1971

Individual Differences in Person Perception: Assessment of a Model

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INDIVIDUAL DIFFERENCES IN PERSON PERCEPTION: ASSESSMENT OF A MODEL

by

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A Dissertation Submitted to the Faculty of the Graduate School

of Loyola University in Partial Fulfillment of

the Requirements for the Degree of

Doctor of Philosophy

April

1971

ACKNOWLEDGMENTS

The author wishes to express his gratitude to Dr. Emil J. Posavac for guidance and advice offered in the preparation of this study and in the writing of the dissertation.

The author also wishes to thank Drs. Homer H. Johnson and Edward P. Meyer for their technical assistance and suggestions given in the final preparation of this manuscript.

LIFE

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TABLE OF CONTENTS

Chapter		Page
ACKNOWLEDGMENTS		ii
LIFE		iii
TABLE OF CONTENTS		iv
LIST OF TABLES		vi
LIST OF FIGURES		vii
ABSTRACT		viii
I.	INTRODUCTION	10
	A. Purpose	10
	B. The problem: The measurements of individual differences in person perception	10
	C. Reformulation of the problem: A cognitive structure approach	11
	1. Trait implication	11
	2. Cognitive structures	13
	D. Previous research	14
	1. Idiographic approach	14
	2. Nomothetic approach	18
	3. Tucker and Messick procedure	23
	E. Proposed solution	25
	1. Multidimensional scaling	26
	2. Indscal model	27
	3. Data required by the model	34
	4. Extraction of factors	35
	5. Spaces resulting from the analysis	40
	6. Previous research using Indscal	43

Chapter		Page
II.	METHOD AND PROCEDURE	45
	A. Experimental design	45
	B. Criterion for the validity test	47
	C. Stimuli and instruments	48
	D. Subjects	53
III.	ANALYSIS AND RESULTS	55
	A. Indscal multidimensional scaling	55
	B. Comparison with Norman's configuration	59
	C. Individual weights and correlates	65
IV.	DISCUSSION AND CONCLUSIONS	70
	A. Validity test	70
	1. Rotation	70
	2. Restrictions for rotating	71
	B. Conclusions from the validity test	72
	1. With respect to the scaling of stimuli	72
	2. With respect to weights	73
	C. Individual differences	74
	1. Their existence	75
	2. Their origin	75
	3. Their nature	76
	D. Correlates of individual differences	77
	E. General conclusion	80
REFERENCES		81

LIST OF TABLES

Table | Page

1. TWENTY STIMULI SELECTED OUT OF FORTY SCALES USED BY NORMAN 50
2. SUBJECTS: INDIVIDUAL DIFFERENCES IN AGE, MARITAL STATUS, EDUCATION, MAJOR FIELD 54
3. FACTOR LOADINGS FROM INDSCAL ANALYSIS 60
4. FACTOR LOADINGS FROM INDSCAL ANALYSIS AFTER VARIMAX ROTATION AND FROM NORMAN'S FACTOR ANALYSIS 62
5. MATRIX OF INDIVIDUAL WEIGHTS FROM INDSCAL ANALYSIS. 64
6. CORRELATION COEFFICIENTS OF THE SCALE VALUES FROM THE INDSCAL SOLUTION AND THE LOADINGS FROM NORMAN'S CONFIGURATION 66
7. CORRELATION COEFFICIENTS OF INDSCAL WEIGHTS AND SOME PERSONALITY AND COGNITIVE VARIABLES 69

LIST OF FIGURES

Figure		Page
1.	DISTANCES AB, AC, AD, BC, BD, CD EXPRESSED IN TERMS OF TWO DIMENSIONS	28
2.	EFFECT OF WEIGHTS ON LINE AB	42
3.	NUMBER OF DIMENSIONS VERSUS PERCENTAGE OF VARIANCE ACCOUNTED FOR	56
4.	NUMBER OF DIMENSIONS VERSUS "STRESS" IN KRUSKAL'S MULTIDIMENSIONAL SCALING	57

ABSTRACT

A method has been proposed by Carroll and Chang (1970) to analyze individual differences in multidimensional scaling via an N-way generalization of the "Eckart-Young" decomposition. Its spatial model incorporates the possibility of assigning weights to the dimensions of the geometric configuration of the stimuli. These weights reflect individual differences.

The purpose of this study was to empirically appraise the Indscal method for use in social psychology in the area of person perception.

The interest was spurred by the lack of correlates of individual differences in person perception. Whether this failure should be attributed to a real lack of correlates or to shortcomings of the measuring instruments is not clear. A refinement in the tools of measurement might help extricate these issues and pave the way in the quest for such correlates.

First the validity of the Indscal measurement as applied to a cognitive structure was established. A validity test was conducted using Norman's (1963) research as the criterion.

Next the psychological significance of the measurements of individual differences was examined. These were correlated to some personality

and cognitive variables with the purpose of exemplifying the search for correlates.

Indscal scaling provided measurements of individual differences in person perception which were anchored in valid measurements of a cognitive structure. They were used to investigate some correlates of such differences.

The results showed that the Indscal multidimensional scaling method can be used to advantage to study the determinants of individual differences in person perception.

I. INTRODUCTION

Purpose

The present study attempted to empirically appraise a new method for measuring individual differences for further use in the area of person perception. The method has been recently presented by Carroll and Chang (1970) and it was proposed as an improvement over the procedures currently used for the same purpose.

The problem: The measurement of individual differences in person perception

It is assumed that people react differently to the same person because they perceive him differently. Individual differences in perceiving the same person precede, conceptually, individual differences in responses to the person perceived. For instance, some people might react with a "there but for the grace of God go I" type of attitude when coming across a hobo. Some others might have a feeling of scorn and an attitude of withdrawal. Still others might find the whole thing hilarious. The individual reactions could be explained in terms of the descriptive-evaluative dichotomy: the person is perceived in the same way by all but is evaluated differently. Alternatively, it might be argued that the different attitudes were the results of different ways of perceiving the hobo. In adopting the second alternative, the question follows: what are the determinants of in-

dividual differences in person perception? Were it possible to design an experiment in person perception such that all or most stimulus sources of variance could be kept constant while the characteristics of the perceiver would be allowed to vary, a comparison could be made between individual differences in evaluation and characteristics of the perceiver. The assessment of individual differences would be the first step in such an experiment. Different psychometric approaches have been proposed to tap individual differences. The Carroll and Chang (1970) approach is one of the more recent attempts at measurement of individual tendencies in judgment tasks.

Reformulation of the problem: A cognitive structure approach.

The problem at hand can be reformulated in terms of measuring individual differences in the organization of cognitive structures. By reformulating the problem in this way two assumptions are made: a) that the study of person perception can be approached in terms of cognitive structures and b) that individual differences in person perception reflect themselves somehow in the organization of cognitive structures. In this section, the first assumption is explained by emphasizing a prominent characteristic of the processes involved in person perception.

Trait implication. The term person perception is used here to refer "to the attribution of psychological characteristics (e.g., traits, inten-

tions) to other people, either by describing them or by making predictions of their subsequent behavior" (Shrauger & Altrocchi, 1964). This definition does not cover the whole process nor exhaust its complexity. In spite of its limitations, it operationally defines person perception and as such it describes a usual process that takes place when we perceive others. The same process has been called trait inference (Bruner, Shapiro & Tagiuri, 1958) to refer to the fact that everybody in forming impressions of others has expectancies of certain traits going together. It has been pointed out by Koltuv (1962) that this fact forms the common denominator of several theoretical constructs such as "halo effect", "logical error", "implicit personality theory", "causal texture" and "centrality". Under these different names, the same basic fact is studied, i.e., that an individual infers one trait on the basis of another and that a person has some relatively stable schemes of expectations and anticipations about others. In other words, a person has an "implicit theory of personality" or a scheme of trait relatedness which channels his inferences about personality traits. Diffuse perceptual data are coded into simpler forms and categories according to the limits of the information-organization capacity of the observer. These schemes are gradually built up through both personal and vicarious experience. When they are invariant or inappropriately applied, the individual experiences difficulties in his interpersonal re-

lationships. Some times they have been interpreted as perceptual biases. However, they have a functional value which consists of enabling the individual to organize his social environment. A prominent characteristic of person perception is that the process follows patterns and is functionally structured.

Cognitive structures. The patterns embedded in trait implication can be described as cognitive structures. This term refers to organized systems of interrelationships on the basis of which predictions can be made about the way a person perceives other people. It is assumed that each person has a system of dimensions which he uses to organize his social ecology. Reciprocally, it is assumed that the ecology can be organized as a system of dimensions or factorial structure. The distinction between the organization of cognitive dimensions and the organization of ecological dimensions can be conceptually visualized in terms of the distinction between content and structure. From a practical point of view, this distinction is not relevant since it is not possible to assess the ecological structure independently of one's cognitive structures.

The approach of the study of person perception through studying cognitive structures in the perceiver has at least two important advantages: it sets the problem in a more general frame of reference and it allows for description in terms of mathematical models. In fact, a basic implication

of the cognitive structure approach to person perception is the notion of an n-dimensional space as the framework of mutual distances among psychological events. Space and distance, as mathematical concepts, permit the use of the quantitative tools of mathematics in what had been conceived as a qualitative area of study.

Previous research

Keeping in mind the link between the concepts of person perception and cognitive structure, the review of the previous research was organized around two methodological approaches to the problem: a) idiographic analysis in which a separate analysis is performed for each individual, and b) nomothetic analysis in which cognitive structure is studied without reference to the individuals, that is, individual data are pooled before the analysis.

Idiographic approach. It is reasonable to expect that the major contribution to the study of individual differences in person perception would come from the field of clinical psychology. Kelly (1955) has developed a theory of personality which is organized around his Fundamental Postulate: "A person's processes are psychologically channelized by the way in which he anticipates events". Kelly also devised several procedures to elicit individual construct systems. A construct is defined as a bipolar dimension along which persons are judged alike and different from each

other. The best known of Kelly's procedures is the Role Construct Repertory Test. It has been designed so as to reveal the cognitive structure or construct system of the individual. Basically it requires the subject to judge a number of persons on a series of dimensions which are produced by the individual himself. The basic structure emerges later through factor analysis of these constructs. Individual differences are described in terms of interrelationships among the constructs and the use of different constructs.

In the Role Construct Repertory Test the individual elicits dimensions of his own choice, reflecting the dimensions of his cognitive space. If, on the other hand, the experimenter provides the dimensions, then the situation is similar to that typically used in research with the Semantic Differential (Osgood, Suci & Tannenbaum, 1957). Factor analysis of the scores from the scales of the Semantic Differential yields the factorial structure of meaning or, equivalently, the cognitive structure of the individual or group.

