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THE ASSOCIATIVE BASIS OF THE CREATIVE PROCESS [1]

SARNOFF A. MEDNICK

University of Michigan

The intent of this paper is the presentation of an associative interpretation of the process of creative thinking. The explanation is not directed to any specific field of application such as art or science but attempts to delineate processes that underlie all creative thought.

The discussion will take the following form. (*a*) First, we will define creative thinking in associative terms and indicate three ways in which creative solutions may be achieved—serendipity, similarity, and mediation. (*b*) This definition will allow us to deduce those individual difference variables which will facilitate creative performance. (*c*) Consideration of the definition of the creative process has suggested an operational statement of the definition in the form of a test. The test will be briefly described along with some preliminary research results. (*d*) The paper will conclude with a discussion of predictions regarding the influence of certain experimentally manipulable variables upon the creative process.

Creative individuals and the processes by which they manifest their creativity have excited a good deal of interest and curiosity. There are extended analyses of novels and novelists, poems and poets, mathematics and mathematicians, both biographical and autobiographical. Perusal of the introspections of manifestly creative individuals uncovers a surprising vein of similarity in the processes they describe (Ghiselin, 1952). Thus we find Albert Einstein's self-searching to suggest that "The psychical entities which seem to serve as elements in thought are certain signs and more or less clear images which can be combined . . . This combinatory play seems to be the essential feature in productive thought." Samuel Taylor Coleridge is described as having developed his ideas in the following manner: "Facts which sank at intervals out of conscious recollection drew together beneath the surface through the almost chemical affinities of common elements." In the field of art, we find André Brèton referring to a collage by Ernst as being distinguished by a "marvelous capacity to grasp two mutually distant realities without going beyond the field of our experience and to draw a spark from the juxtaposition." Most explicit, however, is the oft-quoted statement by the mathematician, Poincaré, who talks about an evening when "ideas rose in crowds; I felt them collide until pairs interlocked so to speak, making a stable combination. By next morning I had established the existence of a class of Fuchsian functions." From these experiences, Poincaré felt that he could state that "to create consists of making new combinations of associative elements

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which are useful. The mathematical facts worthy of being studied . . . are those which reveal to us unsuspected kinships between other facts well known but wrongly believed to be strangers to one another. Among chosen combinations the most fertile will often be those formed of elements drawn from domains which are far apart." An exceptionally compelling illustration of a useful combination of elements "drawn from domains which are far apart" occurs in a line from the poem, "The Monkey Puzzle" by Marianne Moore (1951), "The lion's ferocious chrysanthemum head."

We will state our basic hypothesis regarding the nature of creative thinking in the form of a definition. With these introspective statements serving as background, we may proceed to define the creative thinking process as the forming of associative elements into new combinations which either meet specified requirements or are in some way useful. The more mutually remote the elements of the new combination, the more creative the process or solution. An additional criterion of the level of creativeness of a product is described below.

Creative thinking as defined here is distinguished from original thinking by the imposition of requirements on originality. Thus, 7,363,474 is quite an original answer to the problem "How much is 12 + 12?" However, it is only when conditions are such that this answer is useful that we can also call it creative. There are many original ideas expressed in institutions for the mentally ill and mentally retarded; few of these are likely to be creative. There are many fields of creative endeavor in which the usefulness of products would be difficult to measure reliably. While these difficulties must eventually be faced, for the present our research efforts have been concentrated on laboratory situations in which criteria for usefulness can be arbitrarily experimenter-defined and unequivocally explained to the subject. The originality of a response is simply inversely related to its probability in a given population.

It should be pointed out that this definition of creativity is quite similar to basic notions advanced by British associationists from Locke (1690) to Bain (1855), and by those psychologists whose work is based in large measure on their speculations. Freud (1938), Hollingsworth (1928), and Binet (1899) may serve as examples.

