

MULTIDIMENSIONAL SCALING OF THE PERCEIVED SIMILARITY AND
SUBSTITUTABILITY OF LEISURE ACTIVITIES COLLECTED
BY PAIRED-COMPARISON AND SORT METHODS

by

Michael Allan Murray

A thesis
submitted in partial fulfillment
of the requirements for the degree of
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Abstract

Attempts have been made, largely on intuitive grounds, to arrive at the dimensions that describe leisure activities. The extent to which leisure activities are similar or substitutable has also received attention. This study, using multidimensional scaling (M.D.S.), assessed the perceived similarity and substitutability of 20 leisure activities, and the extent to which these concepts are congruent. Since standard methods of data collection for M.D.S. with many stimuli are generally laborious, two alternatives were tested in addition to the standard complete paired-comparison design. An incomplete paired-comparison design and a sorting procedure were used to determine if they reproduce the results of the standard method.

One hundred and thirty-four University of Manitoba undergraduates were tested from which the data of 123 were subsequently analysed. Students were assigned to one of six groups representing either a similarity or substitutability set and one of the three data collection methods.

Nonmetric M.D.S. analyses on eight data sets were conducted with the KYST program, and the data from the 100% Similarity and Substitutability Groups were further analysed using the INDSCAL program. Other analyses, including cluster analysis, property-fitting, and factor matching, provided supplementary information for the interpretation of M.D.S. solutions.

A three dimension solution with stress of .097 in the KYST analysis and accounting for 44% of the variance in the INDSCAL analysis was selected to represent the 100% Similarity Group's data. An athletic/non-athletic activity dimension was reflected in the first dimension of this and all other solutions. The second and third dimensions seemed to reflect group/individual and social-entertainment/individual-involvement variation.

The three dimension solution of the 100% Substitutability Group had a stress of .116 and accounted for 36% of the variance. The first dimension reflected athletic/non-athletic activity variation while the second and third dimensions were correlated with group/individual and mental involvement properties, respectively.

KYST analyses were conducted for the incomplete paired-comparison data, but with the exception of the first dimension these were not the same as the 100% Groups. An inadequate sample size and possibly larger error might account for this. Two sets of data from each of the sorting groups were analysed with the KYST program. These seemed to produce M.D.S. solutions very similar to the 100% Groups.

The M.D.S. solution of the 100% Similarity Group is similar to an earlier M.D.S. study with fewer stimuli, and is related to intuitive formulations. Interpretation of results indicates that similarity and substitutability are not the same. Some problems and shortcomings of both the substitutability and sorting analyses are discussed.

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Chapter 1

INTRODUCTION

Man has always engaged in leisure activities, but in recent years factors such as shorter work weeks and increased mobility have lead to increasing amounts of time available for them. Many people have not found satisfactory ways of utilizing leisure time. In addition, leisure activities are making demands on natural resources and making imperative the need for recreational planning. Such factors have prompted an increasing volume of research on various aspects of leisure and recreation, involving both univariate and multivariate approaches (Amatora, 1959; Sessoms, 1963; Wippler, 1970).

Research has been directed at the meaning of leisure (Bull, 1971, 1972; Donald & Havinghurst, 1959; Ennis, 1968; Foote, 1961), as well as the study of more specific relationships between leisure and factors such as work, occupation, and income (Bishop & Ikeda, 1970; Burdge, 1969; McEvoy, 1974; Standlee & Popham, 1958) and education and age (Graham, 1958; Schmitz-Scherzer, 1971; White, 1975).

Neulinger (1974) and his associates (Neulinger & Breit, 1969; Neulinger & Raps, 1974) have conducted research into people's attitudes toward leisure.

The ways in which people spend their time and money have also been studied. Time-budget studies (Ennis, 1968; Robertson & Converse, 1972; Zeisel, 1958) and money-budget studies (de Grazia, 1962; Kaplan, 1960) have recorded what people do with their free-time and how much they spend on it (see Warwick & Bishop, 1972, for a bibliography of this literature). Although a knowledge of what people do in their free-time is valuable, other questions have begun to attract research interest. Researchers are concerned with how leisure activities can be described and categorized, in what ways leisure activities are related in terms of satisfactions and motivations, and whether different populations of people indulge in distinct subsets of activities. The literature dealing with the question of whether there are meaningful ways in which leisure activities can be described and grouped is reviewed below.

