SEMANTIC DISTANCE AS A PREDICTOR OF PERFORMANCE ON REMOTE ASSOCIATES TEST ITEMS

A Thesis

Presented to

the Faculty of Graduate Studies and Research

University of Manitoba

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

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by

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October 1965

ABSTRACT OF THESIS

The purpose of the present research was to investigate the pre-solution phase of the problem-solving process in a word-association test, the Remote Associates Test (Mednick, 1962).

The semantic differential (Osgood, Suci and Tannenbaum, 1957) was used to measure the meanings of RAT item concepts. The hypothesis tested was that RAT performance was related to the degree of semantic similarity of RAT item concepts.

Data were treated on an individual and group basis. The results showed that RAT item performance was predictable from the size of the semantic distance between concepts. The results are compatible with the hypothesis that performance on RAT items is related to the degree to which item concepts possess common mediators, ie., are semantically similar.

ACKNOWLEDGEMENT

The author wishes to express his appreciation to Dr. B. M. Springbett for his encouragement and advice in the preparation of this research.

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CHAPTER I

INTRODUCTION

Many studies of thinking and problem-solving have been done (Humphrey, 1951; Vinacke, 1952) but in the main they have been descriptive rather than empirical. In problem-solving, certain new relationships must be discovered among the elements of the problem (Underwood, 1952). This definition extends to a wide range of cognitive behavior, even to a higher-order process such as creative thinking. Often the answer to the question of how the thought process is directed and controlled in problem-solving situations has been given in mentalistic terms, such as "determining tendency", "unconscious processes" and "insight". A more profitable approach lies in the application of the principles of learning theory to problem-solving (Osgood, 1953; Maltzman, 1955).

The Remote Associates Test (RAT) is a unique problem representative of the kind of problem that appears to demand so-called unconscious processes for solution. It's designer (Mednick, 1962) contends that it measures creative thinking ability. This study will attempt to show that the RAT problem-solving process can be related to antecedent learning variables.

In this study the semantic differential (Osgood, Suci and Tannenbaum, 1957) is presumed to measure the implicit mediational processes attached to RAT item concepts. It is hypothesized that if there is a high degree of semantic similarity among the appropriate RAT item concepts, then there will be greater probability of the item being solved correctly. This study experimentally investigates this hypothesis.

CHAPTER II

HISTORICAL INTRODUCTION

The investigation of the regulatory, directive, selective mechanism in the problem-solving process is the central intent of this paper. The answer to the question of how the process operates involves an explanation of processes within the problem-solver. The semantic differential is used to measure the implicit organismic mediators attached to RAT item concepts. It is postulated that these mediators control and direct the RAT associative process. Accordingly, the historical review covers areas pertinent to the topic. It will cover briefly the previous attempts to explain thinking and problem-solving. The Remote Associates Test will be regarded from the standpoint of theory and practical operations. The semantic differential will be described in some detail. Areas of conflict regarding associative and semantic meaning will also be considered.

Thinking and Problem-Solving

The Wurzburg school (Humphrey, 1951) recognized that the thought process had some kind of "built-in" control mechanism. Their studies, however, described the process in terms such as the "determining tendency" and "Aufgabe" but did not explain it. Various members of the school emphasized the role of "unconscious" determinants of problem solutions. Unconscious processes have also been postulated by many creative thinkers (Ghiselin, 1954; Rugg, 1963) to account for inexplicable solutions to their particular problems. Set theorists (Luchins, 1946; Hunter, 1956) have attempted to explain problem-solving in terms of certain structural

aspects of the problem. It is, of course, recognized (Russell, 1963) that set is important in problem-solving. Its exact solution - facilitating function is still a matter under investigation.

The broad area of problem-solving has received the attention of the Gestalt and behaviorist schools of experimental psychology. The proponents of these schools have applied their respective principles to the topic. Certain Gestalt theorists (Wertheimer, 1945; Scheerer, 1963) describe problem-solving in terms of the re-organization of the cognitive - perceptual field to meet structural requirements of the situation. For these theorists, solution is a spontaneous insightful phenomenon only minimally influenced by relevant past experience. Hebb (1949) and Osgood (1953), however, have shown that insight is dependent on experience. Behaviorists (Osgood, 1953; Maltzman, 1955) emphasize the dominant role of previous experience where all responses necessary for solution have been acquired. This latter approach will be elaborated in the coverage of the Remote Associates Test.

The Remote Associates Test

Mednick (1962) has constructed a test to measure creative thinking ability. The test is known as the Remote Associates Test (RAT). It consists of a series of three-word items, with each item word having no obvious relationship to any of the others. The task is to provide an associative connecting "link" between the different words. The item words have high cultural familiarity. Most are derived from common colloquial compound words, eg., "kill-joy", "chamber-music", "jump-for-joy". Others have a synonymous relationship, eg., "bliss-joy". Item examples are as follows:

railroad	girl	class	working
jump	bliss	kill	joy
chamber	staff	blue	music

Mednick defines the creative thought process as the forming of associative elements into new combinations which either meet specified requirements or are in some way useful. Ss that can draw mutually remote ideas into contiguity (high RAT scorers) are said to be exhibiting high creative ability. Mednick (1962) cites several studies demonstrating the validity of the RAT (Miller, 1960; Craig and Manis, 1960; Kowalski, 1960; Karp, 1960).

An explanation of the RAT-solving process must deal with the mechanism that "draws the associates into contiguity" (Mednick, 1962) ie., supplies the associative linkages. In other words, the problem is to explain how one particular response rather than another is elicited by the stimulus triad. The model proposed by Maltzman (1955) is applicable in this case. Each stimulus word in the triad is associated with its own response hierarchy. Incorrect dominant responses in the appropriate habit hierarchy become inhibited and extinguish, thereby promoting the next-dominant response into the dominant hierarchical position. Solution occurs when the appropriate response within the hierarchy is dominant, ie., when the response meets criteria as the S has them formulated.