WAYS OF ACHIEVING A CREATIVE SOLUTION

In terms of associative theory, we may point to three ways of achieving a creative solution. Generally, any condition or state of the organism which will tend to bring the requisite associative elements into ideational contiguity will increase the probability and speed of a creative solution. Therefore, the following three ways of attaining creative solutions are all methods of bringing the requisite associative elements together.

Serendipity. The requisite associative elements may be evoked contiguously by the contiguous environmental appearance (usually an accidental contiguity) of stimuli which elicit these associative elements. This sort of creative solution is often dubbed serendipitous. This is the manner of discovery to which is popularly attributed such inventions as the X ray and such discoveries as penicillin. One physicist has described how he has reduced serendipity to a method by placing in a fishbowl large numbers of slips of paper, each inscribed with a physical fact. He regularly devotes some time to randomly drawing pairs of these

facts from the fishbowl, looking for new and useful combinations. His procedure represents the operational embodiment of this method of achieving creative solutions.

Similarity. The requisite associative elements may be evoked in contiguity as a result of the similarity of the associative elements or the similarity of the stimuli eliciting these associative elements. This mode of creative solution may be encountered in creative writing which exploits homonymity, rhyme, and similarities in the structure and rhythm of words or similarities in the objects which they designate. The contiguous ideational occurrence of such items as alliterative and rhyming associates may be dependent on a factor such as primary stimulus generalization. It seems possible that this means of bringing about contiguity of associational elements may be of considerable importance in those domains of creative effort which are less directly dependent on the manipulation of symbols. Here we might include certain approaches to painting, sculpture, musical composition, and poetry.

Mediation. The requisite associative elements may be evoked in contiguity through the mediation of common elements. This means of bringing the associative elements into contiguity with each other is of great importance in those areas of endeavor where the use of symbols (verbal, mathematical, chemical, etc. . . .) is mandatory. For example, in psychology, the idea of relating reactive inhibition and cortical satiation may have been mediated by the common associates "tiredness" or "fatigue" (Köhler & Fishback, 1950).

INDIVIDUAL DIFFERENCES

From the definition given above, the factors that will make for individual differences in the probability of achieving creative solutions may be deduced. Any ability or tendency which serves to bring otherwise mutually remote ideas into contiguity will facilitate a creative solution; any ability or tendency which serves to keep remote ideas from contiguous evocation will inhibit the creative solution.

Listed below are several illustrative predictions concerning individual differences that one may make from this theoretical orientation.

Need for Associative Elements

It should be clear that an individual without the requisite elements in his response repertoire will not be able to combine them so as to arrive at a creative solution. An architect who does not know of the existence of a new material can hardly be expected to use it creatively.

Associative Hierarchy

The organization of an individual's associations will influence the probability and speed of attainment of a creative solution. There is a whole family of predictions that one may draw from this concept of the associative hierarchy. As an initial example, let us take the question of the manner in which the associative strength around ideas is distributed. If we present an individual with the word "table," what sort of associative responses does he make? The individual who tends to be restricted to the stereotyped responses, such as "chair," may be characterized as having an associative hierarchy with a steep slope (see Figure 1). That is, when you get past the first one or two conventional responses to the stimulus, the individual's associative strengths to other words or ideas (lower in the hierarchy) drops rapidly. We can also conceive of a second sort of individual whose associative hierarchy is charac-

terized by a rather flat slope. This is an individual who perhaps also has as his strongest response the conventional chair. But for him this response is not overly dominant and so it is more likely that he will be able to get to the less probable, more remote kinds of associations to table. It is among these more remote responses that the requisite elements and mediating terms for a creative solution will be lurking. This slope factor may be related to the mathematical analysis of associative production developed by Bousfield, Sedgewick, and Cohen (1954). It probably is closely approximated by their constant, *m*, measuring rate of depletion of the associative reservoir. They found a high negative correlation between rate of association and total number of associations. It would be predicted from Figure 1 that the high creative subject (flat hierarchy) would respond relatively slowly and steadily and emit many responses while the low creative subject (steep hierarchy) would respond at a higher rate but emit fewer responses.

