A Technique for the Development of Strategies for Attitude Change:
Multidimensional Scaling of Sex-Role Concepts

by

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FOR ATTITUDE CHANGE: MULTIDIMENSIONAL

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THESIS ABSTRACT

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This study utilizes metric multidimensional scaling (MMDS) and provides a descriptive comparison of three groups of university students who are different with respect to their self-image and sex-typed attitudes. The subjects were given a packet containing two questionnaires. The first contained all possible pairs of 14 sex-role concepts and the concept self or "me". A criterion pair of concepts was provided and subjects were asked to judge the degree of similarity of each of the 105 pairs. The judgments required were abstract in that definitions were not provided and subjects made the judgments on the basis of their own perceptions of similarity. Similarity of concepts here means the psychological distance which separates two concepts: the smaller the distance, the greater the similarity.

The second questionnaire (Bem's Sex Role Inventory) was designed to categorize individuals into feminine, androgynous, and masculine groups. Scaling the judgments for the first questionnaire in a multidimensional space by means of Galileo 3.0 (a CDC 6000 FORTRAN IV program from Michigan State University) provided a means of comparing the three groups. From this comparison a procedure was developed using vector analytic techniques and linear programming in the determination of message strategies and with

the objective of producing attitude change.

In each of the three groups, three dimensions accounted for 70% or more of the real variance explained, and Poor's Index of Invariance revealed structural significance between the three groups ($p < .005$). Further analysis with Student's t revealed that, while the overall structures were highly similar, the location in space of the self-concept was significantly different across the sex-typed groups ($p < .001$). The structures were independently factor analyzed with Van de Geer's principal components factor analysis, and the resulting spaces were orthogonally rotated with a least-squares rotation to congruence.

Attitude change was conceptualized as the intervening variable that mediates between reception and response tendencies, and operationalized as the relocation in space of the self-concept. A theoretic parallel is drawn between the introduction of messages and the concomitant introduction of cognitive forces consistent with the information processing paradigm. These forces are conceptualized in vector analytic terms. Linear programming is applied in an effort to suggest which content variables are to be used in the optimal message strategy and the relative emphasis to be given each variable. A pilot application of the model is applied with the objective of determining the optimal message strategy for changing the masculine group's self-image so that it is consistent with the androgynous group's self-image.

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H. C. De Leo

CHAPTER 1

Introduction

The Problem

The problem which this study confronts is that of developing a procedure utilizing metric multidimensional scaling which can provide insight into the collective cognitive structure of a group which holds certain beliefs or a set of attitudes. From that structure relationships can be discerned which might be useful in the development of message strategies designed to change the attitudes. Further, the study proposes to define the specific strategy alternates for changing a group's attitudes on sex-typed behavior.

There are three major aspects of this problem. First, the concepts which are to be scaled must be representative of the beliefs or attitudes of the subgroup or subgroups which are engaged in the scaling. Second, at least two groups which are different with respect to some a priori operational definition must be selected in order that there be a basis for comparison of the scaled concepts. And third, message strategies must be suggested by the procedure. As a solution to this problem, this study proposes to develop a package for the social scientist interested in researching attitude change relative to different message strategies; specifically, this study proposes to apply this package as an illustration in the area of sex-typed behavior. The package will consist of:

1. the concepts to be scaled and the procedure for the selection of those concepts;
2. the methods for scaling those concepts;
3. the pilot application of the methods;
4. the step-by-step procedure for determining which message strategies may be assumed to have maximum persuasive or educational impact; this includes:
   4.1. a procedure for locating a concept at the origin of the space in order that the mathematics for vector resolution may be simplified;
   4.2. a vector analytic procedure for predicting the movement of concepts through a persuasive campaign.

Part 4.2 is of great importance since no such vector analytic procedure has been previously established.

Traditionally, scales for the measurement of attitude change have been unidimensional (see Shaw & Wright, 1967) and have been formed by gathering a large number of statements or concepts and having "judges" group them into categories which are representative of some single underlying dimension. In speculating that multidimensional scaling can be a powerful technique in attitude scaling, Green and Carmone (1970, p. 19) note that, "the possibility exists that the statements may tap various portions of an attitude <u>space</u> of two or more dimensions rather than represent intensity levels of a single unidimensional scale."

Multidimensional scaling (MDS) first received widespread recognition with the publication of Torgerson's (1958, chap. 11) work. Torgerson's (1951, 1952) classical formulation for the multidimensional scaling of interval data was based on the earlier work of Richardson (1938) and Young and Householder (1938). The first "nonmetric" computer routines for the multidimensional scaling of ordinal data were introduced by Shepard (1962a, 1962b) and Kruskal (1964a, 1964b) and psychometricians were quick to realize the utility of the methodology. Schroder, Driver, and Streufert (1967, p. 169) note that MDS is well-suited to the measurement of psychological differentiation because it may potentially uncover the number, kind, and organization of dimensions which a subject may use when perceiving or evaluating a complex stimulus attribute. A variation on Torgerson's classical "metric" formulation was recently developed by Woelfel (1974a, 1974b). Most commonly known as metric multidimensional scaling (MMDS), Woelfel's procedure differs from previous "metric" procedures in that it requires the rigid assumption of ratio scale data. The MMDS approach portends to be extremely valuable as an heuristic tool in communication research and perhaps its greatest potential lies in the time series measurement of cultural processes (see Barnett, 1974, 1975; Barnett, Serota & Taylor, 1974; Cody, Marlier, & Woelfel, 1975; Danes & Woelfel, 1975; Woelfel & Barnett, 1974).

While the social sciences fundamentally study the properties of groups or aggregates "as phenomena in their own right rather than simply as epiphenomenal consequences of their multiple individual manifestations" (Gillham & Woelfel, 1975, p. 1), communication research has erroneously assumed in the past that if individuals are the units of response then they must also be the units of analysis (Rogers & Bhowmik, 1971, p. 524). Because the MMDS examination of individual structure is unreliable, and because the macro conceptualization is favored in the analysis of cultural processes, a group of individuals is represented by the "average" person in the MMDS analytic scheme.

This study applies MMDS with the objective of facilitating the selection of message strategies which may be utilized in subsequent studies of attitude change within a subgroup of society. The particular subgroups studied here are comprised of individuals who are masculine, feminine, and androgynous on a scale for the measurement of sex-typed attitudes. Message content will be representative of the area of sex roles. Definitions of these concepts, as well as sampling procedures for selection of subjects (Ss), are deferred to the operational plan section; a rationale for their selection is provided here.

Comstock, Lindsey, and Fisher (1975, p. 7) list role socialization as a high priority research area in the study of television and human behavior. Within that area, Comstock et al. (pp. 8-9) list sex-role socialization as the highest research interest. Busby (1975) found that previous research in the area of sex roles in the mass media has been primarily content analytic, and she has noted that other areas need further study.

Conceptual definitions. A multidimensional space is a metric space of two or more orthogonal dimensions. Multidimensional scaling is any procedure which takes similarity, preference, proximity or any direct or derived similarity measure data and locates the data points in a multidimensional space. Metric multidimensional scaling utilizes interval data classically, and ratio data more recently. Nonmetric multidimensional scaling utilizes ordinal data. An attitude is "an intervening variable that mediates between generalized reception and response tendencies" (McGuire, 1973, p. 219). A sex role is role behavior appropriate to a person's gender (Maccoby & Jacklin, 1974, p. 277). A message is the appropriate significant symbol or symbols "which express the internal responses (meanings) the communicator wishes to present to his audience" (DeFleur, 1970, p. 91).

Assumptions

Perhaps as a consequence of this study's exploratory nature, several assumptions need explicit statement. First, it is assumed that subjects can make reliable ratio scale judgments of the similarity of sex-role concepts. Due to the degree of concept abstraction, a pretest will be executed so that any concepts which subjects may find exceptionally difficult to judge can be eliminated. Second, it is assumed that the stimuli are homogeneous to such a degree that it is possible to analyze in a Euclidean fashion the similarity judgments which subjects make. Third, it is assumed that the first three dimensions will account for approximately 60% of the variance explained to permit discussion of the n dimensional space in terms of those three dimensions. Fourth, related to the third assumption, it is assumed that classical mechanics may validly be utilized as a descriptive tool in the discussion of concept movement through space.

Review of the Literature

Since this is primarily a methodological study, emphasis will be placed on review of the literature of multidimensional scaling.[1] An in-depth review of the literature on attitude change is beyond the scope of this paper and reliance in this area will be place on existing, published reviews so that this study may be viewed in the context of that research. Similarly, the application of the methodology is in the area of sex-role socialization by the mass media and the literature of this area will be selectively reviewed.

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[1] Sources searched were: Psychological Abstracts, 1955-1975 (Vol. 29-54) under the subject index headings of Attitude Measures, Measurement, Method, Method & Methodology, Methodology, Scaling, Scaling (Testing), Statistics, Test and Testing; Comprehensive Dissertation Index 1861-1972 (Vol. 18, 19 [Psychology] and Vol. 31 [Communications and the Arts]) under the keywords Map, Maps, Mapping, Multidimensional, Metric, Metrics, Scaling; Dissertation Abstracts International, 1973- October 1975 (Vol. 34, 35, 36) under the keywords Map, Maps, Mapping, Method, Methods, Methodology, Metric, Metrics, Multi, Multidimensional, Psychometric, Scaling; H. W. Wilson, Co. Bibliographic Index 1951-1974 under the subject headings FACTOR ANALYSIS, FACTORIAL experiment design, MULTIVARIATE analysis, PSYCHOLOGY-mathematical models, PSYCHOLOGY-methodology, PSYCHOMETRY, SCALE analysis (psychology); Psychometrika Index 1936-1970 (Vol. 1-35) under the subject index headings of Computational procedures, scaling; Distance, estimation; Models, multidimensional scaling; Psychophysical scaling, multidimensional.

Fundamentals of Metric and Nonmetric Multidimensional Scaling

The concept of distance. Traditional unidimensional scaling methods require a subject to judge a stimulus-object with respect to a particular defined attribute. The stimulus-object is rated as being brighter, hotter, heavier or any other attribute on which the experimenter may request judgment. But the unidimensional methods only allow judgment on one attribute or dimension at a time (see Torgerson, 1958, p. 260). Multi-dimensional scaling, whether metric or nonmetric, presents a set of data in a multidimensional space where the points representing the stimulus-objects are located by virtue of the distances which subjects may perceive as separating them. The concept of distance, as shall be briefly discussed, is fundamental to multidimensional scaling.

In the physical sciences distance, time, force (or its reciprocal mass), and temperature are described as fundamental explanatory variables. Of these, time and distance are directly observable and are therefore known as fundamental descriptive variables from which all other variables can be derived. Woelfel (1974a, p. 2) suggests that in the study of communication phenomena all the required variables may be derived, similar to the physical sciences, "from two fundamental variables, perceived discrepancy and time." Gulliksen (1946, p. 201) had earlier suggested that derived and defined magnitudes are measured as a function of fundamental magnitudes, and a fundamental magnitude such as length "can be measured without the previous measurement of any other magnitude. . . ." As

Suppes and Zinnes (1963, p. 9) explain, the measurement of distance is a fundamental operation in that "choice of a unit is an empirically arbitrary decision made by an individual or group of individuals."

Generalization of stimuli attributes along a single dimension may be thought of as a proximity function. According to Gregson (1975) it follows that any configuration of two stimuli differing on _n_ variables may be represented as two points on a line such that increasing similarity results in decreasing distance. Shepard (1972, p. 24), in a discussion of the treatment of data, states that with proximity data for use in nonmetric MDS each entry in an _n_ x _n_ matrix "contains some measure of the similarity, substitutability, affinity, confusion, association, correlation, or interaction between the two objects corresponding to that row and column of the matrix." In addition, each point is contained within one multidimensional space (pp. 31-32).

Similarity and proximity. A great deal of confusion surrounds use of the terms _similarity_ and _proximity_. The following discussion of the evolution of the two terms within MDS attempts to summarize the salient characteristics of the two arguments. It appears that the terms were used synonomously as late as 1974 when Shepard (1974) finally drew a distinction between the two. In fact, serious criticism has been directed towards MDS and other psychometric methods which have traditionally failed to distinguish between the two (see Gregson, 1975, p. 104).

In Attneave's (1950) "dimensional view" objects may have some degree of proximity along some dimension defined by the discrete elements which the objects have in common (p. 519). He conceptualized these discrete elements as characteristics with respect to which objects are similar. In Abelson's (1954) MDS model, physical stimuli are scaled in a psychological space with psychological distance being a concept fundamental to the method. Social distance has been widely researched and psychological distance is a concept used in conflict theory and in Lewin's field theory. MDS can provide the researcher with "a 'map' of the way in which an individual structures the similarities and differences among attitudes in a given domain" (p. 407). A short psychological distance on such a map would represent psychological similarity, or attitude agreement, and a long distance would represent dissimilarity, or disagreement with an attitude (p. 407).

Rumelhart and Abrahamson (1973) closely follow Abelson's treatment of similarity. They write that human information retrieval which depends on the form of the relationships among words in a question, rather than the specific content of the question, is known as reasoning. "Perhaps the simplest reasoning task by our definition involves the judgment of similarity or dissimilarity of concepts" (p. 2). The degree of similarity between two concepts is not directly stored but is a function of the "psychological distance" between concepts in the memory structure, and the closer two concepts are within an individual's memory structure, the more similar they are judged to be (p. 2).

In this article Rumelhart and Abrahamson test their conceptualization of analogic reasoning as a kind of similarity judgment. In the classic analogic paradigm, A is to B as C is to D, they explain that "we are simply asserting that the concept A is similar to concept B in exactly the same way and to exactly the same degree that concept C is to concept D" (p. 4). If we apply this conceptualization to MDS, the relationship between objects A, B, C, and D is fully described with the assumption that the vector constructed from point A to point B is exactly the same in direction and magnitude as the vector constructed from point C to point D.

Gregson (1975) selectively reviews MDS and states that the strong assumptions made about psychological distance are unsatisfactory. Further, he states that there are two ways of looking at the development of MDS and its interpretation of similarity and proximity:

> Either nonmetric scalings represent proximity relations of which similarities are a special case . . . or they are interpretable as models of similarity per se. The first, proximity, interpretation was prefered by Shepard and Kruskal, and the second, similarity, one by Torgerson who showed that the variable metric space algorithms do not capture all the important properties of similarity response (p. 104).

I shall treat Shepard's use of the terms first and then follow with Torgerson's.

In his study of the stochastic model relating generalization to psychological distance, Shepard (1958, p. 510) replaces the notion of similarity with that of distance as interpreted through a set of metric axioms. Later, in proposing an analytical method for the "analysis of proximities," Shepard (1962a) argued that there was a "rough isomorphism" between similarity or association measure constraints and the metric axioms. In colloquial reference to proximity, we speak in qualitative terms such as "very" close or "moderately" close and, with the application of powerful quantitative terms such as mathematics allows, we can describe proximity with much greater accuracy. Shepard goes on to say that several diverse empirical procedures have in common the fact that "they start with a fixed set of entities and determine, for every pair of these, a number reflecting how closely the two entities are related psychologically" (p. 125). While we commonly think of the relation between stimulus and response as one of similarity, we should realize that, "Serviceable measures of similarity may also be found for concepts, attitudes, personality structures, or even social institutions, political systems, and the like" (p. 125). In addition, entities may be related by the degree of association or mutual distance. More recently, Shepard (1974) has used the term "similarity data" which is theoretically more neutral than his earlier espoused "proximity data."

Torgerson's (1965) view is that physical distance as a property of a pair of points is invariant. The distances between two points always remains the same regardless of the introduction of additional points into the set. Similarity, however, is not invariant for sets of stimuli which vary on different attributes and this is dependent "upon such things as stimulus context and the cognitive strategy taken by the subject" (p. 383). Schroder et al. (1967) approach similarity in much the same way as Torgerson. In defining measures of integrative complexity, discrimination, and differentiation, they write that multidimensional techniques seem to hold the most promise in the analysis of measures of differentiation and how they underly similarity measures.

Spatial models. Returning to the relation between points A, B, C, and D as defined in the classic analogic paradigm, we can see that a vector from A to B or from C to D can be thought of as a measure of similarity. That is, the closer two points are to each other the more similar are the objects which those points represent; the farther apart those points are, the more dissimilar the objects which they represent. MDS, both metric and nonmetric, seeks to reveal the underlying interrelationships of an array of data by plotting that data in a multidimensional space. Essentially, there are two steps in any given MDS procedure (see Torgerson, 1958, p. 250): (a) a spatial model which fully describes the formal characteristics of the multidimensional space; and (b) a distance model which prescribes the procedure for measuring the distance between all pairs of stimuli.

The various procedures differ in that they combine a variety of spatial and distance models into a single scaling procedure. A brief review of the different spatial models is presented next, to be followed by a short discussion of the distance models and the concommitant problem of the "additive constant" which the distance models raise. The spatial models to be reviewed apply to both the metric and nonmetric procedures, while the additive constant problem is peculiar to methods which utilize interval data. For an excellent introduction to these two steps of MDS, see Torgerson (1958, pp. 250-277).

Green and Rao (1972, p. 8) write that, "While the choice of metric or nonmetric algorithms has probably represented the most controversial issue at both the theoretical and applied levels, it seems to us the least important. . . ." Subkoviak (1972) found that in a direct comparison both the Torgerson (metric) and Kruskal (nonmetric) models produced highly accurate solutions for the input of a known configuration of points. A total of thirty-six cases involving various combinations of normal (assumed by Torgerson) and nonnormal (assumed by Kruskal) density functions were scaled and only minor differences resulted. Similarly, Ekehammer (1972) compared different geometrical models obtained from the description of "content models"[2] in vector terms. With equally intensive (i.e., homogeneous) stimuli the models may be expressed as:

$$s_{ij} = ij \cos \alpha$$

$$s_{ij} = ij \cos \alpha / ij \cos (\alpha/2)$$

$$s_{ij} = ij \cos \alpha (ij \cos (\alpha/2))$$

where s_{ij} is the similarity estimate, *i* is the magnitude of vector $\mathbf{i}$, *j* is the magnitude of vector $\mathbf{j}$, and α is the angle subtending vectors $\mathbf{i}$ and $\mathbf{j}$. On the basis of both theoretical and empirical analyses, Ekehammer (1972, p. 83) found "that

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[2] A content model regards similarity "as the degree of common content ('communality') in relation to total content ('totality') for the percepts compared" (Ekehammer, 1972, p. 79).

the multidimensional scaling methods, based on different theoretical vector models for subjective similarity, give only negligible differences in outcomes for the same data."

Gregson (1975, p. 106) defines a metric space as a pair $(\underline{X},\rho)$ where $\underline{X}$ is a set of points $\underline{x}$, $\underline{y} \in \underline{X}$ and $\rho(\underline{x},\underline{y})$ is a single-valued nonnegative real function defined on arbitrary $\underline{x}$, $\underline{y}$ and satisfying:

$$\rho(\underline{x},\underline{y}) = 0 \qquad \text{iff } \underline{x} = \underline{y}$$

$$\rho(\underline{x},\underline{y}) = \rho(\underline{y},\underline{x})$$

$$\rho(\underline{x},\underline{y}) + \rho(\underline{y},\underline{z}) \geq \rho(\underline{x},\underline{z}).$$

The third requirement is known as the triangle inequality and satisfaction of the first two requirements and not the third results in a semimetric. In addition to this general description of a metric spatial model, specific models have appeared in the literature under these various names: Euclidean, Minkowski, City Block, and L-metrics (Torgerson, 1951; Kruskal, 1964a, 1965b; Attneave, 1950; Guttman, 1968). A brief description of each may help clarify their differences.

Using Torgerson's terminology (1958, pp. 252-253) we can compare the Euclidean space, favored due to its theoretical and conceptual simplicity, with Attneave's (1950) City Block model and the way in which they relate the distance between two points. Letting $\underline{j},\underline{k}$ equal alternate subscripts for stimuli ($\underline{j},\underline{k} = 1, 2, \ldots, \underline{n}$); $\underline{d}_{jk}$ equal the distance between stimuli $\underline{j}$ and $\underline{k}$; $\underline{m}$ equal subscripts for orthogonal axes of the space ($\underline{m} = 1, 2, \ldots, \underline{r}$); $\underline{a}_{jm}$ equal the projection of stimulus $\underline{j}$ on axes $\underline{m}$; then the Euclidean model may be generally represented as:

$$\underline{d}_{\underline{jk}} = \left[\sum_{\underline{m}=1}^{\underline{r}} (\underline{a}_{\underline{jm}} - \underline{a}_{\underline{km}})^2 \right]^{\frac{1}{2}};$$

and Attneave's model may be generally represented as:

$$\underline{d}_{\underline{jk}} = \sum_{\underline{m}=1}^{\underline{r}} \left| \underline{a}_{\underline{jm}} - \underline{a}_{\underline{km}} \right| .$$

Simply stated (Shepard, 1964, p. 58), the city block semi-metric differs from the Euclidean metric in that the Pythagorean distance formula ($\underline{d} = (\underline{a}^2 + \underline{b}^2)^{\frac{1}{2}}$) is replaced by ($\underline{d} = |\underline{a}| + |\underline{b}|$); the latter satisfying only the first two requirements of a metric space. The class of metrics which mathematicians refer to as L-metrics (Guttman, 1968, p. 475) is that class of homogeneous metrics where we have:

$$\underline{d}_{\underline{jk}} = \left[\sum_{\underline{m}=1}^{\underline{r}} \left| \underline{a}_{\underline{jm}} - \underline{a}_{\underline{km}} \right|^{\underline{p}} \right]^{1/\underline{p}}, \quad \underline{p} \geq 1.$$

Kruskal alternatively calls this the Minkowski metric. (See also Green & Carmone, 1970, p. 26.) If we set $\underline{p} = 1$ we have the city block semi-metric; and for $\underline{p} = 2$ the Euclidean metric. While any value for $\underline{p} \geq 2$ will satisfy the requirements of a metric space (see Lowenhar & Stanton, 1975), only the Euclidean metric is invariant under rotation.

Torgerson (1958, p. 254) emphasized use of the Euclidean model arguing that a subject who is required to rate a set of stimulus pairs varying on separate dimensions which are not readily obvious will provide data which may be most thoroughly analyzed through MDS. Not only are the dimensions not readily obvious to the subject; neither are they obvious to the researcher. Thus, subjects are "more likely to judge the overall difference directly" (p. 254); and in this situation the Euclidean model is favored over the city block model.

Shepard's (1964) findings in three experiments varying the stimuli along perceptually distinct dimensions indicate that the state of attention must be uniform over the subjects in order that the data will satisfy the triangle inequality. The results of these experiments indicate that a Euclidean metric may be appropriate for essentially unanalyzable stimuli, while a city block metric may be required for highly analyzable stimuli, even if all subjects are in the same state of attention (p. 82). With a design which eliminated the fluctuations of attention characterized by Shepard (1964), Hyman and Well (1967, p. 246) found that, "The suggestions by Torgerson (1958), Attneave (1950), and Shepard (1964) that the difference in spatial models results from an intrinsic property of the stimulus materials now seems even more plausible."

In a related study Hyman and Well (1968, p. 164) found that the city block model appears to provide a good fit for certain geometrical stimuli; with such stimuli subjects appear to add up the differences along the dimensions. With less analyzable, homogeneous stimuli such as single color patches which varied in hue, saturation, and tone, subjects act in a seemingly Euclidean fashion. Similarly, Schroder et al. (1967, p. 27) suggest that the more abstract structure a situation may have, the more will a subject generate his or her own behavior in assessing the situation. In a situation where stimuli vary over few, discrete dimensions, the subject's behavior is largely determined by the externally given dimensions. If, however, the situation contains a high level of structural complexity, then the subject may handle more kinds of information simultaneously, may combine that information in various ways (i.e., take different perspectives) and on those bases the subject may be said to be generating dimensions internally.

Distance models. All of the distance models yield a measure which is indicative of the psychological similarity between the two objects in a pair of stimuli. In general, distance models which are based on ordinal or interval unidimensional scaling methods will produce comparative distances; and distance models which are based on ratio scales will produce absolute distances (Torgerson, 1958, p. 261). The procedure for converting comparative distances to absolute distances involves the use of an "additive constant", and determination of a particular value of the additive constant will affect the multidimensional mapping of the stimuli. The value of the additive constant "is that value which will allow the stimuli to be fitted by a real, Euclidean space of the smallest possible dimensionality" (Torgerson, 1958, p. 269). Messick and Abelson (1956, pp. 2-3) and Torgerson (1958, pp. 268-277) have proposed pragmatic criteria for selection of such a value.

All multidimensional scaling techniques share a common characteristic of representing objects as n points in a coordinate space. Guttman (1968, p. 471) states that the representation must satisfy two conditions for the ordinal data nonmetric methods: (a) monotonicity, and (b) minimum dimensionality. Interval and ratio data techniques add a third condition that the data conform to a priori metric axioms. According to Coombs, Dawes, and Tversky (1970, p. 15), any order preserving transformation of scale values yields another admissible scale, and the transformation is monotonic (i.e., $\underline{x}_1 > \underline{x}_2 \Longrightarrow \underline{y}_1 > \underline{y}_2$). As Green and Carmone (1970, pp. 8-9) write, the only permissible transformation of interval scales are positive linear (i.e., $\underline{f}(\underline{x}) = \underline{m}\underline{x} + \underline{b}$; $m > 0$), and the only permissible transformations of ratio scales are positive proportionality (i.e., $\underline{f}(\underline{x}) = \underline{m}\underline{x}$, $\underline{m} > 0$). Satisfaction of Guttman's second condition is, as Fillenbaum and Rapoport (1970, p. 20) explain, an objective which facilitates interpretation of the data. The fewer the dimensions, the easier the interpretation. The Galileo system sacrifices parsimony in favor of accuracy of representation (Woelfel, Saltiel, McPhee, Danes, Cody, Barnett, & Serota, 1975). The nonmetric methods, however, sacrifice goodness of fit (i.e., they utilize approximately monotonic transformations) in favor of parsimony (Lingoes, 1972, p. 52; see also Klahr, 1969; Kruskal, 1964a; Sherman, 1972; Spence, 1972; Stenson & Knoll, 1969; Shepard, 1966; and Young, 1970).

