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

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by

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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.

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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.

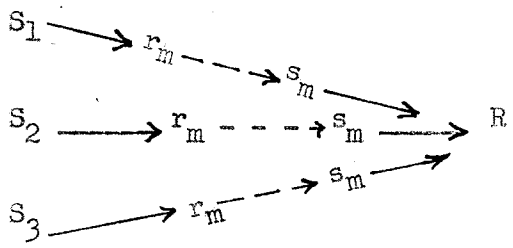

Fig. 1

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.

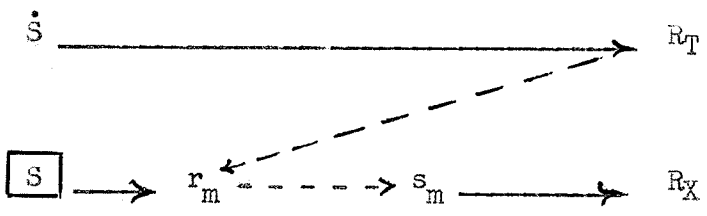

Fig. 2

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