The large number of leisure activities has invited attempts to achieve some parsimony in describing them. Kaplan (1960) used six classes to describe leisure activities.

He created a typology which could be used to differentiate between activities, and allow categorization of them into groups. Although he generated many dimensions along which activities could be categorized, for example, expense, skill, number of people involved, Kaplan only used three, the extremes of each defining two classes of activities.

Activities could be differentiated in his typology on the basis of the involvement of people, on the role of rules and traditions, and on the level of movement necessary to gain experience. The six classes and examples of the activities in each are:

1. Sociability: dance, parties, friends,
2. Association: church activity, club meetings,
3. Games & Sports: watch sports, play in sports, fish,
hunt, cards,
4. Art: photographs, concerts, sew,
5. Mobility: auto, walk, trips, shopping, and
6. Immobility: T.V., radio, books.

Kaplan said that "it is inescapable that the typology... is a theory in which the selection of items and their

relationship is tied up with the social values and academic positions of the scholar (p. 26)."

De Grazia (1962) presented another framework for describing free time activities. He proposed that a series of six polar types could be used. They were active/passive, participant/spectator, solitary/social, indoor/outdoor, in the home/outside the home, and sedentary/on-the-feet. But, he indicated that not enough information was available to say with any exactness how much free-time activity is, for instance, sedentary versus on-the-feet. Although he did not use it as such, his polar types could also be used to create a classification system for leisure activities.

Burch (1965) identified six general types of recreation activities from observation in campgrounds:

1. Symbolic labour: hunting, fishing,
2. Subsistence play: camp chores,
3. Expressive play: waterskiing, dancing,
4. Unstructured play: drawing, sunbathing,
5. Structured play: games, contests, and,
6. Sociability: friends.

Hendee, Gale and Catton (1971) take issue with a number of studies because they do not consider the possible underlying similarities or differences in the meaning of recreation activities. They collected preference choices for 26 outdoor recreation pursuits to bypass this criticism, and indicate that they grouped "most preferred" activities into five conceptually linked categories. Their classification scheme was, they say, based on stated preferences of recreationists rather than from observation of recreation activities and has more meaning, therefore, because of this. The five groups and some activities in them are:

1. Appreciative-symbolic: hiking, mountain climbing,
2. Extractive-symbolic: fishing, hunting,
3. Passive-free play: relaxing, driving,
4. Social learning: nature study, visiting people, and
5. Active-expressive: swimming, water skiing.

Although preference data was collected and reported, it appears that the categories were not derived in any statistical way from these data but were developed on the basis of their own theoretical framework in the same way as

Kaplan (1960), de Grazia (1962) and Burch (1965).

Hendee et al's (1971) method does not take measured dimensions of similarity of activities into account in their typology. But, they do state the problem well:

Another methodological problem is classification of the wide variety of activities associated with outdoor recreation. Too numerous and diverse to be analyzed separately, recreation activities must be classified into typologies of conceptually or empirically related activities for meaningful analysis (p.33).

This statement can be expanded to include all leisure activities and not just those related to outdoor recreation.

These efforts at describing or differentiating among leisure activities on the basis of some researcher-generated set of dimensions are essentially descriptive. Another descriptive line of research has centered on participation in leisure activities as a means of determining typologies or groupings. The statistical technique of factor analysis has been used most often. It is a procedure which, generally, analyses a matrix of inter-correlations among a set of data variables. In the case to be described, these correlations are computed on frequency or participation rates in leisure activities. The procedure constructs a smaller set of new variables, factors, which can account for, that is, which can reproduce, the interrelations in the data.

Bishop (1970) reported factor analyses of leisure behaviours for four communities. Scores for a very large

number of subjects on 24 leisure activities were recorded on nine category scales corresponding to frequency of participation. Three factors were extracted for each sample. Bishop says that an inspection of the factor loadings indicates remarkable similarity of the four samples across the three factors. Labels for factors and some high-loading activities are presented below:

1. Active-diversionary: bicycling, hiking, swimming outdoors,
2. Potency: hunting, fishing, attending sports events, and
3. Status: attending plays, tennis, reading books, movies.

Bishop says that this study shows that three dimensions (activity, potency, and status) can be used to describe people's behaviour during leisure time. He also suggests that some parsimony in describing leisure activities is present. The stated similarity of factors across samples is not readily apparent, and, if a conservative variable loading cutoff is applied to the factor structure, some distinct differences occur. Therefore, the suggested parsimony of description and the congruence with Osgood's three-factor structure should be more critically evaluated.

