if you have an old chair get one of its good leg and use that as a leg

2- Prop it up with something. Some examples are as follows:

--put a cement block under it

--stack up books under it

--put an old boat under it

--get a whole bunch of pencils and tie them together and put that under it

3- Have some one to hold it. Examples are as follows:

--if you have a son make him hold it up for you

--one person can hold it up while another person can sit on it

4- Lean it against something. Examples are as follows:

--rest it against the wall

--lean it on the table

--stand it in a corner so it won't fall because it is against the wall

B. Classes of original solutions

1- Cut off the other legs

2- Adjust the center of gravity by sitting on it in certain way

Solution to Problem 3:

Solutions to this problem should be a statement of some actions or some alternatives that have some potential for making the bulb light up or appear lighted. The intensity of light does not matter. The constraint in this situation is that the light bulb has to be kept in the candlestick. Therefore, taking the bulb out and placing it in other electrical devices will not qualify as solutions. The following classes of solutions are identified.

A. Classes of popular solutions

1- Connect electricity to it. This class include all the solutions that indicate something should be done to the candlestick or bulb such as put a cord through it or hook it up to electricity.

2- Put something inside the bulb such as match, candle, or wicker

3- Use a battery system

B. Classes of original solutions

1- Produce electricity for it by means of creating an electromagnetic field.

2- Cover it with wax

3- Use a candle shaped like the bulb. Excluded from the acceptable solutions for this problem are those suggesting painting the bulb yellow, or putting something on top of the bulb.

Solutions to Problem 4: The solutions to this problem should reflect the child's understanding of the fact that the student was not asked to plant seeds in a hat, but rather a hat-like pot. Therefore, put a hat inside the pot, get another hat and put it in the sunshine will not qualify as solutions for this problem. Furthermore, the solution must reflect the child's understanding of the fact that a cloth hat will rot eventually unless it is protected from the inside. Therefore, use another hat, fix the hat , put cloth under it, or get a stronger or thicker hat will not qualify as solutions. Additionally, statement of cheating, trading, explaining to the teacher, or bring excuses are not considered solutions. The following classes of solutions were identified:

A. Classes of popular solutions

1- Use a hat-like pot.

2- Put something inside the hat such as a plant pot or plastic bag.

3- Use a hat already made of other materials such as straw hat, army hat, hard hat, water proof hat, or a hat that would not rot.

4- Use an ordinary plant pot and make it look like a hat, either by cutting it or covering it with cloth. However, painting it all by itself will not qualify.

B. Classes of original solutions

1- Use another container that looks like a hat such as a bowl with a brim. In order to be accepted as a solution for this class, the subject must name the container. Therefore, it is not sufficient to say, "Use something that looks like a hat." Such a solution is regarded as a popular and not an original solution.

2- Make a hat-like pot from other materials. Some examples of this class are given below.

--make a clay pot and make it like a hat

--ask your dad to make you a hat out of metal

Notation 1: Any solution not mentioned in this booklet should be considered an original solution, and scored accordingly, only if it satisfies the conditions stated in operational definition and specific conditions of acceptable solutions for each problem solving case.

VI. Knowledge: The information subtest of the WISC-R is employed to measure the level of knowledge. This subtest must be administered and scored according to the standard procedure as detailed in the manual for this test.

<u>Creative</u> <u>Thinking</u> <u>Score</u>: To compute the subject's creative thinking score, use the formula shown below.

$Y = 3.19(OPS) + 1.23(PF) + .56(PS) + .37(K) + .33(C) + .10(A)$

Y = Creative Thinking Score

OPS = Original Problem Solving Score

PF = Problem Finding Score

PS = General or Popular Problem Solving Score

K = Knowledge Score

C = Conformity Score

A = Attentiveness To Detail Score

Appendix F

RECORD FORMS

Name:______________________________

Sex:_______

Birthday:____________________

Attentiveness to detail

Score_____

____

____

____

____

____

____

____

____

____

Conformity

Score	Choice	Item
______	______	Saw
______	______	Bowling pin
______	______	Teddy bear
______	______	Shirt
______	______	Necktie
______	______	Shoe
______	______	Ball
______	______	Smock
______	______	Drape
______	______	Tennis racket