At the time of Torgerson's (1951) formulation of MDS, psychometricians and social scientists were constrained to the unidimensional scaling methods. As Torgerson (1958, p. 260) explains, in a unidimensional model the assigned scale value represents the quantity of the scaled attribute possessed by the stimulus. In the multidimensional model the assigned scale value represents the psychological distance between two stimuli on a similarity or distance continuum. And in each case, the average position is taken as the scale value of the stimulus (unidimensional) or the psychological distance between two stimuli (multidimensional). So it may be said that, "In the multidimensional-scaling models, the notion of a single, unidimensional, underlying continuum is replaced by the notion of an underlying multidimensional space" (p. 248). Schroder et al. (1967, p. 72) elaborate on this conceptualization by explaining that a multidimensional perceptual space constructed from similarity ratings as psychological distance judgments consists of: (a) salient characteristics, each represented by a distinct dimension; (b) weights (eigenvalues, roots) indicating the relative importance of any one dimension in the overall structure; and (c) a specific stimuli order along each dimension.

Ratio Data Metric Multidimensional Scaling

A review of the literature of ordinal and interval data MDS is beyond the scope of this paper; several extensive reviews already exist in this area (Coombs, 1964; De Leo, 1975; Green & Carmone, 1970; Green & Rao, 1972; Shepard, 1972; Shepard, Romney & Nerlove, 1972).

At the data collection stage in the ratio judgment MDS procedures, subjects are asked to make a judgment with regard to the distance (as representative of dissimilarity) between a set of stimuli. Usually this judgment takes the form of paired comparisons as represented by the classic analogic paradigm discussed earlier. As Marlier (1974) points out, there are two aspects in which the paired comparisons ratio judgment method is superior to the traditional ordered alternatives: (a) the subject is not bound by outer limits of attitudinal referents, thereby allowing more accurate representation of subjects at the extreme ends of the scale; and (b) the transitivity of the presumed ordinal scale may be checked by the paired comparison. Utilization of the paired comparisons method requires judgments in terms of the ratio scale of cardinal numbers. Metfessel (1947, p. 234) argues the two basic advantages of having subjects report comparative judgments in terms of a ratio scale: (a) those judgments are reported with greater sensitivity than is possible with an ordinal scale; and (b) subjects are likely to give more consideration to individual differences of the stimuli.

<u>The Galileo system of multidimensional scaling</u>. Woelfel (1974_a) has recently proposed a methodology complete with a mathematical algorithm and computer program for metric multidimensional scaling of ratio data. There are three salient characteristics of the methodology: (a) the interpretation of large arrays of data is facilitated by plotting the *n* stimuli in *k* orthogonal dimensions where $k < n$; (b) no information is lost in the mapping of dissimilarity judgments into a multidimensional space since the mapping is one-to-one; and (c) "the function which maps discrepancies . . . can be seen to

conform in essential respects to the spatial coordinate system of classical (and modern) mechanics" (Woelfel, 1974b, p. 8).

As discussed above, dissimilarities between objects, concepts, or individuals may be represented as any positive real number. The larger the value ascribed, the greater the dissimilarity or distance. Assuming that each concept (or object) can be defined by its relation to every other concept, a distance matrix can be constructed such that each cell $\underline{d}_{\underline{ij}}$ within the matrix "represents the dissimilarity or distance between $\underline{i}$ and $\underline{j}$" (Woelfel, 1974a, p. 7). Woelfel (1974a, p. 7) defines the distance matrix in the following way:

> Assuming that the definition of an object or concept is constituted by the pattern of its relationship to other objects, the definition of any object may be represented by an 1 x $\underline{n}$ vector where $\underline{d}_{11}$ represent the distance or dissimilarity of an object 1 from itself (thus $\underline{d}_{11} = 0$ by definition), $\underline{d}_{12}$ represents the distance or dissimilarity between object 1 and 2, and $\underline{d}_{1\underline{n}}$ represents the distance between the 1st and the $\underline{n}$th objects. Similarly, the second object may be represented by a second vector $\underline{d}_{21}, \underline{d}_{22}, \underline{d}_{23}, \ldots, \underline{d}_{2\underline{n}}$ and the definition of any set of concepts or objects may therefore be represented in terms of the matrix
>
> $$\begin{matrix} \underline{d}_{11}, \underline{d}_{12}, \ldots, \underline{d}_{1\underline{n}} \\ \underline{d}_{21}, \underline{d}_{22}, \ldots, \underline{d}_{2\underline{n}} \\ \vdots \\ \underline{d}_{\underline{n}1}, \underline{d}_{\underline{n}2}, \ldots, \underline{d}_{\underline{nn}}, \end{matrix}$$
>
> where any entry $\underline{d}_{\underline{ij}}$ represents the dissimilarity or distance between $\underline{i}$ and $\underline{j}$.

In the theoretically limiting case, if the number of objects of which an individual holds a definition is $\underline{n}$, then that individual making judgments between concepts $\underline{i}$ and $\underline{j}$ will be providing a map of his or her self conception, however unreliable, at a particular point in time. This matrix contains as subsets attitudes, beliefs, and other elements of the self (Woelfel, 1974a, p. 10).

While the technique of estimating distances in paired comparisons is unreliable for measurement of individual psychological contents (Woelfel, 1974a, p. 17), the error which does occur is random error and is distributed normally (p. 18). Therefore, through the process of arithmetic aggregation of each cell of each individual matrix into one matrix representative of a population, a highly valid representation of the population true score will result. And culture can be described by the matrix $\underline{D}$, such that any entry

$$\underline{d}_{ij} = \sum_{k=1}^{n} \underline{d}_{ij(k)}/\underline{n},$$

where $\underline{d}_{ij(k)}$ is the estimated distance between the $\underline{i}$th object and the $\underline{j}$th object by the $\underline{k}$th person, and $\underline{n}$ is the number of subjects. This use of the arithmetic mean as a measure of cultural elements not only has face validity but also has the advantage of averaging out random variance. Gillham and Woelfel (1975, p. 6) suggest that the MDS system which uses ratio scale judgments will provide reliable configurations which permit analysis of cultural stability over time. In addition, precision will be sufficient to measure the changes of the less stable concepts within the culture.

To include in the matrix $\underline{D}$ all the objects defined by a culture is clearly untenable. Woelfel (1974a, pp. 18–19) recognizes this and provides the qualifications that: (a) researchers need only concern themselves with subsets of $\underline{D}$ which are analogous to subcultures; (b) the limits of such subsets (i.e., the boundaries of such subcultures) may be defined by appropriate sampling; and (c) since the matrix $\underline{D}$ represents the state of a culture at a particular point in time, the culture's movement through time as a process may be described by successive matrices $\underline{D}_{\underline{t}_0}, \underline{D}_{\underline{t}_1}, \ldots, \underline{D}_{\underline{t}_n}$, where each is generated at a new point in time. As point (c) suggests, the velocity of change over $\underline{t}_0$ and $\underline{t}_1$ can be described by $\underline{D}_{\underline{t}_1} - \underline{D}_{\underline{t}_0}$, and the acceleration of change can be described as

$$\lim_{\underline{t}_1 - \underline{t}_0 \to 0} \frac{\underline{D}_{\underline{t}_1} - \underline{D}_{\underline{t}_0}}{\underline{t}_1 - \underline{t}_0} .$$

Putting these symbolic statements into verbal form it can be argued that by subtracting cell values of matrices constructed at different points in time it is possible to determine cultural change with very high precision. Comparing two points in time will yield a velocity for the change and an acceleration may be determined by comparing two or more successive points in time where the time interval between each point approaches zero. This is a key advantage which the ratio data metric procedures have over the interval and ordinal data MDS techniques.

The matrix $\underline{D}$, as further explained by Barnett et al. (1974, pp. 9–10), describes the location of $\underline{n}$ concepts within a culture and thus is an accurate yet cumbersome representation of a finite set of cultural definitions. Because each individual has a particular location within the space, the number of dimensions shared by each member of the social system is one less than n. Implicitly, matrix D describes a vector space V_k of dimensionality $k \leq n - 1$. The value of k is determined by the number of dimensions which the social system members share in their differentiation of the n concepts within their culture. Reduction of matrix D to vector space V_k provides the researcher with data of usable proportions (pp. 10-11); according to Helm, Messick, and Tucker (1959, p. 14) this is the utility of multidimensional scaling.

Reduction of D to V_k is achieved in the following way. First, since this matrix has zero values in the diagonal it has no inverse and cannot be factored, an operation which is essential in finding the underlying dimensions. Further, the true origin of the space is unknown. Torgerson (1958, pp. 255-259) provides a mathematical solution for arbitrarily "double centering" the origin at the centroid of all the stimuli and thus forming a new matrix. This new matrix is the scalar products matrix obtained by forming the scalar product between concept i and concept j. Elements of the centroid scalar products matrix B^* are given by this one step procedure (Torgerson, 1958, p. 258):

$$b^*_{ij} = \frac{1}{2}\left(\frac{1}{n}\sum_{i=1}^{n} d^2_{ij} + \frac{1}{n}\sum_{j=1}^{n} d^2_{ij} + \frac{1}{n^2}\sum_{i=1}^{n}\sum_{j=1}^{n} d^2_{ij} - d^2_{ij}\right).$$

A routine factorization of B^* is performed to arrive at a matrix of coordinate values for the set of concepts (Serota, 1974, p. 62). Galileo uses Van de Geer's (1971, app. A) direct iterative solution which has the advantages of deriving the eigenvector and its corresponding eigenvalue for any given axis and providing the components of both real and imaginary space (Serota, 1974, p. 62).

Woelfel's (1974b) proposed use of Lagrangian mechanics to describe the interrelation of points and the movement of any point (i.e., concept) through space has powerful advantages in the study of communication processes. Both the velocity and acceleration of a point in a _k_ dimensional space may be computed over time and "the precision with which the state of the system can be measured from moment to moment greatly enhances the likelihood of identifying the sources of perturbation in the pattern" (p. 10). Additionally, Marlier (1974, p. 20) suggests that two requisite assumptions be made regarding metric procedures. First, for a given population measured over time the interpoint distances between abstract alternative referents within a stimulus domain are stable. This assumption recognizes that, as an individual's position relative to the referents changes, the individual's perception of those distances may change. Second, individual subjects can reliably and accurately report relative perceived distances between referents in the stimulus domains in which the subjects reside.

<u>Some applications of Galileo</u>. Operationally, a study by Barnett et al. (1974) generated a mean space through the measurements made by a large, representative sample who

judged the distances between political candidates and concepts in the 1972 presidential election. The relative strengths of the candidates were considered to be a function "of the distance from a mean centroid position which represents the culture's collective space" (p. 1). The basis for making judgments was given to the respondents as: "If John F. Kennedy and Dwight D. Eisenhower are 50 Galileos apart, how far apart are ______ and ______?" The authors hypothesize that relevance and salience of concepts in the political sphere "can be operationalized in terms of the location and movement of concepts within the cognitive space, and it is the particular concept-objects that constitute the information which will impact upon an individual's cognitive set" (p. 4).

Marlier (1974) proposes that social judgment predictions about message placement and attitude change may be tested precisely through the following steps. First, abstract yet identifiable positions of individuals relative to a particular issue are content analyzed for selection of ordered alternatives which represent as wide a range as possible. Considering the number of paired comparisons required of MMDS subjects, eleven to fourteen such alternatives are thought to be a reasonable starting point (p. 10). Second, the ordered pairs are presented to the subjects in all possible pairs.

In a study by Barnett (1975) on the movement of spatial configurations of environmental concepts within a multidimensional space, distance estimates were obtained on the 105 paired comparisons generated from an array of 15 concepts.

The subjects were instructed that the colors red and white were ten galileos apart; on that basis they were asked to estimate the distance, in galileos, between each of the 15 environmental concepts. From his experience with the methodology, Barnett suggests that, "In order to maximize the reliability and validity of the spatial manifold, homogeneous concepts should be selected" (p. 29). Cautioning that the data he presented are only an example of the use of MMDS, Barnett (1975) provided the following method of analysis: A three-dimensional solution was found for the mean distance matrices and the spatial coordinates of each point in time. The coordinate systems for each point in time were then rotated to a least-squares best fit congruence and the graphic representation of the rotated systems were plotted. In addition to face validity, the correlations between the axes over time are presented as indications of the quality of the solution. "There is a high correlation between the same dimension at different points in time. This shows that the people are using the same dimensions to differentiate the concepts" (p. 46).

In research intended to gain insight into the different conceptions of the mass media, traditional institutions and interpersonal behavior in different cultures, Barnett and Wigand (1975) have presented data collected from the U.S., Mexico, and South Africa and stated that translated equivalents of the same instrument were being administered in Australia, Israel, Canada, and Micronesia. MMDS is being used in the analysis of the data with the objective of constructing a cross-culturally valid, psychological-equivalent test for use in measuring national development.

A study by Barnett (1974) analyzes the changes which communication between social systems effects in-between system homophily. In investigating social system change it is both necessary and advantageous to utilize a methodology which will focus on aggregates of individuals rather than the individuals themselves. In this study on homophily-heterophily, that is, the extent to which two different societies share cultural conceptions, Barnett utilizes MMDS by having separate groups of people generate different aggregate spaces and then analyzing the correlation between the multidimensional spaces.

Assuming that there is a normal distribution about each mean distance, the law of large numbers provides for decreasing variance with an increasing number of subjects. Thus, reliability coefficients will increase positively. Barnett (1972) illustrated just such an effect. Barnett suggests (p. 18) that for an homogeneous population a sample of more than 50 subjects will produce reliable results. For a heterogeneous population more than 100 subjects are recommended. Gillham (1972) reported reliability coefficients above 0.90 with 29 subjects from a group which was relatively well-defined as an homogeneous group which shared the information on the concepts which were scaled.

As Woelfel (1972, p. 101) notes, the stimuli which are scaled may be represented as <u>points</u> in space, however, the stimuli may actually occupy <u>regions</u> in space. The measurement error between the point and the periphery will produce a distorted configuration which a principal components factor analysis can represent in a real space of only about ten dimensions. Eigenvalues of each eigenvector which represents higher dimensions will be negative, indicating an imaginary space which results when the original distance matrix is not positive-semi-definite. Barnett (1972, p. 8) writes, "If all of the error were removed from the distance matrix, and the size specific to each concept added to the distance matrix; the imaginary space would become the size of the concept, the matrix would become positive-semidefinite, and the problem of negative eigenvalues would be removed." As reliability increases with increasing number of cases, the negative eigenvalues decrease in magnitude to a point where they can be attributable to the size of the concept (Barnett, 1972, p. 8).

In attempting to assess the reliability of ratio data MDS, Danes and Woelfel (1975, pp. 6-7) found a test-retest coefficient of correlation equal to 0.86. In further attempting to test the stability of the matrix $\underline{D}$, the absolute difference values between $\underline{d}_{ij}$ at time one and time two were correlated. The resultant correlation of 0.60 indicated that the larger distances were characterized by greater instability than the smaller. However, a least squares rotation of the axes determined that this instability came from dimensions 9 through 14. Dimensions 1, 2, and 3 were very stable over time with r = 0.97, 0.81, and 0.87, respectively (pp. 7-8).

While nonmetric methods assume that respondents are unable to make ratio scale judgments, the Galileo system assumes such judgments are possible. Recent empirical evidence (Marlier, 1974) supports the latter assumption and systematically explains the apparent unreliability in individual judgments in terms of individual self-perception and cognitive processes. A study by Taylor et al. (1975) provides compelling evidence for the predictive validity of the Galileo system and ratio judgments. Gordon (1976), in a study which varied the criterion pairs given nine groups of subjects, provides further evidence of subjects' abilities to reliably make ratio judgments.

In the study by Taylor et al. (1975), political concepts and candidates in a Michigan congressional election were judged by three random samples of a subset of all voters. Each sample was drawn at one of three different points in time. Taylor et al. (1975, p. 12) predicted that the Democratic candidate would receive 55.7% of the vote and that the Republican candidate would receive 44.3%. "The actual vote total for the area of study was 57.7% for the Democrat, 41.3% for the Republican, and 1.09% for the independent candidates" (p. 12).

Cody et al. (1975) examine the basis of the widely utilized factor analysis of unidimensional semantic differential scales and conclude (p. 5) that the assumptions of this type of analysis are of questionable validity for two reasons. First, the theoretic assumption that bipolar adjectives are equidistant from a common origin is not supported by data collected for validation (pp. 4-5). And second, "assuming the meaning of a trait to be 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 defined by its relation with all other traits" (pp. 5-6). Further, comparability of research in this area is hindered by the varying preferences for unrotated, orthogonal, or oblique factor analytic solutions. Since the choice of any one of these is dictated by the objective of maximizing interpretability (oblique) or comparability (orthogonal), an ideal alternate representation would fulfill both objectives. Cody et al. (1975, pp. 6-7) provide the rationale and assumptions for ratio scale MDS as just such an alternative to the factor analytic semantic space.

The ambiguities which arise in over-time comparisons on the nonmetric MDS configuration limit this technique's usefulness and arise principally from two areas: first, with algorithms such as Kruskal's (1964a, 1964b) the steepest decent iterations will always be different between two analyses, with no ready solution available to this problem; and second, the orientation of the axes will always be arbitrary, even for Torgerson's (1958) classical interval scale MDS model. Woelfel et al. (1975) present a mathematical solution for rotation of the coordinate axes of a multidimensional space generated from ratio scale data. Their solution is a least-squares best-fit rotation to congruence. Gillham and Woelfel (1975) present evidence of the stability and precision of the Galileo system which utilizes this rotational technique.

Attitude Change

This brief overview of the literature on attitude change shall discuss attitude and the analytical components of attitude change paradigms. An in-depth review is not the intent of this section; this brief summary should serve only to provide a context in which this study may be viewed.

According to Katz (1960) the three aspects of attitude, usually the cognitive, affective, and connotative, refer to the intellectual content, the emotional-evaluative component, and the behavioral intentions in the attitude. Since there is high covariance among these three aspects, no attempt shall be made here to differentiate them. Rather, we shall use McGuire's (1973, p. 219) definition of an attitude as

> an intervening variable that mediates between generalized reception and response tendencies. On the reception side, it involves a tendency to group a whole class of stimulus situations into a single conceptual category; on the response side, it refers to the tendency to respond to this set of stimuli with a characteristic class of responses.

McGuire points out that his definition of attitude hypothesizes a mediational state and that attitude can therefore be measured by an individual's self report regarding the stimuli in question. While this is only a definitional conceptualization, it suggests that there are two ways in which attitude change or persuasion can occur: "by inducing the person to reconceptualize the stimuli so that he categorizes specific instances differently, or by changing his response tendencies to the given class of stimuli" (McGuire, 1973, p. 220).

As McGuire (1973, pp. 225-226) points out, several of the many distinctions between education (information) and persuasion (propaganda) have been based on whether the receiver's belief is intellectual or emotional, on whether the source intends deception or not. In short, education is often thought of as a salubrious process and persuasion as a noxious one. However, it may be well to consider that these distinctions factitiously stress conceptual orthogonality, and that in reality education and persuasion may be more or less benign depending on the total communication situation. In a situation where the communication's impact is mediated by the attention, comprehension, and retention factors we apply the term education. Where impact is mediated by yielding and behavioral action we apply the term persuasion. Retention and behavioral action are less tied to the distinction than are attention, comprehension and yielding.

The translation of Lasswell's (1948) formulation of the communication process as "who says what, via what channel, to whom and with what effect" into the five components of source, message, channel, receiver, and destination; and conceptualizing the behavioral steps in persuasion as presentation, attention, comprehension, yielding, retention, and overt behavior suggests a convenient and common sensical persuasive communications analysis (McGuire, 1973, pp. 220-223). Figure 1 presents McGuire's array of the two sets of component variables in a matrix of persuasive communication.

Figure 1

McGuire's Matrix of

Persuasive Communication Variables[a]

	Source	Message	Channel	Receiver	Destination
Presentation					
Attention					
Comprehension					
Yielding					
Retention					
Overt Behavior					

[a]From McGuire (1973, p. 222).

There are a variety of theoretical orientations to persuasive communication. McGuire (1973, pp. 226-229) lists the following as the general ones: (a) the learning paradigm, (b) the categorizing paradigm, (c) the conflict resolving paradigm, (d) the functional paradigm, and (e) the information-processing paradigm.[3] Schramm (1973, p. 38) writes that communication incidents "exist for the purpose of conveying, sharing, or processing information in some way." Further, in writing about

[3]The learning paradigm predicts that communication variables that enhance learning concommitantly enhance attitude change. Unlike this model, the categorizing paradigm views attitude change as a person's shift from a set of preconceived categories (i.e., stereotypes) to a new perception of the stimulus being evaluated. The conflict resolving paradigm, or more commonly consistency theory, views attitude change as a function of an individual's previous information on an object, his or her self-interest, the demands of others and the new communication. The individual attempts to resolve cognitive conflicts by changing their attitude. In the functional paradigm a person is seen as having intellectual and nonrational needs which his or her attitudes may gratify. Finally, the information processing paradigm attempts to include in the analysis of attitude change all of

persuasion, resistance, and attitude change in a communication context, McGuire organizes his exposition consonant with the information-processing paradigm and has used it as a guide in the construction of the persuasive communication matrix above. This model "attempts to delineate the total system involved in a persuasion situation" (McGuire, 1973, p. 228). Within the context of the information-processing paradigm, metric multi-dimensional scaling can be extremely useful in that it provides a means for measuring the total system. The effect of manipulation of any independent (column) variable on the dependent (row) variables can be estimated by constructing multidimensional maps of a group before and after the manipulation. This study proposes to analyze strategies available to the researcher who desires manipulation of the message content as an independent variable.

Sex Roles and the Mass Media

Busby's (1975) review[4] summarizes an extensive body of literature in the area of sex roles. Studies are reviewed in

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the steps necessary for a person to logically proceed from being presented with persuasive communication to being persuaded by that communication.

[4] Busby searched the heading: woman, women, sex roles, women's liberation, feminist, and sex stereotypes. She selectively explicates "some of the most significant material in the area of sex role research" which she found across the psychology, journalism, education, sociology, and communication disciplines. As Busby (p. 127) summarizes, the vast majority of research has been content analytic and that these five additional types of research need to be pursued: cultural analysis, control analysis, audience analysis, media analysis and effects analysis.

the areas of television advertising (Courtney & Whipple, 1974; Dominick & Rauch, 1972; Hennessee & Nicholson, 1972), childrens' programming (Bergman, 1972; Busby, 1974; Cathey-Calvert, 1973; Gardner, 1970; Long & Simon, 1974; Women on Words and Images, 1975), and daytime and prime time programming (Downing, 1974; Gerbner, 1972; Head, 1954; Smythe, 1953; Tedesco, 1974; Turow, 1974). Busby (1975, p. 115) also notes a study by Lazarsfeld and Stanton (1944) which dealt in part with sex roles in radio serials. In addition to studies by Bardwick and Schumann (1967) and Stone (1974) of sex roles in other aspects of broadcast content, Busby (1975) reviews studies of sex-role research in magazine advertising, magazine fiction, newspapers, child-oriented print media, textbooks, other child-oriented media, literature, and film.

An illustrative study in this area by Long and Simon (1974) concluded that the overall image of women on children and family TV programs is the "traditional one that women are dependent, and perform expressive, and socio-emotional roles within a family context" (p. 110). All of the 34 female characters observed by Long and Simon were portrayed as housewives, secretaries, quasi-secretaries. None were found to portray the professions of doctors, professors or executives. A study by the New York Chapter of the National Organization for Women of 1241 TV commercials aired over a one and one-half year period found women portrayed as: domestic adjuncts to men, demeaned housekeepers, dependent on men, submissive, sex objects, unintelligent, and household functionaries (see

Hennessee & Nicholson, 1972). Similarly, Dominick and Rauch (1972, p. 265) concluded from their analysis of television advertisements that despite the activism of women's liberation groups, women were characterized as decorative, useful, and "in line with conventional stereotypes." Women on Words and Images (1975, p. 30) summarize that on the basis of their content analysis, "The prime-time message of the television screen is that there are more men around, and that they are dominant, authoritative, and competent." Further, women are portrayed in more negative behavior than are men.

Theoretic Rationale

Due to its complexity, the area of sex roles and the mass media has been researched with widely different content analytic techniques. The content analyses conducted by feminists have had the objective of describing the inequities which exist in sex-role stereotyping, and armed with these descriptions feminists have pressured the broadcast industry for change (see Adams, 1974; Stanley, 1971). Change can also be brought about through mass media educational campaigns. Multidimensional scaling's ability to take an holistic view of attitude holds much promise in the subsequent design of message strategies for maximizing the effect of such campaigns. More broadly, in the area of attitude change in general there is a great potential for the application of MDS to the design of message strategies in either educational or persuasive campaigns (see Taylor et al, 1975, pp. 5-6).

The Galileo system appears to have its greatest advantage over other MDS techniques in the time series measurement of cultural processes. It also has the capability of approaching attitude scaling from a multidimensional, rather than the traditionally unidimensional, attack. This is more than just a theoretic advantage for it provides the researcher with a tangible representation of a subgroup's cognitive structure of a set of related concepts. Applications are possible in a wide variety of attitude research with the present study representing just one area. In this respect McGuire's representation of attitude change is useful for it provides a means of departure once the methodological issues are resolved. That is, given a procedure such as the one proposed, the individual components of attitude change can be analyzed through the application of controls (see Green and Rao, 1972, pp. 145-146). MDS can provide an accurate means for assessing the effects of independent variable manipulation in a controlled experimental environment.

This study intends to integrate these three areas (sex roles, attitude change, and ratio data multidimensional scaling) in an exploratory way. Extablishing a procedure of information campaign designs is a first step on which other researchers may build. As McGuire's definitional conceptualization suggests, attitude change can occur through an individual either reconceptualizing stimuli or changing his or her response tendencies. Each of these occurrences can be precisely measured through MDS techniques.