It would be predicted that the greater the concentration of associative strength in a small number of stereotyped associative responses (steep hierarchy) the less probable it is that the individual will attain the creative solution. Thus, the word association behavior of the high creative individual should be characterized by less stereotypy and commonality. This last prediction is supported by a study by Mednick, Gough, and Woodworth (Mednick, 1958). Research scientists rated for creativity were divided into relatively high ($N = 15$) and relatively low ($N = 15$) groups. The low creatives gave more stereotyped responses on 80% of a group of 36 test words from the Kent-Rosanoff list. (These test words were chosen for their tendency to elicit stereotyped responses. Stereotypy was defined by the Minnesota Kent-Rosanoff Word Association Norms, Russell & Jenkins, 1954). It should be pointed out that these results lend themselves to another possible interpretation. The highly creative individual may also have a steep hierarchy but a deviant one. That is, his most dominant associative response may be quite strong but quite different from the popular, dominant associative response. There are different predictions that can be made for the flat-associative-hierarchy creative and the steep-deviant associative-hierarchy creative. The latter is more likely to be the one-shot producer (a not uncommon phenomenon among novelists). If he does create further products, they will tend to resemble closely the first product. The former is more likely to be a multiproducer; he is more likely to produce in a variety of avenues of creative expression.

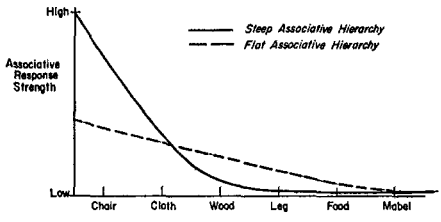

FIG. 1. Associative hierarchies around the word "table."

The prediction suggesting an expectation of less creativity from an individual with a high concentration of associative strength in a few responses leads to another prediction. The greater the number of instances in which an individual has solved problems with given materials in a certain manner, the less is the likelihood of his attaining a creative solution using these materials. Such an individual will "know the meaning" of the elements of the subject matter. That is, he

will have a steep associative hierarchy around these elements. An example of the operation of this principle recently occurred to the writer while teaching an honors freshman introductory course in psychology at the University of Michigan. I was giving a well known interpretation of a well known experiment in stimulus generalization when interrupted by a student who calmly stated that the interpretation was in error. After a few minutes of blustering I asked him to explain. His explanation proved him to be correct. I had been dealing with this material for years and "knew" the "correct" interpretation; for him this material was new, he had a low, flat associative hierarchy. Thus, if a newcomer to a field has the requisite information, he is more likely to achieve a creative solution than a long-time worker in the field. This may be the reason that theoretical physicists and master chess players are often said to have passed their prime by the age of 25.

Number of Associations

The greater the number of associations that an individual has to the requisite elements of a problem, the greater the probability of his reaching a creative solution. This variable is not independent of the preceding one since an individual with a high concentration of associative strength in few associative responses is not likely to have a proliferation of associations. The more associates which are evoked by a requisite element of a problem, the more likely it is that an associate will exist which will serve as a mediating bridge to another requisite element, facilitating combination. It seems likely that this variable will not be related to speed of creative solution since it may take a good deal of time to get to the mediating links.

Cognitive or Personality Styles

Previously learned or innately predisposed methods of approaching problems will influence the probability of a creative solution. If the requisite associational elements of a new and useful combination are probable associates of the concrete representations of relevant aspects of the problem, an individual with a predominately "perceptual" approach will be more likely to reach a creative solution. If, however, the requisite associational elements are not elicited as responses to these concrete representations or if there is no concrete representation then an individual with a "conceptual" approach will be more likely to reach a creative solution.