Nelson (1972) and Witt (1971) also report factor analytic studies dealing with participation rates for children in summer camps and high school students respectively. In another study, McKechnie (1974) reports the

factor analysis of data on participation in 121 leisure activities. He reports seven factors that were extracted: mechanics, crafts, intellectual, slow-living, neighborhood sports, glamour sports, and fast living. In an attempt at a further simplification and interpretation of the data, visual displays of variables representing "psychological distance" as spatial distance were plotted. Activities that were plotted very close together correlated highly and, therefore, were felt to be psychologically "close" or similar while those that were separated on the diagram were uncorrelated and, therefore, dissimilar. Unfortunately, it does not appear that much, if any, simplification was gained, since the plotting axes used determined the distances between activities. This method must be viewed as having some shortcomings.

Hendee and Burdge (1974), Moss and Lamphear (1970), and Wippler (1970) also discuss leisure activities in light of factor analytic studies. The first two of these studies will be discussed later in light of interpretations they make as a result of their studies.

In summary, the factor analytic research reviewed above suggests that when participation in various leisure activities are related in a large enough sample, apparently meaningful patterns appear. But, researchers using factor analysis have tended to say, or imply, that because certain leisure activities load on a factor those activities

are similar, mean the same thing to people, or are related in other ways than because of people's patterns of participation in them. They make an untested assumption that people engage in certain patterns of activities because those activities are functionally similar. Bishop (1970), for example, writes that factor analytically derived patterns of leisure could be used "in developing surrogate activities (p. 169)." Two leisure activity variables may load on the one factor, because they have some common element with respect to participation data. However, it does not necessarily follow that the activities themselves are similar. For example, sewing and knitting may load on the same factor, indicating that a person who engages in one activity is likely to engage in the other, and in this case the activities do seem similar. However, it may also be that concert-going and hiking may load on the same factor, but this does not imply that the activities are similar. There are numerous examples in the literature of this latter situation.

Factor analysis can be seen as relating variables across objects or people, whereas another statistical procedure, cluster analysis, relates objects or people across variables. Cluster analysis (Overall & Klett, 1972) refers to a number of data analytic techniques which have as their goal the grouping of individuals or stimuli based on their similarity across some set of variables. In the case of leisure and recreation, some group of respondents indicate

their participation in a number of activities, and give information relating to a number of socio-economic and personal variables. Individuals are then grouped on the basis of some measure of similarity computed on this data. That is, individuals within a cluster tend to participate in a set of activities in the same way, or people in a cluster may be similar in terms of socio-economic, status, and personal variables.

Tatham and Dornoff (1971) used nine socio-economic characteristics to compute their measure of similarity. After clustering produced ten groups, differences in both the number of activities in which the participants engaged and the number engaging in a particular activity could be seen through a comparison of participation rates. This study was primarily directed at an examination of the technique and its potential application in market segmentation rather than in regards to leisure activities.

Romsa (1973) used cluster analysis and information on participation in 26 activities in the derivation of eight outdoor recreation activity packages. The packages (clusters of people) differed on the basis of the number of activities pursued, and participation rates. One cluster, for example, was characterized by people who engaged frequently in swimming, snowskiing, and tennis. Activities themselves were not grouped except through association by high participation within a given cluster of people.

Ditton, Goodale, and Johnson (1975) identify cluster analysis as a method of reducing and clarifying the large number of possible activity or user groups that could be formed. Their study, focusing on water-based recreation activities, used kind, frequency, and location of activities to group individuals. As in other studies, a number of clusters were produced with differing characteristics. The authors identify some applications of cluster analysis, the main one being as a data reduction device. Individuals can be aggregated into groups, and the characteristics of groups, in terms of activities and other variables, analyzed.

Although cluster analysis as used here may be a useful technique for planners, its results as presently used are not in the spirit of classification of leisure activities addressed by Kaplan, de Grazia, or Bishop. No parsimony in describing leisure activities has been achieved through its use in the studies reported. To summarize the research presented above, Kaplan and de Grazia attempted to describe leisure activities through the use of intuitively derived dimensions along which these activities might be expected to vary. Bishop and other factor analytic researchers empirically derived categories on the basis of relationships among activities. Although this does produce some simpler description of activities, it is not based on any direct attributes of the activities like the descriptive categorizations were. That is, activities are not necessarily

grouped together because they have certain characteristics in common, but because enough people tend to engage in them in a sample of people. The end result may well be consistent with a classification based on respondent defined characteristics of activities, but, theoretically and statistically this need not be the case. It may be that individuals participate differentially and consistently in certain leisure activities and they are doing so because these activities are "psychologically similar" to them. Or, it may be the case that individuals engage in activities because they complement one another, that is, serve different functions. The possibility of psychological similarity of activities is further developed in the concept of substitutability of activities. Evidence relating to substitutability is derived from factor analytic studies based on participation rates. Leisure activity substitutability is very much related to leisure activity types, packages, and similarities. The following section is concerned with this concept.