Hypotheses

Due to this study's exploratory nature, no hypotheses are offered. This decision was reached after much deliberation on the role of hypotheses in theory building. This thesis assumes that the groups under study will hold significantly different attitudes on sex roles and proposes that MMDS is a viable method for measuring those differences. At this point in the theory cycle, certain evidence (such as the controversy surrounding sex roles) exists as support for the assumption of different attitudes. But since this methodology has never been used to measure these attitudes, we can only ask questions based on the existing evidence. It is recognized that hypotheses are essential in scientific inquiry, however, they must be preceded in the cycle by evidence which suggests particular variable relationships. This evidence is first amassed with an exploratory, rather than predictive, approach.

CHAPTER 2

Operational Plan

General Design

This study is a descriptive comparison of three groups which are different with respect to their self-image and sex-typed attitudes. The subjects were given a packet containing two questionnaires. The first questionnaire contained pairs of sex-role concepts and subjects were asked to judge the similarity of those concepts. The judgments required were abstract in that definitions were not provided and subjects made the judgments on the basis of their own perceptions of similarity. Similarity of concepts here means the psychological distance which separates two concepts; the smaller the interconcept distance, the greater the similarity.

The second questionnaire was designed to categorize individuals into androgynous, feminine, and masculine groups. Scaling the judgments from the first questionnaire in a multidimensional space by means of Galileo 3.0 provided a means of comparing the three groups. From this comparison a procedure was developed for the determination of message strategies with the objective of producing attitude change. This procedure utilizes vector analytic techniques and linear programming.

Subjects

Students enrolled in eleven different undergraduate class sections in the departments of Radio-Television-Film and Sociology at Temple University were the subjects for this study. The classes ranged from introductory to upper level, with enrollments ranging from 18 to 139. The questionnaires were completed during a single class session; the first administration being on 19 January 1976 and the last being on 27 January 1976. Subjects were orally informed that the questionnaire was part of a research project in the School of Communications and Theater, that it was not a part of their class, and that completion of the questionnaire was voluntary. Students were instructed not to complete a questionnaire if they had already done so in a previous class. Of a total enrollment of 683 for the 11 sections, 432 students (64%) completed the questionnaires. The actual response rate is somewhat higher than 64% since a single student enrolled in two of the sections would appear twice in the enrollment total but only once in the response total. The extent of cross enrollment in these classes is not known.

From the 432 questionnaires the following groups were created (see the section on instrumentation for the grouping criteria used): feminine (67 Ss), near feminine (49 Ss), androgynous (133 Ss), near masculine (74 Ss), masculine (75 Ss). Following Barnett's (1972) suggestion, each group used in the multidimensional scaling has at least 50 subjects. The intent here is to increase reliability by allowing the law of large numbers to account for random error in distance judgments. Thirty-four questionnaires were not used due to: the consistent use of one number by a subject (14 Ss); the subject did not complete the Bem Sex Role Inventory (9 Ss); no sex was indicated by the subject (4 Ss); the subject used irrational or negative numbers in the paired comparison judgments (3 Ss); the subject used sequential numbers in the paired comparison judgments (2 Ss); and/or the subject gave more than one distance estimate which was greater than 1000 (2 Ss).

Table A provides demographic data for the 275 subjects whose questionnaires were used in the multidimensional scaling of personality characteristics. These data are also provided for the 123 subjects who were categorized as near feminine and near masculine and excluded from the multidimensional scaling on that basis. Table B provides the relative frequency distribution of subjects by the five sex-typed groups and by demographics (age, sex, year in school, race, marital status, and family's annual income were supplied by the subjects). Overall Chi square analyses for the relationship between these demographic variables and a subject's androgyny score on the Bem Sex Role Inventory reveal for the 3 groups scaled: (a) there is no significant relationship between age and androgyny score, χ^2 (6) = 11.7; (b) there is a significant relationship between sex and androgyny score, χ^2 (2) = 66.9, $p < .001$; (c) there is no significant relationship between year in school and androgyny score, χ^2 (8) = 11.57; (d) there is no significant relationship between race and androgyny score,

χ^2 (6) = 10.2; (e) there is no significant relationship between marital status and androgyny score, χ^2 (6) = 10.53; and (f) there is no significant relationship between income and androgyny score, χ^2 (10) = 14.07. The significant relationship between sex and androgyny score can be seen by inspecting table B. It shows that females are more likely to be in the feminine group, and males are more likely to be in the masculine group.

Instrumentation

Selection of sex-role concepts for the MMDS instrument (dependent variable). In the development of unidimensional attitude scales, "judges" have traditionally selected the salient concepts from a larger list representative of a particular domain. Such a procedure was used here so that the total number of sex-role concepts, in addition to the concept of "me", could be reduced to 15 (see Sherman, 1972, p. 353). This required that each subject judge the dissimilarity between the 105 distinct pairs of the 15 concepts. The total number of concepts representing the traditional masculine domain is 23; and the total number representing the traditional feminine domain is 36. These concepts were derived from a review of the literature on sex roles and sex-typed behavior (see, for example, Action for Children's Television, 1974; Bem, 1974, 1975a, 1975b; Busby, 1975; Goldschmidt, Gergen, Quigley, & Gergen, 1974; Maccoby & Jacklin, 1974).

Five expert panelists familiar with the research literature on sex roles acted as judges. Appendix A provides the names and university affiliations of the judges; the cover letter, forms, and instructions used in the judging task; and the concepts selected from the literature. Each judge was asked: (a) to select the seven concepts most representative of the traditional masculine role, and to rank order those concepts; and (b) to select the seven concepts most representative of the traditional feminine role and to rank order those. In order that the seven concepts from each domain would be representative of the widest range of roles, the list submitted to the judges was a priori subdivided into "dimensions", and judges were instructed to select no more than one concept from a subdivision (see appendix A). With the judging task completed there remained the problem of determining which of the seven concepts would be chosen from the rank ordering provided by the judges. Table 1 presents the rank order of each judge's seven choices to represent the traditional masculine role, and table 2 similarly presents the traditional feminine role. The highest ranking provided by a judge was assigned a weight of 7, while the lowest was assigned a weight of 1. The weights for each concept were then summed and the final rankings were ordered by weight with the largest ranked first, next largest ranked second, and so on. The highest ranked concepts through this procedure are: aggressive (agg), masculine (mas), dominant (dom), independent (ind), competitive (com), logical (log), and athletic (ath) in the masculine domain; and feminine (fem), emotional (emo), dependent (dep),

Table 1

Rank Order of Traditional Masculine

Personality Characteristics

Personality characteristic	Judge[a] A	B	C	D	E	$\sum$
	Rank order[b]					
Aggressive	6	6	5	6	7	30
Masculine	7	7	7	7	–	28
Dominant	3	5	6	4	–	18
Independent	5	–	4	5	–	14
Competitive	–	4	2	2	2	10
Logical	1	3	–	–	5	9
Athletic	–	2	–	–	6	8
Confident	–	–	–	–	4	4
Knowledgeable	–	–	3	–	–	3
Emotionally independent	–	–	–	–	3	3
Ambitious	2	–	–	–	–	2
Reliable	–	1	–	–	1	2
Realistic	–	–	–	1	–	1

[a](A) A. Beuf; (B) J. Ericksen; (C) L. M. Haskin; (D) J. Mandle; (E) J. Starr.

[b]The highest ranking provided by a judge was assigned a weight of 7, while the lowest was assigned a weight of 1

Table 2

Rank Order of Traditional Feminine

Personality Characteristics

Personality characteristic	Judge[a] A	B	C	D	E	∑
	Rank order[b]					
Feminine	7	7	7	7	–	28
Emotional	5	5	5	4	3	22
Dependent	3	3	6	6	1	19
Gentle	6	4	–	–	–	10
Romantic	–	2	–	–	6	8
Understanding	–	–	–	–	7	7
Sensitive to the needs of others	2	–	4	–	–	6
Empathetic	–	6	–	–	–	6
Loves children	4	–	2	–	–	6
Affectionate	–	–	–	–	5	5
Tender	–	–	–	1	4	5
Anxious	–	–	–	5	–	5
Weak	–	1	1	2	–	4
Compassionate	–	–	–	–	2	2
Incompetent	–	–	3	–	–	3
Accepting	–	–	–	–	2	2
Compliant	1	–	–	–	–	1

[a](A) A. Beuf; (B) J. Ericksen; (C) L. M. Haskin; (D) J. Mandle; (E) J. Starr.

[b]The highest ranking provided by a judge was assigned a weight of 7, while the lowest was assigned a weight of 1.

gentle (gen), romantic (rom), understanding (und), and sensitive to the needs of others (sen) in the feminine domain. These 14 concepts and the concept "me" were then paired with each other in all possible pairs and used as the basis for the metric multidimensional scaling instrument.

As discussed in chapter 1, the judgment task required of subjects completing an MMDS instrument employs the classic analogic paradigm. The final step in constructing the instrument used in this study was the selection of the criterion pair. That is, a somewhat arbitrary procedure was needed to select the concepts which would represent the basis for the ratio-scale paired comparisons. On the basis of criterion pair manipulations, Gordon and De Leo (1976) recommend that, if an homogeneous set of concepts is evident, two criteria should be considered in the selection of criterion pair concepts: (a) that a sufficiently large dissimilarity between the two concepts of the criterion pair be provided; and (b) that a sufficiently large distance between the pair be provided. The first criterion has the objective of producing the least variable judgments by selecting the extreme or near-extreme dissimilar pair from within the concepts being scaled, and the second criterion provides that the concepts being scaled will not be forced into a restricted space. These two criteria were accepted here and on these bases the criterion pair chosen was "independent" and "dependent", and they were assigned a 10 unit separation.

The final step in the construction of the MMDS instrument was writing the instructions. Appendix B contains the instrument with the instructions just as it appeared to the subjects. This instrument was presented as the first of two questionnaires in the packet.

Validity/reliability of the MMDS instrument. In chapter 1 evidence of the predictive and content validity of MMDS was offered. Chapter 3 provides evidence of the content validity of the particular MMDS instrument developed above. Since the subjects are categorized according to sex-typed behavior by an instrument (the Bem Sex Role Inventory) which has established validity and reliability, this instrument may be utilized as a measure of the content validity of the MMDS instrument. In this multidimensional formulation, the concept "me" is the self-concept which each individual possesses in relation to all other concepts in the space. If the MMDS instrument is a valid representation of the subject's perceptions of sex-typed behavior, then the self-concept of the group categorized as masculine by the Bem instrument should be significantly closer to that group's location of the concept masculine than the concept feminine. Conversely, the feminine group's self-concept should be significantly closer to the concept feminine than the concept masculine. The results of *t*-tests reported in table 6 indicate that such is in fact the case, thus supporting the argument of content validity.

In addition to the evidence in chapter 1 on the reliability of MMDS, chapter 3 also provides evidence of the reliability of this particular instrument. While this study reports significantly different self-concepts for the three groups, both the Bartlett's test and the Pearson product moment correlations of tables 4 and 5 provide evidence that different groups of Ss produced statistically identical structures overall. Stated another way, the MMDS instrument proved reliable in a form of test-retest reliability involving equivalent groups of subjects (average $r = .87$).

Bem Sex Role Inventory (independent variable). The second of the the two questionnaires was the Bem Sex Role Inventory (BSRI). The BSRI is composed of 20 masculine personality characteristics, 20 feminine personality characteristics, and 20 neutral characteristics (Bem, 1975a, p. 635). Bem (1975b) has conceptualized masculinity and femininity as two orthogonal dimensions and the roles in the BSRI are gleaned from the positive ends of the dimensions. The respondent is given a scale from 1 to 7 (see appendix B) and asked to indicate how well each of the characteristics describes himself or herself. A person may be described as significantly sex typed by the Student's t ratio for the difference between that individual's mean feminine and mean masculine score, respectively. Bem (1975a, p. 635) writes:

> On the basis of his responses, each person receives an "Androgyny Score" defined as Student's t ratio for the difference between his or her endorsement of masculine and feminine personality characteristics. That is, the Androgyny Score is the difference between a person's endorsement of masculinity and femininity standardized with respect to the standard deviations of his or her masculinity and femininity scores.

If there is no significant difference, then a person is said to equally endorse characteristics of both masculine and feminine personalities and may therefore have an adrogynous sex role.

In the present study the androgyny difference score for each subject was computed by hand following the procedure provided by Bem and Korula (1974, pp. 2-3). The actual selection of subjects for the three groups scaled with MMDS followed Bem and Korula's (1974, p. 9) suggested criteria for classifying subjects in terms of the androgyny *t*-ratio: $t \geq 2.025$, feminine; $1.0 \leq t \leq -1.0$, androgynous; $t \leq -2.025$, masculine. Subjects not used in the MMDS procedure were those with androgyny *t*-ratios greater than 1.0 and less than 2.025 (near feminine, n = 49); and those with *t*-ratios greater than -2.025 and less than -1.0 (near masculine, n = 74).

Table C summarizes the percentage of subjects classified as masculine, feminine, and androgynous through the above procedure. It also presents comparative data from samples taken from Stanford University and Foothill Junior College by Bem and Korula (1974, table I). Table D presents more detailed data on the relative frequency distribution of the entire range of androgyny *t*-ratios, including the relative frequencies for subjects falling in the near masculine and mear feminine categories. Intraclass correlations of the distribution of males at Stanford, Foothill, and Temple yielded an r = .64; and of males at Stanford and Temple yielded an only slightly higher correlation, r = .69. Similarly, intraclass correlations of the distribution of females at the three colleges yielded an r = .51; and females at Stanford and Temple correlated slightly higher, r = .67.

Validity/reliability of the BSRI. In testing the validity of the instrument as a measure of two orthogonal dimensions, Bem (1974) reports empirical and conceptual independence of the masculinity and femininity scores (average $r = -.03$); and the *t*-ratio is internally consistent (average $\alpha = .86$). Further, the instrument's reliability in a test-retest over a four week interval was high (average $r = .93$). The correlation of a subject's tendency to describe himself or herself in a socially desirable direction and the subject's score on the BSRI was very low (average $r = -.06$). Bem has administered the instrument to over 2000 undergraduates in a university and a community college.

Administration of questionnaires. As reported in the above section on subjects, the questionnaires were administered in classrooms during regularly scheduled class sessions. Six of the eleven administrations were done at the beginning of the class; and the remaining five were done during the last 30 minutes of class. Most subjects completed the questionnaires in 30 minutes, but a few subjects stayed as much as 20 minutes longer in order to finish. Regardless of when the Qs were administered, the experimenter employed the same introduction for each of the eleven classes:

> My name is (experimenter's name) from the School of Communications. We would greatly appreciate your cooperation in completing two short questionnaires which are a part of a research project being conducted in the School of Communications. This is not a part of your

> class, you will not be graded on this, and your participation is completely voluntary. Please do not open this packet until told to do so.

At this time the packet was distributed.

> In this packet are two short questionnaires. The first questionnaire is on white paper and I'll read the instructions to this first questionnaire aloud while you read silently with me. When you've finished the first questionnaire (which takes about 20 minutes), please proceed to the second questionnaire. The second questionnaire is printed on gold-colored paper and has different instructions than the first. Read the instructions on the gold paper yourself and complete that part of the packet. Please note the different instructions for the two different questionnaires.

The instructions for the first questionnaire were then read aloud, and the subjects were asked to begin the questionnaires.

Analysis of Galileo Output

Two prefatory comments are offered to this section. First, while this methodology's greatest potential is in time series measurement of cultural processes, the limitations imposed by a master's thesis schedule preclude actual application to a time series. This study establishes a procedure for use by others and a pilot application of that procedure to a single point in time is executed. Analysis of data for any subsequent points in time, however, may follow the procedure recommended here. And second, these analyses of Galileo output have been suggested by previous study. Since there is limited experience with this methodology, it is difficult to anticipate exactly what additional analyses may provide further insight.

The Galileo program provides two related forms of output. First, the following statistics for each of the 105 paired, intercell comparisons averaged within each group of subjects are provided: (a) mean intercell distances, (b) standard deviation, (c) variance, (d) skewness, (e) kurtosis, (f) minimum distance judgment, (g) maximum distance judgment, (h) range of distance judgments, and (i) the number of judgments made on the pair. Second, the centroid scalar products matrix and the unstandardized factor solution of the centroid scalar products matrix are given. This unstandardized, or normal, solution gives the projection of each point along each dimension in space, and the eigenvectors and their corresponding eigenvalues for each dimension. And third, a plot of the first three of n dimensions, and plots of each of the three individual planes are provided. The plots are created through orthogonal decomposition of the n dimensional solution, and as such the first three dimensions account for more variance explained than do any other three dimensions.

The initial step in the analysis of data is ascertainment of goodness of fit. As Torgerson (1958, p. 278) suggests, this can be done by determining whether the centroid scalar products matrix contains any "substantial negative latent roots." This is a simple matter of inspecting the proportion of the variance explained by the largest negative latent root (which in this case will correspond to the eigenvector of the 15th dimension). If this proportion is not unacceptable, then it may be concluded that (within reasonable allowances for experimental error) the distance judgments provided by subjects exist in a real space. This is closely associated with questions of validity and no hard and fast rule for acceptance or rejection can be offered. The best that can be done is to say whether the multidimensional space provides a perfect (i.e., no negative latent roots), excellent, good, poor, bad, or very bad fit (i.e., a negative latent root accounting for 30% or more of the total variance explained).

From the statistics provided, an analysis of variance was performed to test for significant differences in the overall structure of the data of the three groups of Ss. Bartlett's test for homogeneity of variance was performed as a test for differences of each dimension across groups. The eigenvalues for each eigenvector of the normal solution were examined for the amount of variance explained by each successive dimension in order that a minimal number of dimensions could be suggested as the most parsimonious solution and the amount of both real and imaginary variance explained could be maximized.

At the completion of these analyses, the spaces for the second and third groups were "fit" to the space of the first group with a least-squares rotation to congruence. This not only provided a visual check of the content validity of the procedure, but it also provided the point of departure for determination of message strategies.

Optimization of Message Strategies

Part 4.2 of the outline in the introduction to this study referred to "a vector analytic procedure for predicting the movement of concepts through a persuasive campaign." This section sets forth the mathematics of this procedure. First, a rationale is provided for the conceptualization of points in coordinate space as vectors. Second, a basic introduction to linear programming is given, and it is followed by the formulation of attitude change as a linear programming problem. Finally, a hypothetical example is given using the formulation.

Representing points as vectors. The representation of points in a coordinate space as vectors is by no means a novel thought. The coordinate values for a point in three dimensions, for example, have long been used in matrix algebra to fully describe a vector from the origin of the space to a point. Implicit in such a description are both the direction and magnitude of the vector. While not novel in a mathematical sense, there are powerful advantages in conceptualizing points as vectors in a group's cognitive space. Multidimensional scaling provides the coordinate values for points in an *n* dimensional space, and from this information it is a simple matter of subtracting the coordinates of one point from those of another in order to obtain the vector from the first point to the second. For example, if point *A* has coordinates (2,3,4), and point *B* has coordinates (3,4,5), then the vector from *A* to *B* is fully described by (1,1,1). If we subtract *A* from all other points in the space, including *A* itself, we obviously have *A* at the origin (see below) and a set of vectors emanating from *A* to all other concepts in the space.

Locating a concept at the origin. The normal solution for each group provides the projection of each stimulus on each dimension of the space. By subtracting the projection of any concept $\underline{i}$ along each dimension from the projection of each of the 14 other concepts along each dimension, we can shift the entire space so that $\underline{i}$ is at the origin, and the structure remains unchanged. This is done by the elementary row operation performed on the normal solution matrix $\underline{S}$. Thus, $\underline{S} - \underline{s}_{ij} = \hat{\underline{S}}$, ($\underline{j}$ = 1, 2, . . . , $\underline{n}$); where $\underline{S}$ is the normal solution matrix, $\underline{s}_{ij}$ is the projection of the concept $\underline{i}$ along each of $\underline{j}$ dimensions, and $\hat{\underline{S}}$ is the new matrix having the concept $\underline{i}$ at the origin of the space.

Linear programming. An approach which has demonstrated potential in the area of allocating scarce resources is linear programming. (Greater depth than the following brief overview is available in any number of operations research texts such as Hadley, 1962; Hiller & Lieberman, 1967; Kemeny, Snell, & Thompson, 1966; and Thierauf & Klekamp, 1975). "Programming" in this sense is the use of mathematical techniques which, through an iterative process, are designed to optimize an objective function. The modifier "linear" describes a direct proportionality among two or more variables. Linear programming can be described as a mathematical technique which can determine the best allocation of a system's limited resources. Thierauf and Klekamp (1975, pp. 158-159) list five requirements to the use of linear programming: (a) there must be a mathematically well-defined objective function; (b) there must be alternative courses of action; (c) equations and/or inequalities of the first degree must fully describe the objective function and constraint functions; (d) the variables in the system must be interrelated; and (e) the activities must be finite.

The general form of the linear programming model can be stated in the following way (Hiller & Lieberman, 1967, pp. 127-128). Find $x_1, x_2, \ldots, x_n$ which maximize the linear function

$$Z = c_1x_1 + c_2x_2 + \ldots + c_nx_n,$$

subject to the constraints,

$$\begin{aligned} a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n &\leq b_1 \\ a_{21}x_1 + a_{22}x_2 + \ldots + a_{2n}x_n &\leq b_2 \\ &\vdots \\ a_{m1}x_1 + a_{m2}x_2 + \ldots + a_{mn}x_n &\leq b_m \end{aligned}$$

and

$$x_1 > 0,\ x_2 > 0,\ \ldots,\ x_n > 0,$$

where the a_{ij}, b_i, and c_j are given constants. The Z function which is being maximized is known as the objective function. The x_n for which a solution is sought are known as decision variables.

Formulating attitude change as a linear programming problem. For the purposes of the present study, messages designed to change attitudes (i.e., move concepts through cognitive space) are composed of content variables, or forces, which may be validly represented by the vector between two points. Given this objective of moving one group's location of a concept closer to the location of the same concept for a second group, the linear programming approach is simplified considerably by shifting the entire space so that the concept to be moved is located at the origin. It's important to note that this arithmetic transformation does not alter the structure of the space; it is merely a convenience. In any message the selection of content is limited by at least two decisions: (a) of what content shall the message be composed; and (b) what shall be the relative emphasis of that content. The procedure described in this section establishes just how the different content possibilities may be quantified and mathematically analyzed in order to find an optimum strategy for affecting attitude change.

The objective of moving points can be restated as moving the first group's location of a concept in the direction specified by the vector $\underset{\sim}{\alpha}$ which has its origin at point 1 and its terminus at point 2. The vector $\underset{\sim}{\alpha}$ then fully describes the attitude change objective. Since different persuasive messages will yield different amounts of attitude change along this vector, we can further define our objective as maximizing movement in the direction of $\underset{\sim}{\alpha}$. $\underline{Z}$ is the chosen overall measure of effectiveness, and we want to maximize movement in the direction of $\underset{\sim}{\alpha}$, therefore $\underline{Z} = \underset{\sim}{\alpha}$. This satisfies the first linear programming requirement (see above) of a mathematically well-defined objective function.

Given $\underline{n}$ content variables, the decision variables $\underline{x}_1$, $\underline{x}_2$, . . . , $\underline{x}_n$, represent the various levels of emphasis given the corresponding content variables. The number of content variables which can be incorporated into a message, and the relative emphasis which can be given the different content variables indicates that there are alternate courses of action. Thus, the second requirement is satisfied.

The parallelogram rule for the resolution of vectors (see Maxwell, 1958, pp. 59-60) shows clearly that first degree equations fully describe the constraints, thus satisfying the third requirement. Similarly, vectors emanating from a single point are interrelated by their common point, can be resolved, and therefore satisfy the fourth requirement of interrelated variables. Finally, the vectors are dimensionally finite, satisfying the fifth requirement.

All of the above information can be represented in the following model for $\underline{m}$ dimensions. Maximize $\underline{Z} = \underset{\sim}{\alpha}$, subject to the constraints,

$$
\begin{array}{llllllll}
\underline{x}_1 & & & & & & & \leq 1 \\
& \underline{x}_2 & & & & & & \leq 1 \\
& & & \vdots & & & & \\
& & & & & \underline{x}_{\underline{n}} & & \leq 1 \\
\underline{a}_{11}\underline{x}_1 & + \underline{a}_{12}\underline{x}_2 & + & \cdots & + & \underline{a}_{1\underline{n}}\underline{x}_{\underline{n}} & - \underline{b}_1\underline{\alpha} & = 0 \\
\underline{a}_{21}\underline{x}_1 & + \underline{a}_{22}\underline{x}_2 & + & \cdots & + & \underline{a}_{2\underline{n}}\underline{x}_{\underline{n}} & - \underline{b}_2\underline{\alpha} & = 0 \\
& & & \vdots & & & & \\
\underline{a}_{\underline{m}1}\underline{x}_1 & + \underline{a}_{\underline{m}2}\underline{x}_2 & + & \cdots & + & \underline{a}_{\underline{mn}}\underline{x}_{\underline{n}} & - \underline{b}_{\underline{m}}\underline{\alpha} & = 0
\end{array}
$$

and,

$$\underline{x}_1 > 0,\ \underline{x}_2 > 0,\ \ldots,\ \underline{x}_{\underline{n}} > 0,\ \underline{\alpha} > 0,$$

where $\underline{\alpha}$ is the scalar magnitude of $\underset{\sim}{\alpha}$; the $\underline{a}_{\underline{ij}}$ coefficients of each decision variable represent the coordinates of concept j along each of m relevant dimensions[5]; and the b_j coefficients of the objective function represent the desired end location in space of the concept which is being acted upon.

The Devonshire program on linear programming following Hadley's (1962) format and titled LINPRO is the computer program used here in solving problems of this form. LINPRO is capable of handling a maximum of 45 decision variables (concepts) each with a maximum of 160 coefficients (coordinates on separate dimensions). (See appendix C.)