Sarbin, Taft and Bailey (1960) developed a six-stage model of clinical inference to describe how a clinician cognizes other persons which they included in a more general theory of cognition. Social ecology can be described as a system of dimensions. Given an individual's pattern of responses on such devices as an adjective check list, factor analysis de-

rives a module which is the cognitive representation of the ecology. A person's system of dimensions is characterized by his modules.

Todd and Rappoport (1964) compared two models for the study of cognitive structures: a) the factor analytic model and b) the implication model proposed by Hays (1958). Their study was designed to test whether the two models manifested convergent validity and whether the dimensions were psychologically relevant. Judgments of the likelihood of co-occurrence and ratings were obtained from the same set of stimuli. The analysis was carried out for each individual separately. Two configurations resulted after applying the corresponding procedures. They were compared at two levels: a) at the level of implication relationship and b) at the level of dimensionality. The models were in substantial agreement about the extent to which one trait implies another. However, the dimensions of one were different from those of the other.

In a cognitive structure approach to person perception, individual differences are represented by differences in the geometric elements of the structure. The number of dimensions (Bieri, 1955; Kelly, 1955), the weights assigned to the dimensions (Bloxom, 1968; Carroll and Chang, 1970; Horan, 1969), the function underlying the relation between distances and similarities (Kruskal, 1964; McGee, 1968; Shepard, 1962) are all analytical elements that have been used to describe and quantify individual differ-

ences in person perception. More commonly, though, the factor structure as a whole is considered to convey the individualized portrait of the person's cognitive structure. Among the elements, the number of dimensions has been profusely studied with the purpose of characterizing the individuals. A self-contained area of research under the label of cognitive complexity has resulted. Bieri (1966) defined cognitive complexity as the degree to which an individual can construe social behavior multidimensionally. This capacity is determined by the use of the Role Construct Repertory Test of which Bieri has made several modifications. Individuals that are cognitively complex tend to make fine distinctions among people and to perceive them as different from one another. This differentiating ability is shown by the number of dimensions along which they judge other people. Cognitively complex people use more dimensions than those who are less complex.

In an approach other than cognitive structure, individual differences in person perception can be measured by a large variety of measurements. For instance Cronbach (1955) suggested that perceivers differ in response biases toward rating consistently higher (or lower) on particular traits, tendencies to make more extreme (or more central) ratings on certain traits, and tendencies to associate particular traits with each other. Zajonc (1960) also proposed several measurements of individual differ-

ences. Typically, subjects would be asked to read a letter of application from a candidate to his prospective employer and then to describe the personality of the applicant. From the responses, several scores (differentiation, complexity, unity and organization) are derived which characterize each individual's perception.

The methods reviewed in this part are illustrations of the idiographic approach to the study of cognitive structures. This essentially implies a separate analysis for each individual. Three remarks seem necessary: a) a method which is being used idiographically can be used nomothetically as well; b) the choice of an idiographic approach seems to be dictated primarily by concrete situations in clinical psychology; c) the use of an idiographic approach does not necessarily imply abandoning the search for general principles since these can be sought in the unique context of the individual in which they are operative.

Nomothetic approach. While in an idiographic approach the emphasis is on the individual's cognitive structure, in a nomothetic approach the interest of the research focuses on the content of the cognitive structure. The area of person perception, thus, stretches so as to include the field of research known as taxonomies of personality attributes. In fact, these types can be considered as the basic dimensions of the factorial structure of personality or as primary dimensions of a "lay personality theory".

Norman's work is illustrative of such an approach. His research continued that of Allport and Odbert (1936), Cattell (1947, 1957) and Tupes and Christal (1961). The common aim of these researchers was to construct a taxonomy of personality characteristics or, in other words, to determine the organizational features of personality. They derived such structure from the examination of the natural language. The personality structure was contained in a set of trait descriptive terms which corresponded to independent factors found through factor analysis. The initial set of descriptive terms proposed by Allport was condensed by Cattell and still more by Tupes and Christal (1961). At this stage, a problem arose because of the clear disparity in the dimensionality of the factor solutions that were obtained. One of the main objectives of Norman's research (1963) was to determine the degree of factor similarity in these solutions. It might be recalled that a similar difficulty was met by Todd and Rappoport (1964) in a study concerned with the methodology: the same set of stimuli yielded configurations which had different dimensions depending on the method of analysis applied. The problem in Norman's case was somewhat different: dissimilar configurations had been obtained in spite of mapping the same domain and in spite of the same analytical procedures being used. Norman designed a peer-nomination task to obtain ratings with some selected scales from previous research by Cattell and

Tupes and Christal. These ratings were factor analyzed with a principal axes method and a normalized varimax procedure. A five-factor structure emerged. The factors were: Extraversion or Surgency, Agreeableness, Conscientiousness, Emotional Stability and Culture. This structure proved to be highly stable under different experimental conditions. The same five dimensions were obtained when the judges were familiar with each other as well as when they were completely unacquainted (Passini & Norman, 1966). Norman and Goldberg (1966) demonstrated that a computer program could be written to simulate the subjects' ratings. The results of these studies suggested that the factorial structure reflected the rater's conceptual factors, his "lay personality theory", rather than ratee's characteristics. D'Andrade (1965) showed that the stability of the five-dimensional structure obtained by Norman was semantically originated, i. e., trait covariation was attributable to properties of the meaning of the scales rather than to properties of the person being rated. This last mentioned study is particularly interesting from the point of view of the experimental design because the five-dimensional structure was obtained through factor analysis using only twenty scales (the positive poles) out of the forty used by Norman. For the same reason, Hakel's study (1969) is also relevant. Hakel employed exactly the same scales and derived judgments of likelihood of co-occurrence of traits. The configuration that resulted from

Kruskal (1964) multidimensional scaling analysis was similar to that provided by factor analysis. Hakel as well as Mulaik (1964) did not insist on the possible semantic origin of such stability and invariance. Instead they emphasized that the factor structure may be partly or wholly attributable to the operation of the implicit theories of the judges or perceivers.

Lay and Jackson's study (1969), to be mentioned again later on account of the experimental design, used a successive interval multidimensional scaling. The same method had been used before by Jackson, Messick and Solley (1958) in an attempt to identify the relevant variables of "lay personality theory". They succeeded in placing twenty persons in a structure of four dimensions. Multidimensional scaling is increasingly being used in conjunction with the Tucker and Messick procedure (1963), to be mentioned later.

Rosenberg, Nelson and Vivekananthan (1968) used Kruskal's multidimensional scaling (1964) which is an implementation of Shepard's nonmetric approach, to determine the multidimensional structure of personality impressions. Their emphasis was on the nature of the dimensions obtained. They were identified in terms of descriptive and evaluative categories. This specific interest was carried over to another study by Rosenberg and Olsham (1970). They analyzed the trait adjectives from which Peabody (1967) had removed the confounding between the evaluative and the

descriptive aspects. Their analysis, again using Kruskal's method, revealed that the subjects were using evaluative judgments independent of any particular descriptive dimension.

The studies mentioned in this section were illustrations of the nomothetic approach to the study of cognitive structure. A final remark, suggested by Jackson and Messick (1963), seems relevant from the point of view of the present research. These authors pointed out that a nomothetic approach necessarily implies the assumption that every judge perceives the stimuli in the same way. If such assumption is not met, pooling of data has more serious consequences in multidimensional measurements that it might have in unidimensional ones. In the unidimensional case the result is a cancelling out of individual differences or a mutilation of information which might be called error. However, in the multidimensional case, pooling might result in a distortion of the space. By way of illustration, if one subset of judges was cognitively simple and another cognitively complex, the obtained space, representing an average, might provide more dimensions than would characterize many of the judges and possibly distort the relationships in general. The nomothetic representation would be accurate for all judges only to the degree that judges are homogeneous; however, such judge homogeneity is usually unlikely in person perception research. This warning is certainly valid for nomothetic multidimensional

scaling in which estimates of psychological distances are averaged.

Tucker and Messick procedure. Tucker and Messick (1963) provided an alternative between doing individual analysis and using pooled data. The procedure is called Point of View Analysis. It was designed to divide the group of heterogeneous judges into homogeneous subgroups. The averaging of measurements with these fairly homogeneous subgroups would not cause departure from individual scores to any appreciable extent. In order to achieve this homogeneity, from the raw data matrix (subjects by stimuli) a subjects by subjects matrix of sums of squares and raw cross-products is obtained. This matrix is subjected to a principal components analysis to extract the dimensions of the subject space. After an appropriate rotation each judge has a projection on each of the rotated subject dimensions. These projections can be considered as individual scales values which indicate how much the individual judgments are similar to the various dimensions. They can be correlated with other measurements on the judge. The resulting factors provide then a criterion for the clustering of the judges. In each cluster, "idealized" subjects are defined that represent the whole cluster in an optimal way. Interpoint distances are re-computed for the "idealized" individuals and a multidimensional scaling is performed for each point of view.

The Tucker and Messick procedure has been widely used. For ex-

ample, Walters and Jackson (1966) applied it to study patterns of trait inferences. Judgments of likelihood of joint occurrence were obtained from 139 subjects comparing 30 trait-descriptive adjectives. These judgments were subjected to factor analysis in the manner described above. The results showed that two points of view were necessary to describe the group of judges. This study not only supported the claim that multidimensional scaling can serve well to explain and order trait inference data, but it demonstrated as well that there were "individual" differences among judges, individual standing for group differences among judges.

The procedure was used by Messick and Kogan (1966) to study individual consistencies in Role Constructs in the context of Kelly's research. The authors extracted several viewpoints from judgments of similarity among role figures. In this case the number of viewpoints was found to be different for males and females. Another finding was that individual projections correlated with cognitive and personality measurements in a significant way.

Wiggins (1966) applied the procedure proposed by Tucker and Messick to establish homogeneous viewpoints with respect to social desirability of selected MMPI items. The finding of individual differences served to question the use of "average" social desirability scale values as a valid measurement.

In spite of its appeal, the Tucker and Messick procedure has been the object of some criticism. On mathematical grounds, Ross (1966) hinted at the possibility of obtaining untenable spatial results by following the rationale of the procedure. Cliff (1968), however, tried to answer Ross' objections. At the level of psychological interpretation, some researchers (Carroll & Chang, 1970) report experiencing that two "individual" configurations from the Points of View Analysis can be as difficult to compare as two configurations from two separate analyses in an idiographic approach. Furthermore, certain dimensions from two points of view might well be common and it would be surprising if there were no such common dimensions when judges confront the same set of stimuli. However, this is contrary to the rationale of the procedure since the dimensions, or the configurations, are built up on the basis of independent points of view. Bloxom (1968) suggested a refinement of the Tucker and Messick procedure by assuming a model in which the space would be the same for all judges and their differences would be represented by individual weights applied to the various dimensions. This is precisely the model, independently proposed by Carroll and Chang which is discussed next.

