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A Reconceptualization of Multiple Attribute Measurement: The Location of Unidimensional Scales in an N- Dimensional Space

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ABSTRACT

A dimensional model of judgment is proposed wherein concepts are represented as points in a multi-dimensional space, and the projections of each concept on the dimensions represent the values or magnitudes on that dimension. Attributes are held to be distinct from dimensions, and are fundamentally scaled into the space. The proposed model does not rely on the central assumption that every concept or object in the space is construed on every attribute. Attributes can be scaled into the space with stimuli, and the location of any stimulus may or may not have a projection on an attribute. Projections of stimuli on attributes and distances of stimuli from attributes are held to be significant in the judgment of the stimuli. It is argued that the model is preferable to utilization of property vectors since 1) property vectors lead to multiple interpretations of the space, and 2) property vectors assume that every object is construed on every attribute. The model is consistent with basic measurement theory and demonstrates an application of fundamental measurement to the social sciences. The model is broad in generality and scope, with applications to cognitive theory, group dynamics, and communication which are suggested in the paper.

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As foundations of current scaling techniques, Thurstone (1927) and Likert (1932) have had considerable impact on the construction and application of unidimensional scales. Thurstone (1927) presented a mathematical model for relating scale values of a set of stimuli to observable proportions; where the mean and standard deviation are taken as the stimuli's scale value and discriminal dispersion. He made it possible to measure (assign scale values to) attitude statements, etc., along a unitary continuum. Likert (1932) has offered the summated approach that is also quite appealing. Finally, the semantic differential (Osgood, et al., 1957) is another scaling device extensively in use, for the obvious reasons that scale construction is non-laborious, the scales purport to achieve high reliability, and have demonstrated efficacy in past research.

The goal of measurement in each case is to obtain some number that corresponds to a quantity or magnitude of some attribute for some object. Each approach assumes that the scale is indeed unidimensional, there exists some (center) point of neutrality and that the distance between each of the end points and the center are equal. Further, traditionally, the lengths of each attribute scale are standardized; the distances between all pairs of bipolar adjectives are equal, with the further qualification of equal differentiation of scale categories. Finally, it is necessarily implied that any scale attempts to achieve some correspondence, some isomorphism, between the numbering system in the scale with that inherent or latent in the phychological continuum.

One of the central limitations of unidimensional scales is that, by definition, they measure only one attribute, and factor analysis was developed precisely because objects of cognition are multidimensional in nature. Consider the typical factor analysis experiment: the E selects a set of attribute scales presumably exhaustive of dimensions of judgment in a particular domain, or to investigate some theoretical construct. Ss evaluate a number of concepts on these scales, which generates a matrix of scores and ultimately a correlation matrix. The correlation matrix is factor analyzed by any usual procedure to determine the projections of the stimuli on r orthogonal axes. The goal of the procedure is to present a parsimonious representation of the data to represent the factors, or dimensions, of judgment.

In developing factor theory, a number of noteworthy assumptions have been made concerning a common origin, bipolarity, equidistance from origin and standardization of scale metric. The assumption of a common origin implies that (1) the centroid from which vectors originate is a point of neutrality, and (2) all vectors originate from this meaningful neutral location; that is, all attributes intersect at a meaningful location. The strong version of the assumption holds that these facets are necessarily true. Osgood <u>et al</u>., (1957) made this explicit and argued that intensity and direction are indicated by factor loadings. The weaker version of this assumption is never fully discussed in factor analytic research. It is made possible by arguing that the centroid is not necessarily a meaningful point of neutrality; that the sole reason that vectors originate at the origin is mathematical convenience. Hence, the weaker assumption of common origin only asserts that the attribute-line segments in the space intersect at the origin (or at some point, in the case of transformation), and not that there is any special significance to the centroid.

The "meaningful origin" aspect of the assumption of common origin is directly related to the assumptions of bipolarity and equidistance from the origin:

> "One of the difficult methodological problems we have faced -- unsuccessfully so far -- is to demonstrate that the polar terms we now use are true psychological opposites, i.e., fall at equal distances from the origin of the semantic space and in opposite directions along a single straight line through the origin . . . And why use the adjectives? We assume that it is the lexical (root) meanings of our polar terms that determine judgments; adjectives are merely the most general and natural qualifiers in English" (Osgood, <u>et al</u>., 1957, p. 327-328).