By constraining the x_j to a maximum of 1, a convention is introduced which permits comparing the various solutions. This convention provides not only optimality *within* a given system of n content variables, but it also provides a means of comparing the relative efficacy *between* systems having n content variables.

Once an optimal solution is found, the content variables represented by the x_j must be translated to proportions representing relative content emphasis. This is a straightforward problem of summing the values of x over all n and dividing each x_j by this sum. Symbolically we have,

$$E_j = x_j \Big/ \sum_{j=1}^{n} x_j , \quad (j = 1, 2, \ldots, n),$$

where E_j is the relative emphasis given content variable x_j,

---

[5] In linear programming terms, an activity can be defined by the specific combination of resources which it consumes; in this attitude change model, a concept can be defined by the specific value of its coordinates in a multi-dimensional space.

and $\underline{n}$ is the number of content variables in the message.

Thus far, consideration has been given only to messages designed to move concepts closer together. However, messages can also move concepts farther apart. This may be operationalized as persuading a group to perceive more dissimilarity than exists between two concepts. In terms of vector analysis, reversing the sense of the vector constructed from point 1 to point 2 provides a means of accounting for increased dissimilarity.

A note on the meaning of vector magnitudes is necessary before proceeding further. It must be remembered that the vectors which are being discussed represent forces, not displacements which are further dependent on mass. For example, if a combination of very weak forces act on an object of great inertial mass, the resultant displacement of that object may be slight. But if there is any displacement at all, then that displacement will be in the direction of the resultant of the individual forces in the system. As discussed in chapter 4, further study is needed in the exploration of measures of the inertial mass of concepts.

This study employs content variables which, when represented as vectors, resolve to a vector with the same direction as the objective function and some scalar multiple of its magnitude. In designing message strategies, the interest is in finding the combination of content variables which maximize movement in the direction of the objective function. By employing the procedure described herein, it can be determined which combination of content variables and their respective emphases will result in the greatest movement in the direction of the objective function.

In a three-dimensional space there are only three directions in which a point can move. The three components of a vector in three dimensions may then be conceptualized as limited resources. That is, in terms of linear programming, movement in the $\underline{i}$ direction is limited by the vector's coefficient in that direction. The same holds for movement in the $\underline{j}$ and $\underline{k}$ directions. In the general linear programming model the number of relevant scarce resources is represented by $\underline{m}$, so that each constraint corresponds with a restriction of the availability of the resource. Further, a vector represents the proportionate consumption of these resources in an activity.

<u>Example using the linear programming model</u>. Given three points in space (2,-2,4), (2,2,-3), and (-1,1,2), we want to use the concepts represented by these points in a message. With the me_1 located at the origin, we want to move it towards me_2 which is located at (6,2,6). We have 4 vectors,

$$\underset{\sim}{x}_1 = \begin{bmatrix} 2 \\ -2 \\ 4 \end{bmatrix},\ \underset{\sim}{x}_2 = \begin{bmatrix} 2 \\ 2 \\ -3 \end{bmatrix},\ \underset{\sim}{x}_3 = \begin{bmatrix} -1 \\ 1 \\ 2 \end{bmatrix},\ \underset{\sim}{\alpha} = \begin{bmatrix} 6 \\ 2 \\ 6 \end{bmatrix}$$

and we want to determine how much of $\underline{x}_1$, $\underline{x}_2$, and $\underline{x}_3$ we should emphasize in a message, where $\underline{x}_{\underline{n}}$ is the amount in the direction $\underset{\sim}{x}_{\underline{n}}$. We want to combine these vectors so that the resultant is in the direction of $\underset{\sim}{\alpha}$ in some scalar multiple of the amount $\underline{\alpha}$. Further, we want to maximize movement in the direction $\underset{\sim}{\alpha}$. The problem can be stated as follows. Maximize $\underline{Z} = \underset{\sim}{\alpha}$, subject to the constraints

$$\begin{aligned}
\underline{x}_1 \qquad\qquad\qquad & \leq 1 \\
\underline{x}_2 \qquad\quad & \leq 1 \\
\underline{x}_3 & \leq 1 \\
2\underline{x}_1 + 2\underline{x}_2 - 1\underline{x}_3 - 6\underline{\alpha} & = 0 \\
-2\underline{x}_1 + 2\underline{x}_2 + 1\underline{x}_3 - 2\underline{\alpha} & = 0 \\
4\underline{x}_1 - 3\underline{x}_2 + 2\underline{x}_3 - 6\underline{\alpha} & = 0
\end{aligned}$$

and,

$$\underline{x}_1 > 0,\ \underline{x}_2 > 0,\ \underline{x}_3 > 0,\ \underline{\alpha} > 0.$$

This linear programming problem can be solved by inspection or with the simplex procedure (Hadley, 1962) which provides $\underline{x}_1 = 1$, $\underline{x}_2 = 1$, $\underline{x}_3 = 1$, and $\underline{\alpha} = \frac{1}{2}$ as the optimal solution. Therefore, a message containing equal amounts of content variables $\underline{x}_1$, $\underline{x}_2$, and $\underline{x}_3$ would result in maximal movement in the direction $\underset{\sim}{\alpha}$. For the iterative steps in a maximization problem using the simplex method of linear programming, see Thierauf and Klekamp (1975, pp. 182-183).

Errors in Data Processing and Analysis

The Galileo program utilizes an extraordinary amount of raw data in performing the scaling. Minimization of errors in data transcription from questionnaires to punched cards and a check for proper storage of data were accomplished through the following procedure.

Interstimulus distance judgments required 14 data cards per subject as input. Each card accommodated 8 five-digit data values, including a four-digit row-and-column address for each value. For accuracy, the four-digit addresses and card identification numbers were prepunched through the use of a simple FORTRAN card-punch program, and then subject identification numbers and data values were entered by manual keypunch.

The data were then stored on a disk file and a listing was obtained. A check on keypuncher accuracy was made by randomly beginning with subject number 7 and checking all 105 interstimulus judgments, as provided by every tenth subject's questionnaire, with the data values as they appeared on the listing. Of a total of 2730 data values (26 subjects, 105 values per subject), a total of 18 discrepancies were found. The only perceptible pattern to the keypunching discrepancies was that they resulted mostly from poor legibility of the value on the questionnaire. This rate of error (.006) was deemed acceptable, and the analysis of data storage proceeded.

In order to properly sequence on disk the subjects in each of the three data sets, the data were sorted by subject identification with a SORT program. A SELDEL program was then used to process all 3850 records (275 Ss, 14 records per S), and improperly punched records were selected and deleted. These records were corrected, visually checked for accuracy and added to the file through a SORT/MERGE program. Finally, a FORTRAN program was written to check for proper sequence of subjects within data sets, cards within subjects, and for proper number of cards per subject. Since Galileo addresses were prepunched by the computer and since they must be properly sequenced, no check was necessary on the Galileo addresses. At the completion of these data checks, Galileo reported proper storage of data.

Approximately 10% of the androgyny scores and 10% of the statistics were computed twice. No errors were found in these computations and no further systematic check was executed.

CHAPTER 3

Results

Galileo Data

Distance means matrices. Similarity judgments as provided by the subjects comprise the raw data input to Galileo and are first averaged by the program to provide the mean inter-stimulus distances for each group. For the masculine Ss the number of judgments per cell ranged from 69 to 75 with an average of 73.49 judgments per cell. Only two judgments for this group exceeded the extreme value 100 and both were deleted from the computations. The number of judgments per cell for the androgynous group ranged from 127 to 133 with an average of 130.50 judgments per cell. Six judgments in excess of the extreme value were deleted from the androgynous group. For feminine Ss the judgments per cell ranged from 62 to 67 and averaged 66.22. Two extreme values were deleted from this group. While not conclusive, the high number of average judgments for each group indicates that the Ss did not have difficulty understanding the paired comparisons. Ss were instructed to leave blank any pair which they did not understand. Since all but four of the class sections were free to leave when finished with the questionnaire, it was to the Ss' advantage to do as few comparisons as possible. The distance means between all concept pairs and the number of judgments per cell are presented in symmetric matrix form in tables E, F, and G.

From the information inherent in the mean interstimulus distances, the Young and Householder (1938) technique creates a structure using the Euclidean metric. The origin of the structure is then defined by the geometric mean (Torgerson, 1958), and axes are provided through orthogonal decomposition (Van de Geer, 1971). In chapter 1 it was noted that the expectation prior to data collection was that the three groups would produce different spatial structures for the same personality characteristics. However, when mapped and rotated to congruence on a single set of axes, the structures appeared to be highly similar. The only concept which appeared to vary considerably between groups was the concept "me". That is, the three groups seemed to perceive the personality characteristics in the same way, but they differed in the one important respect of their own location in space. This suggests the necessity for two statistical tests. First, an attempt was made to establish that the point locations were not significantly different. And second, the locations of the self-concepts for the three groups were compared. This latter test is reported in the section below on rotation, while the former is dealt with next.

The originally planned one-way analysis of variance was performed using the unrotated mean interstimulus distances as scores and the three groups as treatments. Since the least squares rotation tends to diminish differences between groups, using the unrotated structures provides a more conservative measure of similarity between groups. The test revealed that the overall structure of each group prior to factor analysis and rotation was not significantly different across the three groups, $F\ (2,312) = .12$ (see table 3). By this test, then, the three groups did not produce significantly different structures.

Table 3

One Way ANOVA of Mean Intercell Distances for Masculine, Androgynous, and Feminine Groups

Source	df	SS	MS	F	p
Total	314	833.68			
Between	2	.64	.32	.12	n.s.
Within	312	833.04	2.67		

Normal solution matrices, eigenvalues and eigenvectors. The percentage of imaginary distance accounted for by the largest negative latent roots for the masculine, androgynous, and feminine groups, respectively, were -9.818, -8.228, and -7.841. Tables H, J, and K provide both the positive and negative eigenvalues, as well as the percentage of real and imaginary distance accounted for by each eigenvector of the normal solution. While the largest negative eigenvalues indicate that the judgments provided by the subjects in each group will not fit into a strictly Euclidean space, they are not so large as to invalidate representation of the structures in a real space. Acceptable goodness of fit to a real space is indicated by the total percentage of imaginary distance accounted for by the sum of the negative latent roots within each space. For the masculine group this is 19.928%, for the androgynous it is 14.915%, and for the feminine it is 18.943%. Stated another way, the procedure for the resolution of vectors which optimize the objective function could be executed in 3 to 9 dimensions for the masculine and feminine groups. Using 3 dimensions in each case explains more than 70% of the real variance. Each additional dimension accounts for a decreasing amount of variance explained until, at 9 dimensions, all of the real distance which may be validly represented in a Euclidean space is accounted for. As an aid to the interpretation of these results, recall that the normal solution is formed through an orthogonal decomposition, or principal components, factor analysis of the spatial representation of points.

The analysis of variance reported in the previous section was a test of the similarity of the spatial representations before the factor analysis of the points. The test found no significant difference in the overall structures. Each of the spatial representations were factor analyzed independently and the Bartlett's test was chosen to test for significant differences of each dimension between groups. None of the three Chi square values obtained from the test proved significant (see table 4). For example, the first dimension of the masculine

Table 4

Bartlett's Test for the Difference of

Each Dimension Among Groups

Dimension	Variance			df	χ^2	p
	Masculine	Androgynous	Feminine			
1	.8649	1.5625	.7921	2	1.95	n.s.
2	.9604	1.0816	.7392	2	.50	n.s.
3	.7744	.7225	.8281	2	.06	n.s.

group is the same as the first dimension for the androgynous group which is the same as the first dimension for the feminine group, χ^2 (2) = 1.95; and this is true of the three major dimensions. This test provides a basis for using three dimensions in the linear programming problem as well as a basis for rotating the three groups to congruence without introducing intolerable distortion into the space.

Another basis for the overall similarity of the structures is provided by Poor's (1972) Index of Invariance. Poor argues that a multidimensional configuration can be interpreted as a spatial representation of the underlying processes from which the raw data were generated. In an attempt to identify those sets of data which have significantly related underlying processes, Poor developed the Index of Invariance. "One function of the index of invariance is to measure the magnitude and significance of the relationship between two multidimensional configurations, and thereby estimate the magnitude and significance of the relationship between the processes from which the two sets of data derive" (p. 4). For 15 points in 3 dimensions Poor's index substantiates no significant difference in the overall structure of the three groups. Table 5 presents the Pearson product moment correlations for all six possible pairs of groups, all significant at the .005 level of significance in Poor's Index of Invariance (see Poor, 1972, table 8; and Poor & Wherry, in press). This test provides further evidence that the three groups may be rotated without the introduction of intolerable distortion.

After rotating the androgynous and feminine spaces to the masculine space, three dimensional plots were generated to represent the three structures on a single set of axes. It should be noted here that the rotation of the second and third spaces to congruence with the first is a purely arbitrary procedure which does not affect the representation of the three

Table 5

Pearson Product Moment Correlation Between Groups on Mean Interstimulus Distances

	Group		
Group	Masculine	Androgynous	Feminine
Masculine	1.0000		
Androgynous	.9442[a]	1.0000	
Feminine	.7734[a]	.8850[a]	1.0000

[a]Poor's Index of Invariance significant, $p < .005$ (15 points in 3 or more dimensions).

spaces on common axes. The same result would have been obtained had the first and third spaces been rotated to fit the second or had the first and second been rotated to fit the third. Table L presents the coordinate values for the scaling of all 15 concepts by the 3 groups.

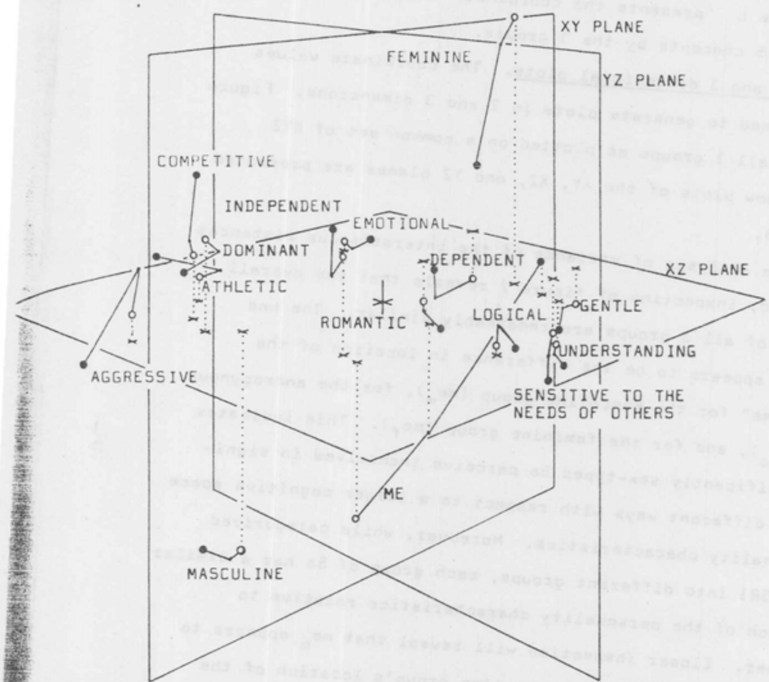
Planar and 3 dimensional plots. The coordinate values were next used to generate plots in 2 and 3 dimensions. Figure 2 presents all 3 groups as plotted on a common set of XYZ axes. Shadow plots of the XY, XZ, and YZ planes are presented in figure 3.

As the analysis of variance of the interstimulus distances illustrated, inspection of figure 2 reveals that the overall structure of all 3 groups are remarkably similar. The one exception appears to be the difference in location of the concept "me" for the masculine group (me_m), for the androgynous group (me_a), and for the feminine group (me_f). This indicates that significantly sex-typed Ss perceive themselves in significantly different ways with respect to a larger cognitive space of personality characteristics. Moreover, while categorized by the BSRI into different groups, each group of Ss has a similar conception of the personality characteristics relative to each other. Closer inspection will reveal that me_m appears to be relatively close to the masculine group's location of the concept "masculine" (mas_m); and me_f appears to be relatively close to the feminine group's location of the concept "feminine" (fem_f); and finally, me_a appears somewhere between me_m and me_f. This makes intuitive sense, however, the problem of

Figure 2

Three Dimensional Plot of Fifteen Concepts for

Three Groups after Orthogonal Rotation to Congruence



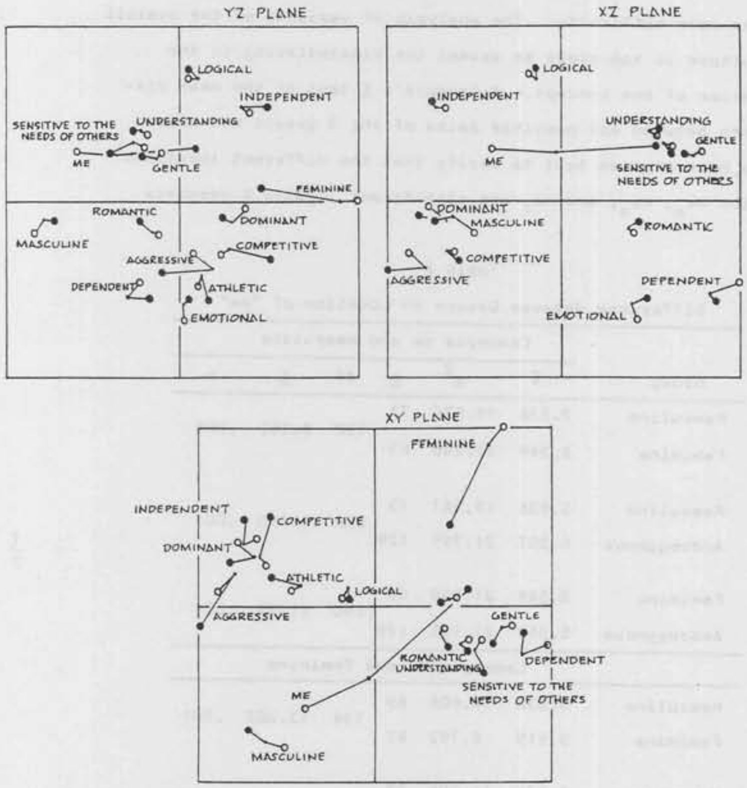
o location of concept for masculine subjects

· location of concept for androgynous subjects

● location of concept for feminine subjects

Figure 3

Planar Plots of Fifteen Concepts



o location of concept for masculine subjects

· location of concept for androgynous subjects

• location of concept for feminine subjects reporting a valid test of the significance of these deductions poses some difficulty. The analysis of variance of the overall structure is too gross to reveal the dissimilarity in the location of one concept. A Student's t test of the mean distances between all possible pairs of the 3 groups was chosen as a more precise test to verify that the different locations of the me_m, me_a, and me_f are significant. Table 6 presents

Table 6

Difference Between Groups on Location of "me"

Group	$\bar{x}$	s^2	n	df	t	p
	Concepts me and masculine					
Masculine	3.836	18.576	73	132	8.357	.001
Feminine	8.349	21.248	63			
Masculine	3.836	18.567	73	200	3.410	.001
Androgynous	5.357	21.795	129			
Feminine	8.349	21.148	63	190	6.339	.001
Androgynous	5.357	21.795	129			
	Concepts me and feminine					
Masculine	8.638	14.608	69	134	13.363	.001
Feminine	3.119	8.792	67			
Masculine	8.638	14.608	69	194	5.317	.001
Androgynous	6.543	15.823	127			
Feminine	3.119	8.702	67	192	9.564	.001
Androgynous	6.543	15.823	127			

six separate two-tailed $\underline{t}$-tests (all significant, $p < .001$) for the difference between mean distances between the following points (see figure 2): (a) me_m-mas_m and me_f-mas_f; (b) me_m-mas_m and me_a-mas_a; (c) me_f-mas_f and me_a-mas_a; (d) me_m-fem_m and me_f-fem_f; (e) me_m-fem_m and me_a-fem_a; (f) me_f-fem_f and me_a-fem_a. Two conclusions may be deduced from these results. First, me_m is significantly closer to mas_m than to fem_m, and me_f is significantly closer to fem_f than to mas_f. This supports the content validity of the multidimensional representation of significantly sex-typed groups. And second, me_m, me_a, and me_f all occupy significantly different locations in the space. This supports the conjecture that the three groups perceive themselves in significantly different ways with respect to a cognitive space of personality characteristics which are common to all groups.

Pilot Application to Masculine Space

Since the only major structural difference between groups is the location of the self-concept, it appears that the attitude change objective for the present data is to move the sex-typed individuals toward the androgynous individuals in self-image. For the purposes of illustration, the remainder of this chapter shall deal with the case of moving me_m to me_a. Bear in mind that while the same procedure would be followed given a different objective, the constants $\underline{a}_{ij}$ and $\underline{b}_j$ would assume different values in the linear programming model. This pilot application is presented in an attempt to illustrate the proposed methods for selecting optimal message strategies.

General decision steps. Given n concepts scaled in m dimensions by two or more groups, the following decisions must be made in the application of this procedure. Assumptions are provided where they are attendant to the particular decision step.

First, a primary target group must be selected. It is assumed that the location of concepts as scaled by the group selected are the only locations relevant to the analysis. That is, decision variables are permissible only when constructed from the judgments provided by the target group. Second, the researcher must decide which concept is to be moved, and inherent in this decision is the definition of the objective function. By deciding to move a concept from point 1 to point 2, the vector connecting those two points becomes the objective function. The third step is to adjust the spatial coordinates of each concept so that the concept to be acted upon is located at the origin. Having completed this step, the coordinates of each concept then describe the vectors (or content variables) which can be chosen to act upon the concept to be moved.

The fourth decision relates to the number of content variables which the researcher desires to include in the message. This number may be arbitrarily chosen beginning with 1, or it may be predetermined by factors endogynous to the cognitive space (this latter condition is discussed in chapter 4). The actual number of concepts finally used in the optimal message, however, is dependent upon the feasible solutions provided by the linear programming model. For example, should the researcher decide to include only two concepts in a message, then this decision is contingent upon the linear programming model producing a solution containing only two decision variables. The researcher should be aware that there may not be any solution of two decision variables, in which case the two-concepts criterion must be abandoned in favor of three concepts. Again, should three decision variables produce no feasible solutions (a situation not uncommon in a space of four or more dimensions), then the next highest number of concepts must be tried, and so on. Appendix C provides a FORTRAN computer program which creates all possible combinations of n-tuples and inputs those combinations into the LINPRO computer program.

Execution of the above four steps provides the optimal solutions which maximize the objective function in the linear programming model. These optimal solutions are then rank ordered, and the one solution which provides the largest value for the objective function multiplier α is chosen as the optimal message strategy. The x_j for this solution then translate to the relative emphasis given each content variable in the message.

Execution of decision steps in masculine space. For application of these steps to this study, the masculine sample was arbitrarily chosen as the target group. The second decision is obvious given these data. The only concept with a significantly different location across the three groups is the self-image, and the me_m is therefore chosen as the concept which is to be moved. Further, it was decided to move it to the location of the me_a. This defines the objective function as the vector eminating from me_m and terminating at me_a. Completing the third step provides a space containing 15 vectors, 14 of which are decision variables, and one of which is the objective function. Moving me_m to me_a represents changing the masculine group's attitude with respect to their self-concept so that their attitude might become consistent with the androgynous group's attitude. Spence, Helmreich, and Stapp (1975, p. 35) provide a rationale for this decision suggesting that androgyny "may lead to the most socially desirable consequences, the absolute strengths of both masculine and feminine components influencing attitudinal and behavioral outcomes for the individual."

For the fourth step it was decided to arbitrarily seek a minimum number of concepts which would produce an optimal solution. This was done through the following sequence. First, all vectors emanating from me_m were checked to find any scalar multiples of the vector from me_m to me_a. None were found. While it may appear that designing a message which contains a straightforward relationship between me_m and me_a would be the most effective in maximizing motion along the objective function, the content variable me_a cannot be used in a message targeted for the masculine group. Since me_a exists only by virtue of judgments made by the androgynous subjects, its use would violate the assumption made in the first step above.

Second, all possible pairs were alternately substituted in the linear programming model and none were found to provide a solution. The third step was to try all possible triads of the 14 concepts. Of 364 possible combinations the LINPRO program provided 79 optimal solutions. Table 7 provides the rank order of the objective function values for each of the top 20 solutions and figure 4 illustrates the vectors which maximize the objective function. The values of the objective function are a measure of the relative effectiveness of the various combinations of the content variables. Had no solutions been found in all possible triads, the next step would have been to execute the linear programming problem

Figure 4

Illustration of Optimal Solution for Masculine Group

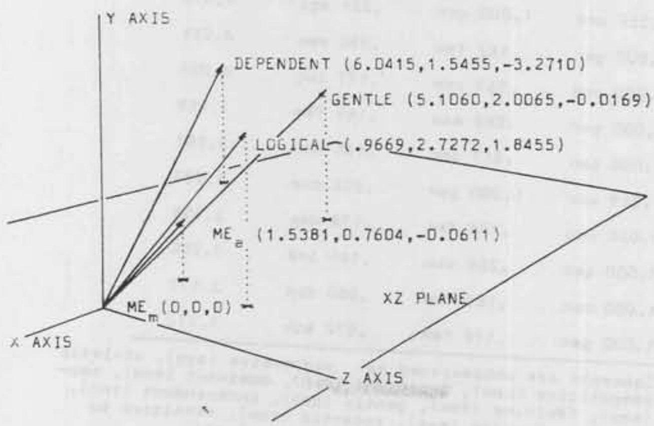


Table 7

Optimum Solutions for Three Content Variables

Rank	Multiplier/ concept	Multiplier/ concept	Multiplier/ concept	Multiplier objective
	Values of decision variables[a]			
1	1.000 gen	.907 log	.732 dep	6.933
2	1.000 sen	.865 log	.722 dep	6.400
3	1.000 und	.813 log	.781 dep	6.333
4	1.000 gen	.520 rom	.312 log	4.786
5	1.000 und	.739 sen	.288 ath	4.777
6	1.000 und	.508 gen	.253 ath	4.342
7	1.000 sen	.514 rom	.278 log	4.284
8	1.000 gen	.194 fem	.059 dep	4.283
9	1.000 gen	.110 rom	.168 fem	4.208
10	1.000 gen	.264 log	.217 emo	4.097
11	.364 und	1.000 gen	.221 agg	4.076
12	1.000 gen	.162 fem	.050 emo	4.061
13	1.000 und	.563 rom	.177 log	4.061
14	1.000 gen	.088 mas	.185 fem	3.988
15	1.000 gen	.217 ind	.186 dep	3.987
16	.269 und	1.000 gen	.202 com	3.983
17	1.000 und	.174 fem	.178 dep	3.958
18	1.000 gen	.268 rom	.146 ind	3.900
19	1.000 sen	.185 fem	.080 dep	3.871
20	1.000 gen	.116 fem	.072 ath	3.773

[a]Concepts are abbreviated as: aggressive (agg), athletic (ath), competitive (com), dependent (dep), dominant (dom), emotional (emo), feminine (fem), gentle (gen), independent (ind), logical (log), masculine (mas), romantic (rom), sensitive to the needs of others (sen), and understanding (und).

with all possible quadruples as the content variables.