In a problem-solving situation, by definition new relationships must be discovered among the stimuli (Underwood, 1952). To explain the interaction between the problem elements and their associative responses, mediation processes may be invoked (Maltzman, 1955; Cofer, 1957; Cofer and Foley, 1942; Osgood, 1953; Dollard and Miller, 1950). Mediation

relates isolated habits within the hierarchy, thereby facilitating solution. Cofer (1957) and Underwood (1952) speculate that mediation activity may continue in the problem-solving situation until a response pattern occurs in contiguity with the formulation of the problem by the S.

Mednick (1962) comments briefly on the role of mediation in the RAT associative process, but does not pursue its function in detail. A further explanation is needed at this point. Osgood's representational mediation hypothesis (Osgood, 1953) may be applied. According to Osgood, signs are associated with systems of mediating responses. In certain kinds of verbal problems, such as the RAT, the concepts (signs) may possess similar mediation processes. This pattern fits the Hullian convergent hierarchy model as shown in Fig. 1.

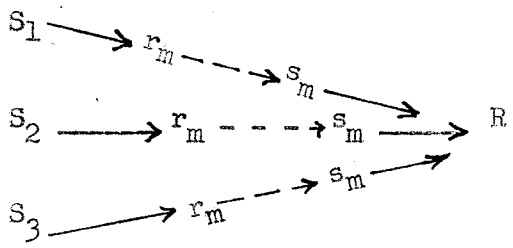

Fig. 1

It is now possible to see how specific overt responses (RAT answers) may be elicited by the problem stimuli. The structuring of the response hierarchy around the stimulus triad is determined by the degree of similarity between each of the mediators of the three stimulus words and that of the response word. Correct solution will be facilitated by a high degree of similarity. In other words, the more the RAT stimulus concepts share common mediation processes with the response concept, the greater the probability of the correct response being at the top

of the habit hierarchy and given as the answer. Conversely, the lower the degree of similarity, the lower the appropriate response in the hierarchy and the less the likelihood of its occurrence.

For purposes of predicting whether or not correct solution to a RAT item will occur, the similarity of the concept mediators must be determined. This is achieved with the semantic differential.

The Semantic Differential

An understanding of the semantic differential necessitates some prior discussion of its theoretical basis. According to Osgood (1953), a mediating response to a sign carries the meaning of that sign. The acquisition of sign meaning follows the mediation principles originally laid down by Hull (1930). These principles constitute the basic structure of Osgood's representational mediation theory. The process begins with a contiguous occurrence of sign and significate. A portion of the original response to the significate becomes conditioned to the sign and is then elicited by the sign in the absence of the significate. This response is a light-weight, "detachable", implicit response (r_m). Attached to this fractional implicit anticipatory response is self-stimulation (s_m) which provides the stimulus for overt response which "take account" of the significate but which now occur to its sign. This $r_m - s_m$ paradigm may be represented schematically as in Fig. 2.

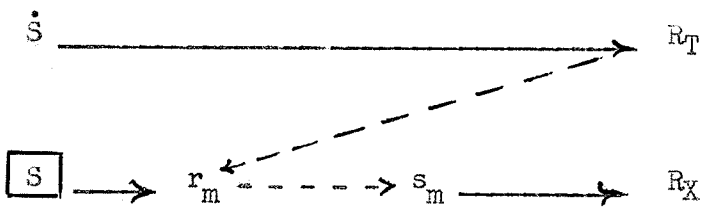

Fig. 2

The process of the establishment of meaning can best be illustrated with an example from Osgood (1953, p.696): A spider (stimulus-object) is experienced negatively, unpleasantly, etc., and elicits autonomic fear responses. The labelling word SPIDER is associated with its referent, "spider", the stimulus-object. Through the short-circuiting process, the "detachable" parts of the response, anxiety, fear, etc., become conditioned to the word SPIDER. With repetition of the sign process the associated mediation reaction becomes effortless and implicit, consisting mainly of the autonomic "fear" component which carries the distinctive (unpleasantness) connotative meaning of the word.

Most of the signs employed in ordinary communication are those which have not been associated with actual stimulus objects in the process of acquiring meaning (eg. words such as ZEBRA, COMMUNIST, JAIL). Such symbols have in the past been associated with other signs. They are termed assigns. Assigns receive their meaning through a process of higher - order conditioning as they are paired with signs which already have conditioned meanings. There is no essential difference between the learning of sign meanings and the learning of assign meanings.

When relationships among signs must be considered, as on the RAT, principles of sign-sign semantic generalization are applicable. Early non-mediation studies by Reiss (1940) and Razran (1939) demonstrated the direct relationship between amount of generalization and word similarity. In Osgood's model, the magnitude of semantic generalization varies with the degree of mediational similarity (1953, p.705).

With meaning placed in the context of mediation theory it follows that there will be wide varieties of meanings for the same

concepts across individuals. The $r_m - s_m$ process becomes attached to signs or assigns early in the experience of the individual. This being so, the context in which the sign meaning is established is important. Selective secondary reinforcement will contribute to the final stabilized mediating process (Brown, 1958). With early conditioning postulated as the important variable in meaning acquisition, it follows that referents will receive similar meanings to the extent that individuals are conditioned in similar ways towards them. Accordingly, referents will receive unique, idiosyncratic meanings to the extent that the reinforcements associated with them are unique (Brown, 1958). This matter raises important problems for a theory attempting to deal with meaning in a learning theory framework, as shall be noted momentarily.

Osgood, Suci and Tannenbaum (1957) in their book The Measurement of Meaning outline a method for systematically indexing meanings, ie., mediation processes. This device is known as the semantic differential. It will be considered at this point.