Moss and Lamphear (1970) were the first to address themselves to the notion of leisure activity substitutability, from the viewpoint of personality needs related to recreation behaviour. The question they were concerned with was, do some types of activities tend to fulfill the same needs in people, while other activities do not. A factor analysis on college student participation rates, for an unspecified number of recreation activities was, performed. Eight

factors emerged. The authors say "we can assume overlap within a cluster (as related to needs), which suggests the possibility of substituting one for another (p. 130)." They then discuss the clusters (factors) in view of the activities in them and possible substitutions, and need-fulfilling relations.

Although the data presented was construed as evidence for substitutability of activities, the proper interpretation of it may be seen in the previous comments relating to other factor analytic research. For any given individual, whose needs with regard to leisure vary with situation-specific factors (Witt & Bishop, 1970), a pair of activities engaged in may not fulfill different needs, and therefore be substitutable, or may fulfill different needs and be complementary. Factor analysis can not differentiate among variables loading on factors in this regard since activities are related only on the basis of participation.

Hendee and Burdge (1974) made more explicit the substitutability notion. They defined the concept as the interchangeability of recreation activities in satisfying participants' motives, needs and preferences. One of the four questions which they suggest are basic to the understanding of the concept, relates to whether there are "related types of leisure activities that are potential tradeoffs for one another with minimal loss of satisfaction to the participant (p. 58)?" They refer to past empirical

work (as discussed earlier) which indicates that some leisure activities do tend to consistently load on certain factors. They present the labels describing five factors derived from the similarity of participation patterns in 69 leisure activities. The authors say that a major implication of the potential substitutability of activities as determined by factor analysis is that, at least at an aggregate level, activities in the same factor may provide similar satisfactions. The same criticism applied to Moss and Lamphear's (1970) statements about their data and applied to other factor analytic research is relevant in regard to Hendee and Burdge's research.

Beaman (1975) also criticizes the use of factor analysis in research relating to substitutability of activities. He makes a case for cluster analysis being the appropriate methodology, and suggests that researchers have confused factor analytic results drawn from non-specific population samples with what may be truly meaningful for specific collectivities within the population. He does not indicate how substitutability of activities is to be determined by cluster analysis, which as presently used does not define substitutable activity groupings.

It is possible to derive a typology or classification scheme that provides similarity and substitutability information and does not depend totally on the generation of categories by the researcher, or factor analysis. Rather

than using people's participation rates we can use people's direct comparison of leisure activities. An analytic technique is available through which activities can be compared and contrasted on a number of dimensions simultaneously. This technique is multidimensional scaling. Both Becker (1976) and Ritchie (1974, 1975) have scaled leisure or recreational activities, with the latter's study being the more extensive. The following overview, using Ritchie's study to illustrate many of the points made, is included to briefly acquaint the reader unfamiliar with multidimensional scaling with some of the more important methods used. See Green and Carmone (1970), Shepard, Romney, and Nerlove (1972), and Subkoviak (1975) for more extensive, non-mathematical reviews.

Multidimensional scaling (M.D.S.) provides a numerical and spatial representation of a set of objects or stimuli, leisure activities for example, based upon their interrelationships. These relationships between stimuli may be ones of affinity, association, interaction, distance, or similarity. Shepard (1972) discusses these and other proximity measures applicable to scaling. In the case of the Ritchie study, the 12 leisure activities listed below were scaled, using as a proximity measure housewives' judgements of perceived similarity among them.