Another cognitive style of importance may lie along the "visualizer-verbalizer" dimension. The visualizer is one who tends to call up relatively complete memorial sensory representations of the relevant concrete aspects of problems. If the problem deals with horses, he tends to picture a horse in terms of its sensory qualities. On the other hand, the verbalizer explores the problem by associating with words around the word "horse." If the requisite elements are high in his verbal associative hierarchy to the word horse, the verbalizer will be more likely to attain a creative solution; the visualizer may be thrown off or at least delayed by many false leads. On the other hand, if a requisite verbal associative response to the word horse is very low, or not present in the verbalizer's hierarchy, then the visualizer will be more likely to attain the creative solution. It is therefore clear that some types of problems will be solved more easily by the visualizer and some by the verbalizer.

Factors such as these (admittedly very poorly defined) may be partly re-

sponsible for differential aptitudes for creative work in differing fields.

Selection of the Creative Combination

The creative combination of elements is only one among the many which may present themselves to the subject. How or why is the creative combination selected? Some speculations regarding this problem follow. The explanation of the process of selection may be related to the nature of the problem. Problems either entail a specific and relatively objective set of testable criteria (Paint a realistic portrait of this individual. Design a refrigerator so that it will be automatically free of frost.) or they do not (The chemist mixes two liquids out of curiosity. The painter dabs hopefully at a fresh canvas waiting for an idea. The psychologist tosses a new test into a correlation matrix). When specific criteria are provided, they form an important part of the stimulus set which is determining which associative elements are being elicited and thus becoming eligible for entering into combination with other elements. Important sets of associations to each of these combinations are the consequents of the combinations. The set of consequents for each combination (*If I put x, y, and z together, a and b will happen*) is continually compared with the set of requirements of the problem. When the set of consequents of a new combination achieves a close fit with the set of problem requirements, this combination is selected. When there is complete overlap of sets, "search behavior" is terminated. As with the other requisite elements of the problem, individual differences in this case will vary with (among other things) the structure of the associational hierarchies around the requirements of the problem. When the refrigerator-defroster problem was presented to an undergraduate class almost all of the proferred solutions were based on the principle of ridding the refrigerator of already heavily accumulated frost. A couple of individuals (possibly familiar with the defroster principles presently in use) suggested methods which disposed of the frost before it built up to an overly annoying level. In addition to these there were two unique responses, i.e., a "new" method of preventing moisture from condensing in the freezer compartment, and a method of allowing frost to accumulate but limiting the location of accumulation to a small box which could be regularly and conveniently removed and emptied. Thus it may be seen that an individual's associations to the requirements may be characterized as to their stereotypy; the imposed requirements of the problem may be viewed as part of the requisite elements in the situation. The earlier theoretical statements concerning these elements may be seen as being relevant here. The foregoing suggests an explanation of the selection process for the case where the subject must hunt for a combination of elements which will satisfy given criteria. In the case where no criteria are specified, the subject is typically producing random combinations of elements; the task of selection in this case consists in finding relevant criteria for the given partial products.

If we may continue along a bit further with this example of the defroster, we may begin to see some glimmerings of a solution to the most serious problem in research on creative thinking—how may we determine to what degree behavior is creative? We have suggested one criterion in our hypothesis. In the following an additional criterion is developed. To begin with let us examine the requirements as originally stated—"*Design a refrigerator so that it is automatically free of frost.*" The

first thing that strikes us is that while some requirements have been stated, there are even more that are strongly implied and essential, many that are desirable, and a number that we would only become aware of after some method of satisfying them had been suggested.

Let us examine some possible solutions:

1. Simply refraining from opening the refrigerator door would solve the problem as stated since this would prevent moisture from entering and condensing as frost. This solution meets many of the implied requirements. It is cheap, convenient, effective, does not require special training, etc. . . . However, it is not an optimal solution since it violates one essential, implied requirement—the usefulness of the refrigerator must not be impaired. (This is the cutting-off-your-nose-to-spite-your-face solution.)