Meanings of concepts can be located in a hypothetical, multi-dimensional Euclidian space. This space is composed of N straight line functions passing through the origin. The straight line functions are bi-polar semantic scales defined by polar adjectives. The independence of these scales is obtained by factor analysis. To obtain a semantic differentiation, a series of these scales is selected which is designed to represent the semantic universe. A concept whose meaning is desired is judged, or rated, against these scales. Differences in meanings of concepts are functions of the differences between the rating on the semantic scales. A series of semantic scales would take this form:

CONCEPT A

POLAR TERM X								POLAR TERM Y
good	____	____	____	____	____	____	____	bad
slow	____	____	____	____	____	____	____	fast
etc.								

Each of the seven spaces provided for rating represents a different degree of intensity of the "meaning" of the particular concept for the subject - extremely good, quite good, slightly good, etc. Any number of scales can be used in composing a semantic differential for test purposes. There is no specified or standardized form.

Osgood, Suci and Tannenbaum (1957) sampled their scales by three independent factor analyses. The three main extractable factors which emerged from each analysis have been designated, in order of magnitude, as evaluative, potency and activity factors, and in total have accounted for most of the variance of the scales, though not all of it.

In a semantic differential test form, the factorial composition of the scales is the principal criterion of scale selection. Typically, three scales are selected which represent each of the three major factors, these being maximally loaded on the particular factor in question and minimally on other factors. Once a test form has been established and a semantic rating profile obtained in the form of a series of checkmarks against the scale poles, this raw data is quantified. Each of the seven scale positions is assigned a digit from 1 (extremely X) to 7 (extremely Y) to indicate the degree of intensity of meaning. When the same scales are used to measure the meaning of different concepts, a basis for quantitative comparison of meaning similarity exists.

To this end the generalized distance formula, D, from solid geometry is employed and differences between ratings of concepts are summed over sets of scales. D is the linear distance between points in semantic space and is defined as $D_{il} = \sqrt{\sum_j d_{il}^2}$, where i and l are the concepts and d_{il} is the difference between their co-ordinates on the same dimension.

The semantic differential provides dimensions along which Ss rate concepts. Rating a concept, ie., locating it in the hypothesized semantic space, is the encoding process equated with the evocation of the corresponding mediating reaction. The direction of ratings, eg., whether the rating is toward "good" or "bad", "beautiful" or "ugly", ie., toward which antagonistic pole, is equated with, and depends upon, what mediators are elicited by the concept. The intensity, or habit strength, with which they are elicited is indicated by the distance of the rating from the scale origin point, this distance being described by the adjectival modifiers "extremely", "quite", etc. A concept elicits the checking of the scale position corresponding to the mediation process associated with the concept.

The semantic differential, since its inception, has been used widely and diversely by many investigators. Studies of attitude (Osgood and Tannenbaum, 1955), personality (Osgood and Luria, 1954), abnormal behavior, (Brod, Kernoff and Terwilliger, 1964; Luria, 1959), perceptual organization (Taylor and Manson, 1962) have employed the differential. As yet no studies using the differential to investigate verbal problem-solving have appeared in the literature.

While the differential has enjoyed an enthusiastic reception among psychologists, it is not without its flaws, especially those of a statistical and methodological nature. Three important problems in

this regard can be mentioned. One criticism has been that the seven-point scale does not offer a fine enough discrimination, especially among homogeneous concepts (Gulliksen, 1958). Secondly, it has been objected that the number of factors or semantic dimensions is not exhaustive enough of the conceptual meaning space (Gulliksen, 1958). Osgood, Suci and Tannenbaum (1957, p.323) also admit the possible insufficiency of their factors. However, they suggest that a proliferation of dimensions is impractical and that such a potentially enormous number of factors is not needed as the differential as presently constituted can discriminate among mediation processes. Thirdly, the concept-scale confounding of the Osgood, Suci and Tannenbaum studies has been pointed out by the authors (1957), by Osgood in a later article (1962) and by Dicken (1957). Osgood refers to the interaction of scales and concepts as denotative contamination, ie., certain concepts are more denotatively relevant with certain scales. In such cases the scales are not "pure" indicators of the dimensionality of semantic space. Gulliksen (1958) suggests that methods other than factor analysis be used to minimize this confounding. At present, these inherent methodological effects can best be minimized by selecting an equal number of scales to represent each of the main factors and by selecting those scales which are maximally loaded on the factor in question and minimally loaded on the others.

Apart from the methodological problems, theoretical questions concerning the nature of semantic measurement have arisen. Flavell (1961) regards mediation acquisition as a form of discrimination learning. He contends that the implicit mediation response is an unspecified kind of response which occurs to some undetermined stimulus aspect of the referent object. His study demonstrated that the semantic

differential measures not only the discriminable properties of the referent object, but also aspects of the total stimulus configuration in which the object is located. He suggested that non-referent attributes ought to be measured as they contribute to $r_m - s_m$. His conclusion was that D is not entirely adequate as an index by which to compare meanings. Osgood, Suci and Tannenbaum (1957, p.324) acknowledge that situational context cues enter into the representational process and become tied to the mediation response. As we have seen, non-referent attributes do enter the process in the form of contextual secondary reinforcers in the early consolidation of the mediation response.

Osgood's Interpretation of Meaning

It should be noted that Osgood does not contend that representational mediation constitutes the entirety of meaning (1957, p.325). There are extra-mediation determinants of the production of meaning as it relates to language, namely habits of usage and association which are in large part culturally determined. It would be correct to state that the semantic differential indexes only part, or one aspect, of meaning. This is also a safer statement in view of the many senses in which the term is typically used.