Proposed solution: Indscal Method

The Tucker and Messick model for individual differences could be considered as a middle way solution between doing a separate analysis for

each individual and a nomothetic approach of pooling the data. The Indscal method can be looked upon as an improvement over the Tucker and Messick procedure. Before an exposition of its rationale and procedures, the general theory of multidimensional scaling is outlined.

Multidimensional scaling. Multidimensional scaling can be broadly characterized as one of several solutions to the problem of data reduction. It attempts to make explicit the structure that underlies such data. In this respect multidimensional scaling is one of the methods that fall under the general heading of factor analysis: all of them are used to describe the hidden factors that are able to generate the structure of covariation in the responses. In these methods, the observable variables are represented as functions of a smaller number of latent factors.

More specifically, multidimensional scaling is a generic name given to several different methods pursuing the purpose of discovering the dimensions on which a set of stimuli vary. The multidimensional scaling procedures, then, lead to the determination of a) the minimum dimensionality of the set and b) the projections of the stimuli on each of the dimensions making up a psychological space. The dimensionality corresponds to the number of different ways the stimuli are seen to relate to each other. The points in the space represent stimuli and their projections on each dimension are called the scale values of the stimuli

on the various attributes. The distances among points correspond to estimated psychological distances among the stimuli. While in unidimensional scaling each stimulus can be represented by a point along a single dimension, in multidimensional scaling each stimulus is represented by a point in a space of several dimensions. Thus each stimulus is assigned as many numbers, or coordinates, as there are independent dimensions. The final result of the scaling is a geometric representation of n stimuli such that the interstimulus distances correspond to the empirical measurement of such distances.

The reductive power of such an approach can be visualized in Figure 1 which was adapted from Guilford (1954). The empirical distances AB, AC, AD, BC, BD, CD can be expressed more parsimoniously in terms of the coordinates on the axes or dimensions 1 and 2.

Indscal model. Indscal is the abbreviated name (Individual Differences Scaling) of a computer program that implements the procedures proposed by Carroll and Chang (1970) to perform multidimensional scaling in a way that takes into account individual differences in person perception and in judgments in general. The abbreviation of the program is used here to refer to the mathematical model itself.

The basic information was available in an article by Carroll and Chang already mentioned. Several studies using the model have also been

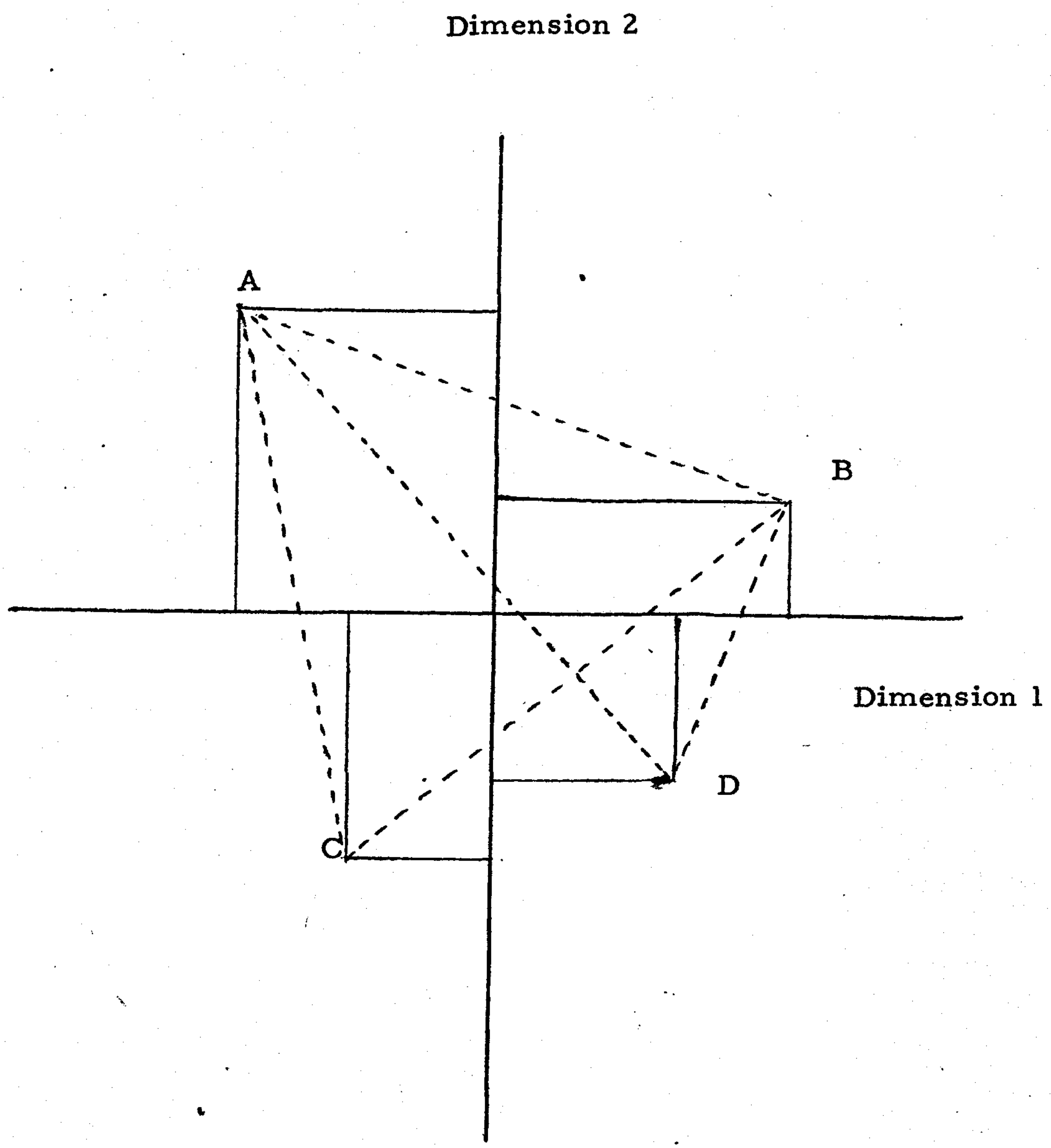

Fig. 1. Distances AB, AC, AD, BC, BD, CD expressed in terms of two dimensions.

recently published (Wish, 1970; Wish, Deutsch & Biener, 1970). Additional information was provided by some internal publications from Bell Telephone Laboratories by Carroll and Chang, Carroll and Wish, and Wish and Carroll.

The procedures implemented by Indscal are part of a method to obtain a multidimensional configuration of stimuli from either similarity or dissimilarity of judgments. While all multidimensional scaling methods yield a geometric configuration of the stimuli as a final result, Indscal additionally provides a way of parameterizing the individual judges. In this respect it is similar to the individual differences model proposed by Tucker and Messick. It differs, though, from the latter in the main assumption and in the procedures to obtain individual differences.

The Indscal method assumes that individual judges perceive the stimuli in terms of a common set of dimensions, but that these dimensions are differentially important or salient in the perception of the various individuals. This assumption is embedded in the spatial model according to the following formula:

$$d_{jk}^{(i)} = \sqrt{\sum_{t=1}^{r} w_{it} \, (x_{jt} - x_{kt})^2} \qquad (1)$$

where:

$d_{jk}^{(i)}$ = is the distance between the jth and kth stimuli for the kth subject (i going from 1 to N)

x_{jt} and x_{kt} = are the coordinates of the jth and kth stimuli on the t axis (t going from 1 to r)

w_{it} = is the weight that the ith subject attributes to the t dimension.

According to this spatial model, the stimuli points are mapped into a space which is common to all the subjects, that is, the r dimensions are the same for all. Individual differences are represented by weights.

From the general theory of multidimensional scaling, it is known that distances and similarity are assumed to be functionally related so that it can be written:

$$s_{jk} = L \quad (d_{jk}) \qquad (2)$$

where:

s_{jk} = similarity score between the jth and kth stimuli

L = some function relating distances and similarities

d_{jk} = distance between the jth and kth stimuli.

The functional link is given by the isomorphism between the properties of the distance in the Euclidean space and the properties of similarity

relation. In particular, similarity is assumed to be symmetrical much in the same way as distance is: if stimulus A is judged to be similar to stimulus B, the same relation could be reversed by saying that B is similar to A. Secondly, in a triangle, one side (or the distance between A and C) cannot be larger than the sum of the two other sides (or the distance between A and B plus the distance between B and C). In the same way, if stimulus A is similar to stimulus B and this is similar in turn to stimulus C, then stimuli A and C should be moderately similar to each other as well. In general, then, the more similar two stimuli are, the more closely they lie in the psychological space. The greater the psychological dissimilarity, the larger the distance will be.

Two further remarks about the general multidimensional scaling theory should be added. The space is assumed to be Euclidean so that the distance between any two points is equal to the square root of the sum of squares of the differences in projections over all orthogonal axes of the space:

$$d_{jk} = \sqrt{\sum_{t=1}^{r} (y_{jt} - y_{kt})^2} \qquad (3)$$

The spatial model in the Carroll and Chang method assumes the space to be Euclidean, although the presence of weights implies a modified

Euclidean space. That the space is still Euclidean, though, becomes evident if the coordinates of each point are expressed in terms of a new variable derived from equation (1) as follows:

$$y_{jt}^{(i)} = w_{it}^{\frac{1}{2}} \; x_{jt} \qquad (4)$$

The second point is that the functional relationship between similarities (or dissimilarities) and distances is assumed to be linear. In other words, the increment of distance as function of similarity is constant all along the range of the function. This assumption might not always be met. It might be that, at the extremes of the function, dissimilarity does not allow fine discriminations and things are "just" dissimilar independently of the degree of their dissimilarity. The Carroll and Chang method makes this assumption of linearity.

The difference between formulas (1) and (3) lies in the presence of weights as well as in the absence of the index (i) in formula (3), indicating that individual estimates of distances have been collapsed into a typical value. Furthermore it indicates that the configuration from formula (3) is contained in a space of r dimensions which are equally important to all subjects. It is useful at this point to compare the Tucker and Messick procedure and the Carroll and Chang method. Both procedures have been

designed to assess individual differences by means of weights; however the way they are obtained is different. In the Tucker and Messick procedure, a matrix of observations with rows representing stimulus pairs and columns representing individuals, is premultiplied by its transpose and the resulting sum of squares and cross-products matrix is subjected to a principal components analysis. The weights are contained in a matrix $_{N}W_{r}$, r being the number of latent roots and N the number of subjects. The elements of this matrix represent projections of points corresponding to individuals on unit-length principal vectors. This phase precedes the analysis of the distances between stimuli. In the Carroll and Chang method, the factor analytic procedure to obtain individual differences is eliminated as unnecessary. Individual differences are given representation in the spatial model into which similarity judgments are fitted.