Table 7 also provides the optimum level of utilization of each of the three content variables. Computing the relative emphasis of each variable by the formula provided in chapter 2, we have 38%, 34%, and 28% of the message content devoted respectively to persuading masculine individuals to perceive the concepts gentle, logical, and dependent as closer to their self-image. This is a convenient juncture to reiterate that there are variables in the design of persuasive communication which are not accounted for in the above selection of content and relative emphasis. While consideration of these variables is beyond the scope of this study, this procedure can accommodate these other variables as will be discussed in chapter 4.

CHAPTER 4

Discussion

This study establishes a technique for selecting combinations of content variables which have been scaled in a multidimensional space. On the basis of related past research (Taylor et al., 1975), this technique assumes that the representation of forces as vectors and the resolution of these vectors can be applied to concepts in a cognitive space. Having made this assumption, a mathematical technique was employed for selecting the optimal combination of content variables for affecting attitude change. This technique, known as linear programming, provided the optimal of all feasible combinations and the proportion of total message content that each content variable should be assigned. A procedure for the selection of concepts to be scaled in the area of sex-typed behavior was provided and the concepts selected from that procedure were scaled by a sample of Temple University students. Measures of content validity and alternate treatments reliability are provided for the MMDS instrument. From the a priori categorization of subjects into three sex-typed categories a comparison was made of the spaces of each group. Finally, a pilot application of the content selection procedure was performed on the cognitive space generated by the masculine group.

Instrumentation

Bem Sex Role Inventory. The distribution of androgyny t-ratios as reported in chapter 2 compare favorably with the distributions reported by others (Bem & Korula, 1974). This suggests that the instrument performed reliably in this application. The BSRI presented only minor difficulty to some subjects who questioned the experimenter for definitions of terms on the inventory. The extremely low incidence of subjects questioning the meaning of "self reliant" and "unsystematic" can probably be attributed to the subjects' ignorance rather than the instrument's failings.

Another problem is the matter of setting cut-off points for the androgyny t-ratio in determining which subjects are to be included in a significantly sex-typed group. The cut-off points used herein resulted in discarding questionnaires for 31.9% of the males and 29.6% of the females. In order to compensate for this attrition, more questionnaires must be administered than will be used in the multidimensional scaling.

In the broader context of past performance and the instrument's high validity and reliability, the problems encountered with the BSRI seem to be far outweighed by its utility in providing a measure of an individual's sex-role stereotype as reflected by their self-concept. Further, the scaling results presented above for both the BSRI and the MMDS instruments suggest that there is a relationship between sex-role stereotypes and self-concept. This is consistent with the finding by Rosenkrantz, Vogel, Bee, Broverman, and Broverman (1968, p. 287) who write that "sex-role stereotypes, with their associated social values, influence self-concepts."

<u>Metric multidimensional scaling instrument</u>. From the discussion of this instrument's validity and reliability in chapter 2, and from the results presented in chapter 3, the MMDS instrument seems to have performed the function of tapping the cognitive space of the subjects' attitudes on sex-role stereotypes. It did not perform without problems; two of which are discussed here.

First, 21 questionnaires were not used due to the inability of the subjects to properly complete them. The difficulty which these subjects experienced appears to be related to the demands of ratio scale measures. That is, these subjects were just not able to apply the criterion pair to the 105 comparisons. The second problem is inherent to multidimensional scaling. That is the problem of presenting subjects with all possible pairs of the concepts to be scaled. With just 15 concepts the subjects are required to make 105 ratio scale judgments -- admittedly a fatiguing task. This fatigue factor may have been responsible for some of the sequential, irrational, and disproportionate numbers given by subjects within the 21 questionnaires discarded. While utilization of one of the nonmetric routines would solve the problems which arise from Galileo's requirement of ratio scale judgments, the second problem of subject tedium would still remain.

Neither of these problems appears to be major for this study. Discarding 21 Qs represents less than 5% of the total administered. As reported in chapter 2, the time in which most subjects completed both questionnaires was less than 30 minutes. If a study requires scaling more than 15 concepts, then serious consideration should be given to the effects which such a large number of judgments might have on the results.

Metric multidimensional scaling. Perhaps the most interesting result of this study is the three dimensional plot of the 15 concepts for the 3 groups (figure 2). Herein appears evidence that subjects are in fact capable of reliably reporting similarity in terms of a ratio scale. Three different groups with significantly different self-concepts reported nearly identical perceptions of the avarage individual. But there is one important problem in the use of reports relative to the average individual: the problem of categorizing both the average male and the average female as the average individual. Of great utility would be a comparison between the multidimensional spaces produced by judgments made relative to both the average female and the average male. Further insight could be gained by requesting subjects to make judgments relative to their conception of both the ideal male and the ideal female.

Use of the Euclidean metric in constructing this multidimensional space seems to be justified by the relatively small negative eigenvalues. This is consistent with the findings by others (Hyman & Well, 1967, 1968; Schroder et al., 1967; Shepard, 1964; Torgerson, 1958) that the Euclidean metric may be appropriate for stimuli which exist in a highly complex structure.

The most significant finding of this scaling procedure is the location of the masculine group's self-concept as significantly close to the concept "masculine"; and the location of the feminine group's self-concept as significantly close to the concept "feminine". This finding, along with the consistent finding produced by the BSRI suggests that MMDS may be validly utilized as a measure of the relationship between sex-role stereotypes and self-concepts of college students.

Since it is advantageous to use at least 50 subjects per MMDS treatment, a nonmetric MDS technique may prove more practical in terms of the fewer subjects needed. It has been suggested (Woelfel, 1974a) that MMDS is unreliable for the measurement of individuals due to random error and that this error is averaged out with a large number of subjects. The nonmetric techniques, however, are limited in a different way. Galileo contains a means of rotating two structures to congruence, a necessary step in the procedure and a step not contained in the nonmetric routines. If a nonmetric routine were utilized, the experimenter would be faced with the additional inconvenience of taking the MDS output and performing orthogonal rotations. Given the limited empirical evidence supporting the contention that the metric and nonmetric procedures produce the same metric space, two factors influencing the choice of one technique over the other would seem to be the time and resources which the researcher has at his or her disposal.

Generation of Message Strategies

With respect to the pilot application to the masculine sample, it is evident that human communication is so complex that a tremendous variety of messages may be effective in producing attitude change. It is also intuitively evident that some messages may be more effective than others. Table 7 presents the top 20 of the 79 feasible combinations of all content variables taken 3 at a time. Table 7 reveals that through this technique different strategies may be assigned weights relative to their theoretical effectiveness. If the validity and reliability of this linear programming model is established through empirical test, it will provide a means for the systematic analysis of the highly complex phenomenon of attitude change. This point is discussed further in the section below on theoretical implications.

Further inspection of table 7 reveals that there is a core of 3 concepts (gentle, understanding, sensitive to the needs of others), and 1 of the 3 appears in each of the solutions. Considering the given objective of changing the masculine group's self-concept so that it becomes more like that of the androgynous group, these concepts are logical choices for a persuasive message. The message containing any one of these concepts would be urging masculine subjects to move closer in their self-image to these traditionally feminine personality characteristics. Since these subjects already possess masculine characteristics, it's imperative that they acquire feminine characteristics if they are to become androgynous individuals. What is not logical, and what this technique reveals, is that combining all three of these concepts in a message may not be as effective as the optimal strategy proposed.

The optimal strategy for changing one group's attitude has been presented here. However, if the objective of a persuasive campaign is to convert two groups, then additional steps are necessary. For example, if the objective is to convert both masculine and feminine subjects, then the optimal strategy for converting one group may not be the optimal strategy for converting the other. One course of action might be to solve the linear programming model independently for each of the groups, to rank order the solutions, and to select the one strategy which has the highest coincidence of relative emphasis for the same three concepts. The content variables derived in this way are not likely to be the same as the optimal solution for either of the groups taken individually, but consideration must be given to the goal of maximizing two separate objective functions simultaneously.

This general model might also be used in the special case of concepts having a strong predetermined association with the concept being acted upon. For example, a political candidate who is strongly associated with certain issues might require that, of all the issues scaled, only those issues may be stressed which are designed to increase the candidate's popularity. The special case is then a matter of determining which issues are to be excluded from the linear programming model and inputting the remaining permissible concepts. Campaign strategies could then be designed emphasizing the specific proportions of issues provided by the model.

Limitations

While this methodology may have great potential in the study of communication, it is now at an embryonic stage and caution is warranted in the interpretation of results. Several limitations of which the reader should be aware are stated here. First, the strict requirements of higher than ordinal judgments have long been considered a limitation by those who have favored the nonmetric MDS techniques. But the risks must be weighed against the potential utility afforded by ratio scales. Taylor et al. (1975), Gordon and De Leo (1976), and Gordon (1976) offer evidence that subjects can in fact make reliable ratio scale judgments. However, until construct validity can be established for MMDS, proceeding with caution is warranted. Second, the software of this MMDS technique (i.e., Galileo 3.0) is just recently operational. Success has been enjoyed with the program, nonetheless, it is new and the success is based on performance in a limited range of applications.

Danes and Woelfel (1975), Taylor et al. (1975), and Woelfel, Woelfel, Gillham and McPhail (1974) offer evidence of high predictive validity in describing the motion of dependent variables which resulted after the introdution of information into the system. Third, researchers using this methodology are borrowing heavily from the physical sciences and the assumptions made in this respect must be considered as assumptions pending empirical verification. Fourth, Galileo only permits use of the Euclidean distance function in creating a metric space. This point was discussed above, however, it should be repeated here that several of the nonmetric algorithms have the capability of utilizing a wide variety of distance functions (see Lowenhar & Stanton, 1975; Green & Carmone, 1970, pp. 24-27).

A limitation in design may have resulted from the wording of the instructions to the MMDS instrument. Subjects were told to "Think of the personality characteristics on the next few pages as they would apply to the <u>average</u> person" (see appendix B). This particular instruction may have been the cause of the overall structural similarity between the three groups. Administered <u>without</u> the instruction to make judgments with respect to the average, a pretest produced feedback from subjects who stated that they found themselves making judgments variously with respect to their own ideal, the average, and themselves. On the basis of this feedback it was decided that subjects should be instructed to provide judgments according to their own conception of the average person. While the assumption that the subjects would produce significantly different structures was shown to be false, instructing subjects to provide judgments relative to their conception of the average person may not have been a serious limitation. Subjects did produce significantly different locations for the self-concept and those locations were shown to have content validity.

Findings pertinent to the multidimensional structure of sex-typed personality characteristics are limited as to their generalizability since the subjects in this study were not selected with techniques designed to draw a representative sample. The study design did not provide for selection of a random sample because its purpose was primarily methodological. However, on the basis of analyses which show no statistical difference in the distribution of androgyny _t_-ratios for this and other samples of students, and on the further consideration that this sample was chosen independently of the comparative samples, a case may be made, albeit a weak one, for the applicability of these findings to college students.

A further limitation of the multidimensional structure is that it may not be generalized beyond the concepts which were scaled. Greater detail could have been provided had the judges not been limited to 7 concepts from each of the traditionally masculine and traditionally feminine domains. As mentioned above, combining the concepts in all possible pairs limits the number of concepts which the researcher can effectively present to subjects in an MDS questionnaire.

Recommendations for Future Research

While this study concentrates on a procedure for the optimal selection of content variables, it can also be suggested that the effect of other variables in persuasive message design can be assessed with a similar procedure. For example, if sources are to be scaled rather than content variables, then the objective might be defined as finding the optimum combination of credible sources for a cultural subgroup. By appropriate sampling, the sources to be scaled could be selected from a universe of sources and the same vector analytic procedure applied to content variables could then be applied to select the optimal source or combination of sources. By analogy, any of the message variables given in figure 1 may be so treated. The highest priority should be given to empirically testing the effect which these strategies have on attitudes.

Saltiel and Woelfel (1975) hypothesize that a measure of mass may be a function of the number of messages received by an individual on a particular concept. But since no reliable procedure exists for the measurement of the mass of the concepts in this study, reference is made to maximizing movement without providing any absolute measure of the movement. In reality it seems that the concepts considered here are of a very high mass and they are therefore difficult to move. The intuitive parallel is that attitudes on sex roles are very hard to change. None of this excludes the possibility that these attitudes may be changed, that some strategies may be more effective than others in affecting change, and that the procedure given herein may provide a valid measure of the relative effectiveness of different strategies. Future research is needed on this notion of mass, whether it is a function of the number of messages as Saltiel and Woelfel hypothesize, or whether some other measure similar to attitude intensity or ego involvement might be a more accurate descriptor.

Theoretic Implications

Application of this procedure may produce the most readily interpretable results when the concept to be moved is one which is not very well fixed in the subject's cognitive space. Taylor et al. (1975) performed a crude "eyeball" vector analysis in a cognitive space of political issues and candidates and found the analysis to be a valid measure for predicting movement of a political candidate who was little known among the voters. With the procedure established herein, the vector analysis no longer need be crude, but rather systematic and exhaustive.

This mathematical approach also provides a means of deriving message strategies from a multidimensional space of greater than 3 dimensions. Should the researcher find that the multidimensional space which has been generated is of 4 or more dimensions, then it is a simple matter of increasing the _m_ resources in the linear programming model to account for the higher dimensions.

In terms of this vector analysis approach to attitude change, it must be stressed that the vector magnitudes are representative of forces, not displacements. This implies that the more dissimilar two concepts are (i.e., the farther apart they are in a multidimensional space) the greater the force needed to pull them together. The linear programming model accounts for this requirement, as well as the vector's direction, since all of this information is contained in the $\underline{a}_{\underline{ij}}$ coefficients which represent the coordinate values of the concepts. This conceptualization of vectors as forces and not displacements has great importance for it minimizes the necessity for quantifying the mass of concepts (which will affect the amount of displacement) and emphasizes the importance of quantifying the relative forces (which will affect the direction of displacement). This is not to say that the concept of mass is unimportant; it only de-emphasizes the necessity for an accurate measure of mass. The same forces will produce movement in a specified direction regardless of the mass of the concept on which they act. In the case of cognitive spaces which represent a subgroup of 50 or more individuals, it seems unlikely that any persuasive campaign will convert the whole group completely. The implication here is that a concept located in space by virtue of the judgments of 50 or more subjects is necessarily of large mass. Such a complete conversion is represented by moving a concept the full distance from its location at time 1 to a location coincident with the objective at time 2. Using the example of me_m

and me_a, displacement along this entire vector would indicate that the masculine subjects had been persuaded to hold the same attitudes as the androgynous subjects. Not only does this total conversion seem unlikely, but it seems that all movements affected by persuasive campaigns will be represented as very small displacements in the space. Given these premises, the importance of predicting the <u>direction</u> of displacement greatly outweighs the importance of predicting the <u>amount</u> of displacement.

Since the advent of attitude change research, controversy has surrounded findings of primacy and recency effects. No trend has yet been established for predicting either of these effects. The mathematics of vector resolution upon which this study is based preclude the possibility of there being <u>any</u> primacy or recency effects. That is, given more than one content variable in a message, the same objective function will result regardless of the order in which the variables are combined. If attitude change research should produce conclusive evidence for an order effect, then the utilization of vector analytic procedures would be suspect on the basis of their inability to account for such effects.

The purpose of this study was to develop a procedure using MMDS and vector analytic techniques which would provide insight into attitudes on sex-typed behavior; and which would provide a procedure for determining which content variables could be most effectively utilized in messages designed to change those attitudes. Further study is needed to explore the validity and reliability of both the MMDS system and application of the linear programming model presented in this study. Time series studies producing plots which record the movement of concepts through space should be given the highest priority in any further study with this technique.

References

Abelson, R. P. A technique and a model for multidimensional attitude scaling. Public Opinion Quarterly, 1954, 18, 405-418.

Action for Children's Television. Sex roles as portrayed on television: A bibliography. Newtonvill, Mass.: Author, 1974.

Adams, W. NOW action to create a feminist broadcast media. Washington, D. C., National Organization for Women National Broadcast Media (FCC) Task Force, April, 1974. (Mimeographed)

Attneave, F. Dimensions of similarity. American Journal of Psychology, 1950, 63, 516-556.

Bardwick, J. M., & Schumann, S. I. Portrait of American men and women in TV commercials. Psychology, 1967, 4, 18-23.

Barnett, G. A. Reliability and metric multidimensional scaling. Unpublished research report, East Lansing, Michigan State University, 1972.

Barnett, G. A. Social system homophily as a function of communication. Paper presented at the Annual Meeting of the International Communication Association, New Orleans, 1974.

Barnett, G. A. The diffusion of complex innovations. Unpublished manuscript, East Lansing, Michigan State University, 1975.

Barnett, G. A., Serota, K. B., & Taylor, J. A. A method for political communication research. Paper presented at the Annual Meeting of the Association for Education in Journalism, San Diego, 1974.

Barnett, G. A., & Wigand, R. T. Measuring the national development process: An improved method through multidimensional scaling. Paper presented at the Annual Meeting of the International Communication Association, Chicago, 1975.

Bem, S. L. The measurement of psychological androgyny. Journal of Consulting and Clinical Psychology, 1974, 42, 155-162.

Bem, S. L. Sex role adaptability: One consequence of psychological androgyny. Journal of Personality and Social Psychology, 1975, 31, 634-643. (a)

Bem, S. L. Beyond androgyny: Some presumptuous prescriptions for a liberated sexual identity. Unpublished paper Department of Psychology, Stanford University, Palo Alto, Cal., 1975. (b)

Bem, S. L. & Korula, C. W. Scoring packet for the Bem Sex Role Inventory. Unpublished paper Department of Psychology, Stanford University, Palo Alto, Cal., 1974.

Bergman, J. Are little girls being harmed by "Sesame Street"? New York Times, January 2, 1972, p. 13.

Busby, L. J. Sex roles as presented in commercial network television programs directed toward children: Rationale and analysis. Ph.D. Dissertation, The University of Michigan, 1974.

Busby, L. J. Sex-role research on the mass media. Journal of Communication, 1975, 25, 107-131.

Cathey-Calvert, C. Sexism on "Sesame Street": Outdated concepts in a "progressive program." Pittsburgh, Pa.: KNOW, Inc., 1973.

Cody, M., Marlier, J., & Woelfel, J. A reconceptualization of multiple attribute measurement: The location of unidimensional scales in an n-dimensional space. Paper presented at the Annual Mathematical Psychology Meetings, W. Lafayette, Ind., 1975.

Coombs, C. H. A theory of data. New York: John Wiley and Sons, 1964.

Coombs, C. H., Dawes, R. M., & Tversky, A. Mathematical Psychology. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1970.

Comstock, G., Lindsey, G., & Fisher, M. Television and human behavior: The research horizon, future and present. Santa Monica, Cal.: The Rand Corporation, 1975.

Courtney, A. E., & Whipple, T. W. Women in TV commercials. Journal of Communication, 1974, 24, 110-118.

Danes, J. E., & Woelfel, J. An alternative to the "traditional" scaling paradigm in mass communication research: Multidimensional reduction of ratio judgment of seperation. Paper presented to the Annual Meeting of the International Communication Association, Chicago, 1975.

DeFleur, M. L. Theories of mass communication. New York: David McKay Co., Inc., 1970.

De Leo, H. C. Multidimensional scaling: A review of the literature. Unpublished paper, School of Communications, Temple University, Philadelphia, Pa., 1975.

Dominick, J. R., & Rauch, G. E. The image of women in network TV commercials. Journal of Broadcasting, 1972, 16, 259-265.

Downing, M. Heroine of the daytime serial. Journal of Communication, 1974, 24, 130-137.

Ekehammar, B. Multidimensional scaling according to different vector model for subjective similarity. Acta Psychologica, 1972, 36, 79-84.

Fillenbaum, S., & Rapoport, A. Structures in the subjective lexicon. New York: Academic Press, 1971.

Gardner, J. A. "Sesame Street" and sex-role stereotypes. Women: A Journal of Liberation, 1970, 1, 42.

Gerbner, G. Violence in television drama: Trends and symbolic functions. Television and Social Behavior, Vol. 1. Washington, D.C.: U.S. Government Printing Office, 1972.

Gillham, J. R. The aggregation of shared information in a sociology department. Ph.D. Dissertation, University of Illinois, Urbana, 1972.

Gillham, J. R., & Woelfel, J. The Galileo system of measurement: Preliminary evidence for precision, stability and equivalence to traditional measures. Unpublished paper, University of Akron, Akron, Ohio, 1975.

Goldshmidt, J., Gergen, M. M., Quigley, K., & Gergen, K. J. The women's liberation movement: Attitudes and action. Journal of Personality, 1974, 42, 601-617.

Gordon, T. F. Subject abilities to use metric MDS: Effects of varying the criterion pair. Unpublished paper, School of Communications, Temple University, Philadelphia, Pa., 1976.

Gordon, T. F., & De Leo, H. C. Structural variation in "Galileo" space: Effects of varying the criterion pair in metric multidimensional scaling. Paper presented at the Annual Meeting of the International Communication Association, Portland, Oregon, 1976.

Green, P. E., & Carmone, F. J. Multidimensional scaling and related techniques in marketing analysis. Boston: Allyn and Bacon, Inc., 1970.

Green, P. E., & Rao, V. R. Applied multidimensional scaling. New York: Holt, Rinehart and Winston, 1972.

Gregson, R. A. M. Psychometrics of similarity. New York: Academic Press, 1975.

Gulliksen, H. Paired comparisons and the logic of measurement. Psychological Review, 1946, 53, 199-213.

Guttman, L. A general nonmetric technique for finding the smallest coordinate space for a configuration of points. Psychometrika, 1968, 33, 469-506.

Hadley, G. Linear programming. Reading, Mass.: Addison-Wesley, 1962.

Head, S. W. Content analysis of television dramatic programs. Quarterly of Film, Radio and Television, 1954, 9, 175-194.

Helm, C. E., Messick, S., & Tucker, L. Psychophysical law and scaling models. Princeton: Educational Testing Service, 1959.

Hennessee, J. A. & Nicholson, J. NOW says: TV commercials insult women. New York Times Magazine, May 28, 1972, pp. 12-13 et seq.

Hiller, F. S., & Lieberman, G. J. Introduction to operations research. San Francisco: Holden-Day, 1967.

Hyman, R., & Well, A. Judgments of similarity and spatial models. Perception and Psychophysics, 1967, 2, 233-248.

Hyman, R., & Well, A. Perceptual seperability and spatial models. Perception and Psychophysics, 1968, 3, 161-165.

Katz, D. The functional approach to the study of attitudes. Public Opinion Quarterly, 1960, 24, 163-204.

Kemeny, J. G., Snell, J. L., & Thompson, G. L. Introduction to finite mathematics (2nd ed.). Englewood Cliffs, N.J.: Prentice-Hall, 1966.

Klahr, D. A Monte Carlo investigation of the statistical significance of Kruskal's nonmetric scaling procedure. Psychometrika, 1969, 34, 319-330.

Kruskal, J. B. Multidimensional scaling by optimizing goodness of fit to a nonmetric hypothesis. Psychometrika, 1964, 29, 1-27. (a)

Kruskal, J. B. Nonmetric multidimensional scaling: A numerical method. Psychometrika, 1964, 29, 115-129. (b)

Lasswell, H. D. The structure and function of communication in society. In L. Bryson (Ed.), Communication of ideas. New York: Harper, 1948.

Lazarsfeld, P., & Stanton, F. Radio research, 1942-1943. New York, 1944.

Lingoes, J. C. A general survey of the Guttman-Lingoes nonmetric program series. In R. Shepard, A. Romney, and S. Nerlove (Eds.), Multidimensional scaling: Theory and applications in the behavioral sciences, Vol. 1, New York: Seminar Press, 1972.

Long, M. L., & Simon, R. J. The roles and statuses of women on children and family TV programs. Journalism Quarterly, 1974, 51, 107-110.

Lowenhar, J. A., & Stanton, J. L. The Minkowski metric: Effects and implications for models of brand preference. Unpublished paper, School of Business Administration, Temple University, Philadelphia, Pa., 1975.

Maccoby, E. E., & Jacklin, C. N. The psychology of sex differences. Stanford, Cal.: Stanford University Press, 1974.

Marlier, J. Procedures for a precise test of social judgment predictions of assimilation and contrast. Paper presented to the Speech Communication Association Convention, Chicago, 1974.

Maxwell, E. A. Coordinate geometry with vectors and tensors. London: Oxford University Press, 1958.

McGuire, W. J. Persuasion, resistance, and attitude change. In I. de Sola Pool, W. Schramm (Eds.), Handbook of communication. Chicago: Rand McNally, 1973.

Metfessel, M. A proposal for quantitative reporting of comparative judgments. Journal of Psychology, 1947, 24, 229-235.

Messick, S. J., & Abelson, R. P. The additive constant problem in multidimensional scaling. Psychometrika, 1956, 21, 1-15.

Poor, D. D. S. Invariance of multidimensional configurations. Ph.D. Dissertation, The Ohio State University, 1972.