Problem 1: Drawer Score_____

Problem 2: Broken Chair Score_____

Problem 3: Candle Holder Score_____

Problem 4: Hat Flower Pot Score_____

Sum of Scores: _____

Solution 1 Original score____ Popular score____

Solution 2 Original score____ Popular score____

Solution 3 Original score____ Popular score____

Solution 4 Original score____ Popular score____

Sum of Original score: ____ Sum of Popluar Score: ____

Appendix G

LITERATURE REVIEW

LITERATURE REVIEW

Creative thinking has been regarded as a highly esteemed human quality. As a consequence, large volumes of theoretical and empirical material have been produced in an effort to uncover its nature. Despite all the efforts, creative thinking still seems to be a very challenging topic which is not yet fully understood. In an extensive review of literature, six variables were found to be contributing to creative thinking. The variables include problem finding, original problem solving, general problem solving, knowledge, attentiveness to details, and lack of conformity. The focus of this review is on the literature related to these variables. No empirical evidence exists regarding the contribution of knowledge to creative thinking. However, the role of knowledge as an influential factor has been emphasized by scientists and eminents in their discussion of creative thinking (e.g., Buttimer, 1983; Mackinnon, 1970).

Problem Finding

Very few researchers have concerned themselves with problem finding. Additionally, those who have studied problem finding have utilized different materials such as assorted unrelated objects, "in-basket," or discrepant events. In a longitudinal study, Getzels and Csikszentmihalyi (1976) presented 31 art students with a number of different objects from which to select and arrange a still-life to paint. The problem formulation was conceptualized as "discovery-oriented behavior" measured by the number of objects being touched and manipulated prior to drawing. Paintings of the subjects were then rated for their quality and originality by art experts. In general they found a strong relationship between problem finding and the quality and originality of the paintings.

"In-basket" technique was used by Shulman (1965) and Allender (1969) to study inquiry styles. Shulman (1965) presented 21 teacher trainees with a simulated "teacher's in-basket" containing various materials such as phone messages, memoranda from various members of the faculty and administration, school newsletters, and so on. Subjects were asked to assume the role of a 6th-grade teacher who has been away for a while. As a result many things have been piled up on her desk which need to a be attended to. Problem sensitivity was measured as the number of "imbedded potentially problematic elements" to which the subject reacted in the inquiry situation. Shulman reported the existence of a consistent seeking style for his subjects.

Allender (1969) studied problem sensitivity, problem formulation, and search behavior of 51 children in grades 4 to 6 by asking them to pretend to be the mayor of a small city. Children were given four different types of materials: 1) "The Mayor's Work" included letters, telephone messages, a local newspaper, and reports; 2) "The Mayor's Questions" included about 80 pages of multiple-choice formulations of potential problems; 3) "The Mayor's File" included 250 pages of data regarding general information, department, current business, and correspondence; and 4) "The Mayor's Decisions" included about 30 pages of possible decisions. Children used these materials to formulate plans of action, to search for information, and to make decisions. Problem sensitivity was measured by the number of question pages requested. Problem formulation was measured by the number of questions asked. Search behavior was measured as the number of file pages viewed. High significant correlations were found between these three measures ($r > .77$). It was concluded that problem sensing generates problem formulation which in turn generates search behavior.

Ivany (1969) employed "discrepant events" to study inquiry styles in 12 eight-grade science classes by means of three filmed experiments. The first film included a description of the problem situation, a verbal formulation of the problem, and a solution reached by examination of the relevant data in terms of a sound hypothesis. The second film contained a verbal description and formulation of the problem situation; children were required to solve the problem. The third film included nonverbal presentation of a problem situation. Children were required to formulate the problem and to solve it as well. Children were randomly assigned to view one of these films. The effects of differential treatments were assessed in subsequent class discussion of problematic situations. It was found that different treatments did not affect children's strategy of inquiry.

Getzels and Smilansky (1983) studied high school students' perceptions of existing school problems. Students (n = 122) were told that they were part of a study to determine the different ways people discover important problems in the school. At the end of this phase children were asked four specific questions about each of the problems they had posed such as, "Who has the problem?" The problems given were analyzed for content and quality. The results indicated that the content and the quality of problems expressed were directly related to the individual's intellectual ability. More complex problems were posed by those with higher intellectual ability.

In sum, the studies reviewed, although not numerous, reflect different conceptualizations of problem finding and related activities. The assorted objects constituted no problem at all. Consequently, subjects had to construct or formulate a problem out of them. The "in-basket" technique contained hidden problems which had to be sensed. Finally the discrepant events clearly depicted the problems. They didn't have to be sensed or reformulated. As a result, no conclusive statement can be made regarding the nature of problem finding. Therefore, more theoretical and empirical research is needed in this area.

General Problem Solving and Original Problem Solving

Creative thinking has been conceptualized as the process of solving a complex problem (Newell & Shaw, 1962). However, in the psychological literature, problem solving is called creative if the product of thinking is original as determined by infrequency of its occurrence. Equating creative thinking with general problem solving or original problem solving has generated three distinct lines of research-- identification studies, training programs, and comparative studies.