General semantic theory dichotomizes meaning into the referential, or denotative, and the experiential, or connotative. Mosier (1941) has dichotomized meaning as the "usual" (denotation) and the "individual" (connotation). Osgood, Suci and Tannenbaum (1957) use connotative meaning in Mosier's sense, ie., the subjective, incidental response which a concept suggests and which shows considerable variability across individuals. This aspect of meaning is presumed to be measured by the semantic differential. Yet as Brown (1958) has stated, connotation is a

very ambiguous term. Essentially, what Osgood, Suci and Tannenbaum suggest is that connotation may be equated with a certain physiological state of the organism. Osgood (1953, p.701) speculates that "the affective, connotative aspects of meaning" may be mediated by the autonomic nervous system.

Some theorists outside the area of psychology proper have tended to view Osgood's notion of meaning in these terms. Ullmann (1962) and Weinreich (1958) have suggested that what the semantic differential does measure is not meaning in any traditional sense of the word, but rather the affective components of words, the power or intensity with which they can elicit extra-linguistic emotive reactions. Osgood, Suci and Tannenbaum (1957, p.189) have tacitly concurred with this interpretation, holding that attitude may be considered as a major dimension of meaning. Attitude, of course, implies a subjective, affective-evaluative response. In a more recent article, Osgood (1962) refers to mediation sign-processes as "affective meaning systems". Though systematic empirical investigation of "meaning-as-affect" is in incipient stages it would seem plausible to treat an implicit affective process as a component of meaning. Whatever the semantic differential is in fact measuring, it at least provides a consistent index of "meaning", thus making possible reliable comparisons of semantic data.

Meaning and Association

Although this study is concerned with the semantic relationships of word-associates found on the RAT, it contends, with Osgood (1953, p.709) that not all associative linkages are semantically determined. Osgood cites examples of culturally common compound words (eg. WASTE-BASKET) as being determined by overlearned verbal habits. This type

of association is found on the RAT, but to the extent that such direct associations are operative on the RAT, they will be related randomly to the hypothesis under investigation.

Certain research evidence, however, suggests that there are similar semantic components to stimulus words and their response components. For instance, a positive correlation between Osgood's measure of meaning and that of Noble (1952) has been demonstrated. Jenkins and Russell (1956) found a high correlation (.71) between the intensity of meaning as measured by the semantic differential and Noble's "m". That is, high "m" (meaningful) words were found to elicit extreme ratings on the semantic differential scales. Noble (1958) also found the same kind of relationship. DeBurger and Donahoe (1965), using the method of repeated association, found the meaning of the response became repeatedly less similar to the stimulus word with succeeding association. Staats and Staats (1959) investigated the relationship between the meaning of stimulus words and the meaning of their word-associates. They compared semantic differential meaning scores (scale co-ordinates) for a given set of words with those of the associates to each of the words. They found the co-ordinates were comparatively similar. Their results supported the hypothesis that the meaning of the associates of a stimulus word tends to be similar to the meaning of the word. It should be noted, however, that while the Staats and Staats data show comparitive similarity of word ratings in terms of semantic co-ordinates, it does not necessarily follow that between the stimulus and response words there will be a small D. This study will attempt to demonstrate this latter effect.

Synthesis

The study was undertaken as an investigation of the pre-solution stage in a word-association problem, the Remote Associates Test. This test presents a unique challenge in that it is neither a free-association nor a controlled association test. The task of this study is to explain how the appropriate associative linkages are formed. The study postulates that the associative process is directed by mediational processes.

The semantic differential is used to measure the mediators attached to RAT item concepts. It is assumed that the previously acquired meanings of these concepts are being indexed by the differential. The interpretation of what happens in the experimental situation may then be subsumed under the Hullian convergent hierarchy model.

While this study focuses on the semantic relationships among RAT item concepts, it is acknowledged that direct, non-semantic associations may operate on the RAT to affect the dependent variable. Another influence on the dependent variable may be set, instructions, etc. While these factors may contribute to RAT performance, it is suggested that predictions concerning performance may be made on the basis of another variable, the semantic similarity among item concepts. Specifically, the experimental hypothesis to be investigated in this study is that success or failure on the RAT can be predicted from the magnitude of semantic distance between RAT stimulus and response concepts.

CHAPTER III

METHOD AND RESULTS

I. METHOD

Subjects

Ss were 34 students enrolled in Introductory Psychology. Each S was naive to the task. All Ss participating in the experiment were doing so in partial fulfillment of the course requirement of four hours of experimental work.

Materials

Twelve 2" x 4" index cards were used. On each card was printed, in block letters, a word from three four-word RAT items, so that there were 12 stimulus cards altogether. The 12 stimulus words were as follows: 'rat', 'blue', 'cottage', 'cheese", 'surprise', 'line", 'birthday', 'party', 'high', 'electric', 'wheel', 'chair'.

Each S was provided with 12 identical semantic differential test forms. This test form was devised by selecting a representative sample of scales from those on each of three factor analyses of the descriptive semantic scales. The three factors with the highest loadings on these analyses were the evaluative, potency, and activity factors. Three scale dimensions were selected that showed maximal loadings on each of these factors, yielding a total of nine scales. The nine scales were: 'good - bad', 'valuable - worthless', 'nice - awful' (evaluative factor); 'strong - weak', 'large - small', 'heavy - light' (potency factor); 'fast - slow', 'active - passive', 'hot - cold' (activity factor).

The semantic differential test sheet which was presented to Ss was in the following form:

good ——x——x——x——x——x——x—— bad

worthless ——x——x——x——x——x——x—— valuable

nice ——x——x——x——x——x——x—— awful

weak ——x——x——x——x——x——x—— strong

large ——x——x——x——x——x——x—— small

light ——x——x——x——x——x——x—— heavy

fast ——x——x——x——x——x——x—— slow

passive ——x——x——x——x——x——x—— active

hot ——x——x——x——x——x——x—— cold

The polar opposites were alternated from scale to scale to reduce ratings in terms of positional preference.