Poor, D. D. S., & Wherry, R. J. Invariance of multidimensional configurations. The British Journal of Mathematical and Statistical Psychology, (in press).

Richardson, M. W. Multidimensional psychophysics. Psychological Bulletin, 1938, 35, 659-660. (abstract)

Rogers, E. M., & Bhowmik, D. K. Homophily-heterophily: Relational concepts for communication research. Public Opinion Quarterly, 1971, 34, 523-538.

Rosenkrantz, P. S., Vogel, S. R., Bee, H., Broverman, I. K., & Broverman, D. M. Sex-role stereotypes and self-concepts in college students. Journal of Consulting and Clinical Psychology, 1968, 32, 287-295.

Rumelhart, D. E., & Abrahamson, A. A. A model for analogical reasoning. Cognitive Psychology, 1973, 5, 1-28.

Saltiel, J., & Woelfel, J. Accumulated information as a basis for attitude stability. Human Communication Research, 1975, 1, 333-344.

Schramm, W. Men, messages and media. New York: Harper and Row, 1973.

Schroder, H. M., Criver, M. J., & Streufert, S. Human information processing. New York: Holt, Rinehart, and Winston, 1967.

Serota, K. B. Metric multidimensional scaling and communication: Theory and implementation. M.A. Thesis, Michigan State University, 1974.

Shaw, M. E., & Wright, J. M. Scales for the measurement of attitudes. New York: McGraw-Hill, 1967.

Shepard, R. N. Stimulus and response generalization: Tests of a model relating generalization to distance in a psychophysical space. Journal of Experimental Psychology, 1958, 55, 509-523.

Shepard, R. N. The analysis of proximities: Multidimensional scaling with an unknown distance function. I. Psychometrika, 1962, 27, 125-140. (a)

Shepard, R. N. The analysis of proximities: Multidimensional scaling with an unknown distance function. II. Psychometrika, 1962, 27, 219-246. (b)

Shepard, R. N. Attention and the metric structure of the stimulus space. Journal of Mathematical Psychology, 1964, 1, 54-87.

Shepard, R. N. Metric structures in ordinal data. Journal of Mathematical Psychology, 1966, 3, 287-315.

Shepard, R. N. A taxonomy of some principal types of data and of multidimensional methods for their analysis. In R. Shepard, A. Romney, and S. Nerlove (Eds.), Multidimensional scaling: Theory and applications in the behavioral sciences, Vol. 1. New York: Seminar Press, 1972.

Shepard, R. N. Representation of structure in similarity data: Problems and prospects. Psychometrika, 1974, 39, 373-422.

Shepard, R. N., Romney, A., & Nerlove, S. (Eds.). Multidimensional scaling: Theory and applications in the behavioral sciences.(2 vol.). New York: Seminar Press, 1972.

Sherman, C. Nonmetric multidimensional scaling: A Monte Carlo study of the basic parameters. Psychometrika, 1972, 37, 323-355.

Smythe, D. W. Three years of New York television, 1951-1953. Urbana, Ill.: National Association of Educational Broadcasters, 1953.

Spence, I. A Monte Carlo evaluation of three nonmetric multidimensional scaling algorithms, Psychometrika, 1972, 37, 46-486.

Spence, J. T., Helmreich, R., & Stapp, J. Ratings of self and peers on sex role attributes and their relation to self-esteem and conceptions of masculinity and femininity. Journal of Personality and Social Psychology, 1975, 32, 29-39.

Stanley, N. C. Federal communications law and women's rights: Women in the wasteland fight back. The Hastings Law Journal, 1971, 23, 15-51.

Stenson, H. H., & Knoll, R. L. Goodness of fit for random rankings in Kruskal's nonmetric scaling procedure. Psychological Bulletin, 1969, 71, 122-126.

Stone, V. A. Attitudes toward television newswomen. Journal of Broadcasting, 1974, 18, 49-62.

Subkoviak, M. J. The relative efficiency of two multidimensional scaling models: Metric and nonmetric scaling under conditions of normality and nonnormality (Ph.D. Dissertation, State University of New York at Buffalo, 1972). Dissertation Abstracts International, 1972, 33, 1530A-1531A. (University Microfilms No. 72-27, 332)

Suppes, P. & Zinnes, J. Basic measurement theory. In R. Luce, R. Bush, and E. Galanter (Eds.), Handbook of mathematical psychology, Vol. 1. New York: John Wiley and Sons, 1963.

Taylor, J. A., Barnett, G. A., & Serota, K. B. A multidimensional examination of political attitude change. Paper presented to the Annual Meeting of the International Communication Association, Chicago, 1975.

Tedesco, N. A. Patterns in prime time. Journal of Communication, 1974, 24, 119-124.

Thierauf, R. J., & Klekamp, R. C. Decision making through operations research (2nd ed.). New York: John Wiley & Sons, Inc., 1975.

Torgerson, W. S. A theoretical and empirical investigation of multidimensional scaling. Ph.D. Dissertation, Princeton University, 1951.

Torgerson, W. S. Multidimensional scaling: I. Theory and method. Psychometrika, 1952, 17, 401-419.

Torgerson, W. S. Theory and methods of scaling. New York: John Wiley and Sons, 1958.

Torgerson, W. S. Multidimensional scaling of similarity. Psychometrika, 1965, 30, 370-393.

Turow, J. Advising and ordering: Daytime, prime time. Journal of Communication, 1974, 24, 138-141.

Van de Geer, J. Introduction to multivariate analysis for the social sciences. San Francisco, Cal.: Freeman, 1971.

Woelfel, J. Sociology and science. Unpublished paper, Department of Communication, Michigan State University, 1972

Woelfel, J. Procedures for the precise measurement of cultural processes. Unpublished paper, Department of Communication, Michigan State University, 1974. (a)

Woelfel, J. Metric measurement of cultural processes. Paper presented at the Annual Meeting of the Speech Communication Association, Chicago, 1974. (b)

Woelfel, J., & Barnett, G. A. A paradigm for mass communication research. Paper presented at the Annual Meeting of the International Communication Association, New Orleans, 1974

Woelfel, J., Saltiel, J., McPhee, R., Danes, J. E., Cody, M., Barnett, G., & Serota, K. Orthogonal rotation to theoretical criteria: Comparison of multidimensional spaces. Paper presented at the Annual Meeting of the Mathematical Psychological Association, Purdue, Ind., 1975.

Woelfel, J., Woelfel, J., Gillham, J., & McPhail, T. Political radicalization as a communication process. Communication Research, 1974, 1, 243-263.

Women on Words and Images. Channeling children. P.O. Box 2163, Princeton, New Jersey, 1975.

Young, F. Nonmetric multidimensional scaling: Recovery of metric information. Psychometrika, 1970, 35, 455-473.

Young, G., & Householder, A. S. Discussion of a set of points in terms of their mutual distances. Psychometrika, 1938, 3, 19-22.

APPENDICES

APPENDIX A

List of judges engaged in the rank ordering of personality characteristics

Dr. Ann Beuf
Assistant Professor
Department of Sociology
University of Pennsylvania

Dr. Julia Ericksen
Visiting Professor
Department of Sociology
Temple University

Ms. Lynn Martin Haskin
Instructor of Journalism
Pennsylvania State University
Media, Pennsylvania

Dr. Joan Mandle
Assistant Professor
Department of Sociology
Temple University

Dr. Jerry Starr
Assistant Professor
Department of Sociology
University of Pennsylvania

TEMPLE UNIVERSITY
SCHOOL OF COMMUNICATIONS AND THEATER
PHILADELPHIA, PENNSYLVANIA 19122

DEPARTMENT OF RADIO-TELEVISION-FILM

10 December 1975

Dr. Ann Beuf,
Assistant Professor
Department of Sociology
University of Pennsylvania
Philadelphia, Pennsylvania 19174

Dear Dr. Beuf,

As we agreed recently through our telephone conversation, I have enclosed a set of sex-role concepts, instructions and a form for rank ordering the salient concepts, and a return envelope for your convenience. You are one of several expert panelists who are familiar with the literature on sex-typed behavior and I would like to offer an explanation of your collective role in my research.

I am attempting to utilize multidimensional scaling as a heuristic tool in the assessment of the optimal message strategy which will effect attitude change in the area of sex roles. The Bem Sex-Role Inventory is being used to divide individuals into androgynous, feminine and masculine groups. The individuals (Temple University undergraduates) will be asked to judge the dissimilarity of the 14 sex roles which you, as experts, select as being most representative of feminine and masculine sex roles. A limitation of the multidimensional scaling methodology is that every concept must be paired with every other concept. Thus, fourteen concepts require of each subject 91 judgments of dissimilarity. In addition, I am adding the concept of "self" to the scaling instrument bringing the total number of judgments to 105. I am hesitant to include here a lengthy discussion of my thesis, however, if you would like more information I will be more than happy to discuss it with you.

Your role as a judge, then, is to rank order the seven masculine roles and the seven feminine roles which you believe to be most representative of sex roles. I have enclosed a set of instructions for this task.

I very much appreciate your agreement to do this, especially since this request reaches you at an extremely busy time in your academic schedule.

Sincerely,

Hank De Leo

enclosures

INSTRUCTIONS

The set of concepts which I have enclosed has been selected from a review of the literature on sex roles. The concepts are divided into the traditionally male and female domains and each of these domains have been subdivided into what may be loosely viewed as "dimensions." For example, there are 11 dimensions to the male domain and 14 dimensions to the female domain.

Please select (1) the seven concepts from the male domain which you believe to be most representative of the traditional masculine sex roles, and rank order those concepts; and (2) the seven concepts from the female domain which you believe to be most representative of the traditional feminine sex roles, and rank order those concepts. Please rank order your selections on the form provided for that purpose.

Some of the subdivisions represent a special problem in that several concepts represent a single dimension of sex-typed behavior. Where there is more than one concept in a subdivision, please select the one which you believe to be most representative of the subdivision. Please select no more than one concept from any one subdivision.

MALE DOMAIN

I.
logical
realistic
knowledgeable

II.
creative

III.
active
impulsive
outgoing

IV.
confident

V.
independent
self reliant
individualistic
emotionally independent
defends own beliefs

VI.
competitive
ambitious

VII.
dominant

VIII.
reliable

IX.
aggressive
violent
forceful
assertive

X.
athletic

XI.
masculine

FEMALE DOMAIN

I.
incompetent
ignorant

II.
emotional

III.
fearful
anxious

IV.
romantic

V.
affectionate
warm
loves children

VI.
patient

VII.
soft spoken
shy

VIII.
weak

IX.
talkative
outgoing
friendly

X.
gentle
tender

XI.
cooperative
helpful
sharing
understanding
empathetic
sympathetic
compassionate
sensitive to others' needs

XII.
conformist
accepting
yielding
compliant
susceptible to influence
flatterable
gullible

XIII.
dependent
childlike

XIV.
feminine

APPENDIX B

QUESTIONNAIRE

PART I

This questionnaire asks you to tell us how similar or how different two characteristics are from each other. Difference between characteristics can be measured in units, so that the <u>more different</u> two characteristics are the <u>more units apart</u> they are.

To help you know how big a unit is:

> "Independent" and "dependent," as personality characteristics, are 10 units apart.

1. You are supposed to tell us how many units apart the personality characteristics on the next few pages are from each other. If you think any of the two characteristics are more different then "independent" and "dependent," write a number bigger than 10. If you think they are not so different, use a smaller number.
2. Think of the personality characteristics on the next few pages as they would apply to the <u>average</u> person.
3. Judge the characteristics relative to yourself <u>only</u> when a characteristic is paired with "me." Judgments involving "me" should indicate how close that characteristic is to you. (Use a small number if close to you, and a large number if far away from you.)
4. Zero can be used as a distance. If you see two characteristics as identical, then they would be zero distance apart.
5. If you do not know what is meant by any one of the characteristics, then leave that pair blank.
6. Please work quickly. Judge the characteristics as pairs rather than trying to relate each judgment to all others.
7. Remember, the <u>more different</u> the characteristics are from each other, the higher the number you would write.

Remember: "Independent" and "dependent" are 10 units apart.

essive & athletic ________
essive & competitive ________
essive & dependent ________
essive & dominant ________
essive & emotional ________
essive & feminine ________
ressive & gentle ________
ressive & independent ________
ressive & logical ________
ressive & masculine ________
ressive & romantic ________
ressive & sensitive to the needs of others ________
gressive & understanding ________
gressive & me ________
hletic & competitive ________
hletic & dependent ________
hletic & dominant ________
hletic & emotional ________
thletic & feminine ________
thletic & gentle ________
thletic & independent ________
thletic & logical ________
thletic & masculine ________
thletic & romantic ________
athletic & sensitive to the needs of others ________
athletic & understanding ________
athletic & me ________
competitive & dependent ________
competitive & dominant ________
competitive & emotional ________
competitive & feminine ________
competitive & gentle ________
competitive & independent ________
competitive & logical ________

competitive & masculine ________
competitive & romantic ________
competitive & sensitive to the needs of others ________
competitive & understanding ________
competitive & me ________
dependent & dominant ________
dependent & emotional ________
dependent & feminine ________
dependent & gentle ________
dependent & independent ________
dependent & logical ________
dependent & masculine ________
dependent & romantic ________
dependent & sensitive to the needs of others ________
dependent & understanding ________
dependent & me ________
dominant & emotional ________
dominant & feminine ________
dominant & gentle ________
dominant & independent ________
dominant & logical ________
dominant & masculine ________
dominant & romantic ________
dominant & sensitive to the needs of others ________
dominant & understanding ________
dominant & me ________
emotional & feminine ________
emotional & gentle ________
emotional & independent ________
emotional & logical ________
emotional & masculine ________
emotional & romantic ________
emotional & sensitive to the needs of others ________
emotional & understanding ________

Remember: "Independent" and "dependent" are 10 units apart.

ional & me ______
nine & gentle ______
nine & independent ______
nine & logical ______
nine & masculine ______
nine & romantic ______
nine & sensitive to
e needs of others ______
nine & understanding ______
nine & me ______
le & independent ______
tle & logical ______
tle & masculine ______
tle & romantic ______
tle & sensitive to
he needs of others ______
tle & understanding ______
tle & me ______
ependent & logical ______
ependent & masculine ______
ependent & romantic ______

independent & sensitive to
the needs of others ______
independent & understanding ______
independent & me ______
logical & masculine ______
logical & romantic ______
logical & sensitive to
the needs of others ______
logical & understanding ______
logical & me ______
masculine & romantic ______
masculine & sensitive to
the needs of others ______
masculine & understanding ______
masculine & me ______
romantic & sensitive to
the needs of others ______
romantic & understanding ______
romantic & me ______
sensitive to the needs
of others & understanding ______
sensitive to the needs
of others & me ______
understanding & me ______

QUESTIONNAIRE

PART II

On the following page, you will be shown a large number of personality characteristics. We would like you to use those characteristics in order to describe yourself. That is, we would like you to indicate, on a scale from 1 to 7, how true of you these various characteristics are. Please do not leave any characteristic unmarked.

Example: sly

Mark a 1 if it is NEVER OR ALMOST NEVER TRUE that you are sly.

Mark a 2 if it is USUALLY NOT TRUE that you are sly.

Mark a 3 if it is SOMETIMES BUT INFREQUENTLY TRUE that you are sly.

Mark a 4 if it is OCCASIONALLY TRUE that you are sly.

Mark a 5 if it is OFTEN TRUE that you are sly.

Mark a 6 if it is USUALLY TRUE that you are sly.

Mark a 7 if it is ALWAYS OR ALMOST ALWAYS TRUE that you are sly.

Thus, if you feel it is sometimes but infrequently true that you are "sly", never or almost never true that you are "malicious", always or almost always true that you are "irresponsible", and often true that you are "carefree", then you would rate these characteristics as follows:

Sly	3		Irresponsible	7
Malicious	1		Carefree	5

DESCRIBE YOURSELF

1	2	3	4	5	6	7
OR NEVER	USUALLY NOT TRUE	SOMETIMES BUT INFREQUENTLY TRUE	OCCASIONALLY TRUE	OFTEN TRUE	USUALLY TRUE	ALWAYS OR ALMOST ALWAYS TRUE

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Reliable	
Analytical	
Sympathetic	
Jealous	
Has leadership abilities	
Sensitive to the needs of others	
Truthful	
Willing to take risks	
Understanding	
Secretive	
Makes decisions easily	
Compassionate	
Sincere	
Self-sufficient	
Eager to soothe hurt feelings	
Conceited	
Dominant	
Soft-spoken	
Likable	
Masculine	

Warm	
Solemn	
Willing to take a stand	
Tender	
Friendly	
Aggressive	
Gullible	
Inefficient	
Acts as a leader	
Childlike	
Adaptable	
Individualistic	
Does not use harsh language	
Unsystematic	
Competitive	
Loves children	
Tactful	
Ambitious	
Gentle	
Conventional	

Please provide the following information for statistical purposes only.

1. Age: ____ 17-24 years
   ____ 25-34
   ____ 35-49
   ____ 50-

2. Sex: M F

3. Year in school: ____ Freshman
   ____ Sophomore
   ____ Junior
   ____ Senior
   ____ Graduate

4. Race: ____ Black
   ____ Caucasian
   ____ Mexican-American
   ____ Oriental
   ____ Other (specify): ____________

5. Marital status: ____ single
   ____ married
   ____ cohabiting
   ____ seperated or divorced
   ____ widowed

6. What is your average family income per year?

   ____ less than $5,000
   ____ $5,000 - $7,999
   ____ $8,000 - $9,999
   ____ $10,000 - $14,999
   ____ $15,000 - $20,000
   ____ greater than $20,000