Several studies have focused on this "difficult methodological" problem of bipolarity and equidistance. Wishner (1960) argued that one of the bipolar adjectives may be the grammatical opposite of the other, yet possess positive or negative implications of its own. This implies that the meaning of an adjective is not necessarily strictly defined as the opposite of its grammatical antonym, but by its set of formal relations of implicating similarities and dissimilarities, with all other traits and concepts. He recommended the construction of single adjective scales. Green and Goldfried (1965) used single adjective scales and argued that the bipolarity assumption would hold if the scores on such scales correlated more highly negatively between bipolars than between non-bipolars. They found concept x scale interactions, concluded that bipolarity is not a valid general assumption, and that Osgood and his associates ". . . have in fact imposed an arbitrary and artificial structure in the domain they call generalized semantic space" (p. 31).

More stringent tests of both bipolarity and equidistant assumptions have been offered by multidimensional scaling analyses. To test the assumption of bipolarity, Anderson (1970) and Danes and Woelfel (1975) argued that a line drawn from the centroid to each of the bipolars should have an angle between the lines equal to 180°. Anderson (1970) found that the angle cosines varied from -.800 (good-bad) to -.648 (clean-dirty); angles of 143° to 138°. Danes and Woelfel (1975) obtained angles of 168° (good-bad), 152° (favorable-unfavorable) and 138° (positive-negative). The fact that there does not exist 180° between these lines supports Wishner's contention that each trait adjective possesses its own unique set of formal relations with other traits since, in MDS, the location of a trait is dependent upon its perceived similarities with all traits. The grammatical opposite is only one of many traits used as a reference point in the location of a trait.

Both Anderson (1970) and Danes and Woelfel (1975) assessed the common origin and equidistance assumptions by computing the distance between each concept point from the origin. Anderson used a ratio of the smaller distance to the larger and argued that this ratio should be 1.00. The obtained ratios varied from .846 (strong-weak) to .916 (hard-soft). Danes and Woelfel (1975) obtained ratios of .794 (good-bad), .783 (favorable-unfavorable) and .897 (positive-negative). Note that in these studies the centroid is located by "double centering" and that double centering should, in fact, enhance the likelihood of supporting the notion of equidistance from origin. The fact, however, that the ratios do not approach 1.00 suggests that the lengths of the vectors from this centroid to each trait point are not standard. For example, while the ratios for good-bad and favorable-unfavorable are .794 and .783, the distance of "good" to centroid was 45.39 and "favorable" to centroid was 66.32 (Danes and Woelfel, 1975). These studies, then, would seem to indicate that the theoretic assumption of equidistance of bipolars from a common origin does not conform to data collected to test it.

Hence, the invalidity of the strong version of the assumption of a common origin is realized by the two crucial distinctions of: (1) locating individual points in the space vs. locating pairs of grammatical opposites in the space jointly; and, (2) allowing the distances from each pair of grammatical antonyms to vary in length as a free parameter according to Ss perceptions of dissimilarities vs. constraining all attribute line segments to equal and arbitary length. Is the process of locating individual points at odds with Osgood _et al_.'s theory of general sematic space? Anderson (1970) argued that it was not. Osgood _et al_. conceptualized meaning as a compound reaction to bipolar, adjectival components, and admitted that this assumption may be unwarranted. Our conclusions are that meaning is more accurately conceptualized as the result of the sum of compound reactions to all traits taken singularly and, secondly, that standard length and common differentiation of semantic differential scales impose severe and arbitrary constraints on measuring the meaning of a concept. In light of these conclusions, adoption of the "weaker version" of the assumptions of common origin for mathematical convenience must also be rejected. Rather, a representation of semantic space which makes no assumptions, or assumptions more commensurate with available data, should be sought.

A final criticism stems from the arbitrary scale categories offered by traditional unidimensional scales. Gulliksen (1958) pointed out that on many of the individual items in the Measurement of Meaning (Osgood, Suci and Tannenbaum, 1957, p. 127). the variance approached zero. Gulliksen asserted: "Clearly, it is not possible to determine accuracy of measurement when such a coarse grouping is used. For any measurement one needs a unit so fine that a reasonable determination of error is possible" (p. 116). The two relevant implications are that a more precise scaling device is needed and that without accurate measurement there can be no accurate measurement of change. Additionally, it may be noted that low variances in scaled values of stmmuli may result from "ceiling effects" resulting from stimuli being perceived by S's as having projections beyond the end point of the presented attribute (scale). Factor analysis cannot empirically test this possibility, because it constrains the aggrangement of attributes such that a stimulus which projects on one attribute must project onto all attributes.