The primary goal of the identification approach has been to develop a a psychometric procedure to differentiate creative from less creative individuals. Undoubtedly the greatest impetus for this approach came from the factor analytic studies of Guilford and his associates (Guilford, 1967). Among the factors that Guilford identified were convergent production (processing information in a way that leads to one right answer) and divergent production (generating multiple solutions to a given problem). Guilford believed that divergent production represents the special thinking processes relevant to creative achievements. Thus, he developed a battery of tests to tap divergent production. Guilford's work also provided the basis for two other tests: Torrance Tests of Creative Thinking (Torrance, 1962) and Wallach-Kogan's Battery (1965). In these tests visual and verbal stimuli are used to pose questions demanding multiple answers. Responses to test items are scored for the number and variety of ideas expressed, as well as the originality of ideas as determined by statistical infrequency.

Crutchfield and Covington (1965) also developed a set of "complex problem solving tasks" to differentiate between creative and non-creative subjects in their study. In a time-free situation they asked subjects to think of ways in which a man could get himself out of a deep pit without using any tools; or to solve the mysterious disappearance of a jewel from a darkened room; or to explain what might have brought to an end the life of a city buried in the sand thousands of years ago, and so on.

Smilansky (1984) used the Progressive Matrices Test (Raven, 1958) as the measure of problem solving which was used to identify creative from non-creative subjects. These matrices consist of a series of items, presented in order of difficulty. Subjects are asked to complete a missing element in the design sequence by choosing the correct alternatives.

Ganesan and Surbamanian (1982) used solutions to a real life problem as the measure of creative thinking. They presented 56 agricultural research scientists with the following problem: "Population Explosion: By 2000 A.D. It is predicted that the population of India will reach 100 crores. How might one solve this problem of population?" Subjects were given 10 minutes to generate as many solutions as possible.

In sum, almost invariably in all the identification studies a problem or some questions are posed to which the respondent must generate as many responses as possible. The scoring procedure is also identical in all the existing studies. Responses are scored for the number of ideas, variety and the originality of ideas expressed.

The goal of training programs has been to improve or enhance creative ability. Numerous programs have been developed for this purpose. The most famous one was developed by Covington, Crutchfield, and Davis (1971) for

5th and 6th graders. The program consisted of a workbook in which a brother and a sister (Jim and Lila) together had to solve a series of detective stories. The reader (child), along with Jim and Lila had to formulate hypotheses, gather evidence, and ask questions in order to solve the crime. Throughout the stories, however, Jim and Lila were guided by a wise "Uncle John" who would provide hints and explain their mistakes.

Brainstorming is another well known creative training technique. The major assumption of this program is the notion that if you have lots of ideas, some of them will be original (Osborn, 1963). Through this program, a group of individuals is encouraged to generate as many solution paths as possible to a given problem. The only rule of this program is that all judgment should be deferred until some later time so that no one hesitates to offer unusual or off-beat ideas.

Other training programs include Creative Ideas Checklists (Davis & Roweton, 1968), Attribute Listing (Halpern, 1984), Browsing (Wicker, 1981) and few others. Although the contents of these programs are significantly different from one another, they all share a few common principles. Among the principles are the following:

1. They teach different ways of accomplishing the same objectives and selecting the best among them;
2. They help individuals to develop confidence to speak freely;
3. They teach individuals how to evaluate the quality of an idea by its consequence.

In the comparative studies a divergent thinking test is usually used as the measure of creative thinking. Based on the test performance the creative subjects are then compared with less creative ones on some other measures. For instance, Westra (1978) employed the Torrance test (Thinking Creatively in Action and Movement) to explore the effects of preschool experience on creative thinking of prekindergarten children. Holger (1984) used the Alternate-Uses Test as a measure of creativity to compare the performance of 49 college students on a Figure Reversal Rate.

Attentiveness to Detail

Schachtel (1959) has put forth a perceptual theory in which creativity has been described as an "openness" toward exploring different aspects of the world. That is "to go beyond embeddedness in the familiar and in the routine, and to relate to another object, or the same one more fully, or from another angle, anew, afresh" (p. 241). Such openness toward the environment enables the person to perceive and to experience objects in their fullest sense. Behaviors of many creative individuals have supported Schachtel's notion of creativity as an attentiveness to the details of the environment upon encounters. For instance, Cezanne spent many days, weeks, or even months looking at the same mountains, as did many of the Chinese and Japanese masters in looking at the blades of grass or bamboo leaves or branches or trees without tiring of it and without ceasing to discover something new in them (Schachtel, 1959). It is through this openness and attentiveness to the details of the world that mankind is able to enlarge the scope of his understanding of the world.