APPENDIX C

This appendix contains a modified version of LINPRO, a FORTRAN program for the solution of linear programming problems through the simplex procedure. The original LINPRO program was obtained from Lehigh University and modified by Ed Siegrist of Temple University's Scientific and Academic Systems. Additional modifications by Ed Siegrist provide the user with the capability of inputting all concept position vectors and having the program generate all possible n!/x!(n - x)! combinations. Further, the program will automatically input each combination to the simplex procedure in LINPRO. This program then provides all optimal Z values where solutions are found; and rank orders all solutions from highest optimal Z value to lowest.

```
      PROGRAM MODEL(INPUT,OUTPUT,TAPE6=OUTPUT,TAPE7,TAPE8,TAPE9,TAPE10)
      DIMENSION IC(15),IM(15)
      COMMON /LPBLOCK/NREAD,NRITE,NSTOR,IS,N,M,NL,NG,NE,PROG,BIG,EPS,
     1X(40,170),NW(30),QUAN(60),COEF(170),BCOEF(60),JVARB(170),
     2IVARB(60),EVAL(170),ROW(170),JVAR(10)
      COMMON /PROB/MSV,NSV,ISV,NESV,NGSV,NLSV,AA(15,20),BB(15),CC(20),
     1N1,N2,N4,N5,VECT(20),VMAX,KOL(20),IV(20),NAUX
      NSTOR=9$NREAD=10$READ *,NRITE
      NAUX=0
      READ *,NL,NG,NE,IS,N
      NSV=N$ISSV=IS$NESV=NE
      NGSV=NG$NLSV=NL$MSV=NL+NG+NE
      M=MSV
      READ*,N1,N2
      N3=N-N2$N4=N1+N2
      READ *,((AA(I,J),I=1,M),J=1,N4)
      READ *,(BB(I),I=1,M)
      READ *,(CC(J),J=1,N)
      VMAX=-1.E+200
      CALL COMB(IC,IM,N3,N1)
      PRINT(6,6)
    6 FORMAT(//////////)
      PRINT *,' RIGHT HAND SIDE VECTOR'
      PRINT *,(BB(I),I=1,M)
```

```
      PRINT *,' OBJECTIVE FUNCTION COEFFICIENTS'
      PRINT *,(CC(J),J=1,NSV)
      PRINT *,' OPTIMUM VALUE: ',VMAX
      PRINT *,' OPTIMUM SET OF ACTIVITY VECTORS'
      PRINT *,(KOL(I),I=1,N)
      PRINT *,' A MATRIX ACTIVITY VECTORS'
      DO 2 J=1,N4
    2 PRINT 4,J,(AA(I,J),I=1,MSV)
    4 FORMAT(//,* COL(*,I2,*)*,(8E15.7))
      PRINT(6,6)
      REWIND NAUX
      STOP
      END
      SUBROUTINE COMB(IC,IM,N,M)
      DIMENSION IC(N),IM(N)
      DO 2 I=1,N
      IC(I)=I
    2 IM(N-I+1)=M-I+1
   10 IP=N
4     CALL USER(IC,N)
      IF(IC(IP).GE.IM(IP)) GO TO 6
      IC(IP)=IC(IP)+1
      GO TO 4
    6 IP=IP-1
      IF(IP.EQ.0) RETURN
      IF(IC(IP).GE.IM(IP)) GO TO 6
      IC(IP)=I1=IC(IP)+1
      IP1=IP+1
      DO 8 I=IP1,N
    8 IC(I)=IC(I-1)+1
      GO TO 10
      END
      SUBROUTINE USER(IC,N3)
      DIMENSION IC(15)
      COMMON /LPBLOCK/NREAD,NRITE,NSTOR,IS,N,M,NL,NG,NE,PROG,BIG,EPS,
     1A(40,170),NW(40),DUAL(60),COEF(170),BCOEF(60),JVARB(170),
     2IVARB(60),EVAL(170),ROW(170),JVAR(10)
      COMMON /PROB/MSV,NSV,ISV,NESV,NGSV,NLSV,AA(15,20),BB(15),CC(20),
     1N1,N2,N4,N5,VECT(20),VMAX,KOL(20),IV(20),NAUX
```

```
      DO 1 I=1,N
    1 VECT(I)=0.
      DO 2 I=1,48
      DO 2 J=1,170
    2 X(I,J)=0.
      N=NSV$IS=ISSV$NE=NESV
      NG=NGSV$NL=NLSV$M=MSV
      DO 8 J=1,N
    8 COEF(J)=CC(J)
      DO 10 I=1,M
   10 QUAN(I)=BB(I)
      REWIND NREAD
      WRITE(NREAD)(COEF(J),J=1,N)
      DO 4 J=1,N3
      IV(J)=IC(J)
      J1=IC(J)
      DO 4 I=1,M
    4 X(I,J)=AA(I,J1)
      DO 6 J=1,N2
      JX=J+N3
      JA=J+N1
      IV(JX)=JA
      DO 6 I=1,M
    6 X(I,JX)=AA(I,JA)
      DO 12 I=1,M
   12 WRITE (NREAD) QUAN(I),(X(I,L),L=1,N)
      CALL LP(OPT,VECT,IND)
      IF(IND.NE.0) GO TO 14
      IF(OPT.LT.VMAX) GO TO 25
      VMAX=OPT
      DO 16 J=1,NSV
   16 KOL(J)=IV(J)
   25 WRITE(NAUX) OPT,(IV(J),J=1,NSV)
   27 FORMAT(1X,E15.7,20I3)
      RETURN
   14 PRINT *,' IND= ',IND
      PRINT *,' FAILING COLUMNS'
      PRINT *,(IV(I),I=1,NSV)
      RETURN
      END
      SUBROUTINE LP(OPT,VECT,IND)
```

```
C     ..............................................................
C
C        PURPOSE
C           PROVIDES SOLUTION TO THE STANDARD LINEAR PROGRAMMING
C           PROBLEM USING THE SIMPLEX METHOD DUE TO G. B. DANTZIG.
C           SPECIFICALLY, LP MINIMIZES OR MAXIMIZES A LINEAR
C           FUNCTION SUBJECT TO LINEAR CONSTRAINTS WHERE THESE
C           CONSTRAINTS MAY INCLUDE BOTH EQUALITIES AND INEQUALITIES
C           AND FOR WHICH UNKNOWN VARIABLES ARE NON-NEGATIVE.
C           TABLEAU OUTPUTS FOLLOWING THE FORMAT OF HADLEY (SEE
C           REFERENCE) ARE OPTIONAL.
C
C        USAGE
C           CALL LP(OPT,VECT,IND)
C
C        DESCRIPTION OF PARAMETERS
C           ARGUMENTS
C
C              OPT    - ON RETURN-THE OPTIMAL VALUE OF THE OBJECTIVE
C                                 FUNCTION.
C              VECT   - ON RETURN-THE VALUES OF THE VARIABLES OF THE
C                                 PROBLEM CORRESPONDING TO THE
C                                 OPTIMAL VALUE
C              IND      ON RETURN-'0' IMPLIES NORMAL SOLUTION ATTAINED
C                                 '1' IMPLIES THERE ARE NO FEASIBLE
C                                      SOLUTIONS
C                                 '2' IMPLIES SOLUTION IS UNBOUNDED.
C
C
C           COMMON BLOCK PARAMETERS
C
C              NREAD  - TAPE UNIT NUMBER, FROM WHICH INPUT IS  TO BE
C                       READ BY LP
C              NRITE  - TAPE UNIT NUMBER UPON WHICH INTERMEDIATE
C                       PRINTOUT IS TO BE WRITTEN
C              NSTOR  - TAPE UNIT NUMBER OF SCRATCH TAPE
C              IS     - INTEGER VARIABLE INDICATING NUMBER OF TABLEAUS
C                       TO BE PRINTED; MUST BE AT LEAST 1, IN WHICH
C                       CASE BOTH THE INITIAL AND FINAL IS PRINTED; IF
C                       NEGATIVE, FUNCTION WILL BE MAXIMIZED; IF
```

```
C            POSITIVE, FUNCTION WILL BE MINIMIZED.
C       N      TOTAL NUMBER OF VARIABLES
C       NL     INPUT VARIABLE INDICATING NUMBER OF LESS-THAN
C              OR-EQUAL-TO CONSTRAINTS
C       NG     INPUT VARIABLE INDICATING NUMBER OF GREATER-
C              THAN-OR-EQUAL-TO CONSTRAINTS
C       NE     INPUT VARIABLE INDICATING NUMBER OF EQUALITY
C              CONSTRAINTS
C       NOTE-OTHER 'COMMON' PARAMETERS (SEE REMARKS) ARE USED
C            INTERNALLY BY LP AND NEED NOT CONCERN THE USER,
C            EXCEPT THAT THESE NAMES SHOULD NOT BE USED FOR
C            OTHER PURPOSES.
C     TAPE PARAMETERS
C
C       PRIOR TO EXECUTION OF LP, CERTAIN VARIABLES MUST BE
C       WRITTEN ON TAPE 'NREAD'.  THESE VARIABLES ARE
C         COEF  -   A REAL VECTOR OF DIMENSION N CONTAINING
C                   THE ORDERED SET  OF OBJECTIVE FUNCTION
C                   COEFICIENTS
C         QUAN  -   A REAL VECTOR OF DIMENSION M CONTAINING THE
C                   VALUES OF EACH CONSTRAINT
C          X    -   A TWO-DIMENSIONAL M BY N ARRAY WHICH
C                   CONTAINS THE CONSTRAINT COEFFICIENTS
C       PRESUMING THAT THE PRECEEDING ARRAYS AND VARIABLES
C       CONTAIN THE VALUES WHICH DEFINE THE PROBLEM, THEN THE
C       FOLLOWING BINARY-WRITE SEQUENCE COULD BE  USED TO EXECUTE
C       LP AND PRINT THE INFORMATION RETURNED:
C
C          WRITE (NREAD)(COEF(J),J=1,N)
C          M=NL+NG+NE
C          DO 1 I=1,M
C        1 WRITE(NREAD) QUAN(I),(X(I,L),L=1,N)
C          CALL LP(OPT,VECT,IND)
C          PRINT 2,IND,OPT,VECT
C        2 FORMAT(I10,/1X,E15.7/(1X,6E15.7))
C
```

```
REMARKS
    THREE DISK FILES ARE USED BY LP. THESE ARE:
      NREAD     TO PROVIDE INPUT TO LP
                (NOTE THAT LP REWINDS "NREAD" PRIOR TO
                EXECUTION.)
      NRITE     TO WRITE INTERMEDIATE OUTPUT INFORMATION
      NSTOR     AS SCRATCH
    INTERMEDIATE OUTPUT IS PLACED UPON TAPE "NRITE". IF IT
    IS DESIRED TO OBTAIN THIS INFORMATION (I.E. PRINTOUT
    OF INPUT, PLUS TABLEAU OUTPUT, PLUS AN EVALUATION OF
    THE INITIAL CONSTRAINTS USING THE SOLUTION VECTOR),
    THEN, THE FOLLOWING CARDS COULD BE USED IN THE MAIN
    PROGRAM (WRITTEN BY USER) TO ESTABLISH THE REQUIRED
    FILES.

      PROGRAM MAIN(INPUT,OUTPUT,TAPE6=OUTPUT,TAPE9,TAPE10)
      NRITE=6
      NSTOR=9
      NREAD=10

    IF NO INTERMEDIATE OUTPUT IS DESIRED, THE PROGRAM CARD
    MUST OMIT 'TAPE6=OUTPUT' AND THEN, THE INTERMEDIATE
    OUTPUT INFORMATION IS PUT ONTO THE FILE TAPE6 AND IS NOT
    SEEN BY THE USER ON THE OUTPUT FILE.
  SIZE LIMITATIONS
    1.  MAXIMUM NUMBER OF COEFFICIENTS FOR VARIABLES IN
        CONSTRAINT EQUATIONS IS 160.
    2.  MAXIMUM NUMBER OF CONSTRAINTS IS 45
    3.  MAXIMUM NUMBER OF OBJECTIVE  FUNCTION VARIABLES IS
        160.
  COMMON BLOCK
    A COMMON BLOCK AS FOLLOWS, MUST BE PROVIDED WITHIN THE
    CALLING PROGRAM

    COMMON/LPBLOCK/NREAD,NRITE,NSTOR,IS,N,M,NL,NG,NE,PROB,
   +BIG,EPS,X(48,170),NW(30),QUAN(60),COEF(170),BCOEF(60),
   +JVARB(170),IVARB(60),EVAL(170),,ROW(170),JVAR(10)
```

```
C         THE USER SHOULD AVOID USING THE NAMES IN THE COMMON
C         BLOCK SINCE USAGE WITHIN LP MAY CONFLICT AND CAUSE
C         CHANGED VALUES TO THE USER VARIABLES.
C
C      SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C         AMAX1,ABS
C
C      METHOD
C         SIMPLEX METHOD DUE TO G.B.DANTZIG AND FOLLOWS THE FORMAT
C         OF HADLEY (SEE REFERENCE).
C
C      REFERENCE
C         LINEAR PROGRAMMING,G.HADLEY,UNIV OF CHICAGO, ADDISON-WESLEY
C         PUBLISHING CO. INC.,1967.
C
C     ...................................................................

      DIMENSION VECT(1)
      CALL LPA
      CALL LPB(OPT,VECT,IND)
      RETURN
      END
      SUBROUTINE LPA
      COMMON /LPBLOCK/NREAD,NRITE,NSTOR,IS,N,M,NL,NG,NE,PROB,BIG,EPS,
     1X(48,170),NW(30),QUAN(60),COEF(170),BCOEF(60),JVARB(170),
     2IVARB(60),EVAL(170),ROW(170),JVAR(10)
  101 FORMAT (10F8.0)
  102 FORMAT (21H0COEFFICIENTS FOR THE,I3,10H VARIABLES,//(10F12.3))
  103 FORMAT (///I5,34H LESS THAN OR EQUAL TO CONSTRAINTS)
  104 FORMAT (///I5,37H GREATER THAN OR EQUAL TO CONSTRAINTS)
  105 FORMAT (///I5,30H STRICTLY EQUAL TO CONSTRAINTS)
  106 FORMAT (9H0QUANTITY,F12.3,20H, COEFFICIENTS BELOW,//(10F12.3))
  107 FORMAT (///18H START JOB CALLED ,25A3,A1,///)
  108 FORMAT (///29H       NUMBER       ASSIGN TO,//10X,1HI,9X,18HITH GI
     1VEN VARIABLE,//7X,6H100 +N,7X,23HSLACK OF NTH CONSTRAINT,//7X,6H20
     20 +N,7X,24H-SLACK OF NTH CONSTRAINT,//7X,6H300 +N,7X,34HARTIFICIAL
     3 SLACK OF NTH CONSTRAINT,//)
```

```
110   FORMAT(5G20)
      WRITE(NSTOR,17)N,NL,NG,NE
   17 FORMAT(4I5)
      REWIND NREAD
      BIG=1000.6*1000.0
      READ(NREAD)(CBEF(J),J=1,N)
      WRITE (NRITE,102) N, (CBEF(J),J=1,N)
      M=NL+NG+NE
      PROB=1.00
      XMAX=0.
      IF(IS) 109,1010,1010
  109 PROB=-PROB
      IS=-IS
 1010 DO 1011 J=1,N
 1011 IVARB(J)=J
      I=0
      J=N
      IF (NL) 1015,1015,1012
 1012 WRITE (NRITE,103) NL
      DO 1014 K=1,NL
      I=I+1
      J=J+1
      READ(NREAD)QUAN(I),(X(I,L),L=1,N)
      WRITE (NRITE,106) QUAN(I), (X(I,L),L=1,N))
      WRITE(NSTOR,110)QUAN(I),(X(I,L),L=1,N)
      XMAX=AMAX1(XMAX,QUAN(I))
      DO 2 L=1,N
    2 XMAX=AMAX1(XMAX,X(I,L))
      COEF(J)=0.0
      JVARB(J)=100+I
      IVARB(I)=JVARB(J)
      BCOEF(I)=0.0
      DO 1013 II=1,M
 1013 X(II,J)=0.0
 1014 X(I,J)=1.0
 1015 IF (NG) 1019,1019,1016
 1016 WRITE (NRITE,104) NG
      DO 1018 K=1,NG
      I=I+1
```

```
      J=J+1
      JJ=NG+J
      READ(NREAD) QUAN(I),(X(I,L),L=1,N)
      WRITE (NWRITE,106) QUAN(I), (X(I,L),L=1,N)
      WRITE(NSTOR,110)QUAN(I),(X(I,L),L=1,N)
      XMAX=AMAX1(XMAX,QUAN(I))
      DO 4 L=1,N
    4 XMAX=AMAX1(XMAX,X(I,L))
      COEF(J)=0.0
      COEF(JJ)=BIG*PROB
      JVARB(J)=200+I
      JVARB(JJ)=300+I
      BCOEF(I)=COEF(JJ)
      IVARB(I)=JVARB(JJ)
      DO 1017 II=1,M
      X(II,J)=0.0
 1017 X(II,JJ)=0.0
      X(I,J)=-1.0
 1018 X(I,JJ)=1.0
      J=JJ
 1019 IF (NE) 1023,1023,1020
 1020 WRITE (NWRITE,105) NE
      DO 1022 K=1,NE
      I=I+1
      J=J+1
      READ(NREAD) QUAN(I),(X(I,L),L=1,N)
      WRITE (NWRITE,106) QUAN(I), (X(I,L),L=1,N)
      WRITE(NSTOR,110)QUAN(I),(X(I,L),L=1,N)
      XMAX=AMAX1(XMAX,QUAN(I))
      DO 6 L=1,N
    6 XMAX=AMAX1(XMAX,X(I,L))
      COEF(J)=BIG*PROB
      JVARB(J)=300+I
      BCOEF(I)=COEF(J)
      IVARB(I)=JVARB(J)
      DO 1021 II=1,M
 1021 X(II,J)=0.0
 1022 X(I,J)=1.0
 1023 N=J
```

```
      EPS=1.E-12*XMAX
      WRITE (NRITE,100)
      RETURN
      END
      SUBROUTINE LPROUTVAL,VECT,IND)
      COMMON /LPBLOCK/NREAD,NRITE,NSTOR,IS,N,M,NL,NG,NE,PROB,BIG,EPS,
     1A(40,170),NW(30),QUAN(60),COEF(170),BCOEF(60),JVARB(170),
     2IVARB(60),EVAL(170),ROW(170),JVAR(10)
      DIMENSION VECT(1)
  201 FORMAT(//17H OPTIMUM SOLUTION,//15H TABLEAU NUMBER,
     1,I4,22H, OBJECTIVE FUNCTION =,F13.3)
  202 FORMAT(//* THERE ARE NO FEASIBLE SOLUTIONS                    *,//,15H
     1 TABLEAU NUMBER,I4,22H, OBJECTIVE FUNCTION =,F13.3)
  203 FORMAT(//* THE SOLUTION IS UNBOUNDED*,//                    15H TABLE
     1AU NUMBER,I4,22H, OBJECTIVE FUNCTION =,F13.3)
  204 FORMAT(15H TABLEAU NUMBER,I3,2X,22H, OBJECTIVE FUNCTION =,F15.3,
     11H,,I4,11H TO REPLACE,I4,8H, EVAL =,F16.3,8H, QUAN =,F10.3//)
  205 FORMAT (12H ROW PROGRAM,7X,5HCOEF.,8X,8HQUANTITY,5(I7,9H VARIABLE)
     1)
  206 FORMAT (1X,3HROW,4X,7(I7,9H VARIABLE))
  207 FORMAT (1H )
  208 FORMAT (1X,I5,I6,F14.3,6F16.3)
  209 FORMAT (1X,I3,4X,7F16.3)
  211 FORMAT(*0*,10X,10HCONSTRAINT,15X,5HQUAN ,10X,10HDIFFERENCE/10X,
     1                  10HEVALUATED )
  212   FORMAT(1X,3E20.4)
  213   FORMAT(4I5)
  214   FORMAT(5D20)
  215 FORMAT(*0 ABSOLUTE VALUES SMALLER THAN*,E15.3,*ARE SET TO ZERO*)
 2010 FORMAT (/20X,20HNET-EVALUATION ROW  ,5F16.3)
 2011 FORMAT (25H PROGRAM RESTRICTS YOU TO,I4,11H ITERATIONS,//)
 2012 FORMAT (40X,5F16.3)
 2013 FORMAT(/*0END, GO TO NEXT PROBLEM*)
      ITER=1
      IR=200
      IND=0
      NK=0
      WRITE(NRITE,215) EPS
      NC=N+1
```

```
      SMALL=1.0/(BIG*1000.0)
      KK=1
      L=N+1
      NW(KK)=505
      IF (L-5) 2016,2016,2014
 2014 L=L-5
      DO 2015 K=2,30
      KK=KK+1
      NW(KK)=707
      IF (L-7) 2016,2016,2015
 2015 L=L-7
 2016 NW(KK)=100*L+L-1
 2017 VALUE=0.0
C*    STORES(PER,JCOL,DIV,I,BIG,IROW,Q,QUAN)
      JCOL=-10
      PER=-.0005*PROB
      DO 2020 J=1,N
      SUM=COEF(J)
      DO 2018 I=1,M
 2018 SUM=SUM-X(I,J)*BCOEF(I)
      IF (PROB*(SUM-PER))  2019,2020,2020
 2019 PER=SUM
      JCOL=J
 2020 EVAL(J)=SUM
      IF (JCOL) 2029,2029,2021
 2021 Q=BIG
      IROW=-10
      DO 2057 I=1,M
      VALUE=VALUE+QUAN(I)*BCOEF(I)
      X(I,NC)=-0.
      IF(X(I,JCOL).EQ.0.) X(I,NC)=BIG
      IF(X(I,JCOL).EQ.0.) GO TO 2057
      DIV=QUAN(I)/X(I,JCOL)
      IF (X(I,JCOL)) 2023,2026,2022
 2022 IF (DIV-BIG) 2024,2028,2026
 2023 IF (DIV+BIG) 2027,2028,2028
 2024 IF (DIV-Q) 2025,20125,2028
20125 IF (IVARB(I)-300) 2028,2028,2025
 2025 Q=DIV
```

```
      IROW=I
      GO TO 2028
 2026 DIV=BIG
      GO TO 2028
 2027 DIV=-BIG
 2028 X(I,NC)=DIV
 2057 CONTINUE
C*    DEL=
      GO TO 2031
 2029 DO 2030 I=1,M
      VALUE=VALUE+QUAN(I)*HCOEF(I)
 2030 X(I,NC)=0.0
 2031 ITER=ITER+1
      LAST=100000
      IF (JCOL) 2032,2032,2035
 2032 DO 2033 I=1,M
      ITEST=IVARB(I)
      QTEST=QUAN(I)
      IF(ITEST.GT.300.AND.QTEST.NE.0.) GO TO 2034
 2033 CONTINUE
      WRITE(NRITE,201) ITER,VALUE
       GO TO 2038
 2034 WRITE(NRITE,202) ITER,VALUE
      IND=1
      WRITE(NRITE,2055) IVARB(I),QUAN(I)
 2055 FORMAT(///,*0FOR VARIABLE*,I8,*THE QUANTITY IS*,E20.7,//)
      NK=1
      GO TO 2038
 2035 IF (IROW) 2036,2036,2037
 2036 WRITE(NRITE,203) ITER,VALUE
      IND=2
      NK=1
      GO TO 2038
 2037 LAST=0
      WRITE (NRITE,204) ITER, VALUE, JVARB(JCOL), IVARB(IROW), PER, D
      IF (ITER-IS) 2038,2040,2040
 2038 LL=NW(1)/100
      L=NW(1)-100*LL
      WRITE (NRITE,2012) (COEF(J),J=1,L)
```

```
      WRITE (NRITE,205) (JVARB(J),J=1,L)
      WRITE (NRITE,207)
      DO 2039 I=1,M
2039  WRITE (NRITE,208) I, IVARB(I), BCOEF(I), QUAN(I), (X(I,J),J=1,L1)
      WRITE (NRITE,2010) (EVAL(J),J=1,L)
      IF (KK-1) 2048,2048,2040
2040  WRITE (NRITE,207)
      JJ=5
      DO 2047 K=2,KK
      L1=NW(K)/100
      L=NW(K)-100*L1
      WRITE (NRITE,207)
      IF (L) 2043,2043,2041
2041  DO 2042 J=1,L
      JC=JJ+J
      ROW(J)=COEF(JC)
      JVAR(J)=JVARB(JC)
2042  EVAL(J)=EVAL(JC)
       WRITE (NRITE,209) K, (ROW(J),J=1,L)
      WRITE (NRITE,206) (JVAR(J),J=1,L)
2043  WRITE (NRITE,207)
      DO 2045 I=1,M
      DO 2044 J=1,L1
      JC=JJ+J
2044  ROW(J)=X(I,JC)
2045  WRITE (NRITE,209) I, (ROW(J),J=1,L1)
      WRITE (NRITE,207)
      IF (L) 2047,2047,2046
2046   WRITE (NRITE,209) K, (EVAL(J),J=1,L)
      WRTTE (NRITE,207)
2047  JJ=JJ+7
2048  IF (LAST+IR-ITER) 2054,2053,2049
2049  DO 2050 J=1,N
2050  ROW(J)=X(IROW,J)
C*     STORES(DIV,PIV,D)
      D=QUAN(IROW)
      PIV=ROW(JCOL)
      DO 2051 I=1,M
      DIV=X(I,JCOL)/PIV
```

```
      QUAN(I)=QUAN(I)-B*DIV
      IF(ABS(QUAN(I)).LT.EPS) QUAN(I)=0.
      DO 2051 J=1,N
      X(I,J)=X(I,J)-ROW(J)*DIV
 2051 IF(ABS(X(I,J)).LT.EPS) X(I,J)=0.
      DO 2052 J=1,N
      X(IROW,J)=ROW(J)/DIV
 2052 IF(ABS(X(IROW,J)).LT.EPS) X(IROW,J) = 0.
      QUAN(IROW)=B/DIV
      IF(ABS(QUAN(IROW)).LT.EPS) QUAN(IROW)=0.
      BCOEF(IROW)=COEF(JCOL)
      IVARB(IROW)=JVARB(JCOL)
C4    (B)
      GO TO 2017
 2053 WRITE (NWRITE,2011) IR
      GO TO 2056
 2054 IF(NK.EQ.1) GO TO 2056
      OPTVAL=VALUE
      WRITE(NWRITE,211)
      REWIND NSTOR
      READ(NSTOR,213)N,NL,NG,NE
      DO 50 J=1,N
50    X(1,J)=0.
      DO 51 J=1,M
      IJ=IVARB(J)
51    IF(IVARB(J).LT.100)X(1,IJ)=QUAN(J)
      NC=NL+NG+NE
      DO 55 J=1,N
   55 VECT(J)=X(1,J)
      DO 52 J=1,NC
      READ(NSTOR,214)B,(X(2,K),K=1,N)
      AX=0.
      DO 54 I=1,N
54    AX=AX+X(1,I)*X(2,I)
      DIF=B-AX
      IF(NL.LT.J.AND.J.LE.NL+NG)DIF=-DIF
      IF(J.GT.NL+NG)DIF=ABS(DIF)
      IF (DIF.LE.EPS) DIF = 0.
52    WRITE(NWRITE,212)AX,B,DIF
```

```
2056 WRITE(NWRITE,20)(A)
     REWIND NSTOR
     RETURN
     END
*END-OF-RECORD*
SORT
BYTESIZE,60
FILE,INPUT=TAPE8(CR),OUTPUT=TAPE10(CR)
FIELD,OPTIMUM(1,1,1,FLOAT)
KEY,OPTIMUM(D)
END
*END-OF-RECORD*
      PROGRAM LSTX(INPUT,OUTPUT,TAPE5=INPUT,TAPE10)
      DIMENSION NN(20)
      REWIND 10
      READ *,NOFAV
      PRINT 6
    6 FORMAT(////////////////,* LIST OF PROBLEM-MAXIMUMS AND ASSOCIATED A
     1SSOCIATED ACTIVITY VECTORS*)
    2 CONTINUE
      READ(10) OPT,(NN(I),I=1,NOFAV)
      IF(EOF(10).NE.0) GO TO 20
      PRINT 4,OPT,(NN(I),I=1,NOFAV)
    4 FORMAT(1X,E12.5,20I3)
      GO TO 2
   20 PRINT 8
    8 FORMAT(////////////////////)
      STOP
      END
*END-OF-RECORD*
```

Table A

Demographics of Subjects by Sex-typed Group and Sex

	Androgyny Score					
	$t > 2.025$		$1.0 \geq t \geq -1.0$		$t < -2.025$	
	Male N=13	Female N=54	Male N=77	Female N=56	Male N=57	Female N=18
Age						
17-24 yrs.	11	49	61	41	46	13
25-34	1	2	16	10	8	3
35-49	0	1	0	3	2	1
50-	1	0	0	1	0	1
Sex						
Male	13	-	77	-	57	-
Female	-	54	-	56	-	18
Year in school						
Freshman	5	21	27	16	21	5
Sophomore	4	19	17	16	13	4
Junior	0	9	17	11	10	5
Senior	3	3	15	10	9	4
Graduate	0	0	1	2	3	0
Race						
Black	1	13	7	12	12	6
Caucasian	12	39	66	40	40	10
Mexican-American	0	0	0	0	0	1
Oriental	0	0	0	0	0	0
Other	0	0	3	2	2	1
Marital Status						
Single	12	47	70	41	48	10
Married	1	4	7	5	4	4
Cohabiting	0	0	0	3	2	3
Separated or divorced	0	0	0	6	2	1
Widowed	0	0	0	0	0	0
Family's annual income						
less than \$5,000	0	3	6	8	3	2
\$5,000 - \$7,999	1	7	2	6	3	1
\$8,000 - \$9.999	2	3	7	1	3	2
\$10,000 - \$14,999	2	16	27	13	16	2
\$15,000 - \$19,999	4	12	19	9	9	6
greater than \$20,000	2	11	12	12	21	5

Table B

Relative Frequency Distribution of Subjects

by Sex-Typed Group and by Demographics

	Sex-Typed Group				
	Feminine $t > 2.025$	Near feminine $2.025 > t \geq 1.0$	Androgynous $1.0 \geq t \geq -1.0$	Near masculine $-1.0 > t \geq -2.025$	Masculine $t < -2.025$
Age[a]					
17-24 yrs.	89.5%	77.6%	76.7%	89.2%	79.5%
25-34	4.5	20.4	19.5	5.4	14.8
35-49	1.5	2.0	2.3	1.4	4.0
50-	1.5	-	.8	-	1.3
Sex[b]					
Male	19.4	32.6	57.9	71.6	76.0
Female	80.6	67.4	42.1	28.4	24.0
Year in school[a]					
Freshman	38.8	18.7	32.3	43.3	34.7
Sophomore	31.3	28.5	24.8	20.3	22.6
Junior	13.4	24.5	21.1	17.6	20.0
Senior	9.0	18.4	18.8	12.2	17.3
Graduate	-	2.0	2.3	1.4	4.0
Race[a]					
Black	20.9	12.2	14.3	9.5	24.0
Caucasian	76.1	77.5	79.7	83.8	66.6
Mexican-American	-	-	-	1.4	1.3
Oriental	-	-	-	-	-
Other	-	6.1	3.8	-	4.0
Marital Status[a]					
Single	88.1	85.7	83.4	85.1	77.3
Married	7.5	10.2	9.1	5.5	10.6
Cohabiting	-	-	2.3	1.4	6.7
Separated or divorced	1.5	2.0	4.5	2.8	4.0
Widowed	-	-	-	-	-
Family's annual income[a]					
less than $5,000	4.5	12.2	10.5	6.8	6.7
$5,000 - $7,999	11.9	10.2	6.0	4.1	5.3
$8,000 - $9,999	7.5	6.1	6.1	2.7	6.7
$10,000 - $14,999	26.9	16.3	30.1	16.3	24.0
$15,000 - $19,999	23.9	26.6	21.1	28.4	20.0
greater than $20,000	19.4	22.4	18.0	33.8	34.7

[a] χ^2 not significant; [b] χ^2 (2) = 66.9, $p < .001$

Table C

The Percentage of Subjects Classified as

Masculine, Feminine or Androgynous

	Stanford Univ.[a]		Foothill J. C.[a]		Temple University	
classification	% Males N=444	% Females N=279	% Males N=117	% Females N=77	% Males N=216	% Females N=182
feminine $t > 2.025$	6.0%	34.0%	9.0%	40.0%	6.0%	29.7%
near feminine $1.0 < t < 2.025$	5.0	20.0	9.0	8.0	7.4	18.1
androgynous $-1.0 \leq t \leq 1.0$	34.0	27.0	44.0	38.0	35.6	30.8
near masculine $-2.025 < t < -1.0$	19.0	12.0	17.0	7.0	24.5	11.5
masculine $t < -2.025$	36.0	8.0	22.0	8.0	26.4	9.9

[a]These data are from Bem and Korula (1974, Table I).