From another point of view, however, the Tucker and Messick procedure yields group differences as well as individual differences. Group differences are those found between any two points of view: their pattern is formed by the contribution of all judges clustered around the idealized individual. Individual differences are those found within each point of view. Indscal in turn provides information about individual differences only. To obtain group differences, a separate analysis must be carried out.

There is still another aspect of both models which lends itself to comparison. In the Indscal model, weights correspond very directly to the distance estimates of each individual. In the Tucker and Messick procedure, weights correspond to the distance estimates of the "idealized" individual. The "real" individual's estimates are certainly not lost: it is always possible, and sometimes advisable, to recover them. However, Tucker and Messick point out that since much of the error variance is in the original distance estimated by the procedure, the reproduced distance measures should be more stable. This remark emphasizes a characteristic of their method which is highly desirable in certain circumstances, but which implies the removal of information under the label of error variance. When the investigation is focussed on individual differences, the error variance might include valid information.

Data required by the model. The basic data for performing the multidimensional scaling as programmed by Indscal are the judgments of similarity (or dissimilarity) among n stimuli taken in all possible pairs. The first step, then, in order to carry out the analysis is to obtain a score measuring similarity (or dissimilarity) $s_{jk}^{(i)}$. The index, i, in parenthesis, indicates that the judgments from each individual are submitted to analysis without any previous pooling across subjects.

The original data are transformed twice before being analyzed.

Judgments of similarity are transformed into absolute distances $d_{jk}^{(i)}$ and these in turn are converted into scalar products $b_{jk}^{(i)}$. These are standard transformations required by most metric scaling methods (Torgerson, 1958). The first transformation is necessary because similarity judgments are collected in an interval scale which yields relative distances between points. In order to meet the assumptions of ratio measurement, however, absolute distances are obtained by adding a constant. The second transformation automatically builds up a spatial frame of reference and defines and origin in the space. Each stimulus is considered as the end point of a vector starting from this common origin. The interpoint distance is, thus, expressed as the scalar product of these vectors.

The judgments of similarity (or dissimilarity) elicited by each of the N individuals judging n stimuli taken in pairs yield $\frac{n(n-1)}{2}$ different similarity scores $s_{jk}^{(i)}$, which can be visualized as the elements of a solid rectangular parallelogram matrix $n \times n \times N$.

Extraction of individual differences and stimulus loadings. The multidimensional scaling analysis is performed on the matrix containing the scalar products $b_{jk}^{(i)}$ which in terms of the spatial model of equation (1) become:

$$b_{jk}^{(i)} = \sum_{t=1}^{r} w_{it} \; x_{jt} \; x_{kt} \qquad (5)$$

The analysis is described as an N-way generalization of the Eckart-Young decomposition. Applying the theorem proposed by Eckart and Young (1936), a matrix can be approximated by the product of two other matrices of smaller rank. Generalizing the approach, Carroll and Chang presented their method as an approximation of a matrix by the product of n matrices. In this case n equals three. The decomposition into the product of three matrices is required by the spatial model that contains three parameters. The solid matrix B which contains the scalar products is approximated by the product of the following matrices: W containing subject weights, X_L and X_R containing the coordinates of the points in the multidimensional space.

The approximation is achieved by means of a least squares solution. Tucker and Messick in their application of the Eckart-Young theorem allow for the experimenter to determine the degree of approximation as a function of the amount of variance accounted for. In a least squares solution, as proposed by Carroll and Chang, the approximation is the best possible in the sense that the sum of the squared differences between pre-

dicted and empirical values is a minimum. In a summary description of the procedure it can be said that if two parameters out of the three are held constant, a least squares solution yields an estimate of the third parameter. The same procedure can be used holding constant another pair of such parameters and solving for the remaining one. Changing the pair of parameters to be held constant in each iteration, an estimate can be worked out for the other parameter. The process is expected to converge toward a better and better estimate of the three parameters.

More analytically, the decomposition can be described in matrix form. With that purpose equation (5) can be written:

$$z_{ijk} \cong \sum_{t=1}^{r} w_{it} \; x^{(L)}_{jt} \; x^{(R)}_{kt} \qquad (6)$$

where a) $z_{ijk} \equiv b^{(i)}_{jk}$ b) the sign $\cong$ implies a least squares solution for the parameters on the right, and c) the superscripts (L) and (R) have been put on the x's to distinguish the x on the right from the one on the left.

In matrix form equation (6) can be rewritten

$$Z^{*} \cong W \; X_L \; X_R \qquad (7)$$

the dimensions of the matrices being respectively (N x n x n), (N x r),

(n x r) and (n x r). For a least squares solution, any pair of matrices on the right side can be held constant and the third matrix on the same side can be computed. Assuming, for instance, that the estimates of $x_{jt}^{(L)}$ and $x_{kt}^{(R)}$ are given, they can be multiplied and their product substituted to simplify equation (6) in this way:

$$z_{is}^{*} \cong \sum_{t=1}^{r} w_{it} \quad g_{st} \tag{8}$$

where

$$s = n(j-1)+k \quad \text{so that } s \text{ varies from 1 to } n^2$$

$$z_{is}^{*} \equiv z_{ijk}$$

$$g_{st} \equiv x_{jk}^{(L)} \cdot x_{kt}^{(R)}$$

Given the equation in this form, it is immediately apparent that a least squares solution is available for the w's (holding the x's, and thus the g's fixed). In matrix form:

$$Z^{*} \cong W \cdot G^{T} \tag{9}$$

where Z^* is the $N \times n^2$ matrix with entries z_{is}^{*} and G is the

$n^2 \times r$ matrix with entries g_{st}. The least squares solution for W is

$$\hat{W} = Z^* G (G^T G)^{-1} \tag{10}$$

that is, $\hat{W}$ is defined by postmultiplying Z^* by the right pseudo-inverse of G^T.

Having solved for W a better estimate can be achieved for X_L by similar means. Given the new values for both W and X_L the same procedures can be used to estimate X_R. The process can be iteratively repeated time and again until the whole process converges. At each step of this iterative procedure the total error sum of squares is being reduced.

Intuitively, this procedure is one of successive approximations. An arbitrary configuration is given by the initial matrices X_L and X_R which are supplied either by the experimenter or by the computer. In the iterative procedure, the points are moved a little to improve the arbitrary configuration. A configuration is considered an improvement over the previous one if the interpoint distances are closer to the empirical distances. This process is iterated until no further improvement is possible. The iterations can be visualized as the stretching of the distances that are small and the compressing of those that are too large. The final criterion of fitness of the configuration with respect to the empirical data is the

sum of the squared differences between the empirical distances and the distances derived from the model: this sum must be a minimum. The convergence to a minimum which is not simply a local minimum is a standard difficulty in a multivariable function. Experimental work, however, has shown that the particular iterative method used by Carroll and Chang is practically free of such problems.

Spaces resulting from Indscal analysis. For any specified dimensionality, Indscal determines the stimulus coordinates in the space, the subject weights and the unique orientation of axes that account for the maximum of the total variance in the data. This information is contained in two matrices: the matrix of the "group stimulus space" and the matrix of the "subject space". The matrix of the "group stimulus space" contains the coordinates of each stimulus in the r-dimensional space. A configuration of points is the final result of the analysis, each point corresponding to a stimulus. Distances between points reflect the similarities among stimuli. Except for a difference in the orientation of axes and weights of dimensions, the configuration obtained from an Indscal analysis is very similar to that provided by other multidimensional scaling methods using pooled data.

The matrix of the "subject space" yields the weights for each individual. Each judge receives a set of r weights. These can be plotted in a

space called the "subject space". When a set of weights is applied to the dimensions or to the coordinates of the "group stimulus space", a differential stretching and squeezing of the axes occurs. This modified "group stimulus space" can be considered a private space for a particular judge: its coordinates are given by formula (4). The geometric effect of applying weights to the "group stimulus space" can be illustrated by means of the diagram in Figure 3. Assume two points and their coordinates in a bidimensional space: A(2, 2) and B(4, 4) and the initial set of weights is 1 and 1 respectively. The distances between the two points is 2.83. If the weight of 2 units is applied to dimension 1 and a weight of 0.50 to dimension 2, the new coordinates are A(4, 1) and B(8, 2). Both distance and the orientation of the line have changed. Thus the line has been stretched along dimension 1 and has been compressed along dimension 2. A change along dimension 1 will be followed by a relatively smaller change in dimension 2.

The way in which individual differences are "picked up" should be emphasized. While in the Tucker and Messick procedure they are the elaborate result of a factor analysis, in the Carroll and Chang method they are more realistic so to say. In fact they are obtained through what is essentially a standard regression procedure which minimizes differences between predicted and empirical values. In this sense, weights

from Indscal can be said to best represent individual differences in perception in a least squares solution sense.

A multidimensional solution from the Indscal method eliminates the need for rotation. The axes are determined with reference to each individual in the group through a regression approach such that the axes remain fixed when the maximum of variance in the data has been accounted for.

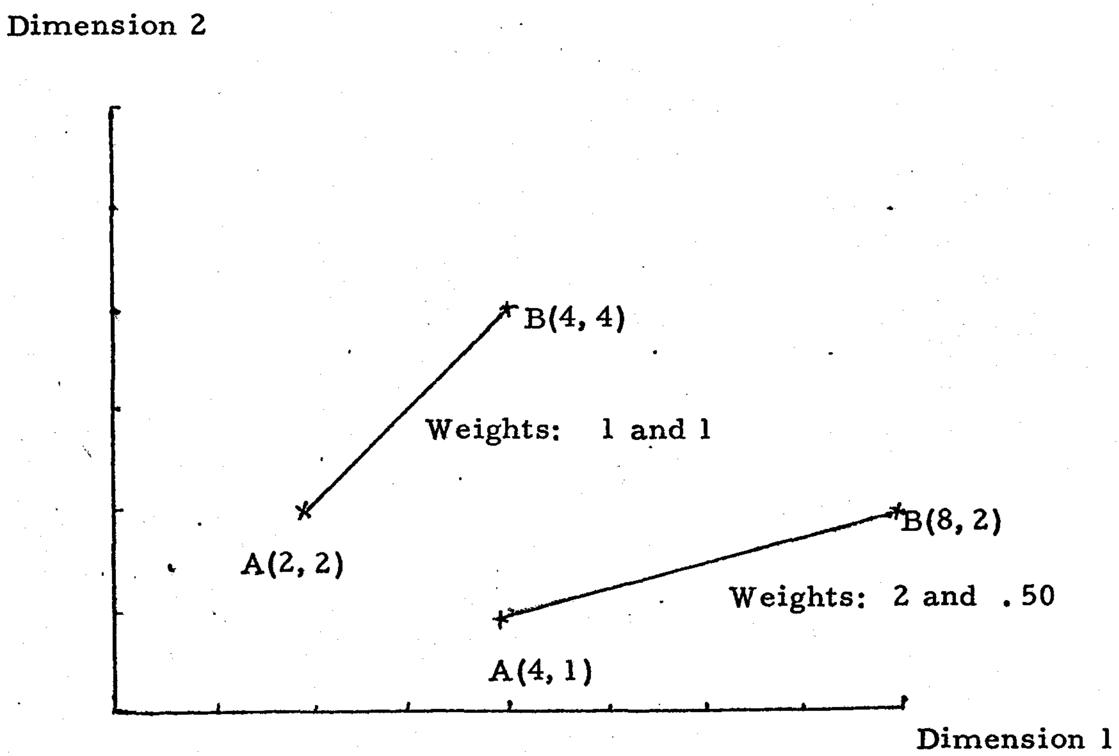

FIG. 2. Effect of weights on line AB

Referring back to Figure 2, it can be seen that since the weights modify the spatial relationships of the points, no rotation would be able to keep the pattern of differential stretching and squeezing of axes invariant. The space is usually interpreted in terms of the axes as they come out of the analysis. Previous research has shown, according to Carroll and Chang, that when an a priori set of physical dimensions exists, the axes discovered by the model correspond in a one-to-one manner to those dimensions.