In conclusion, the validity of the assumptions upon which factor analysis of unidimensional scales rests are questionable. First, both a meaningful centroid and the equidistance from origin condition are artifactual, stemming from the forced standardization of pairs of points and standard lengths between end points. Secondly, assuming the meaning of a trait to be the opposite of its grammatical antonym and conceptualizing meaning as a compound reaction to bipolar terms is questionable since the meaning of each individual trait is uniquely defined by its relation with all other traits. Linguistic determinancy of a trait's location in the space can only be realized as the result of its location in terms of its set of formal relations with all traits.

These conclusions apply equally to unrotated, orthogonal, and oblique factor analytic solutions. In seeking an alternative representation, however, it is useful to keep in mind the advantages of these factor analytic modes. Proponents of orthogonal rotation seek comparability of factor spaces across time and/or groups, and mathematical independence of factors. Proponents of oblique rotation seek to maximize the interpretability of the factor space. Ideally, an alternative representation would allow both comparability and interpretability, without the constraints imposed by the assumptions of factor analysis.

The alternative representation of "semantic space" proposed here may be described as a multi-dimensional array of linguistic elements (descriptor concepts, including unidimensional scale anchors). This configuration is stable in a space generated through metric multi-dimensional scaling procedures from aggregated data of a sample of language users (i.e., a sample of Ss who share a common language). Such an array constitutes a single multidimensional scale, in contrast to "semantic spaces" derived through factor analytic techniques, which constitute constrained multidimensional arrays of unidimensional scales.

This alternative model rests upon the following assumptions:

1. Within a given cognitive domain, it is assumed that there exists a structure, i.e., a formal set of relations among the linguistic units used to describe objects residing in the domain.
2. It is assumed that the meaning of a linguistic unit is determined by its dissimilarity relations (physical separation in the spatial representation) to all other concepts in the domain.
3. Within a given domain, it is assumed that a subset of linguistic units

will bear stable, linguistically determined, relations to each other, describing a structure which is generally applied to other linguistic units representing objects within the domain. The sub-set of linguistic units so designated (e.g. adjectives) may be identified as having meanings (locations) determinable by reference to other linguistic elements of the subset, and independent of particular perceivable referents (objects of the domain) which might exemplify instances to which they refer. Two implications of this assumption of abstract determinability (without necessary reference to particular perceivable referents) are:

a. that the relationships between elements of this subset will be as stable across time as the language of which they are a part, and,

b. that the stable structural array of the subset will constitute a common, stable sub-structure in the individual cognitive structures of users of the language.[2]

4. It is assumed that Ss can report ratio judgments of dissimilarities among traits and concepts.

Within the semantic space characterized by these assumptions, it is useful to specify definitions for a number of terms. By attribute we will refer to a line segment between points representing linguistic units which Ss perceive as grammatic opposites. Dimension refers to a reference line, orthogonal to all other dimensions, through the configuration of attribute end points. Note that the goal of factor analysis has been to identify attributes which load highly on one dimension, but not on others. To designate this condition, we say that for a given dimension there may be an attribute or set of attributes that are exemplar of that dimension. Of course, there may also be any number of attributes which are not exemplar of any dimension. Typically, non-exemplar attributes are purged from the interpretation of factor analytic solutions because they are not considered to be identifiably useful in the interpretation of dimensions of judgment in the domain. Note also that every stimulus in a typical factor analytic semantic space is constrained to have a projection on every attribute. This is necessarily true only because of the combination of double-anchoring of unidimensional scales (bounding at both ends) and the standardization of the lengths of attributes emanating from a common and semantically meaningful origin. This is not necessarily true in the proposed model, given the rejection of these assumptions. Implications of these observations will be discussed below, but first a general description of the derivation and characteristics of the proposed semantic space is in order. Here Einstein's conception of the measurement of distance is instructive:

> For this purpose (the measurement of distance) we require a "distance" (Rod S) which is to be used once and for all, and which we employ as a standard measure. If, now, A and B are two points on a rigid body, we can construct the line joining them according to the rules of geometry; then, starting from A, we can mark off the distance S time after time until we reach B. The number of these operations required is the numerical measure of the distance AB. This is the basis of all measurement of length. (Einstein, 1961)