Table D

Relative Frequency Distribution of the Androgyny _t_-ratio

_t_-ratio	Stanford Univ.[a]		Foothill J. C.[a]		Temple University	
	% Males N=444	% Females N=279	% Males N=117	% Females N=77	% Males N=216	% Females N=182
4.01 or above	-%	9.0%	2.0%	10.0%	.5%	9.3%
3.51 to 4.00	1.0	3.0	1.0	4.0	-	3.3
3.01 to 3.50	.5	5.0	2.0	10.0	1.4	3.8
2.81 to 3.00	1.0	2.0	-	-	-	2.2
2.61 to 2.80	1.0	4.0	-	8.0	.9	2.2
2.41 to 2.60	1.0	4.0	1.0	1.0	.5	3.8
2.21 to 2.40	1.0	4.0	-	5.0	1.4	2.7
2.01 to 2.20	1.0	3.0	3.0	1.0	1.4	1.6
1.81 to 2.00	1.0	3.0	2.5	1.0	-	4.9
1.61 to 1.80	.5	4.0	2.5	3.0	3.2	3.8
1.41 to 1.60	2.0	5.0	-	1.0	-	3.3
1.21 to 1.40	2.0	4.0	2.5	1.0	1.4	3.3
1.01 to 1.20	.5	4.0	1.0	1.0	2.3	4.4
.81 to 1.00	3.0	5.0	1.0	4.0	1.9	2.7
.61 to .80	3.0	2.5	1.0	4.0	3.2	2.7
.41 to .60	2.0	4.0	4.0	7.0	3.7	2.2
.21 to .40	3.0	2.5	3.0	7.0	3.7	4.9
.00 to .20	4.0	5.0	7.0	5.0	5.1	1.6
-.01 to -.20	4.0	.5	3.0	3.0	2.3	3.8
-.21 to -.40	3.0	2.0	3.0	5.0	4.2	4.4
-.41 to -.60	2.5	2.5	7.0	-	5.6	3.8
-.61 to -.80	4.5	2.0	8.5	3.0	2.3	1.1
-.81 to -1.00	5.0	2.0	5.0	1.0	5.1	1.6
-1.01 to -1.20	4.0	3.0	3.0	1.0	5.6	3.8
-1.21 to -1.40	4.5	3.0	5.0	3.0	5.1	2.7
-1.41 to -1.60	4.0	1.0	2.5	1.0	3.7	1.6
-1.61 to -1.80	4.0	3.0	2.0	1.0	4.2	1.6
-1.81 to -2.00	2.5	2.0	4.0	-	4.6	1.6
-2.01 to -2.20	3.0	1.0	1.0	-	3.7	2.7
-2.21 to -2.40	3.0	1.0	2.0	-	2.3	2.7
-2.41 to -2.60	4.0	1.0	2.0	3.0	3.2	.5
-2.61 to -2.80	3.0	.5	3.0	-	1.9	1.6
-2.81 to -3.00	3.0	.5	2.0	1.0	.9	-
-3.01 to -3.50	5.0	1.0	2.5	-	6.9	1.1
-3.51 to -4.00	5.0	1.0	2.0	1.0	1.4	1.1
-4.01 or below	9.0	1.0	9.0	3.0	6.9	.5

[a]These data are from Bem and Korula (1974, Table I).

Table E

GALILEO DISTANCE MEANS AND SAMPLE SIZE MATRICES FOR MASCULINE GROUP

--GALILEO MEANS MATRIX SET NO. 1

	1	2	3	4	5	6	7	8
1	0.000							
2	4.600	0.000						
3	3.227	2.120	0.000					
4	8.867	7.095	7.587	0.000				
5	2.986	4.892	4.240	8.932	0.000			
6	5.527	4.904	5.216	4.162	6.107	0.000		
7	7.770	6.096	5.753	4.986	6.292	3.770	0.000	
8	8.493	6.932	6.730	4.541	7.480	4.378	3.542	0.000
9	3.568	5.081	4.162	9.838	3.662	6.680	5.556	6.351
10	6.640	5.849	4.986	6.243	5.054	8.311	5.722	5.767
11	4.867	3.784	4.486	6.757	4.627	5.973	9.639	6.405
12	5.984	6.189	6.365	6.135	6.230	3.320	3.671	3.297
13	7.137	6.699	7.432	5.644	7.280	3.703	3.863	2.743
14	6.676	6.671	6.877	5.411	7.219	3.987	4.288	2.811
15	4.027	4.813	3.360	7.838	5.135	4.892	8.638	4.730

--GALILEO MEANS MATRIX SET NO. 1

	9	10	11	12	13	14	15
9	0.000						
10	4.548	0.000					
11	5.310	5.542	0.000				
12	6.542	7.111	5.000	0.000			
13	5.918	5.795	5.699	3.918	0.000		
14	5.534	4.822	5.736	4.137	1.973	0.000	
15	3.781	3.730	3.836	3.822	4.139	3.877	0.000

-- SAMPLE SIZE FOR EACH PAIR

	1	2	3	4	5	6	7	8
1	0							
2	75	0						
3	75	75	0					
4	75	74	75	0				
5	74	74	75	74	0			
6	74	73	74	74	75	0		
7	74	73	73	72	72	74	0	
8	75	73	74	74	75	74	72	0
9	74	74	74	74	74	75	72	74
10	75	73	7[illegible]	74	74	74	72	73
11	75	74	74	74	75	75	72	74
12	73	74	74	74	74	75	73	74
13	73	73	74	73	75	74	73	74
14	71	70	73	73	73	75	73	74
15	73	75	75	74	74	74	69	74

-- SAMPLE SIZE FOR EACH PAIR

	9	10	11	12	13	14	15
9	0						
10	73	0					
11	71	72	0				
12	72	72	71	0			
13	73	73	73	73	0		
14	73	73	72	73	73	0	
15	73	74	73	73	72	73	0

Table F

GALILEO DISTANCE MEANS AND SAMPLE SIZE MATRICES FOR ANDROGYNOUS GROUP

--GALILEO MEANS MATRIX SET NO. 2

	1	2	3	4	5	6	7	8
1	0.000							
2	4.705	0.000						
3	3.293	2.436	0.000					
4	7.895	6.414	7.311	0.000				
5	3.553	5.364	4.282	8.313	0.000			
6	5.346	5.541	4.955	4.462	5.400	0.000		
7	6.649	5.792	5.435	5.417	6.338	4.023	0.000	
8	8.000	6.530	6.917	5.038	7.446	4.137	3.565	0.000
9	4.244	5.288	4.053	9.992	4.946	6.477	5.729	6.194
10	6.409	5.754	4.833	6.581	5.408	7.840	5.703	5.868
11	5.046	4.146	4.424	6.750	4.366	6.504	9.605	6.731
12	6.023	6.573	6.553	5.568	6.069	3.603	4.267	3.527
13	7.348	6.819	7.169	5.915	6.750	3.577	4.059	2.824
14	7.146	6.636	6.708	5.845	6.766	4.277	4.492	2.892
15	5.346	5.489	5.031	6.500	5.962	4.160	6.543	3.892

--GALILEO MEANS MATRIX SET NO. 2

	9	10	11	12	13	14	15
9	0.000						
10	4.515	0.000					
11	4.878	5.569	0.000				
12	6.252	7.039	5.389	0.000			
13	6.519	5.422	5.702	4.183	0.000		
14	6.107	4.853	5.777	4.708	2.341	0.000	
15	4.631	4.592	5.357	4.203	3.228	3.811	0.000

-- SAMPLE SIZE FOR EACH PAIR

	1	2	3	4	5	6	7	8
1	0							
2	132	0						
3	133	133	0					
4	133	133	132	0				
5	132	132	131	131	0			
6	133	133	132	132	130	0		
7	131	130	131	132	130	130	0	
8	133	132	132	131	130	131	131	0
9	131	132	132	132	130	130	129	129
10	132	130	132	129	130	131	128	129
11	130	130	132	132	131	131	129	130
12	133	131	132	132	130	131	131	131
13	132	127	130	129	128	130	131	131
14	130	129	130	129	128	130	130	130
15	130	131	131	130	130	131	127	130

-- SAMPLE SIZE FOR EACH PAIR

	9	10	11	12	13	14	15
9	0						
10	130	0					
11	131	130	0				
12	131	129	131	0			
13	129	128	131	131	0		
14	131	129	130	130	129	0	
15	130	130	129	128	127	127	0

Table G

GALILEO DISTANCE MEANS AND SAMPLE SIZE MATRICES FOR FEMININE GROUP

--GALILEO MEANS MATRIX SET NO. 3

	1	2	3	4	5	6	7	8
1	0.000							
2	4.746	0.000						
3	3.582	2.522	0.000					
4	7.197	6.606	6.970	0.000				
5	3.269	4.924	3.955	8.164	0.000			
6	6.273	5.985	5.424	3.836	6.045	0.000		
7	6.881	6.239	4.788	5.000	6.015	3.209	0.000	
8	8.806	6.970	7.269	4.388	7.119	3.104	2.687	0.000
9	3.896	5.470	4.537	9.818	3.136	6.758	5.328	6.239
10	6.742	6.460	5.387	6.409	5.746	7.758	4.561	5.258
11	4.597	4.224	4.697	7.031	4.209	7.313	3.167	6.343
12	7.077	7.262	7.394	5.742	6.123	2.896	3.239	2.439
13	7.879	7.523	7.818	4.313	7.313	2.940	3.254	2.075
14	7.424	7.609	7.348	5.136	7.224	3.224	3.463	2.075
15	7.224	8.125	5.567	5.269	7.134	2.597	3.119	2.373

--GALILEO MEANS MATRIX SET NO. 3

	9	10	11	12	13	14	15
9	0.000						
10	3.738	0.000					
11	4.212	5.662	0.000				
12	6.563	7.308	5.167	0.000			
13	6.537	5.642	5.955	3.875	0.000		
14	6.185	4.682	6.045	4.406	1.212	0.000	
15	5.746	4.701	8.349	2.652	2.167	2.136	0.000

-- SAMPLE SIZE FOR EACH PAIR

	1	2	3	4	5	6	7	8
1	0							
2	67	0						
3	67	67	0					
4	66	65	67	0				
5	67	66	67	67	0			
6	66	65	66	67	66	0		
7	67	67	66	67	67	67	0	
8	67	66	67	67	67	67	67	0
9	67	66	67	66	66	66	67	67
10	66	63	62	66	67	66	66	66
11	67	67	66	65	67	67	66	67
12	65	65	66	66	65	67	67	66
13	66	65	66	67	67	67	67	67
14	66	64	66	66	67	67	67	67
15	67	64	67	67	67	67	67	67

-- SAMPLE SIZE FOR EACH PAIR

	9	10	11	12	13	14	15
9	0						
10	65	0					
11	66	65	0				
12	64	55	66	0			
13	67	67	67	64	0		
14	65	66	67	64	66	0	
15	67	67	63	66	66	66	0

Table H

GALILEO NORMAL SOLUTION FOR MASCULINE GROUP

GALILEO COORDINATES OF 15 VARIABLES IN A METRIC MULTIDIMENSIONAL SPACE

		1	2	3	4	5	6	7	8
1	AGGRESSI	-3.773	.366	-1.266	-1.255	.737	-1.532	-.749	.351
2	ATHLETIC	-2.013	.436	-2.044	1.300	-1.368	.319	1.449	.675
3	COMPETIT	-2.785	1.058	-1.266	1.234	-1.624	.334	-1.000	-.212
4	DEPENDEN	4.311	-.969	-1.587	3.028	.663	-.636	-.345	-.116
5	DOMINANT	-3.304	1.581	-.153	-.023	2.167	.745	.050	-.769
6	EMOTIONA	1.858	.107	-2.880	-1.668	-.403	-.661	.029	-.780
7	FEMININE	3.224	4.348	.049	.036	.089	.136	.088	.287
8	GENTLE	3.375	-.508	1.267	-.227	-.729	1.583	-.140	-.637
9	INDEPEND	-2.873	1.671	2.305	-1.196	-.564	-.050	.870	-.160
10	LOGICAL	-.764	.213	3.129	3.251	.461	-.269	-.518	.264
11	MASCULIN	-2.228	-3.509	-.750	.746	.827	.657	1.118	-.002
12	ROMANTIC	1.682	-.575	-.733	-2.175	.826	1.515	-.863	1.083
13	SENSITIV	2.653	-.861	1.354	-1.374	.141	-.706	1.138	.004
14	UNDERSTA	2.287	-.845	1.692	-.759	-.111	-1.400	.057	.167
15	ME	-1.731	-2.514	1.284	-.919	-1.113	-.034	-1.172	-.155

EIGENVALUES (ROOTS) OF EIGENVECTOR MATRIX--

112.239	47.314	43.804	37.393	14.060	11.741	9.517	3.647

NUMBER OF ITERATIONS TO DERIVE THE ROOT--

5	27	16	8	13	11	13	6

PERCENTAGE OF DISTANCE ACCOUNTED FOR BY INDIVIDUAL VECTOR--

39.864	16.804	15.558	13.281	4.994	4.170	3.380	1.295

CUMULATIVE PERCENTAGES OF REAL DISTANCE ACCOUNTED FOR--

39.864	56.668	72.226	85.506	90.500	94.670	98.050	99.346

CUMULATIVE PERCENTAGES OF TOTAL (REAL AND IMAGINARY) DISTANCE ACCOUNTED FOR--

49.785	70.771	90.201	106.787	113.024	118.232	122.453	124.071

TRACE 225.449

GALILEO COORDINATES OF 15 VARIABLES IN A METRIC MULTIDIMENSIONAL SPACE

		9	10	11	12	13	14	15
1	AGGRESSI	-.090	-.004	-.170	-.911	-1.008	.514	.292
2	ATHLETIC	.245	-.006	.283	-.462	-.305	-.127	-.554
3	COMPETIT	-.118	-.004	-.212	1.106	-.563	-.346	-1.061
4	DEPENDEN	-.069	-.006	-.110	-.479	.604	-1.745	-.532
5	DOMINANT	.225	-.000	.242	.228	-.335	-.910	-.615
6	EMOTIONA	.066	-.008	.101	.111	1.044	1.975	-.436
7	FEMININE	.003	.000	-.034	.242	-.026	.327	3.327
8	GENTLE	-.233	.004	-.034	-.932	-1.189	.575	-.320
9	INDEPENC	-.405	.007	-.185	-.462	1.390	-.897	-.933
10	LOGICAL	.223	.009	.040	-.008	.462	2.067	-.714
11	MASCULIN	-.401	-.002	-.160	.469	.043	.653	2.167
12	ROMANTIC	-.030	-.002	-.005	.190	.560	.052	-1.393
13	SENSITIV	.772	.004	-.247	.471	-.625	-.312	-.932
14	UNDERSTA	-.667	.005	.329	.622	-.602	-.456	-.573
15	ME	.479	.004	.160	-.184	.551	-1.059	2.225

EIGENVALUES (ROOTS) OF EIGENVECTOR MATRIX--

1.842	-.000	-.493	-4.600	-7.923	-15.449	-27.644

NUMBER OF ITERATIONS TO DERIVE THE ROOT--

4	16	4	7	6	23	6

PERCENTAGE OF DISTANCE ACCOUNTED FOR BY INDIVIDUAL VECTOR--

.654	-.000	-.175	-1.634	-2.814	-5.487	-9.818

Table J

GALILEO NORMAL SOLUTION FOR ANDROGYNOUS GROUP

GALILEC CCORDINATES OF 15 VARIABLES IN A METRIC MULTIDIMENSIONAL SPACE

		1	2	3	4	5	6	7	8
1	AGGRESSI	-3.387	1.249	1.102	-1.167	.590	.999	1.098	.926
2	ATHLETIC	-2.095	1.844	.278	1.451	-1.910	-.665	-.805	-.021
3	COMPETIT	-2.943	1.056	1.154	.999	-1.012	.390	-.144	-.276
4	DEPENDEN	3.445	3.629	-1.066	1.937	.515	.141	.626	.101
5	DOMINANT	-2.986	.342	.614	-.835	2.558	-.348	-.907	-.864
6	EMOTICNA	1.674	1.785	1.105	-2.098	-.372	.944	-.927	-.169
7	FEMININE	2.396	-.417	4.027	1.019	.364	-.483	-.047	.145
8	GENTLE	3.301	-1.197	-.219	.000	-1.031	-.971	.109	-.513
9	INDEPEND	-3.046	-3.037	1.009	-.589	-.952	-.627	.169	.284
10	LOGICAL	-.953	-2.072	-.809	3.467	1.205	.275	.649	-.169
11	MASCULIN	-2.584	.799	-3.920	-.552	-.029	-.947	-.400	.240
12	ROMANTIC	1.813	.363	-.092	-2.271	.365	-1.560	1.506	.017
13	SENSITIV	2.732	-1.449	-.556	-.682	.430	.515	-.971	-.187
14	UNDERSTA	2.322	-1.630	-.553	.102	.297	.497	-.964	1.295
15	ME	.309	-1.266	-1.274	-.781	-1.019	1.840	1.098	-.802
	EIGENVALUES (ROOTS) OF EIGENVECTOR MATRIX--	97.847	44.802	42.116	33.265	16.965	11.499	9.723	4.517
	NUMBER OF ITERATICNS TO DERIVE THE ROOT--	6	27	10	8	8	182	6	7
	PERCENTAGE OF DISTANCE ACCOUNTED FOR BY INDIVIDUAL VECTOR--	37.000	16.942	15.926	12.579	6.415	4.348	3.677	1.708
	CUMULATIVE PERCENTAGES OF REAL DISTANCE ACCOUNTED FOR--	37.000	53.942	69.868	82.447	88.862	93.211	96.887	98.595
	CUMULATIVE PERCENTAGES OF TOTAL (REAL AND IMAGINARY) DISTANCE ACCOUNTED FOR--	43.435	63.323	82.019	96.785	104.316	109.421	113.737	115.742

TRACE 225.273

GALILEC CCORDINATES OF 15 VARIABLES IN A METRIC MULTIDIMENSIONAL SPACE

		9	10	11	12	13	14	15
1	AGGRESSI	.345	-.064	.003	.283	-.789	.409	-.014
2	ATHLETIC	.755	-.320	.004	-.137	.068	.561	-.512
3	COMPETIT	-.702	.384	.002	-.262	-.797	-.187	-.817
4	DEPENDEN	-.104	.030	.008	.165	.567	-1.268	-1.251
5	DOMINANT	-.198	-.241	.001	-.017	-.119	-.553	-.680
6	EMOTICNA	-.360	.088	.004	.120	1.005	1.550	.610
7	FEMININE	.233	.041	-.001	-.069	-.030	-.881	2.663
8	GENTLE	-.508	-.144	-.003	.412	-1.027	.479	-.153
9	INDEPEND	-.075	.088	-.006	.225	1.125	-.985	-1.316
10	LOGICAL	.015	.055	-.004	-.001	.418	1.744	.293
11	MASCULIN	-.065	.156	.002	.065	.016	-.409	2.576
12	ROMANTIC	.101	.040	.001	-.379	.118	.716	-.721
13	SENSITIV	1.061	.320	-.003	.028	-.474	-.142	-1.088
14	UNDERSTA	-.562	-.219	-.003	-.258	-.198	-.157	-.527
15	ME	.064	-.215	-.003	-.175	.107	-.878	.937
	EIGENVALUES (ROOTS) OF EIGENVECTOR MATRIX--	3.138	.577	-.000	-.680	-5.391	-11.347	-21.759
	NUMBER OF ITERATICNS TO DERIVE THE ROOT--	4	4	8	13	16	9	14
	PERCENTAGE OF DISTANCE ACCOUNTED FOR BY INDIVIDUAL VECTOR--	1.187	.218	-.000	-.257	-2.038	-4.291	-8.228
	CUMULATIVE PERCENTAGES OF REAL DISTANCE ACCOUNTED FOR--	99.782	100.000	100.000	99.743	97.704	93.413	85.185

Table K

GALILEO NORMAL SOLUTION FOR FEMININE GROUP

GALILEO COORDINATES OF 15 VARIABLES IN A METRIC MULTIDIMENSIONAL SPACE

		1	2	3	4	5	6	7	8
1	AGGRESSI	4.023	1.158	-.735	-.835	2.446	-.110	-.274	-.573
2	ATHLETIC	3.315	2.307	.075	.970	-2.078	-.885	-.258	-.348
3	COMPETIT	3.244	.962	-2.182	.844	-.533	-.186	1.256	.301
4	DEPENDEN	-2.637	3.687	.396	2.171	.951	.760	-.152	.023
5	DOMINANT	3.521	-.429	-.152	-1.419	.020	1.299	-1.054	1.036
6	EMOTIONA	-2.099	1.931	-1.264	-1.838	-.072	-.990	-.187	.536
7	FEMININE	-1.838	-.557	-2.280	.216	-1.058	.564	-.972	-.697
8	GENTLE	-3.231	-.653	.957	.135	-1.722	.259	.219	.337
9	INDEPEND	3.870	-3.420	-.219	-.890	-.297	-.737	-.062	-.278
10	LOGICAL	.663	-2.714	.107	3.418	.388	.743	-.062	.019
11	MASCULIN	2.999	.376	3.892	-.077	.045	-.041	.661	.916
12	ROMANTIC	-2.135	.244	1.076	-2.728	-.429	1.342	.633	-.646
13	SENSITIV	-3.191	-.453	1.304	-.040	.495	-.829	-.677	-.113
14	UNDERSTA	-2.772	-1.124	.907	.353	.920	-1.175	-.292	.234
15	ME	-2.933	-1.315	-1.581	-.281	.924	.035	1.231	.157
	EIGENVALUES (ROOTS) OF EIGENVECTOR MATRIX--	125.157	48.292	35.623	32.647	17.953	9.404	6.791	3.085
	NUMBER OF ITERATIONS TO DERIVE THE ROOT--	5	8	26	5	12	8	8	5
	PERCENTAGE OF DISTANCE ACCOUNTED FOR BY INDIVIDUAL VECTOR--	44.777	17.278	12.745	11.680	6.423	3.365	2.430	1.104
	CUMULATIVE PERCENTAGES OF REAL DISTANCE ACCOUNTED FOR--	44.777	62.055	74.800	86.480	92.903	96.267	98.697	99.801
	CUMULATIVE PERCENTAGES OF TOTAL (REAL AND IMAGINARY) DISTANCE ACCOUNTED FOR--	55.236	76.549	92.271	106.679	114.602	118.752	121.749	123.111

TRACE 226.586

GALILEO COORDINATES OF 15 VARIABLES IN A METRIC MULTIDIMENSIONAL SPACE

		9	10	11	12	13	14	15
1	AGGRESSI	-.071	.007	-.275	.479	-.576	-1.441	.095
2	ATHLETIC	.004	-.006	-.314	-1.074	-.428	-.073	.167
3	COMPETIT	.033	-.002	.538	.365	-.217	-.342	-1.641
4	DEPENDEN	.021	.003	-.152	.371	.053	1.991	-.643
5	DOMINANT	.038	.000	.044	-.413	-.578	.274	-.017
6	EMOTIONA	-.015	-.000	-.107	.189	2.028	-.468	.725
7	FEMININE	-.083	-.003	.442	.406	-.149	.168	1.344
8	GENTLE	-.077	-.005	-.427	1.104	-.980	-1.212	-.263
9	INDEPEND	.061	-.001	-.258	.565	.437	2.177	-.942
10	LOGICAL	-.007	.001	-.137	-.378	1.451	-1.179	-.207
11	MASCULIN	.006	.000	.309	.320	.273	.202	2.395
12	ROMANTIC	-.084	-.001	.039	-.602	.554	-.184	-1.614
13	SENSITIV	.518	.002	.280	-.138	-.421	-.657	-1.026
14	UNDERSTA	-.486	.003	.259	-.492	-.595	.244	-.755
15	ME	.144	.003	-.241	-.701	-.836	.502	1.973
	EIGENVALUES (ROOTS) OF EIGENVECTOR MATRIX--	.557	.000	-1.263	-4.923	-9.918	-14.903	-21.916
	NUMBER OF ITERATIONS TO DERIVE THE ROOT--	4	7	5	7	67	7	16
	PERCENTAGE OF DISTANCE ACCOUNTED FOR BY INDIVIDUAL VECTOR--			[illegible]	-1.761	-1.548	-5.332	[illegible]

Table L

Galileo Coordinates after Orthogonal Rotation to Congruence

	CONCEPTS	GALILEO FACTORS 1	2	3
	MASCULINE GROUP			
1	AGGRESSIVE	-3.7730	.3664	-1.2658
2	ATHLETIC	-2.0130	.4361	-2.0440
3	COMPETITIVE	-2.7049	1.0582	-1.2661
4	DEPENDENT	4.3108	-.9687	-1.9872
5	DOMINANT	-3.3042	1.5813	-.1529
6	EMOTIONAL	1.8583	.1073	-2.8798
7	FEMININE	3.2241	4.3475	.0489
8	GENTLE	3.3753	-.5077	1.2669
9	INDEPENDENT	-2.8731	1.6712	2.3048
10	LOGICAL	-.7638	.2130	3.1293
11	MASCULINE	-2.2276	-3.5093	-.7500
12	ROMANTIC	1.6817	-.5755	-.7334
13	SENSITIVE TO NEEDS OF OTHERS	2.6530	-.8610	1.3538
14	UNDERSTANDING	2.2871	-.8445	1.6916
15	ME	-1.7307	-2.5142	1.2838
	ANDROGYNOUS GROUP			
1	AGGRESSIVE	-3.3705	.8454	-1.6483
2	ATHLETIC	-1.8036	.4806	-1.8007
3	COMPETITIVE	-2.8059	1.2169	-1.1834
4	DEPENDENT	3.6259	-1.2502	-2.3380
5	DOMINANT	-2.8271	1.2241	-.4588
6	EMOTIONAL	1.6793	.0725	-2.5370
7	FEMININE	2.8505	3.9162	.0466
8	GENTLE	3.1534	-.5717	1.1485
9	INDEPENDENT	-3.1683	1.4950	2.3516
10	LOGICAL	-.6859	.4293	3.0656
11	MASCULINE	-2.6649	-3.3517	-.3952
12	ROMANTIC	1.6472	-.6575	-.7076
13	SENSITIVE TO NEEDS OF OTHERS	2.4412	-1.1218	1.4727
14	UNDERSTANDING	2.1212	-.9732	1.7612
15	ME	-.1926	-1.7538	1.2227
	FEMININE GROUP			
1	AGGRESSIVE	-4.2574	-.4292	-1.7272
2	ATHLETIC	-2.5052	.7220	-2.4347
3	COMPETITIVE	-2.5434	2.2120	-1.4159
4	DEPENDENT	3.6837	-.7210	-2.3831
5	DOMINANT	-3.5060	1.0723	-.3560
6	EMOTIONAL	2.0487	.1821	-2.4050
7	FEMININE	1.8709	1.9853	.3776
8	GENTLE	2.9695	-.9046	1.2101
9	INDEPENDENT	-3.1495	2.1291	2.4068
10	LOGICAL	-.6498	.1905	3.2957
11	MASCULINE	-3.1283	-3.0480	-.4473
12	ROMANTIC	1.8295	-.9729	-.4818
13	SENSITIVE TO NEEDS OF OTHERS	2.7084	-1.7017	1.1997
14	UNDERSTANDING	2.3135	-1.1344	1.8112
15	ME	2.3152	.4186	1.3499