- | | |
|-----------------|---------------------------|
| 1. Bowling | 7. Snowmobiling |
| 2. Shopping | 8. Playing bridge |
| 3. Golf | 9. Swimming |
| 4. Handicrafts | 10. Reading |
| 5. Gardening | 11. Visiting with friends |
| 6. T.V. viewing | 12. Movies |

All M.D.S. algorithms attempt to fit the stimuli being scaled in an n - dimensional space on the basis of their inter-relationships in order to best account for the relationships. Certain procedures are available for scaling group data, that is, average or aggregate analysis, while other procedures take individual variability into account, that is, individual or disaggregate analysis. M.D.S. procedures may also be classified on the "metric" of the input data needed. When ratio or interval scaled data is necessary the procedure is classed as "metric." Those using data appropriate for ranking, for example, frequency counts, or scale data not assuming interval properties, are called non-metric methods. There are many non-metric, aggregate algorithms available, among them TORSCA (Young, 1968), and KYST (Kruskal, Young, & Seery, 1972). Regardless of the algorithm used, the scaling procedure tries to develop, through an iterative process, a solution in which the matrix of interstimulus (activity) distances in the n - dimensional space closely matches the original matrix of proximity, or similarity, data. Information about the nature of the solution is available by determining the projections of each stimulus in the space on each dimension and the

resulting relative positions of stimuli in relation to one another. Shepard (1974) discusses the representation and determination of structure in M.D.S. which includes both interpretation of results and various decision making aids. In some scaling methods, for example, a descriptive statistic called "stress" (Kruskal, 1964), analogous to the standard error of estimate in bivariate regression, is available as an aid in determining the "badness - of - fit" of scaling solutions. But Subkoviak (1975) suggests, as have others, that "interpretability of results is a consideration of equal if not greater importance than the stress curve when choosing the dimensionality in which to represent a final configuration (p. 399)."

Ritchie (1975) presents the stress values from an aggregate, non-metric analysis using the TORSCA 9 program, (Young, 1968), and provides other information about a dis-aggregate analysis using the INDSCAL program (Chang & Carroll, 1972). Stress values for the four, three, and two dimensional solutions were .024, .045, and .125, respectively. Both the three and four dimensional solutions might adequately represent the leisure activity similarity structure.

INDSCAL is a computer program for M.D.S. implementing Carroll and Chang's (1970) methods. It uses individual subjects' data to form a group solution but also computes the degree and orientation of individual differences in

perception. It is assumed in the model that all subjects use the same set of dimensions in making their similarity judgements, for example, but that subjects differ in the importance or salience they attach to each dimension. The procedure, in a very simplified sense, tries to produce inter-stimulus distances in a certain dimensionality, that is, stimulus coordinates, and subject saliences which will account for as much of subjects' similarity data variance as possible. The sum of a subject's squared n - dimension saliences indicates the proportion of variance accounted for in his input data by the n - dimensional solution and is equal to the square of the correlation between the subject's input inter-stimulus ratings and the solution's inter-stimulus distances. INDSCAL analysis also provides data indicating both the total variance accounted for and the amount each dimension accounts for in an n - dimensional solution. In Ritchie's study, for example, in two, three, and four dimensions these values equalled 48.6, 55.2, and 61.1 percent respectively. Carroll (1972) presents a much more extensive discussion of the analysis of individual differences in M.D.S.

Before discussing methods of collecting similarity data for M.D.S. it should be noted that in INDSCAL analyses the stimulus dimension loadings, and therefore dimensions, are interpretable as output. In other procedures solutions are often rotated to principal components, but it is usually

necessary to further rotate, reflect, uniformly shrink or stretch the entire configuration in order to be able to interpret the dimensions along which variation among stimuli occurs. Shepard (1974) discusses a number of procedures for determining the interpretable form of M.D.S. solutions, both from internal analyses of the data and from the use of external measures. Ritchie uses two such procedures, that is, asking subjects on what basis they did their similarity comparisons and by reference to the rating of each activity on a number of scales.

To this point there has been no discussion concerning the methods of collecting data appropriate for multidimensional scaling, in particular, similarity or dissimilarity data. Although there are many such methods available, only two of these shall be discussed here. One, derived from the method of successive intervals, involves subjects making paired comparison judgements, that is, rating stimulus pairs on a scale from similarity to dissimilarity for example. The numerical values attached to the endpoints and the intervals between them determines whether the data is similarity (large values indicating similarity) or dissimilarity (small values indicating similarity). One method of collecting this data requires sorting of pairs into piles along an ordered continuum corresponding to the numbered scale. The standard method uses paper-and-pencil tests. With this method, for n stimuli, there are ${}_n C_2$ possible, non-redundant pairs that

can be formed. When n is small ($n < 20$) this is an excellent way of collecting data. But, when n becomes much larger the number of comparisons becomes large and unmanageable.