Procedure

The 12 cards on which the stimulus words were printed were shuffled so that the order of presentation to Ss was random and not ordered in terms of membership in the same RAT item. That is, an effort was made to avoid presenting in succession the four concepts from the same RAT item. This same order was maintained for each S. Ss were provided with the 12 stimulus cards and 12 semantic differential test forms and instructed in the manner proposed by Osgood, Suci and Tannenbaum (1957). The instructions were as follows:

"The purpose of this experiment is to measure the meaning of the concepts printed on these cards. You are to judge these concepts by rating them against each one of these twelve descriptive scales.

Make your judgements in terms of what these concepts mean to you. There are twelve concepts to be rated. Rate each concept on each scale in order. Now here is how you are to use these scales.[1]

Be sure to make your check marks in the middle of the spaces. Give each concept a separate and independent judgement on each scale. Don't look back and forth through the items. Work at a fairly high speed through the scales. Don't hesitate or puzzle over individual items, as I'm interested in your immediate "feelings" about the concepts. But by the same token, don't be careless."

Upon completion of their ratings, Ss were instructed to return in one wk. for the second part of the experiment. The second part consisted of testing Ss on the three RAT items.[2] Ss were tested in groups of three (as 34 Ss were used, one of these groups had four Ss). In the test situation Ss sat at spaced intervals around a table. A blackboard was used for presentation of the test items. Instructions were roughly similar to those suggested by Mednick and Halpern (1959). "I am going to write several sets of words on the blackboard. Each set will consist of three words. You are to provide a fourth word that can be related to each of the three. For example, what word is related to these three?[3] 'OUT' 'DOG' 'CAT'. The answer here is 'HOUSE'.

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1. Instructions on scale use are given in Appendix A.

2. These items are drawn from the examples given by Mednick (1962). They are not found on the actual Remote Associates Test.

3. The procedure in presenting the practice words was identical to that employed during the actual test.

Here is another example: 'SOCIAL' 'WORKING' 'ROOM'. Your answer should have been 'CLASS'. Try this final example: 'POOL' 'WIND' 'SOCIAL'. The answer to this is 'WHIRL'. You will notice that in each of these the fourth word is related to the other three in various ways. You will have sixty seconds to answer each test item." [1]

The three test items were presented on the board. At the end of 60 secs. the three words on the blackboard were erased and the next three presented. The order of item presentation was the same for each group of Ss. The same order of within-item concept presentation was maintained for all groups on all four items. The items were as follows:

RAT	BLUE	COTTAGE	CHEESE
FOOT	TOAD	PIGEON	STOOL
SURPRISE	LINE	BIRTHDAY	PARTY
HIGH	ELECTRIC	WHEEL	CHAIR

In addition to the three test items, a fourth was added (foot - toad - pigeon). This extraneous item was presented as the second item in order to minimize the possibility of Ss answering the items on a simple recall basis from the previous semantic rating situation. The interval of one wk. between the two parts of the experiment was felt to be a further means to this end.

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1. Practice items two and three were E's own invention, but their structure is the same as the actual RAT items.

In order to assess the effects of recall from the semantic rating session on the RAT item performance of the experimental Ss, a control group of 31 Ss was run. These Ss were selected from the same population as the experimental Ss. They answered the same RAT items as the experimental group under the same conditions, but did no semantic differential ratings prior to being tested on the RAT items.

II RESULTS

The object of the experiment was to determine if RAT success or failure could be predicted from the known semantic relationships among the item concepts. Following Osgood, Suci and Tannenbaum (1957), meaning similarity between two concepts is indexed by D, the generalized distance formula, the calculation of which has been outlined in Chapter I. The greater the magnitude of the D between the concepts, the less similar they are in meaning. Conversely, the less the magnitude of D, the more similar are the concepts in meaning.

In attempting to form a predictive basis for RAT performance from the semantic similarity of item concepts it was necessary to know the semantic relationship between the "answer" concept (super-ordinate) and each of the "problem" concepts (sub-ordinates) for each item. To this end the semantic differential profiles of all Ss for all concepts were analyzed. For each S a D was obtained between the appropriate item concepts, eg., between "rat" and "cheese", "blue" and "cheese", "cottage" and "cheese", and so on for each item.

The data were considered from two standpoints. The first treatment of the data involved two intra-S analyses. In this type of analysis, D's from each of the items were averaged to obtain a mean

distance ($\bar{D}$). These $\bar{D}$'s were then classified according to relative size within each S. In the second treatment of the data, the same procedure was used to obtain $\bar{D}$. In this treatment, the $\bar{D}$'s from all Ss were pooled. The classification of $\bar{D}$ was made with no reference to the source of $\bar{D}$.

In each of the following analyses, a reversal of the predicted direction would negate the hypothesis under consideration. Therefore, the most legitimate test of significance would necessarily be a one-tailed test.

The two types of treatment to be considered represent different ways of analyzing the semantic relationships among RAT item concepts. It should be noted, however, that where the second type of analysis is concerned, ie., when ratings are grouped for the purpose of determining their predictive value, certain sources of confounding may come into play. One of these concerns rater characteristics (Anastasi, 1964, p.86). Ratings may vary according to individual differences in personality styles among Ss. Some raters may be characteristically cautious and avoid the extremes of scales. Their ratings would show a central tendency effect. Others may be more radical and emphatic in making decisions. Their ratings would be away from neutrality, possibly at the extreme poles of the scale. It is likely that these individual "styles" would hold across all concepts. In addition, with this type of analysis there is no control over individual differences in what may be called "cognitive flexibility", ie., some Ss may demonstrate the ability to succeed on RAT items even though their concept ratings show comparative semantic remoteness.