The analogous measurement procedure proposed here is two-staged: first, an arbitrary distance (or dissimilarity in the general case) is stipulated between two elements of the stable subset of linguistic elements constituting a part of the language spoken by S. It is vital to note that rules for the perception or measurement of this initial measurement distance or discrepancy are not stated; rather the scientist must assume the subject and himself/herself share a common referent for the ordinary language sumbol "distance" or "difference," and that the subject can make this initial recognition unaided by further definition. Ultimately it is this a priori call to common experience as codified in ordinary language symbols that establishes a link between the everyday experience of the observer and the scientific theory.

Secondly, the scientist specifies a rule by which other instances of distance or dissimilarity are to be compared to this unity. In this case, the observer is asked to make ratio comparisons of all other distances or discrepancies to this arbitrary standard.

Since this technique yields both a true zero (that is, no difference between two stimuli) and a standard unit or interval of measure (Rod S), it may be seen to constitute, by definition, a ratio scale whose validity rests on the conventional linguistic symbol system. This means that numbers yielded by these procedures represent discrepancies among stimuli as they appear to the respondents, rather than as defined by the scientist's fiat. Formally, these procedures performed for a single observer over the (N(N-1)/2 possible non-redundant pairs of N stimuli, yield the N X N symmetric matrix S where any cell sij represents the discrepancy or difference between the _ith_ and _jth_ stimuli as reported by the observer and expressed as a ratio to some arbitrary discrepancy S_{xy}.

Techniques which map the structure of discrepancy or dissimilarity data onto a space where they may be interpreted as distances are well known in the multidimensional scaling literature and have been since Torgerson (1958) defined the procedure. Computational equations for Torgerson's method, called metric or classical or Torgerson multidimensional scaling, have been detailed in several places (Torgerson, 1958; Woelfel, 1974; Serota, 1974) but certain salient aspects deserve mention here.

First, metric multidimensional scaling (MMDS) yields a coordinate system of $k \leq N$ orthogonal dimensions for N stimuli. Second, the mapping of discrepancies into this space is one-to-one, that is, no information is lost by MMDS. Third, the function which maps discrepancies (sij) reported by the respondents onto distances in the space (s'_{ij}) is the simple

$$s_{ij} = s'_{ij}$$

that is, distances in the space conform exactly to discrepancies reported by the respondent(s).

It should, perhaps, be noted here that the latter two of these characteristics do not hold for non-metric models (Kruskal, 1964; Young and Torgerson, 1967; Lingoes, 1972). Proponents of non-metric multidimensional scaling generally reject the metric model on the basis of the following assumptions.

First, many psychometricians, for philosophical or heuristic reasons, resist the notion that _k_, the dimensionality of the space, should be left a free parameter to be discovered inductively as a consequence of the rule for measuring distances (Shepard, 1972; Veldman, 1974; Kaiser, 1958). Rather, they feel that _k_ should be set at some arbitrary small value and distances (Dissimilarities) reported by observers adjusted accordingly. This assumption is similar in intention to the practice of relativity theorists, who generally assume the 4-dimensional character of the space-time continuum as an axiom and adjust different observations to fit this constraint (Reichenbach, 1958). The view taken here, however, is that the generality of language and the applicability of many linguistic units to a wide variety of concepts and contexts make it at least plausible that linguistically determined semantic spaces be represented as having a large number of dimensions. This plausibility alone is sufficient reason to reject arbitrary constraint of dimensionality, leaving the question of dimensionality to empirical resolution.

Second, respondents are generally assumed under non-metric models to be unable to make reliable ratio judgments of discrepancies among stimuli. It is assumed here that respondents can make such judgments (Coombs, 1964; Shepard, 1962 a, b). This assumption is supported by recent empirical evidence that most of the apparent unreliability in individual judgments may be systematically explained in terms of individual self-perception and cognitive processes; i.e., by individual perspectives, or points of view, within a culturally normative domain within which the arrangement of stable concepts is determined by an aggregate of which the individual is a member (Marlier, 1974).