Previous research using Indscal. The Indscal method has been used mainly in research in which measurements of the type used in psychophysics were available. It has been applied to study cognitive structures in only one published study. Wish, Deutsch and Biener (1970) investigated the differences in conceptual structures or how different people conceive of nations. Judgments of similarity among nations, elicited by judges who were of eight different nationalities, were submitted to an Indscal analysis. Four dimensions were extracted and were interpreted as Political Alignment and Ideology, Economic Development, Geography and Population, and Culture and Race. The weights from the analysis make it possible to identify and typify groups of judges: economic development was more important to "doves", males and subjects from developed countries; whereas the opposite was true for "non-doves", females and subjects from underdeveloped countries. This study, besides its substantive inter-

est, was also methodologically inspired in the sense that it had been designed to test the efficiency of the Indscal procedures in an area in which it had not been tested before and where fundamental measurements were not available.

II. METHOD AND PROCEDURES

Experimental design. In order to appraise the Indscal method of measuring individual differences in person perception, a validity test of the measurements it provides was designed. These measurements would be said to be valid to the extent to which they agreed with the measurements obtained independently in previous research.

As it has been mentioned, the Indscal analysis provides two types of measurements: a) a geometric configuration of the stimuli in the space, and b) the weights each individual assigns to the dimensions of the configuration. Both sets of measurements are generated by applying the same spatial model represented in equation (1). They are strictly dependent on each other in the sense that determining one set implies the determination of the other. Due to this mutual dependence it seems possible to apply a validity test to one set of measurements and to draw some conclusions for both. These conclusions would apply strictly in one case while in the other they must be stated more tentatively.

The validity test involved a comparison between the spatial configuration of stimuli from Indscal analysis and a criterion. If the two configurations agreed, then it may be concluded that the Indscal spatial model provides a valid scaling of the stimuli or, equivalently, that it yields measurements that measure what they are expected to. This qualification would

apply strictly to the measurements contained in the matrix of the "group stimulus space" and would not apply to the measurements of individual differences as contained in the matrix of weights. However, if one set of measurements was verified as valid, then one would feel more confident about the Indscal spatial model as a whole. In turn, this would implement the main purpose for measuring such differences which is the search of their correlates. In fact, more accurate measurements of individual differences would increase the likelihood of discovering personality and cognitive variables that correlate with such differences. The validity test proposed in this study can be illustrated by re-examining two studies that have already been mentioned, from the point of view of the experimental design. In the study by Todd and Rappoport (1964) two models were compared. In order to evaluate the psychological significance of the dimensions they had obtained through the application of the models, the authors used a set of experiments designed to test variations of the hypothesis: "If according to the model, Trait 'x' implies Trait 'y', then given the information that a person-object has Trait 'x' the subject should infer that he also has Trait 'y'". This amounts to fixing an empirical criterion to which they compared the conclusions obtained from the models. The degree of correspondence allowed them to reach specific conclusions about the usefulness of the models. Lay and Jackson (1969) were concerned with

the accuracy of judgments in person perception. They compared trait inferential dimensions to those derived independently from factor analysis mapping the same domain. From this comparison they were able to assess the extent to which inferential relationships are predictive of an empirical trait relationship criterion. The experimental design in both studies included the selection of a criterion and the comparison of the experimental results with the criterion. The strategy adopted in this study is basically similar to that procedure.

Criterion used for the validity test. In the present study the criterion required by the validity test was a well-known cognitive structure. The highly stable five-dimensional structure which has resulted from the studies of Norman (1963), Passini and Norman (1966), Norman and Goldberg (1966), D'Andrade (1965) and Hakel (1969) was chosen to be the empirical criterion for the comparison. There were two reasons for choosing what might be called "Norman's configuration" for brevity's sake. One reason was the fact that this configuration has a fairly well established position in psychology. Another advantage lay in the fact that the configuration is produced by the perceiver almost independently of the person perceived. D'Andrade (1965) suggested that the structure is semantically generated. His suggestion, however, does not deny the contention that the five dimensional structure is partially or wholly attributable to the opera-

tion of the judge. It was felt that using a domain little influenced by a source of variance other than the perceiver would permit a better understanding of the role of the perceiver himself.

In summary, the group space from the Indscal analysis was to be compared to Norman's configuration. The correspondence between the two sets of dimensions was to be interpreted as establishing the validity of the Indscal scaling and enhancing indirectly the metric qualifications of the weights as measurements of individual differences. These, finally, were to be compared to measurements of personality and cognitive variables to exemplify the investigation of correlates of individual differences in person perception.

Stimuli and instruments. The scales Norman used in his study (1963) as well as in his other studies that have been mentioned earlier were the stimuli in the present study. Twenty scales were selected out of the original 40 using the following criteria: a) there was to be an equal number of scales from each pole, 10 from the positive pole and 10 from the negative pole; b) each of the five factors Extraversion, Agreeableness, Conscientiousness, Emotional Stability and Culture was to contribute an equal number of stimuli; two were chosen out of the original four that represented each factor; c) each stimulus was to have the highest saturation in the corresponding factor. With these constraints, 20 stimuli were selected

from the table of factor loadings reported by Norman (1966) in his sample C. The stimuli are presented in Table 1.

The 20 descriptors of personality were compared in pairs. The judge was expected to score the degree of their dissimilarity. All possible pairs of the 20 descriptors were presented to the subjects. There were 190 such pairs. Each stimulus in turn was taken as the standard and the others were compared to it. This way of presenting the stimuli in a pair comparison task has been used before by Klingberg as quoted by Guilford (1954, p. 249). Each subject was given a booklet in which the stimuli, i. e., the descriptors of personality, were printed. To facilitate the identification of the standard stimulus, this was underlined and the variable stimuli were printed next to it. For each pair of standard and variable stimuli there was a graphic scale ranging from 0 ("indistinguishable pair") to 9 ("extremely dissimilar pair"). The order of the "standard" stimuli as well as the order of the "variable" stimuli was established randomly. The instructions were self-explanatory and read as follows:

> If A and B stand for the descriptions of two different persons, you are expected to compare A and B and to measure their dissimilarity on the corresponding scale.
>
> Examples.
>
> A. Comes out readily with his real feelings on various questions so that you know where you stand with him. Expresses his feelings, sad or gay; easily and constantly. Easy to understand.

TABLE 1

20 STIMULI SELECTED OUT OF 40 SCALES USED BY NORMAN (1963)

Factor	Positive pole	Negative pole
Extra-version	Talks a lot, to everybody	Says very little; gives the impression of being occupied with thoughts.
	Likes to be in large groups. Seeks people out for the sake of company. Likes parties as often as possible. Not fond of being alone.	Does not miss company. Goes his own way
Agreeableness	Does not mind when people use his property, time or energy. Generous, gives people "the benefit of doubt" when their motives are in question. Warm-hearted.	Gets irritable or resentful if property or other rights are trespassed on. Inclined to be "close" and grasping. Is generally surly, hard and spiteful.
	Gentle-tempered. Blames himself (or nobody) if things go wrong.	Goes his own way regardless of others. Blames others, not himself, whenever there is conflict or things go wrong. Headstrong. Predatory, tends to use other people for his own ends.

Factor	Positive pole	Negative pole
Conscientiousness	Has a sense of responsibility to his parents, community, etc. Can be depended upon to be loyal to agreed standards, trustworthy.	Does not take responsibilities seriously. Undependable. Thoughtless. Refuses to accept responsibilities of his age.
	Sees a job through in spite of difficulties or temptations. Strong-willed. Persisting in his motives. Painstaking and thorough.	Gives up rather easily. Led astray from main purposes by stray impulses. Slipshod. Does not finish a job thoroughly.
Emot. stability	Calm, tough. "What's the fuss about?" attitude.	Worries constantly, sensitive, hurried; seems to suffer from more anxieties than other people. Slight suppressed agitation most of the time.
	Self-possessed, hard. Does not lose composure e. g., through emotional provocation.	Easily embarrassed or put off balance in conversation. Gets confused in emergency. Blushes, shows excitability, becomes incoherent. (Not general emotionality, but momentary "nervousness").
Culture	Artistically sensitive to surroundings. Fastidious, not too easily pleased.	Not showing artistic taste. Not interested in artistic subjects. Insensitive to esthetic effects.
	Has wide interest and knowledge, especially in intellectual matters. Enjoys analytical, penetrating discussions in small groups.	Rather ignorant. Unreflective. Does not read much or enjoy intellectual problems. Narrow, simple interests.

B. Keeps his thoughts and feelings to himself. Often leaves you puzzled as to the motives of his actions. Inscrutable. Does not give away information for the fun of it.

indistinguishable pair   0 1 2 3 4 5 6 7 8 (9)   extremely dissimilar pair

B. Careful about principles of conduct. Guided by ideals, ethics, unselfishness. Scrupulously upright where personal desires conflict with principles.

indistinguishable pair   0 1 2 3 (4) 5 6 7 8 9   extremely dissimilar pair

B. Rushes in carefree fashion into new experiences, situations, emergencies. Ready to meet anything; happy-go-lucky. Has a great appetite for life.

indistinguishable pair   0 (1) 2 3 4 5 6 7 8 9   extremely dissimilar pair

On the first scale a score of 9 indicates that the pair is extremely dissimilar. Actually person B is exactly the opposite of person A.

On the second scale a score of 4 indicates that the two persons are not completely dissimilar.

On the third scale a score of 1 indicates that A and B form an almost indistinguishable pair: they are almost similar at least in some respect.