Analysis 1

It is hypothesized that if, for a given S, a "passed" item is compared with a "failed" item, the $\bar{D}$ associated with the passed item will be smaller than that associated with the failed item. In this analysis, relative size of $\bar{D}$ is the only basis of comparison. Specific items are not considered.

Eight Ss not showing both a correct and incorrect item were eliminated from the analysis, leaving a total of 26 Ss on whom predictions could be made. Fifty-two predictions were made (two per S). A frequency count revealed that the lower $\bar{D}$ was associated with correct solution in 35 comparisons. The higher $\bar{D}$ was associated with correct solution in 17 comparisons. The standard error of proportion was calculated.[1] A "z" - score was statistically significant ($z = 2.69$, $p < .01$).

Analysis 2

It is hypothesized that, where $\bar{D}$'s for each S are ranked as high, medium and low, then low $\bar{D}$'s will be associated with items solved correctly and the number of correct responses will be inversely related to the high, medium and low categories.

Frequencies of correct and incorrect items in the three categories were determined. A chi-square analysis was done on this data. Table 1 shows this analysis.

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1. $s_p = \sqrt{\frac{p(1 - p)}{N}}$

Table 1

Within-S Comparison of Correct and Incorrect Items in Terms of Magnitude of $\bar{D}$.

	Correct	Incorrect
High	15	19
Medium	15	19
Low	25	9
	N=55	N=47

$\chi^2 = 7.878$ df = 2 $p < .01$ (one-tailed test)

Whereas in the previous analysis N referred to predictions made by E, in this analysis N is defined in terms of size of $\bar{D}$ within a given S and the analysis is in terms of comparative size of $\bar{D}$ scores. Also, no Ss are excluded in this analysis as was the case in the previous analysis. However, in actual fact similar kinds of information are derived in both analyses. The inclusion of data from the previously excluded eight Ss who either had all items right or all wrong merely adds a random factor which only serves to decrease the degree of statistical significance.

Analysis 3

It is hypothesized that when data from all Ss are pooled without regard to source, and the high - low classification made with the median as the reference base, then the proportion of correct to incorrect items will be inversely related to the high - low categories.

The treatment proceeded as follows: A mean distance ($\bar{D}$) was obtained as in the previous analyses. Two groups from all (102) $\bar{D}$'s

were formed. One group consisted of $\bar{D}$'s of items solved correctly. The other group consisted of $\bar{D}$'s of items solved incorrectly. The two samples of $\bar{D}$'s were then pooled and rank ordered. The median of the over-all sample was derived by the median test method. From this the number of cases above and below the median for each sample were determined. All cases above the median constituted the "high" category, those below the median, the "low" category. Expected frequencies for each cell were calculated from the data. A 2 x 2 chi-square was applied as a test for the independence of the two samples. Results of this analysis appear in Table 2.

Table 2

Pooled Data Comparison of Correct and Incorrect Items in Terms of Magnitude of $\bar{D}$.

	Correct	Incorrect	
High	23	28	51
Low	32	19	51
	55	47	

df=1 $\chi^2 = 3.18$ $p < .05$ (one-tailed test)

It should be noted at this point that with this latter type of analysis, potential sources of confounding are not controlled (see p.21). The effects of these confounding variables are controlled in the intra-S analyses. Intra-S analyses provide a more sensitive test of the hypothesis.

The results of Analysis 1 suggest that dependable predictions of RAT item success can be made on the basis of the relative size of $\bar{D}$

within a given S. It was found that low $\bar{D}$ is associated with RAT item success. Support for this finding was provided by Analysis 2 in which it was demonstrated that where the relationships among items for individual Ss are concerned, success or failure is related to the size of $\bar{D}$.

The lower level of statistical significance that obtained in Analysis 3 suggests that RAT item performance cannot be predicted with as great a degree of certainty when $\bar{D}$ is considered without reference to its source. As was postulated, uncontrolled confounding factors inherent in this type of analysis may have affected the results of this analysis.

Control Data

In order to determine what effect prior exposure to the stimulus material had on RAT item performance, a control group from the same population of Ss was given the same RAT items as the experimental group, but did no prior semantic ratings of the concepts, hence could not answer RAT items on a recall basis. If a recall factor was operating in the experimental situation, then the experimental group would show superiority over the control group on the RAT items. The two groups were compared in terms of frequencies of items answered correctly and incorrectly. A chi-square comparison appears in Table 3.

Table 3

Comparison of Correct and Incorrect RAT Answers for Experimental and Control Groups

	EXPERIMENTAL (N=34)		CONTROL (N=31)		χ^2	p
	CORRECT	INCORRECT	CORRECT	INCORRECT		
ITEM 1	10	26	6	25	.166	NS
ITEM 2	27	7	21	10	1.143	NS
ITEM 3	18	16	24	7	4.249	$< .05$
TOTAL	55	47	51	42	.016	NS

None of the analyses of item comparisons show statistical significance with the exception of Item #3. However, the effect here is not due to recall as it is in the opposite direction than would have obtained had this variable been operative. On the basis of this analysis, there is no reason to believe that prior exposure to the stimulus material had an affect on the RAT item performance of the experimental group.

CHAPTER IV

DISCUSSION

This study has investigated the pre-solution stage of the Remote Associates Test. The experiment was designed to determine if RAT item performance could be predicted from the semantic distances between the item concepts. Analyses 1 and 2 were intra-S analyses. Results of these analyses were compatible with the hypothesis that RAT item success is related to relatively small semantic distance between stimulus and response concepts. Analysis 3 (analysis of pooled data) also supported the hypothesis, but at a lower level of statistical significance. It was postulated that failure to obtain as high a level of statistical significance with this latter analysis is due to the lack of control over extraneous confounding factors such as variability in the cognitive and personality styles of raters. These factors were controlled in the intra-S analyses.