2. A primitive solution is the hammer-and-screwdriver method. This is tried and true and meets many of the essential requirements. It falls down in that it is inconvenient, messy, uneconomical (when caked with frost, the refrigerator unit is very inefficient), endangers the mechanism, and is hardly automatic.

3. In a refrigerator we once owned another solution was used. The opening and closing of the refrigerator door operated a counter. At a certain count the refrigerator unit was automatically heated and the melted water evaporated outside the refrigerator. The superiority of this solution is immediately apparent. The source of this superiority lies in the number of requirements which it meets. It is economical, automatic, convenient, peculiarly appropriate (the operation of the heating element is contingent upon the number of door openings. The amount of frost accumulated is also in part dependent on the number of door openings.), does not interfere with the normal use of the refrigerator, and does not require special training. Note that the principle behind this highly creative solution (not allowing massive build-ups of frost) was infrequently suggested in the classroom group. However, this solution is not wholly successful at meeting some criteria. The frequent heating and cooling may injure frozen food stored near the heating element. Secondly, since the heating process must be brief and mild, it is inevitable that not all frost is removed. While this solution does effectively curtail the number of defrostings, it does not eliminate them completely. It is clear that a method which would encompass all of the advantages of the "counter" method, but which would, in addition, eliminate defrosting altogether would be even more creative. What is suggested by this discussion is that the creativeness of a product is some function of the number of requirements that the product meets. The most ready application of this definition will be in laboratory research in which tasks, solutions, and requirements may be arbitrarily constructed and varied.

A Test of Creativity

The definition of the creative process has suggested a way of testing for individual differences in creativity. The test items are intended to require the testee to perform creatively. That is, he is asked to form associative elements into new combinations by providing mediating connective links. Since the test situation is contrived, the combination must meet specified criteria that are experimenter imposed.

The definition dictates the structure of the test. We must provide stimulus items from two mutually distant realities and ask the subject to "draw a

spark from their juxtaposition." To state it more usefully, we must provide stimulus elements from mutually remote associative clusters and have the subject find a criteria-meeting mediating link which combines them. A first problem concerns the type of material of which the stimulus item should be composed. If the test is to be appropriate for all fields of creative endeavor, the material must either be nonsensical so as to avoid bias favoring any specific means of creative expression, or it must be so common in society that familiarity could be assumed to be high across fields of interest. The problems involved in constructing the nonsense materials so as to avoid favoring any interest groups soon proved to be apparently insurmountable. This left us searching for materials with which most individuals in the culture could claim acquaintance; this, in turn, brought us to verbal materials.

While it may be true that certain occupational groups have extensive experience in dealing with words, there are some verbal associative habits that could reasonably be assumed to be familiar to almost all individuals that have been brought up in this (USA) culture. Among such habits are the associative bonds between words like "ham and eggs," "bed-bug," "pool-hall," "hound-dog," "whole-wheat," "chorus-girl," "kill-joy," and "red-hot." These became the materials for the test.

Having decided on the materials, the test almost constructed itself in accordance with the definition. Several words from mutually distant associative clusters must be presented to the subject; his task must be to provide mediating links between them. Further, (a factor of extreme importance), the mediating link must be strictly associative rather than being of a sort that follows elaborate rules of logic, concept formation, or problem solving. In their final (or at least present) form, the test items consist of sets of three words drawn from mutally remote associative cluster. One example might be:

Example 1: rat blue cottage

The subject is required to find a fourth word which could serve as a specific kind of associative connective link between these disparate words. The answer to Example 1 is "cheese." "Cheese" is a word which is present in the word pairs "rat-cheese," "blue-cheese," and "cottage-cheese." The subject is presented with several examples so that he has an adequate opportunity to achieve the specific set necessary for the task.