In addition to the general characteristics of MMDS spaces noted above, several others are particularly relevant to the comparison of the proposed scale and factor analytic models. First, no assumptions are made in the MMDS space about the semantic meaningfulness of the centroid. Consequently, no assumptions need be, or are, made as to attribute end point equidistance from, or bipolarity with regard to, the origin. Attributes are not constrained to intersect at a common point (which is selected mathematically but may not accurately represent subject perceptions of the relationship of attributes as they occur naturally), and stimuli which are not perceived by respondents to project on an attribute are not constrained to do so. Therefore, ceiling effects are eliminated. Second, the mapping of dissimilarities represents an example of fundamental ratio measurement, and no standardization is involved in the MMDS routine. As a result, attribute lengths and differentiation are not imposed by the researcher for mathematical rather than theoretic reasons, but may be represented as perceived by respondents. The result is high precision of scaling and increases in absolute amounts of reliable variance in scaled perceptions of stimuli (Danes and Woelfel, 1975). Third, attributes in the space need not be exemplar of any dimension. Interpretability of the MMDS space rests, in fact, on the distances of scaled stimuli from the linguistic units which constitute the scale. Consequently, purging of non-exemplar attributes, which has the effect of reducing the total spatial volume near semantically meaningful points, reduces interpretability, and is not called for. Unlike factor analytic representations, which seek parsimony of representation through division into mathematically independent parts, the MMDS semantic space seeks an accurate and theoretically useful representation of interdependence at some cost of parsimony. In many areas of research, however (e.g., small group research, implicit personality theory), the cost must be considered a small one to pay for a representation of cognitive domains consistent in nature with that which is theoretically expected.

Comparability of MMDS spaces across administrations is dependent not on the orthogonality of semantically meaningful axes, as with factor analytic spaces, but on the stability of the configuration of descriptors in the aggregate space. Rotation of aggregate spaces to a least-squares best-fit of theoretically expected stable concepts (Woelfel et al., 1975) has been shown to empirically yield highly stable configurations (Danes and Woelfel, 1975; Marlier, 1974), thus establishing the comparability of scales of the type proposed here.

Application of the MMDS scale to measure individuals' perceptions of stimulus attributes involves the generation of semantic spaces for individual respondents in which the aggregate configuration of stable descriptors is maintained. Thus, a scale generated from the aggregate NxN matrix (S_{ij}) may be applied to M stimuli by requiring respondents to apply the arbitrary standard dissimilarity (S_{xy}) in making ratio judgments of the dissimilarity between all possible pairs of the M stimuli, and between each of the M stimuli and each of the N descriptors. This procedure generates a new (N+M)x(N+M) dissimilarity matrix S_{ij}*. The space generated from this supermatrix represents the respondent's perception of stimuli (objects of the domain) relative to semantically meaningful points which the respondent (or any speaker of the language) might use to describe the stimuli. The location of any stimulus in such a space therefore represents the "meaning" of that stimulus for the respondent, represented in a quantifiable relationship to known points whose meaning is shared by the respondent and other speakers of the language.

Interpretation of respondent attributions of traits to stimuli as located in the space would appear at first glance to be straightforward. If an attribute, or property vector, is represented as the line segment connecting the linguistic units which would bound a unidimensional scale for the measurement of that attribute or property, then the scaled value of that attribute in the MMDS representation would be determined by the point at which the stimulus projected onto the attribute in the MMDS space. Thus, in Figure 1, the relative amount of "goodness" attributed to stimulus S would be given by the difference in distances between Sp (the projection of S on the good-bad attribute) and good, between Sp and bad.

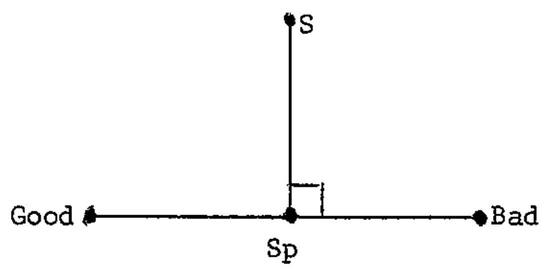

Figure 1.

Such an interpretation follows traditional utilization of factor analytic spaces, in which stimuli are located such that their projections on an arrangement of orthogonal property vectors correspond to unidimensionally scaled values of those properties for the stimulus. Since all distances in the MMDS space are ratios of the standard dissimilarity (S_{xy}), quantifications of attributions in this manner are continuous, and therefore represent an increase in precision over the ordinal or assumed interval levels of measurement typically achieved in factor analytic spaces. The interpretation of MMDS configurations described above may also lead to an anomaly, however, which is resolvable in the MMDS solution but reveals an inherent ambiguity in factor analytic representations.