This study has demonstrated that semantic distance, as determined by the semantic differential, is a reliable predictor of an Ss RAT item performance. At this point some comments are in order concerning the nature of the meaning response measured by the differential. According to Osgood (1953) mediation processes, ie., meaning responses, have both autonomic and motor components. This theoretical postulate is in line with the usual behaviorist notions of meaning, eg. Watson (1924). Autonomic processes, of course, have been experimentally related to emotional or affective states. On this basis, one may speculate that the semantic differential scales measure the affective loading of concepts. As indicated in Ch. I, there have been speculations

(Ullmann, 1962; Weinreich, 1958) that the differential measures the affective components of words. To the extent that this is so, the RAT linkages may be thought of as affective in nature.

One might speculate on the generality of affectively determined associations. It may be that some associative bonds held to be lexically connected are, in part, affectively determined. That is, a word associated with a particular implicit affective state may elicit a word associated with a similar state, with the strength of the bond related to the similarity of the affective processes. This speculation is consistent with the proposal of Staats and Staats (1959).

While the results of this study suggest that an explanation concerning the RAT problem-solving process may be made in terms of the extant representational mediation theory of Osgood, there are alternative explanations that may be considered. First, it is possible that the RAT associative linkages, particularly those involving compound words (eg. SURPRISE-PARTY) are direct, non-semantic associations determined by overlearned verbal habits. Such associations are not investigated in this study. As indicated previously, they would be randomly related to the present hypothesis. Secondly, it may be that the semantic differential polar scale terms provide direct associative mediators between a concept being rated and successive concepts. For example, if a concept is rated as "extremely good", the polar word "good" may mediate the rating of the next concept.

It was pointed out early in Ch. I that "unconscious" processes have been postulated as important variables in solutions to problems. This study does not refute this contention. What the study has demonstrated is that a certain state of the organism is

conducive to correct problem solution. The study was concerned solely with a variable operating prior to the problem-solving process per se. As such this study may be regarded as an empirical investigation of the pre-solution selective-directive mechanism.

It should be noted that while the RAT may represent a valid measurement of creative ability, the type of investigation of the RAT problem-solving process employed in this study cannot be applied to the usual forms of creative accomplishment. The RAT is a contrived device designed to measure individual differences in creative thinking. As such there are predetermined "right" and "wrong" answers. In a non-contrived, "pure" creative act, on the other hand, a creative product or solution, by definition, cannot be known until brought into existence. In studying the RAT problem-solving process, measurements and predictions may be made prior to Ss test performance. In the "pure" creative process the solution or end-product cannot be measured beforehand.

CHAPTER V

SUMMARY AND CONCLUSIONS

This investigation was concerned with the selective-directive mechanism operating in the pre-solution stage of the Remote Associates Test problem-solving process. The semantic differential, which measures implicit mediational processes, was used to determine the inter-concept semantic relationships of RAT items. Semantic distance was indexed by D. It was postulated that performance on RAT items would be related to the magnitude of D between concepts. The hypothesis tested was that success or failure could be predicted from the degree to which item concepts shared common mediators, ie., the smaller the D, the greater the probability of correct solution.

The data were analyzed from two standpoints. First, two intra-S analyses were done. The first intra-S analysis was concerned with prediction of success for particular Ss. Within given Ss comparisons between correct and incorrect items were made. It was predicted that $\bar{D}$'s would be smaller on items solved correctly compared to those of failed items. The second intra-S analysis was concerned with inter-item comparisons within Ss. It was designed to determine if, other factors controlled, low $\bar{D}$'s were associated with superior RAT performance. Results of both of these analyses were statistically significant.

In the second type of analysis, $\bar{D}$'s were pooled over all Ss. Two samples of $\bar{D}$'s (from items correct and items incorrect) were compared in terms of size of $\bar{D}$ (high - low). This was a gross test of the hypothesis because potential confounding variables were not controlled. The results of this analysis, while statistically

significant, did not support the hypothesis as well as the results of the intra-S analyses.

The results of the analyses suggested that RAT performance was related to the magnitude of the semantic distance between RAT item concepts. It was demonstrated that RAT success was related to small D. This finding was compatible with the hypothesis that RAT performance was related to the degree to which item concepts shared common mediators, ie., were semantically similar.

In the discussion, the RAT associative process was discussed in light of the experimental results. The interpretation was made that the semantic differential measures the affective components of words. It was speculated that the RAT associative bonds may be affective in nature. Alternative associative processes that may have been operating in the experimental situation were suggested. Certain relevant points concerning the RAT were made with respect to the general areas of problem-solving and creative thinking.

BIBLIOGRAPHY

Anastasi, A. Fields of applied psychology. New York: McGraw-Hill, 1964.

Brod, D., Kernoff, P. and Terwilliger, R.F. Anxiety and semantic differential responses. J. abnorm. soc. Psychol., 1964, 68, 570-574.

Brown, R. Words and things. New York: Free Press, 1958.

Cofer, C.N. Reasoning as an associative process: III. The role of verbal responses in problem-solving. J. gen. Psychol., 1957, 57, 55-68.

Cofer, C.N. and Foley, J.P. Mediated generalization and the interpretation of verbal behavior: I. Prolegomena. Psychol. Rev., 1942, 49, 513-540.

Cofer, C.N. and Musgrave, B.S. (Eds.) Verbal behavior and learning. New York: McGraw-Hill, 1963.

Craig, M. and Manis, M. Prediction of scores on the Remote Associates Test by size of response repertoire. Unpublished manuscript, 1960. In Mednick, S.A. The associative basis of the creative process. Psychol. Rev., 1962, 69, 220-232.

De Burger, R.A. and Donahoe, J.W. Relationship between the meanings of verbal stimuli and their associative stimuli. J. verb. Learn. verb. Behav., 1965, 4, 25-31.