Experimental evidence for Schachtel's theory is, however, meager and indirect. As part of a bigger study, Thompson and Clark (1981) administered the Remote Association Test (RAT) as measure of creativity and the Concealed Figures Test (CFT) 95 college students. CFT was used as measure of attentiveness to detail and required subjects to search out a figure embedded in other geometric forms. A low correlation ($r = .21$, $p < .05$) was found between the two. Gardner (1961), in a factor analysis of a number of tests, found a factor corresponding to scanning strategy indicating that broad attention was related to creative thinking.

Ward (1969) administered Uses, Pattern and Instances Tests to 53 preschoolers. He administered the first two tests to classify children as creative or non-creative. He then administered Instances under two environmental conditions- "cue-poor" and "cue-rich." The results indicated that creative children did better under the "cue-rich" condition. Ward interpreted his findings as indicating that scanning the environment for task-relevant information tends to be an important strategy for the creative thinker.

Conformity

Independence as a personality attribute of eminents has been stressed in several theoretical discussions of creativity. Furthermore, the general findings of those who have studied personality correlates of creative thinking have provided support for the notion of independence of thought and action as a personality trait of creative individuals. For instance, Barron (1958) administered a battery of tests to writers, artists, musicians, and mathematicians to determine whether they had any personality traits in common. He found that highly creative individuals were nonconforming and unconventional. The only researcher who has directly investigated the relationship between creative thinking and nonconforming styles of action and thought is Crutchfield at the Institute of Personality

Assessment and Research in Berkeley. According to Crutchfield (1962), conformity and creative thinking are inherently opposite to each other. Conformity involves loss of self-reliance which undermines the person's creative power by weakening trust in the validity of one's own processes of thought and imagination. Furthermore, conformity pressures tend to elicit motivations that are incompatible with creative process. He distinguishes between two types of motivation for being non-conformist: "extrinsic, ego-involved" and "intrinsic, task-involved." The latter is merely a form of ego-need. The person is driven to create as a means to achieve a certain end such as money, job promotion, or fulfilling a self-perception that he or she is a "creative person." Such self-conscious and deliberate strivings to be "creative" are less likely to be conducive to genuine creativity. The person who develops such needs or desires to be recognized as "creative" may, as a result, come to be particularly sensitive to and dependent upon the standards and values dictated by his particular "creativity" reference group. Thus, increased susceptibility of the person to conformity pressures from the group may serve further to inhibit the very creativity that he or she insatiably seeks.

In clear contrast is the motive which has to do with the intrinsic value in achieving a creative solution. Here according to Crutchfield (1962), the problem is perceived as inherently challenging, the person is "caught" by it and compelled to be immersed in it, and with attainment of a solution, the creator is "by joy possessed." The creative person may invent a new device, paint a picture, or construct a scientific theory for the sheer intrinsic pleasures involved--pleasures in the creative process. This, then, is the kind of motivation in which the creative act is an end, not a means.

Crutchfield (1955, 1959) has produced ample evidence that lack of conformity is indeed a correlate of creative production. He developed a standardized technique to study conforming tendencies in the individuals varying in age, education, occupation, social class, intelligence, and personality characteristics. Six hundred individuals in groups of five were put under pressure to agree with a false group consensus. The five persons sat side by side in five partly closed booths, each person facing his or her own switchboard. They were shown slides presenting stimuli to be judged. For example, one item was to judge which of two simple geometrical figures was larger. Each person signalled his or her individual judgment by closing one of a row of numbered switches on his board. Also displayed on each board were signal lights which flashed on to show the judgments being made by each of the other four group members. The persons were instructed to wait their proper turn before signalling their judgments. The sequence of flashing lights on each of the boards was not really produced by the responses made by the other group members. Instead, they were manipulated entirely by the experimenter. As many as 50 slides were presented to each group. The results indicated that various populations of people differ markedly in the average amount of conformity behavior induced in them by the test procedure with research scientists being least conforming of all. Even though research scientists were the least conforming group of all, considerable variation existed among them. The effect of various degrees of conforming tendencies on research scientists' productions were further analyzed. It was found that those who were less conforming produced works which were rated highest on originality.

In conclusion, as Moustakas (1967) has stated:

> To be creative means to experience life in one's way, to perceive from one's own person, to draw upon one's own resources, capacities, roots. It means facing life directly and honestly; courageously searching for and discovering grief, joy, suffering, pain, struggle, conflict, and finally inner solitude. (p. 27)

Appendix H

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REFERENCES

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