In the semantic space generated by procedures suggested above, a configuration such as that illustrated in Figure 2 (in two dimensions for illustrative clarity) is possible.

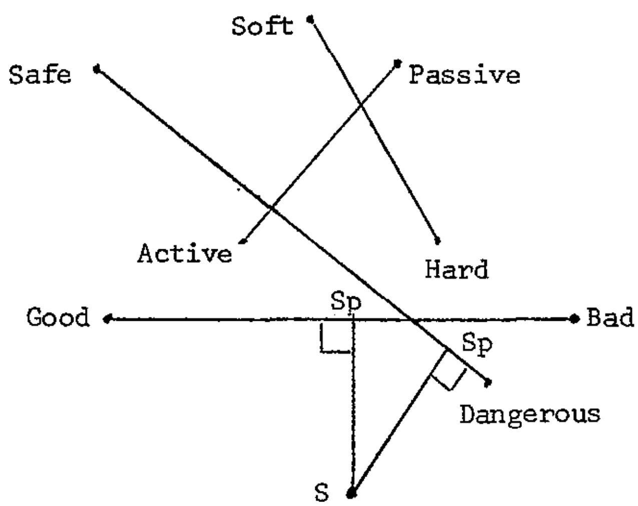

Figure 2

In this hypothetical example, the respondent's attribution of "goodness" to stimulus S could be quantified through the procedure discussed above, resulting in a neutral value. Similarly, we could expect from the configuration that the respondent would scale S at the "dangerous" end of a semantic differential scale anchored by the adjectives "dangerous" and "safe." Since S does not project onto either the "active-passive" or "hard-soft" attributes, however, quantification of the respondent's attribution of these properties to S is not possible by the procedures discussed above. Two interpretations are possible, both of which may be plausibly illustrated if we assume for the moment that S is a gun. In this instance, a respondent might well place an X at the "hard" end of a "hard-soft" semantic differential scale, since "hardness" is an obvious, if unimportant, property of a gun. Asked to scale S (the gun) on an "active-passive" scale, however, the respondent might well be stymied by the conflicting perceptions of actual passivity and potential activity. Faced with this ambiguous perception, such a respondent might well decide that the "active-passive" continuum is irrelevant to his primary perception that the gun is dangerous, and thus mark the neutral point on the semantic differential to indicate his perception that the scale is inapplicable. The point, of course, is that neither hardness nor activity are salient attributes in the respondent's perception of the gun.

A semantic space generated through factor analysis would fail to represent this lack of salience. In such a space, as noted previously, all concepts are constrained to project on all attributes (exemplar or non-exemplar) which are constrained to intersect at a semantically meaningful origin. But the example above illustrates the ambiguity of the origin's "meaning," and the constraint that every concept must project on every standardized attribute makes differentiation of salient from non-salient attributes impossible. Consequently, a factor analytic representation of the example above would either represent the correlation between "active-passive" and "good-bad" as artificially high (if scaled perceptions of the gun were submitted to factor analysis), or result in an indeterminate location of S (the gun) in the semantic space (if the arrangement of attributes had been determined previously by factor analysis of scaled perceptions of other stimuli).

Using property vectors to interpret a semantic space would likewise fail to resolve the ambiguity of interpretation. Property vectors are constrained to intersect at the semantically meaningful origin or, at least, at the center of all points. The property vector is fitted under linear (Chang and Carroll, 1970) or non-linear (Carroll, 1972; Carroll and Change, 1964), best fit with ratings of traits and objects in the space, and the vectors are assumed to be continuous lines (not line segments). While the use of property vectors may be warranted in enhancing interpretability of some configurations, such analyses offer no more than typical oblique factor analysis. We reject the use of property vectors on the grounds that (1) the "meaning" of the origin is ambiguous, (2) every object is constrained to have a projection on each property vector, and (3) no differentiation exists between salient and non-salient attributes. A fourth criticism is simply that any large number of property vectors can be combined in several different ways, yielding several different "interpretations" (Rosenberg and Olshan, 1970; Rosenberg and Sedlak, 1972).