Example 2:	railroad	girl	class
Example 3:	surprise	line	birthday
Example 4:	wheel	electric	high
Example 5:	out	dog	cat [2]

(None of these examples is a test item from any form of the actual test.) The two college level forms of the test (one coauthored by Sharon Halpern and the other by Martha T. Mednick) have 30 items each; the subject is allowed 40 minutes; his score is the number right.

The test, called the Remote Associates Test (RAT), has some interesting correlations with other measures.

Comparisons with Criteria. A study was conducted at the College of Architecture, University of California, Berkeley, by the writer and Sharon Halpern. Ratings of creativity by faculty members of the College who taught the Design courses were correlated with RAT scores. These ratings form an unusually excellent criterion of creative performance since the raters had been advising and evaluating the students in the creation of new designs and models of structures. They had been working with these students for at least a year

[2] Answers to sample RAT items: 2. working; 3. party; 4. chair or wire; 5. house.

and in many cases two or more. The ratings and RAT scores correlated significantly ($r = .70$, $df = 19$, $p < .01$) In this study an early form of the RAT was used.

The RAT was administered to a group of first year psychology graduate students at the University of Michigan whose native language was American English ($N = 35$). Faculty research supervisors (who had been directing the independent research efforts of the students), rated the eight highest and eight lowest RAT scorers either "high" or "low" in research creativity (no middle category allowed). Research creativity was defined as being demonstrated if the student developed new research methods and/or pulled together disparate theory or research areas in useful and original ways. Of the 16 research supervisors, one felt that he had not had enough contact with his student to make the judgment. His student was a low RAT scorer. Of the eight high RAT scorers, six were rated high on research creativity and two were rated low; of the seven low RAT scorers, only one was rated high, the other six being rated low. By Fisher's exact test the probability of these events occurring by chance is less than .05. Miller Analogies Test (MAT) scores were available for these students. Of the seven high MAT scorers, three were rated high on research creativity; of the eight low MAT scorers, four were rated high in research creativity.

Reliability. The Spearman-Brown reliability of the RAT was .92 in one sample (289 women, almost all the students at an Eastern women's college, tested as part of a project under the direction of Theodore Newcomb) and .91 in another (215 men tested at the University of Michigan as part of a project under the direction of Warren T. Norman).

Correlation with Grades. One of the present forms of the RAT correlated negatively with the first-two-year grade point averages of a group of undergraduates at a large Eastern technology college. ($r = -.27$, $N = 74$, $p < .05$). This same correlation was obtained with the summer grades of a smaller group, $N = 34$, of summer students at a large Eastern liberal arts college (not statistically significant in this case). In a study by Miller (1960) it was found that high RAT scorers tended to get higher grades from teachers rated as flexible than from teachers rated as dogmatic. Low RAT scorers received higher grades from teachers rated dogmatic than from teachers rated as flexible.

Correlation with Social Attitudes and Occupational Interests. It is clear that creative individuals must have access to improbable associative responses. Kowalski (1960) hypothesized that this is a general tendency which also manifests itself in their attitudes and interests. She tested and interviewed 15 high RAT scoring and 15 low RAT scoring undergraduate women. The two groups had radically differing views on sexual morality and women's rights. The views of the high creatives were more atypical and "liberal" ($U = 37$, $p < .001$). On the Strong Vocational Interest Blank, Mens' Form (SVIB), the high creative group showed "significantly higher interest on the artist ($p < .05$), psychologist ($p < .005$), physician ($p < .025$), mathematician ($p < .025$), and author-journalist ($p < .05$) keys. The low creative group showed higher interest on the farmer ($p < .05$), math-physical science high school teacher ($p < .05$), office man ($p < .05$), and pharmacist ($p < .01$) keys" (p. 19). (These are the probability values of obtained chi squares.) The only one of these keys related to ACE scores was that of

physician. "The commonality of these interest patterns was evaluated by noting the per cent overlap of the specific key with the general population of interest expression. For example, the Farmer key overlaps 45% with the general population, while the Artist key overlaps 20%" (p. 20). The significant keys of the higher creatives had significantly less commonality than the significant keys of the low creatives. These differences were independent of the influence of intelligence as measured by the ACE.