Obviously your scores may be different from ours. That is the point. We are interested in the individual differences in how we perceive others. Accordingly please score every pair of A and B on the degree of dissimilarity as you see it. You can use any number between 0 and 9. A high number indicates great dissimilarity. A number close to 0 indicates little dissimilarity.

Together with the booklet containing the scales for the dissimilarity judgments, each subject received another booklet with scales on social

desirability (Crowne & Marlowe, 1967), on authoritarianism (Adorno, Frenkel-Brunswick, Levinson & Sanford, 1950) and the Role Construct Repertory Test (REP) in the modified version developed by Bieri (1966).

Subjects. The sample included 37 females as judges, all from the Chicago area. They were heterogeneous with respect to age, marital status, education and major field of interest. Table 2 reports their individual differences along these variables. The age ranged from 19 to 59 years (mean = 29.27). With one exception, they all had MA, BA, BS degree or completed from 1 to 3 years of college. Their fields of major interest included English, education, mathematics, history, political science, phylosophy, music, design, chemistry, physical therapy and sociology.

Judges were contacted either personally by the experimenter or through common friends. They were invited to participate in research on person perception. Upon acceptance, they were given the booklets containing the scales and were referred to the self-explanatory instructions that accompanied each scale. No limits of time were imposed, rather they were encouraged to work at their leisure, in their spare time and to take as many breaks as they thought convenient. The booklets were picked up at a prearranged time. Judges were thanked either personally or by mail.

III. ANALYSIS AND RESULTS

The analysis was carried out in three steps: a) the multidimensional scaling, b) the comparison with Norman's configuration, c) the correlation of the weights with the individual measurements on authoritarianism, cognitive complexity and social desirability.

Indscal multidimensional scaling. The 20 x 20 x 37 matrix of dissimilarities was submitted to Indscal analysis. This analysis is started by providing the number of dimensions on which the configuration of stimuli is to be built. Different numbers of dimensions can successively be used and the results can be compared. The amount of variance accounted for constitutes the criterion for judging the satisfactoriness of one solution as compared to another. The analysis was performed on 3, 4, 5 and 6 dimensions. The amount of variance accounted for using each dimensionality respectively was 49.6%, 54.8%, 57.8% and 59.5%. These results have been plotted in Figures 3 and 4. For each dimensional solution on the abscissa, there is a corresponding percentage of the variance accounted for on the ordinate. Inspection of Figure 3 suggests that the solution in six dimensions accounts for the largest amount of variance. However, the increase of variance accounted for is only 1.7% with respect to the amount explained by a five dimensional solution. This amount is small in itself and also relatively to the increase that is achieved by going from a solu-

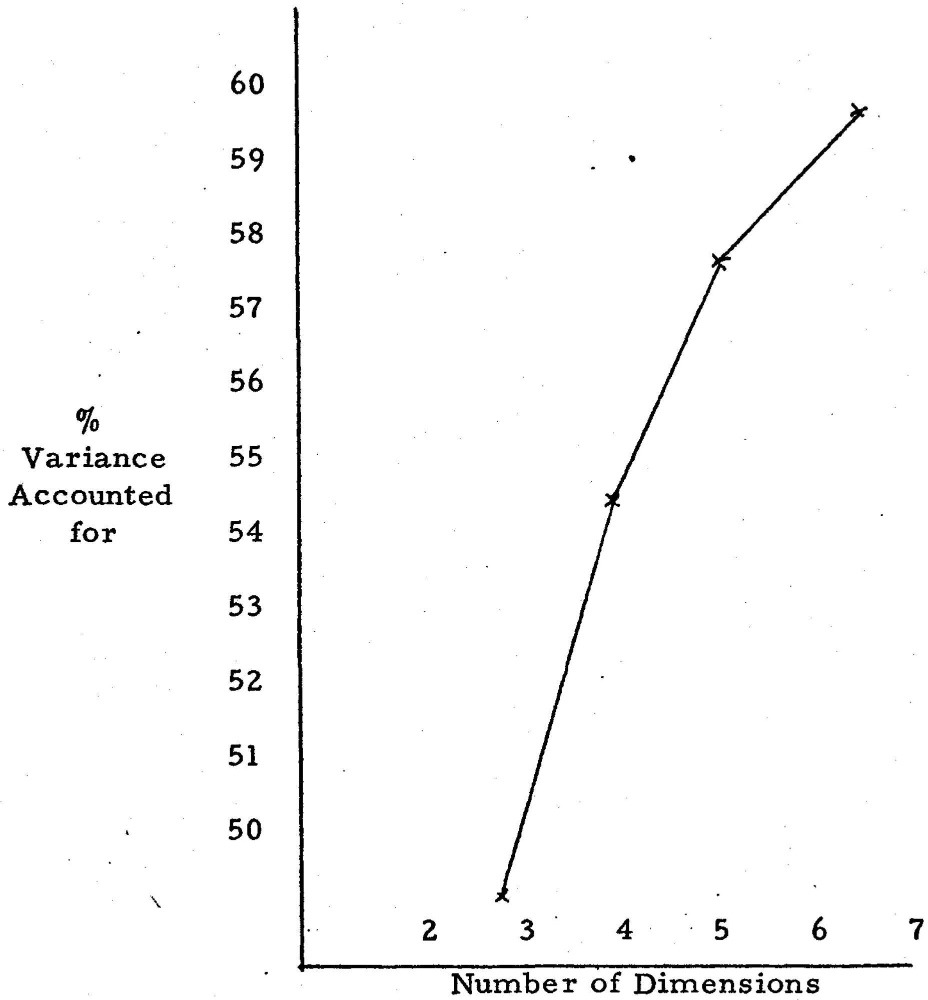

FIG. 3. Number of dimensions versus cumulative percentage of variance accounted for.

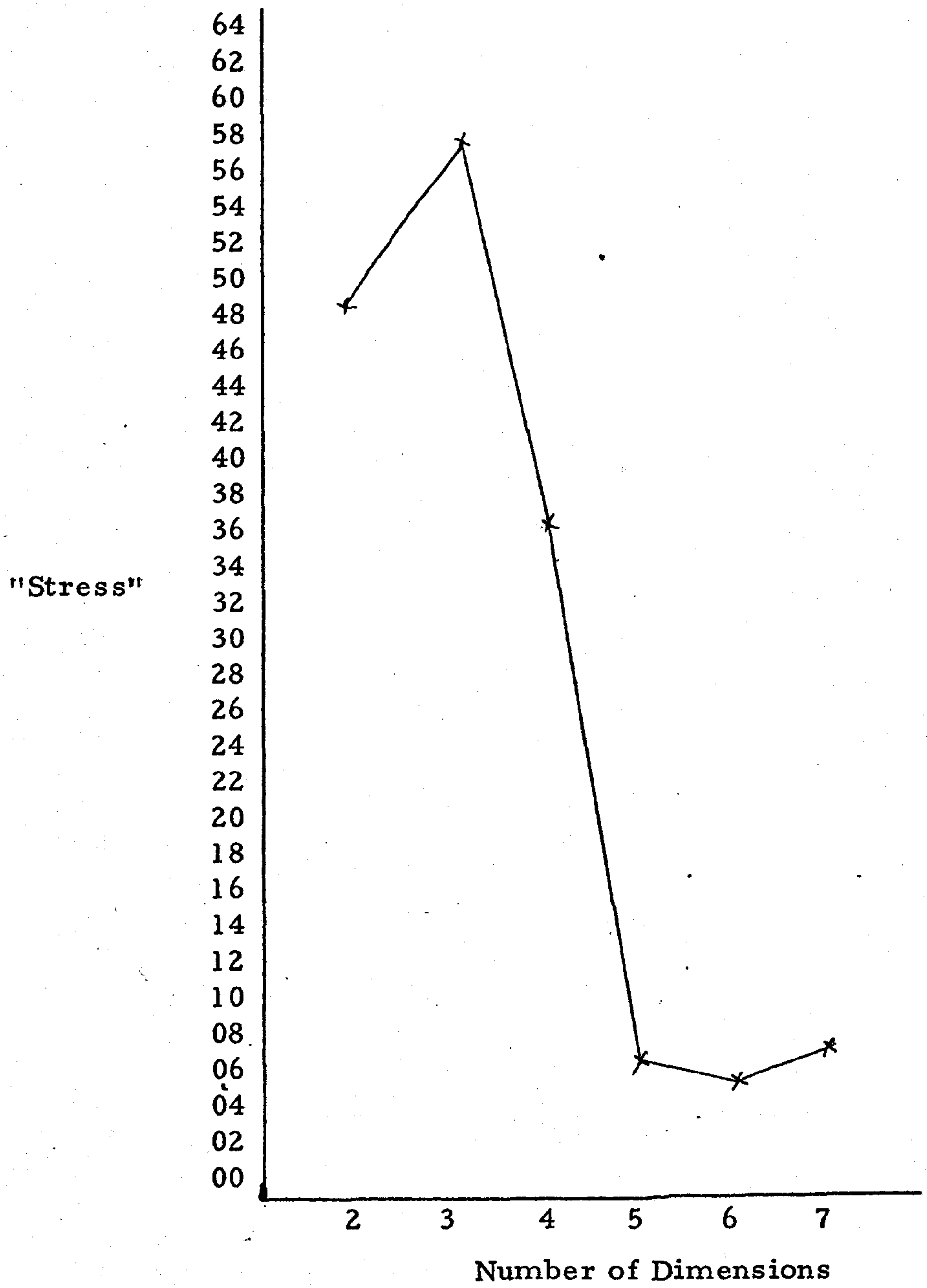

FIG. 4. Number of dimensions versus "stress" in Kruskal's multi-dimensional analysis.

tion of four dimensions to one of five (3% and 5.2% respectively). In the absence of an adequate test of significance, it was decided somewhat arbitrarily that five dimensions were necessary and sufficient to map satisfactorily the domain. While 57.8% of the variance might not be fairly high, it is within the range usually achieved by Indscal analyses.

That five was the correct number of dimensions was confirmed by performing a Kruskal's multidimensional scaling (1964). The matrix of the original scores was collapsed into another of 20 x 20 by pooling the scores across subjects. This matrix containing "average" judgments of dissimilarity was submitted to Kruskal's analysis. The adequacy of a solution is indicated by a measure of goodness of fit called "stress" which is essentially a measure of the percentage of unaccounted for variance. Figure 4 contains the plot of the number of dimensions against the "stress" for each solution. According to Kruskal "stress" values between 10% and 5% are in the "fair" to "good" range. Using the 10% criterion as the minimally acceptable value, the solutions up to the solution in five dimensions are clearly unsatisfactory. The "stress" for the solutions in 5, 6, 7 dimensions is respectively .087, .075, and .097. Since the difference between the "stress" in the three solutions does not exceed .012, little improvement in fit is achieved by adding more dimensions beyond the five basic ones.