In the MMDS model, however, the ambiguity of interpretation of the example is resolvable. A ratio measure of respondent attribution of activity-passivity to S, for example, is given by the difference in the distances from the stimulus S to "active," and S to "passive." The range of possible values of this measure is ± the length of the attribute in the space. A value of zero indicates neutrality, and occurs when S has a projection onto the midpoint of the attribute. A ratio measure of the salience of attributes to the respondent's perception of the stimuli may be obtained by subtracting the distance between the stimuli and the attributes from some arbitrarily large constant. In the case where a stimulus can be projected onto an attribute, the distance between them is the distance between the stimulus (S) and its point of projection (Sp). Where projection is impossible, as in the above example, the distance between the stimulus and the nearest end point of the attribute is the distance between S and the attribute. Thus, in Figure 3,

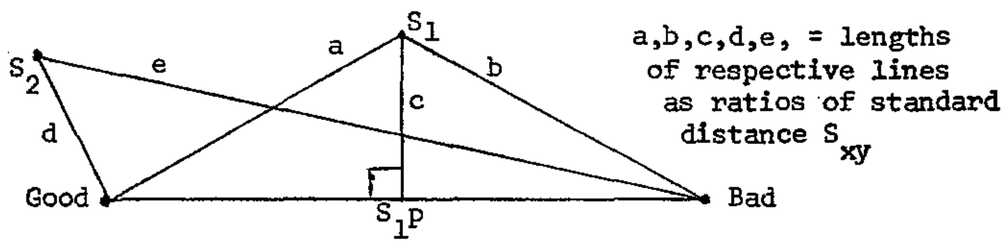

Figure 3

The quantified attribution of "goodness" to stimulus S_1 is given by (a-b). The salience of the good-bad attribute to the respondent's perception of S_1 is (k-c), where k is any large constant. Similarly, the "goodness" of S_2 is given by (d-e), and its salience is (k-d).

This quantified interpretation of the MMDS space is unambiguous and resolves the anomaly which results from projective quantification.

Scales of the type described here have high potential utility in a number of research areas, and a number of theoretic advantages over factor analytic representations. By way of conclusion, a few examples are discussed below.

Work in "implicit personality theory" illustrates the structure and attribute array in n-dimensions that satisfy the assumptions and exemplify the definitions and utility of the model. "Implicit personality theory" is conceptualized as the formal set of relations perceived among traits as they belong in others (Hastorf, Schnieder, and Polekfa, 1970; Hays, 1958; Jackson, 1962; Koltuv, 1962). First, assumption 1 is satisfied because trait adjectives used typically to describe others are readily identifiable. Todd and Rappoport (1964) offer a superior means of trait selection based on using the Kelly Rep Test (1955) as a pretest. Thus, relevancy of traits used as descriptors in the space, for Ss, is enhanced (Hastorf, et al., 1958).

The other assumptions of the model are satisfied in the following manner: First, research supports the conclusion that "implicit personality theory" structures our description of others and recall of others (see Schneider, 1973) and that it is generally applied across reference persons (Hanno and Jones, 1973; Koltuv, 1962; Passini and Norman, 1966; Secord and Bercheid, 1962; Warr and Knapper, 1968), and not necessarily referents. Secondly, the aggregated solution of the configuration of adjectives is representative of the individual case (Anderson, 1970). Further, few personality variables seem to account for differences in the structure of the configuration. Individual differences may more aptly be accounted for by an elevation explanation (Walters and Jackson, 1966) or by a dimensional saliency explanation (Sherman, 1970). Note that whatever explanation is correct, points in the configuration are free from ordinal inversions--the order of the traits in the space is constant; only expansion or contraction of traits on certain dimensions are obtained. This and the conclusion that the configuration is generally applicable to all categories of others is demonstration of the stability of the traits arrayed in the person perception space.

Final support for linguistic determinacy comes from the demonstration of how novel lexical items of a student slang are incorporated into a previously existing configuration of adjectives (Friendly and Glucksberg, 1970). Freshmen and Seniors equally differentiated between common, culturally defined trait labels, but Seniors differentiated more among the slang terms than Freshmen. Hence, it was argued that as one learns to use labels (traits) of a language, one necessarily learns to differentiate along the attributes relevant for the subculture. Clearly, this is a demonstration completely in line with the philosophical discussions that meaning is derived from the entire social convention which is public and rule-governed (Wittgenstein, 1953; see also Barnett, 1975). Implicit personality theory is a culturally defined set of traits within which subtle individual differences are obtained.