Dicken, C.F. Connotative meaning as a determinant of stimulus generalization. Dissert. Abstr. 1958, 18, 1507.

Dollard, J. and Miller, N.E. Personality and psychotherapy. New York: McGraw-Hill, 1950.

Ferguson, G.A. Statistical analysis in psychology and education. New York: McGraw-Hill, 1959.

Flavell, J.H. Meaning and meaning similarity: I. A theoretical reassessment. J. gen. Psychol., 1961, 64, 307-319.

Ghiselin, B. (Ed.) The creative process. New York: Mentor, 1955.

Gulliksen, H. How to make meaning more meaningful. Contemp. Psychol., 1958, 3, 115-119.

Hebb, D.O. The organization of behavior. New York: Wiley, 1949.

Hull, C.L. Knowledge and purpose as habit mechanisms. Psychol. Rev., 1930, 37, 511-525.

Humphrey, G. Thinking: An introduction to its experimental psychology. New York: Wiley, 1951.

Hunter, I.M.L. The influence of mental set on problem-solving. Brit. J. Psychol., 1956, 47, 63-64.

Jenkins, J.J. and Russell, W.A. Annual technical report: Basic studies on individual and group behavior. In Staats, A.W. and Staats, C.K. Meaning and "m": correlated but separate. Psychol. Rev., 1959, 66, 136-144.

Karp, S. A validity study of a measure of creativity. Senior honors thesis, Univ. of Michigan, 1960. In Mednick, S.A. The associative basis of the creative process. Psychol. Rev., 1962, 69, 220-232.

Kowalski, J. Attitudes and occupational interests of creative individuals. Senior honors thesis, Univ. of Michigan, 1960. In Mednick, S.A. The associative basis of the creative process. Psychol. Rev., 1962, 69, 220-232.

Luchins, A.S. Classroom experiments on mental set. Amer. J. Psychol., 1946, 59, 295-298.

Luria, Z. A semantic analysis of a normal and a neurotic therapy group. J. abnorm. soc. Psychol., 1959, 58, 216-220.

Maltzman, I. Thinking: from a behavioristic point of view. Psychol. Rev., 1955, 62, 275-286.

Mednick, S.A. The associative basis of the creative process. Psychol. Rev., 1962, 69, 220-232.

Mednick, S.A. and Halpern, S. Remote Associates Test, Form 1. Institute of Personality Assessment and Research, Univ. of Calif., 1959.

Miller, B. A study of creativity in college students and teaching method types. Senior honors thesis, Univ. of Michigan, 1960. In Mednick, S.A. The associative basis of the creative process. Psychol. Rev., 1962, 69, 220-232.

Mosier, C.I. A psychometric study of meaning. J. soc. Psychol., 1941, 13, 123-140.

Noble, C.E. An analysis of meaning. Psychol. Rev., 1952, 59, 421-430.

Noble, C.E. Emotionality and meaningfulness. Psychol. Rev., 1958, 4, 16.

Osgood, C.E. Method and theory in experimental psychology. New York: Oxford Univ. Press, 1953.

Osgood, C.E. Studies on the generality of affective meaning systems. Amer. Psychologist, 1962, 17, 10-28.

Osgood, C.E. and Luria, Z. A blind analysis of a case of multiple personality using the semantic differential. J. abnorm. soc. Psychol., 1954, 49, 479-491.

Osgood, C.E. Suci, G.J. and Tannenbaum, P.H. The measurement of meaning. Urbana: Univ. of Illinois Press, 1957.

Osgood, C.E. and Tannenbaum, P.H. The principle of congruity in the prediction of attitude change. Psychol. Rev., 1955, 62, 42-55.

Razran, G.H. A quantitative study of meaning by a conditioned salivary technique. Science, 1939, 90, 89-90.

Riess, B.F. Semantic conditioning involving the galvanic skin reflex. J. exp. Psychol., 1940, 26, 238-240.

Rugg, H. Imagination. New York: Harper, Row, 1963.

Russell, W.A. Purpose and the problem of associative selectivity. In Cofer C.N. and Musgrave B.S. (Eds.) Verbal behavior and learning. New York: McGraw-Hill, 1963.

Scheerer, M. Problem-solving. Sci. Amer. 1963, 208, 118-128.

Staats, A.W. and Staats, C.K. Meaning and "m": correlated but separate. Psychol. Rev., 1959, 66, 136-144.

Taylor, J.R. and Manson, G.L. Perceptual learning and verbal meaning. Percept. Mot. Skills, 1962, 14, 223-229.

Ullmann, S. An introduction to the science of meaning. New York: Barnes and Noble, 1962.

Underwood, B. An orientation for research on thinking. Psychol. Rev., 1952, 59, 209-220.

Vinacke, W.E. The psychology of thinking. New York: McGraw-Hill, 1952.

Watson, J.B. Behaviorism. New York: People's Institute, 1924.

Weinreich, U. Travels thru semantic space. Word, 1958, 14, 346-366.

Wertheimer, M. Productive thinking. New York: Harper, 1945.

APPENDIX A

Instructions on use of Semantic Differential Scales

Subjects were insturcted as follows:

"If you feel that the concept is extremely or very closely related to one end of the scale, then place a check mark as follows:"

good X x x x x x x bad

or

good x x x x x x X bad

"If you feel that the concept is quite closely related (but not extremely) to one or the other end of the scale, then place your check mark as follows:"

good x X x x x x x bad

or

good x x x x x X x bad

"If you feel the concept is only slightly related (but not neutral) to one or the other end of the scale, then check as follows:"

good x x X x x x x bad

or

good x x x x X x x bad

"If you think the concept is neutral to either side of the scale, that is if you think the terms at the ends of the scales are equally associated with the concept or if the scale is completely irrelevant, check the middle space:"

good x x x X x x x bad