The matrix of loadings on the five factors of the "group stimulus space" is presented in Table 3. In this table the labeling of the stimuli and the clustering follow the conventions adopted by Norman (1963, 1966). The stimuli that define a factor are clustered forming units that facilitate inspection. Also, in order to facilitate the comparison between Indscal and Norman configurations, the scales were made equivalent. Indscal loadings range from -.50 to .50. This is the range of the random numbers used by the computer program to build up the initial distances among the stimuli. The loadings obtained in factor analysis, on the other hand, range from -1.0 to 1.0. For comparability purpose Indscal loadings were given the same range by multiplying them by 2. This amounts to a linear transformation of the scales that keeps invariant the information they contain.

Comparison with Norman's configuration. In order to compare Indscal "group stimulus space" and Norman's configuration, it is necessary to recall that the latter is a close approximation to the criterion of simple structure. Keeping in mind that a configuration of n vectors and m axes is equivalent to a factor matrix of n rows and m columns, a simple structure has basically the following characteristics: a) each row has one or more zeros, b) each column has m or more zeros. The Indscal configuration as contained in the factor matrix of Table 3 clearly does not

TABLE 3

FACTOR LOADINGS FROM INDSCAL ANALYSIS

Abbreviated label for stimuli	Factor	Dimensions				
		I	II	III	IV	V
Talkative	Extraversion	58	42	44	14	-36
Silent		-50	-54	-26	-20	38
Sociable		68	-40	36	-04	-26
Reclusive		-52	-48	-52	-32	14
Good-natured	Agreeableness	70	-32	24	-16	40
Irritable		-52	52	-24	50	-34
Gentle		34	-56	28	-26	58
Head-strong		-46	-50	-42	-12	-50
Responsible	Conscientiousness	60	-12	-26	64	36
Undependable		-32	34	50	-78	-58
Persevering		28	-20	-66	-66	08
Quitting		-46	30	74	-60	-16
Calm	Emotional Stability	34	10	-56	-74	-04
Anxious		-38	-32	54	68	24
Composed		08	26	-74	-20	-24
Excitable		-36	-46	64	12	38
Artist. sens.	Culture	-02	-70	-04	56	-80
Artist. insens.		-14	-58	-02	-14	76
Intellectual		48	-48	-18	22	-64
Narrow		-34	-66	18	-34	60

Note. - Decimal points omitted.

show the patterns of zeros of a simple structure and it is not similar to Norman's configuration.

A varimax rotation was carried out on the Indscal solution. Table 4 shows the loadings on the rotated factors. In this table the labeling of the stimuli has been omitted. The order of the stimuli and the clustering of the defining variables are exactly the same as before in Table 3. Table 4 shows that Norman's configuration is represented only by 10 stimuli selected in the way that has been mentioned previously. Each defining cluster contributes two stimuli. The table indicates that for each stimulus from Norman there are two Indscal stimuli, one corresponding to the positive pole and the other to the negative pole. The sequence of the signs in the defining clusters follows the order of the stimuli from the positive and negative poles.

Under these provisions, a comparison between Indscal and Norman's configuration is based on clear-cut results. The varimax rotation achieved a very close approximation to an orthogonal simple structure. Each cluster of stimuli defining a factor possesses a set of loadings that are clearly differentiated along the rows (values approximating 1.0 in one dimension and vanishing values on the other dimensions) as well as down the columns (values near 1.0 for the defining variables and values close to zero for the other stimuli). The point to be emphasized is that the simple structure

TABLE 4

FACTOR LOADINGS FROM INDSCAL ANALYSIS AFTER VARIMAX ROTATION AND FROM NORMAN'S FACTOR ANALYSIS

Clusters of stimuli	Pole	Dimensions I		II		III		IV		V	
	P	96	90	-02	02	-10	-02	02	04	06	00
Extra-	N	-88		16		00		-08		-06	
version	P	86	86	18	01	-10	-18	18	-01	04	-02
	N	-92		-04		-04		20		06	
	P	22	17	86	80	18	17	04	12	-02	07
Agreea-	N	-06		-96		12		-16		-06	
bleness	P	20	20	92	80	04	27	-14	19	-08	10
	N	08		-84		-24		38		-02	
	P	24	-03	26	32	92	86	-08	08	04	18
Conscien-	N	20		-20		-114		20		00	
tiousness	P	-10	-05	-14	28	47	74	10	-12	26	27
	N	18		02		-100		-16		-26	
	P	-12	06	20	21	-10	-10	96	82	-08	-07
Emotional	N	-08		-04		22		-108		06	
Stability	P	-10	13	-36	06	18	16	64	71	02	24
	N	18		26		-28		-88		10	
	P	-08	-04	-22	08	18	39	-30	-10	-112	75
Culture	N	-02		22		08		02		-98	
	P	18	-04	08	05	22	47	18	04	90	74
	N	-02		-08		-28		-02		-98	

Note. - Decimal point omitted.

achieved by a varimax rotation on the Indscal solution is substantially identical to the simple structure obtained by a similar rotation on the solution from factor analysis.

Pearson product-moment correlation coefficients were computed between Indscal loadings on the rotated factors and the loadings from the criterion configuration. Within each dimension, the stimuli coming from the positive pole of Norman's scales were correlated independently of those derived from the negative pole. These two correlation coefficients were expected to be essentially of equal magnitude but of different sign. Table 5 shows the correlation coefficients between factors of both configurations. This comparison was intended to confirm the identification of factors based on inspection of the two sets of values. A multiple R was also computed for each factor of Norman's configuration to see the extent to which Indscal values were predictive of the criteria variables. A high R was interpreted as indicating overlapping of the two domains. The Rs are reported in the last column of Table 5: all of them are above .90. The fact that one R was not statistically significant was due to the very small number of degrees of freedom present.

Based on the clustering of stimuli in terms of the loadings as well as in the correlations just reported, the factors of the rotated configuration were confidently identified as Extraversion, Agreeableness, Conscientious-

TABLE 5

CORRELATION COEFFICIENTS OF INDSCAL SCALE VALUES FROM THE SOLUTION AND THE LOADINGS FROM NORMAN'S CONFIGURATION

		Norman's Dimensions					Multiple
		I	II	III	IV	V	R
Indscal Dimensions	I	91***	-32	35	06	35	92
		-92***	-02	-48	05	27	98**
	II	-49	94***	-04	26	-33	98**
		38	-76*	12	-27	40	95*
	III	-75	04	66*	27	54	99**
		41	23	92***	-44	-33	97**
	IV	-03	-18	18	-89***	-41	94
		44	18	-21	91***	48	99**
	V	-39	-21	-12	19	97***	97**
		34	46	25	-36	-95***	99**

Note. - Decimal points omitted

* $p < .05$

** $p < .01$

*** $p < .001$

ness, Emotional Stability and Culture.

The factors of the unrotated configuration could now be identified as combinations of the rotated factors. Thus, the stimuli with the highest loading on the first factor are good-natured-irritable, sociable-reclusive, responsible-undependable. They define a factor which combines the psychological traits (Norman's factors) of Extraversion, Agreeableness and Conscientiousness. Factor II is a combination of Culture (artistically sensitive-artistically insensitive, intellectual-narrow), Agreeableness (gentle-headstrong) and Extraversion (talkative-silent). Factor III (persevering-quitting, composed-excitable) and Factor IV (responsible-undependable, calm-anxious) are two different combinations of Conscientiousness and Emotional Stability. Factor V (artistically sensitive-artistically insensitive, intellectual-narrow) is the purest counterpart of Norman's factor Culture.

Individual weights and correlates.

The matrix of individual weights as they came out of the analysis is presented in Table 6. Each subject (along rows) is characterized by a set of five weights. Means and standard deviations of the weights along each dimension are reported at the bottom of each column. The higher the mean, the more important the dimension was for the subjects as a group. The dimension that was more important on the average was Extraversion-

TABLE 6

MATRIX OF INDIVIDUAL WEIGHTS FROM INDSCAL ANALYSIS

Subject	I	II	III	IV	V
01	64	39	07	23	18
02	45	24	17	38	17
03	33	29	32	36	26
04	40	29	30	31	26
05	39	37	43	25	27
06	33	53	43	21	18
07	37	24	42	26	26
08	39	29	33	19	25
09	51	29	34	26	20
10	51	37	47	13	18
11	25	40	39	30	12
12	48	30	43	27	11
13	18	44	29	18	23
14	45	47	20	24	29
15	61	22	25	08	20
16	46	33	45	26	17
17	33	43	47	14	16
18	56	43	31	16	12
19	59	20	29	24	07
20	39	48	35	28	11
21	35	29	54	18	25
22	39	45	37	04	19
23	38	48	39	28	19
24	62	26	31	17	24
25	42	27	28	22	37
26	40	21	44	33	19
27	51	39	20	37	29
28	39	27	32	18	21
29	40	41	32	07	28
30	48	30	30	22	27
31	34	41	24	31	25
32	61	28	25	26	24
33	58	33	28	22	19

TABLE 6 (Continued)

MATRIX OF INDIVIDUAL WEIGHTS
FROM INDSCAL ANALYSIS

Subject	I	II	III	IV	V
34	19	38	34	37	20
35	47	38	24	20	21
36	47	34	18	27	13
37	50	33	36	10	21
Mean	44	35	33	23	21
S. D.	11	09	10	08	06

Note. - Decimal points omitted.

Agreeableness-Conscientiousness (the combination of three Norman's factors). Culture is the dimension that has less weight. The dimension which provided more individual differences as judged through the dispersion of weights was Factor I again. The least discrimination was provided by Culture.

These sets of weights were compared to independent measures of authoritarianism, cognitive complexity and social desirability. The multiple R was interpreted as indicating the extent to which weights or individual differences are predictive of personality variables. There was no significant correlation with individual measurements of authoritarianism and cognitive complexity. However, the multiple correlation coefficient for social desirability was .59 ($F = 3.274$; df 5, 31; $p < .05$). Table 7 presents the correlation coefficients between the personality variables and the Indscal weights. Subjects who depended most on Factor I (combination of Extraversion, Agreeableness and Conscientiousness) were those with the highest need for approval.

TABLE 7

PEARSON'S CORRELATION COEFFICIENTS OF INDSCAL WEIGHTS AND SOME PERSONALITY AND COGNITIVE VARIABLES

Personality and cognitive variables	Weights - Dimensions					Multiple
	I	II	III	IV	V	R
Authoritarianism	.025	-.015	-.026	-.100	.003	.100
Social Desirability	.536***	-.197	-.097	-.055	.004	.588**
Cognitive complexity	-.182	-.014	.142	-.122	.153	.303

** $p < .05$
*** $p < .001$

IV. DISCUSSION AND CONCLUSIONS

The present study was undertaken to arrive at an empirical appraisal of the Indscal multidimensional scaling method for use in the area of person perception. The interest was spurred by the lack of personality and cognitive correlates of these differences, a fact that has emphasized the need for refinements in the tools of measurement. The appraisal of the method was conceived as a validity test to be applied to the Indscal scaling. A comparison was carried out between the multidimensional configuration of the stimuli obtained through the Indscal analysis and a well-known spatial configuration of the same stimuli.