Another data collection method is the partitioning or sorting technique, such as used by Miller (1969). Subjects are asked to sort stimuli into mutually exclusive and exhaustive subgroups or piles on some particular basis, similarity for example. Whereas the paired comparison method provided each stimulus pair with a value, sorting methods require a processing step to find these distance measures. Although this method is easy to do and quick, the question remains as to what measure can and should be computed. Miller (1969) constructed an n by n stimuli matrix for each subject the i, j , cells of which contains one if stimuli i and j were together in one of that subject's sort piles and zero if not. When all subjects' matrices were added together the result was an aggregate frequency count matrix. But, evidence suggests that this measure does not capture enough information to construct "good" M.D.S. structures, as defined by a known configuration (Rao & Katz, 1971). Burton (1972) suggests another distance measure that can be computed, and compares it with two other measures (Burton, 1975), one of which is Miller's. He indicates that although inter-method correlations across all pairs of stimuli are high (.822, .951, .956), his measure produces much more interpretable scaling solutions. This measure uses information concerning each

subject's sorts, that is, number and size, as well as the sort pile composition, to compute probability increments or decrements which constitute the distance measure. Ritchie used neither of these methods, but had subjects rank order all ${}_{12}C_2 = 66$ pairs of activities from most similar to least similar.

The preceding discussion is very brief and is not a rigorous treatment of the complex subject, multidimensional scaling. But, it is hoped that it will provide the reader with a "feel" for M.D.S. and an indication of where to find more information. Green and Rao (1972) analyse a set of data using many M.D.S. procedures and related techniques. Their presentation (which is recommended to the reader interested in M.D.S.) illustrates and compares procedures, such as INDSCAL and various non-metric scaling algorithms.

Aside from the methodological procedures used by Ritchie, his study is important to this review because of the content of it, that is, leisure activity similarity. From an INDSCAL analysis of his data for 100 women, he found that a four dimensional solution accounted for approximately 61% of the variance in subjects' ratings. He labeled these dimensions, in order of importance, active-passive, individual-group, simple-difficult to perform, and involving-time filling. Figure 1 presents the configuration of stimulus points for the first three dimensions. Note, for example, how points 8, 9, and C, corresponding to reading, shopping and T.V.