Associative Behavior. In the discussion of illustrative predictions it was suggested that highly creative individuals would be characterized by a flat associative hierarchy rather than a steep associative hierarchy. Further, it was proposed that the greater the number of associations that an individual has to the requisite elements of a problem, the greater the probability of his reaching a creative solution. From these two independent statements it may be deduced that when required to display his reservoir of associations to single stimulus words, the highly creative individual will have greater access to less probable associates and therefore produce a greater number of associates. A study by Craig and Manis (1960 unpublished [3]) supports this deduction. Thirty-eight college students had the RAT and an associative task administered to them. In the associative task they were given 1 minute to write as many associates as they could to each of 20 words. The correlation of the number of such associates with RAT scores was .38 ($p < .01$).

In two related studies, Karp (1960) and Kowalski (1960) found RAT scores to be directly related to the originality and quantity of anagrams constructed using the test word "Generation." In the Karp study 40 undergraduates were given 5 minutes to produce as many four letter anagrams from the test word as they could. The productions were scored for quantity (number of acceptable answers) and originality (a weighted score for each response was developed from the frequency with which the response was given by the 40 subjects). The correlation of the RAT with the quantity scores was .44 ($p < .01$); the correlation of the RAT with the originality score was .37 ($p < .05$). Kowalski presented the anagrams task to 15 high RAT scorers and to 15 low RAT scorers, giving them 5 minutes to produce words of any length from the test word "Generation." In this study originality was measured by computing the percentage of responses given by an individual which had not been given by any other of the 30 subjects. The difference on this measure between high and low RAT scorers was significant ($U = 68$, $p < .04$). "Only four subjects in the low creative group gave *any* original responses at all while eleven subjects in the high creative group did" (p. 19).

At the Institute of Personality Assessment and Research, University of California, Berkeley, the RAT was included as part of the assessment battery administered to a group of 40 highly eminent architects. The RAT correlated .31 with the Originality (O-I) Scale of the IPAR Questionnaire Scale and −.31 with the total Conformity Score obtained in the Crutchfield Conformity Experiment (Crutchfield, 1955). Interviewers rated high scorers as significantly higher in "graceful and well-coordinated in movement" and "reticent and taciturn in speech." The college grade point average which the subjects reported correlated −.34 with

[3] Craig, M., & Manis, M. Prediction of scores on the Remote Associates Test by size of response repertoire. Unpublished manuscript, 1960.

RAT score, a result which tends to confirm findings reported above.

EXPERIMENTALLY MANIPULABLE VARIABLES

While only one experimental study (described below) which makes use of this general framework has been completed in this laboratory, it may be useful to indicate briefly the kinds of experimental investigation it suggests.

Massed vs. Distributed Work Sessions. Total time of work being equal, massed sessions of creative work should be more successful than distributed sessions. There are two reasons why this would be so. The first is that the individual making use of the massed session technique is more likely to achieve temporal contiguity of the requisite associative elements within a single intensive work period than is an individual who has distributed his work in shorter periods over several days. Secondly, it may take some time for an individual to work on a problem enough to go beyond its obvious aspects. In the first hour of work, he may get through only the conventional and stereotyped associations to the elements of the problem, while it is perhaps in the later stages of intensive work on a problem that one can begin to entertain the more remote associations that are evoked by elements of the problem. It is, of course, among these remote associations that the key to the creative solution will lie.

Warmup. In creative work a warmup session should serve to arouse the more remote associations to the requisite elements of the problem. While their work has gone considerably beyond the problem of warmup, Maltzman, Bogartz, and Breger (1958) have demonstrated that the repeated elicitation of different word associations to the same stimulus words does indeed tend to produce remote associations to these stimulus words. Further, this induced originality tends to transfer to other relatively unrelated tasks presented after this associative warmup. Associative warmup of this type should become more effective as the warmup stimuli are more similar to the task materials. It may be that the effects of warmup will prove to be a further advantage that massed sessions have over distributed sessions for creative productivity.