Validity test

High correspondence and similarity was found between the two configurations. Before presenting specific conclusions based on this correspondence it is best to make several comments about the method of making this comparison.

Rotation. Both configurations were compared at the stage of a varimax rotation. Norman's configuration of five orthogonal factors was obtained through factor analysis with a varimax rotation. This rotation is usually performed in order to obtain a psychologically meaningful solution. From another point of view, a varimax rotation can be looked upon as a means to bring a solution to a well defined form in mathematical sense or to what is

called a canonical form (Harman, 1968). In this sense, a varimax rotation was performed to obtain a common frame of reference in order to compare Indscal and Norman's solutions. If two configurations are each brought to a canonical form, it is possible to check their equivalence. The pre-rotation matrices may look different, but if they are truly equivalent, they will be identical when each is brought to the same canonical form. Indscal configuration was rotated and compared to Norman's. In the comparison they were found to be essentially identical.

Restrictions for rotating. Indscal method has been proposed as having the characteristics of eliminating the need for rotation. Thus the interpretation of factors is generally carried out in terms of the loadings as they come out of the analysis. This seems true much in the same sense that the principal axes method of factor analysis is said to give a unique solution. This uniqueness is originated by the fact that a solution is achieved through the extraction of the largest possible amount of variance from the variables. In this respect the Indscal scaling method is related to the other methods of multidimensional scaling as the principal axes method is to the other methods of factor analysis. However, it seemed a legitimate procedure to rotate the configuration either to reduce it to a canonical form or to get a lead for identifying the factors. The reason is that this rotation keeps the spatial relationships of the configuration in-

variant. This would not be the case if the corresponding rotation-transformation were applied to the matrix of weights. A change in the weights that are assigned initially to the dimensions would result in a configuration being modified in such a way that the original distances among the stimuli would be distorted. In this study, the "group stimulus space" was referred to as it came out of the analysis and the corresponding matrix was rotated only to facilitate a comparison. No rotation was carried out on the matrix of weights.

Conclusions from the validity test

The conclusions that can be derived from the high correspondence and similarity of the two configurations must be broken down into two separate qualifications of the Indscal measurements. It has been shown that the Indscal method performs two types of scaling simultaneously: a) it gives the scale values of the stimuli along the n dimensions of the geometric configuration and b) it scales the individual judges, or equivalently, it measures the individual differences through sets of weights. Since the conclusions that apply to the scaling of the stimuli are different from those that are applicable to the scaling of the individual differences, these two scalings are discussed separately.

With respect to the scaling of stimuli. The validity test that was conducted permitted the conclusion, it seems, that the Indscal scaling of

the stimuli constitutes a valid measurement. In test theory a measurement is said to be valid when it measures what it is supposed to measure as shown through a comparison with an independent criterion. Indscal scaling reproduced Norman's configuration which is a description of a particular cognitive structure. Consequently it seems that it can safely be concluded that Indscal yields valid measurements of that structure.

Norman's configuration was taken as the empirical criterion for the validity test. Indscal scaling of the stimuli is a valid measurement to the extent to which it is similar to the criterion. The conclusion is drawn in terms of the so-called concurrent validity. Todd and Rappoport (1962) examined the capacity of two models for describing a cognitive structure: since the descriptions from the two models were similar, both methods were said to have convergent validity and the cognitive structure to be invariant across methods. Similarly, it can be said that Norman's configuration is highly invariant across methods, including now Indscal, and that Indscal scaling shows convergent validity with factor analysis for describing cognitive structures.

With respect to weights. Strictly speaking, the validity test applies to the scaling of the stimuli and does not apply to the weights which carry the individual differences. If the scaling of the stimuli is a valid measurement it does not follow that the scaling of individual differences is valid too.

However, it has been pointed out that both scalings are generated by the same spatial model in a single measuring application. Both are mutually dependent so that the determining of one set entails the determination of the other. The fact that the scaling of the stimuli has been shown to be a valid measurement enhances the metric qualifications of the scaling of the individual differences. This enhancing might generate nothing more than a certain amount of confidence for using it. However, the implications of such a confidence are relevant and worth being developed. In fact, any set of numbers obtained through a scaling of some sort could be said to measure individual differences. Indscal weights might not be any better than those obtained by applying a Points of View Analysis: each point of view produces a matrix of individual weights which can be rotated and new sets produced. It seems that almost any set of numbers could be used for parameterizing individual differences. However, a validity test such as the one carried out here, would enhance the psychological significance of the measurements provided by Indscal because it offers an approximation of a criterion of validity. Indscal weights then could be said to be anchored in measurements that have been shown to be valid, or, in other words, they have a greater psychological significance than another set of measurements lacking such anchorage.

Individual differences

After discussing the methodological issues connected with the Indscal measurements, the discussion is next centered on the substantive issue of the individual differences themselves.

Their existence. Considerable individual differences were found in judgments of dissimilarity among the pairs of personality descriptors. According to the operational definition of person perception, these are differences in the way subjects perceive the others. The results confirm the conclusion reached by Walters and Jackson (1966) who established the existence of group and individual differences in trait implication. They also are in agreement with Kelly's corollary of individuality which states that individuals differ from each other in the way they construe the events.

The whole effort to demonstrate individual differences in person perception might stir associations with the fable about the huge mountains shaking and laboring mightily to finally give birth to a tiny rat. Descriptive methods, without recourse to elaborate mathematical models, are available and they fulfill practical purposes more effectively than long, expensive analyses such as Indscal. However, this method as well as similar methods, add a predictive rule to their descriptive power. On the basis of the Indscal spatial model, individual differences are not only adequately described, but they can also be predicted.

Their origin. These differences are due to the perceiver. Studies

such as Norman's indicate that the content and organization of traits may almost wholly hinge on the observer's categories or dimensions. The stable, generalized five-dimensional personality structure can be explained on the basis of a shared implicit personality theory. This approach emphasizes the contribution of the perceiver to person perception. It also emphasizes what all perceivers have in common. However, individual differences among judges occur, but these, it is commonly claimed, occur as a function of the object person and the particular situation; for instance a woman who is one's mother or a business situation as opposed to a casual context. Accordingly, if the variance due to the attributes of the stimulus person as well as to the nature of the interaction situation is experimentally reduced to a minimum, one would not expect individual differences. The results of this study seem to suggest that individuals differ in their perception of others even though the variance due to the stimulus person and to the situation was minimized.

Their nature. In the Indscal analysis, individual differences are not expressed in terms of the number and/or the nature of the dimensions. These are assumed by the spatial model to be common to all the judges. Individual differences are expressed in terms of weights assigned to each dimension. Weights incorporate the possibility that an individual does not give equal credibility, importance or attention to all the items of informa-

tion made available to him. For instance, a trait referring to cognitive assets of personality may be of greater importance than some other trait more closely connected with interpersonal behavior. Consequently, individual differences that are contained in the weights reflect the different degress of credibility, importance and attention on the part of the judges.

Correlates of individual differences

The conclusions from a previous section showed the psychological significance of the Indscal measurements of individual differences in person perception. The importance of those conclusions lies in the fact that an improved tool of measurement is now available in the search for correlates of those individual differences. Reliable personality correlates other than those strictly related to general cognitive characteristics have been difficult to find. Whether this failure should be attributed to a real lack of correlates or to shortcomings in the tools of measurement has not been determined. A refinement in measurement would help extricate these issues. In order to exemplify the search for correlates, the correlation between individual differences and some personality variables was studied.

In the correlational analysis the Indscal weights were the independent variables or the predictors. Authoritarianism, cognitive complexity and social desirability were the dependent variables. They were chosen among those variables that previous research showed to be more closely

connected with person perception.

The authoritarian traits of the perceiver have been shown consistently to affect person perception. In the present study no significant correlation was found between scores on authoritarianism and individual differences. One reason for this might be that the studies showing the effect of the authoritarian personality included the interactions between traits of the judge and the traits of the stimulus person. Some differences in the attribution of weights are evident only when a particular kind of people is described. For instance, the pattern of trait implications might be different when authoritarian people judge other people high on authoritarianism. In this study, as it was pointed out, the source of variance due to the characteristics of the perceived person was reduced to a minimum.

Scores on cognitive complexity were also correlated and they did not covary significantly with individual differences. Such covariation, however, could not have been expected since cognitive complexity entails differentiation in terms of the number of dimensions which in the Indscal situation is assumed to be constant and common to all the judges. Other measures of cognitive complexity, such as the standard deviation of the judgments for each subject, were not used. The use of the standard deviation, in particular, was objected to on the basis of ambiguity of the results: in fact, Shrauger and Altrocchi (1964) have pointed out that high

scores would be obtained just as readily using only the extremes of the scales as by making fine distinctions along the entire continuum.

A statistically significant correlation was found between the weights and the scores obtained from the scale of social desirability. The term social desirability refers to a biasing factor which has been shown to be operative in responses to personality inventories. Its outstanding characteristic is the tendency of the individual to evaluate himself in socially desirable terms. Social desirability is operative in situations requiring self-evaluation; however, it has been demonstrated that it reflects an habitual pattern or style of self-evaluation which the person brings forth to the test situation. The scores on social desirability correlated highly with the weights on the first dimensions, which, in terms of Norman's factors, was a combination of Extraversion, Agreeableness and Conscientiousness. This covariation can be interpreted as indicating that people who are high scorers on social desirability are particularly sensitized to traits connected with that combination of factors. Although the nature of the link between social desirability and the individual differences along Dimension I is interesting in itself, its study was not pursued further since the emphasis was simply on exemplifying the research. The main point seems to be that a refinement in the way of measuring individual differences may represent a breakthrough in the search for correlates.

General conclusion

Summarizing the whole study: Indscal scaling provided measurements of individual differences in person perception which were anchored on valid measurements of a cognitive structure. They were used to investigate some correlates of such differences. The results showed that the Indscal multidimensional scaling method can be used to advantage to study the determinants of individual differences in person perception.

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APPROVAL SHEET

The Dissertation submitted by Tulio Ferisin has been read and approved by members of the Department of Psychology.

The final copies have been examined by the director of the Dissertation and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the Dissertation is now given final approval with reference to content and form.

The Dissertation is therefore accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

May 24, 1971
Date

Homer H. Johnson Ph.D.
Signature of Advisor