Finally, with regard to the general applicability of trait configurations to objects of the domain, reexamination of prior results lends tentative support. Hanno and Jones (1973), for example, generated "implicit personality theory" configurations for a "family doctor" and for a "nationally known politician." They found greater clustering of positive traits for "family doctor" than for "nationally known politician." However, the differences were not great, with canonical correlations of .989 and .881 between the two dimensions, respectively. There were no order inversions. Since interpoint distances are a function of perceived probability of trait co-occurrence or implication, one can conclude that the Ss perceive those traits belonging in the family doctor with greater probability than in the nationally known politician. These results do not indicate that the "implicit personality theory" changes from one stimulus person to another. Indeed, the results support the robustness and generality of the perceived formal relations among traits.

The radical departure from such an approach is to include person-concepts in the paired comparison questionnaire. The result is that of locating both "family doctor" and "nationally known politician" in the person perception space by triangulating distances from the unique locations of each and every stable trait. Person-concepts such as "family doctor" and "nationally known politician" would be points defined by the semantics of the linguistic items. From a theoretic perspective, this representation has a number of advantages. First, comparability of individual spaces is assured by stability of the aggregate trait configuration. Second, because non-exemplars are retained in the model proposed here, the interrelations of non-independent traits are unambiguously known, increasing the precision with which trait co-occurrence may be quantified. And finally, the salience measure discussed above might potentially be utilized to quantify surety of trait inferences made by respondents.

A second area of research which might usefully employ scales of the type proposed here is group dynamics. The potential utility of scales for the characterization of groups has long been recognized by researchers in this area (e.g., Cattell, 1948, 1951; Cattell, Saunders and Stice, 1953; Hemphill and Wertie, 1950; Borgatta and Cottrell, 1956; Hemphill, 1956). Innumerable experimental studies have been conducted, controlling a small number of independent variables, and finding significant interactions, which have been summarized elsewhere (e.g., Cartwright and Zander, 1968; Hinton and Reitz, 1971; Hare, Borgatta, and Bales, 1966; Steiner, 1972). Two problems have hindered the development of comprehensive theory in this area. First, experimenters have largely been limited to the study of zero-history proto-groups because no standard instrument existed for the measurement of characteristics of ongoing naturalistic groups. Development of a standard scale of the type proposed for this purpose could potentially resolve this problem. Second, consolidation of findings has not been feasible as long as each study utilized different operations to study the interactions of a small number of variables. No basis for comparison across studies exists, and generalization of findings to contexts in which variables which were controlled in a laboratory were left uncontrolled elsewhere has been rendered suspect by findings of significant interactive effects between variables studied in different combinations two or three at a time. As Whitehead noted, "Insofar as there are internal relations, everything must depend on everything else. Apparently, therefore, we are under the necessity of saying everything at once." (Whitehead, 1969)

Granting the infeasibility of controlling all variables which affect group processes, it may still be possible to develop a comprehensive scale of the type proposed here, within which holistic representations of group member perceptions of group characteristics could be scaled. Such a scale could be applied to the study of naturalistic as well as laboratory groups. Applied in a large number of studies, it could provide a standard point of comparison for findings, and might lead to identification of functionally equivalent combinations of group characteristics (as perceived by group members), which could in turn lead to the development of consolidated theory.

A final example of areas in which MMDS scales of the type discussed here might be utilized comes from communication. Scales for the measurement of multidimensional constructs such as source credibility (Berlo, Lemert and Mertz, 1969; McCroskey, 1966; McCroskey et al., 1972 a, b, 1973) have been developed factor analytically. It has also been demonstrated, however, that extreme scores on all of the dimensions reported do not constitute maximum credibility (Heston, 1972). Rather, maximal perceived credibility seems to result from receiver attributions of average amounts of some properties to sources. The question then arises whether different combinations of such attributions might not be functionally equivalent with regard to their effects on receiver responses to communication. Application of a standard scale such as that proposed here could potentially lead to empirical resolution of this question.

FOOTNOTES

1. Later research on concept x scale interactions indicates that valid use of the semantic differential may require separate factor analysis be performed on each concept evaluated (Rosenbaum, Rosenbaum, and McGinnies, 1971).

2. Note that this same assumption is implicitly operative in the use of unidimensional scales anchored by linguistic elements with an assumed stable bipolar relation to each other; it is just not applied as broadly in the unidimensional case. The domain specificity stipulation is necessary to avoid the common concept x scale interaction which hinders the identification of stable substructures.

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