Stereotyping Associative Responses. As stated above, if an individual's associative response to a stimulus element of a creative problem is of excessive strength, this will tend to reduce the likelihood of occurrence of more remote associative responses. This will reduce the probability and speed of creative solution. It would therefore be predicted that extensive training of a specific response other than a requisite one to a stimulus element of a problem requiring a creative solution should retard later attempts at solution of the problem. This prediction is related to the concept of "functional fixedness" introduced by Duncker (1945). Birch and Rabinowitz (1951) and Adamson and Taylor (1954) completed experiments which are related to this prediction. Their test situation was the two string problem. The subjects are asked to tie together two strings suspended from the ceiling. When the subject grasps one string he finds that the other string is hanging out of his reach. The solution to the problem requires the subject to attach a weight to one of the strings, get the weight swinging and catch it while holding the other string. Various objects can be used as a weight. The subjects that had been pretrained by having them use a switch in its usual manner of functioning tended to be unlikely to use it as a weight. They had developed strong response strength for the association "switch-close circuit" which had re-

duced the probability of the remote association "switch-weight."

Another feasible experimental approach would make use of the RAT item as a creative task and test the influence upon it of certain variables. For example, the words of which an item is composed may be presented at varying rates to test the massed trials hypothesis. In addition, various pretraining conditions may be evaluated in terms of their effectiveness in increasing or decreasing RAT performance.

Another possible experimental approach would entail separating out high and low RAT scorers and observing the differential effect of certain variables upon their behavior. In an experiment just completed Houston and Mednick (in press) postulated that an important motive impelling the behavior of the creative individual was a need for improbable associative stimulation. It was reasoned that if such stimulation were supplied, it would tend to satisfy this need and be reinforcing. Further, if such stimulation regularly followed a given response the high creative individual should tend to learn that response. Thirty high and 30 low RAT scorers were asked to read aloud only one of two typed words on a 3×5 card. Excepting buffer items and including 40 pairs aimed at gauging the free operant level of noun-choice, there were 160 pairs of words, each pair consisting of a noun and a nonnoun (verb, adjective, adverb, etc.). If a subject in the experimental group (15 high RAT subjects, 15 low RAT subjects) responded with the noun member of a pair, the experimenter responded with an improbable association; if the subject chose the nonnoun, the experimenter responded with the most probable association. In the control group (15 high RAT, 15 low RAT) both the nouns and the nonnouns were invariably followed by their most probable associate. Associative probabilities were obtained from the Russell and Jenkins (1954) and Deese (1960) norms. If the improbable response was satisfying a need, the probability of noun-choice should increase over the 160 trials. It did significantly in the high RAT experimental group; the low RAT experimental group showed a decrease. The high and low RAT control groups showed no reliable change.

Some of the positions which have been taken in this paper are assumptions and not deductions. As more data are gathered some of these assumptions will assume the status of facts, some will be revised. For example, the opening paragraph suggests that the paper is not meant to apply only to one field of creative endeavor but attempts to delineate processes that underlie all creative thought. This may require modification. The explanation may fit the process of scientific discovery and not be appropriate to discussions of painting or music. For the present (paradoxically enough), the more encompassing assumptions seem more parsimonious. It may eventually turn out (as is hinted at in the body of the paper) that the differences between the fields are more determined by differences in suitability of the three means of achieving contiguity, i.e., serendipity, similarity, and mediation.

SUMMARY

An associative theory of creative thinking has been outlined. Differences between high creatives and low creatives have been predicted along specified dimensions. Predictions have been made regarding the effect on the creative process of some experimentally manipulable variables.

The associative definition of the creative process has taken the operational

form of a test. Some preliminary research with this test is described.

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