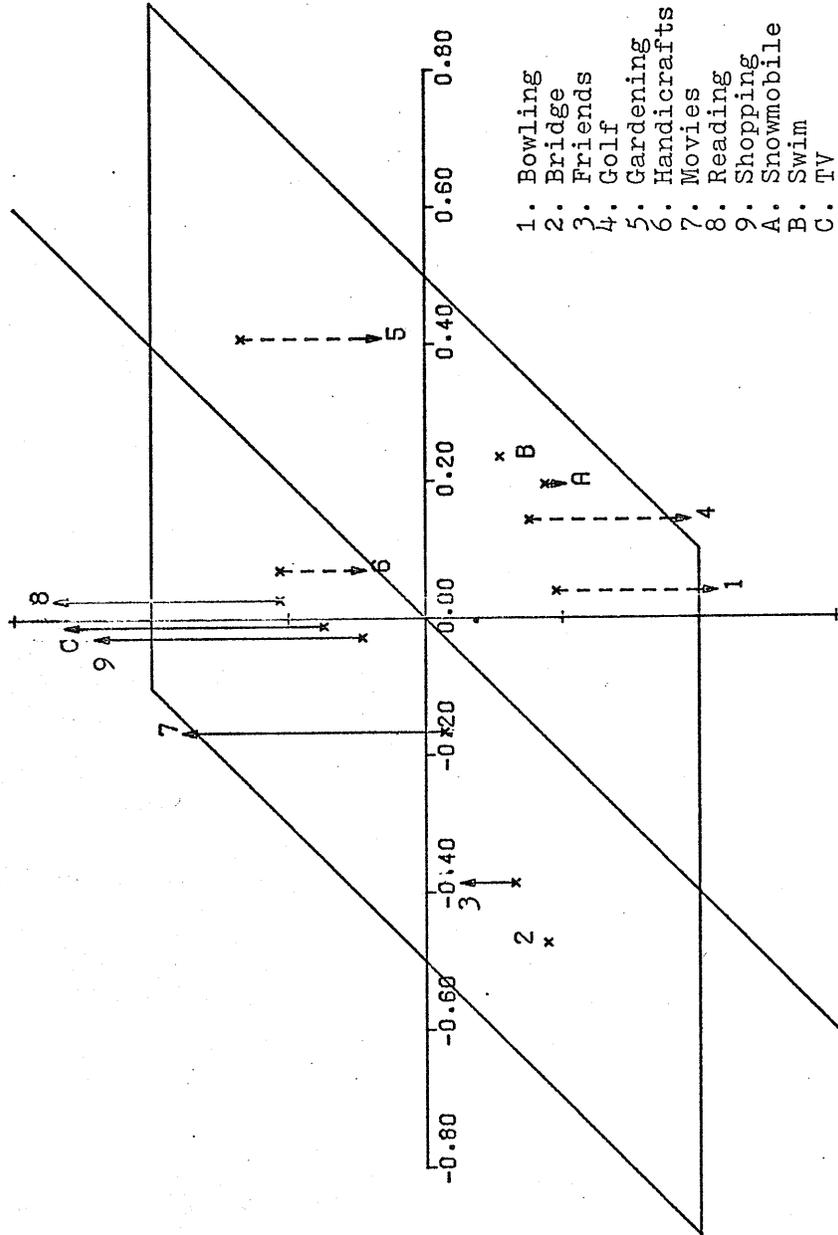


Figure 1
 First Three Dimensions of INDSICAL
 Solution from Ritchie (1975)

appear together in the diagram while points 1 and 4 corresponding to bowling and golf also appear together, but in a different direction. Ritchie further reports that a cluster analysis on the four dimensional inter-activity Euclidean distances using Johnson's (1967) hierarchical clustering scheme resulted in the following five clusters:

1. Active sports: bowling, golf, swimming, snowmobiling,
2. Relaxing entertainment: TV, reading, movies,
3. Social interaction: bridge, friends,
4. Achievement-oriented hobbies: gardening, handicrafts,
and,
5. Shopping.

He does not present any data pertinent to his cluster analysis. The dimensions found to account for people's comparisons of leisure activity similarity in this study relate very closely to de Grazia's model, while the cluster analysis groupings correspond to some of Kaplan's groups. Ritchie concludes, "it is felt that the present study introduced certain technical improvements to the leisure research field... the technique used for measuring perception enables the respondents to choose the judgement criteria they wish rather than imposing the researcher's own prespecified scales (1975, p. 138).

While advocating the use of non-metric M.D.S. procedures for recreation researchers, Becker (1976) discusses the

scaling of 11 recreational activities by 25 university graduate students. These activities, listed below, were scaled using TORSCA9 (Young, 1968) and stress values of .11 and .07 were found for the two and three dimension solutions respectively.

- | | |
|-------------------------|-----------------------------|
| 1. Visiting with others | 7. Softball |
| 2. Boat racing | 8. Motor cycling |
| 3. Relaxing | 9. Water skiing |
| 4. Photography | 10. Mountain climbing |
| 5. Swimming | 11. Viewing natural scenery |
| 6. Hiking | scenery |

He presents the results of the Varimax rotated three dimension solution. The labels he attached to the dimensions were: solitude - social interaction, general environmental setting - water setting, and mechanical/physical objects - importance of interaction.

Becker's discussion of multidimensional scaling, his methods and results are often misleading. Without entering into a detailed critique, suffice it to say the most important virtue of non-metric multidimensional scaling is not the transformation of rank order information into ratio scale information as Becker suggests. Nor can a distance matrix as output from a M.D.S. analysis be used to determine if one pair of activities are twice as similar as another. But, the determination of their relative similarity is

possible. The original similarities recorded by Becker are not what would be expected by his procedure description, which indicates that dissimilarity data was to be collected. His statement that, "we have thus identified three important perceptual dimensions of recreational activities (p. 118)" is quite misleading when the activities used as stimuli are considered, and when the many possible interpretations of the dimensions are stated. Whereas Ritchie acknowledged the importance of individual differences in perception, Becker does not do so. The salience of particular dimensions in people's rating is of extreme importance in understanding "important perceptual dimensions". Becker mentions the aspect of substitutability of recreation activities in relation to similarity, implying that they are the same. This is something that requires further investigation.

Here then is another method whereby leisure activities might be compared and classified. It does not focus on individuals' participation, it does not rely on a subjective determination of a typology, and it does relate to characteristics of activities.

Both leisure activity M.D.S. studies reported involved a limited number of leisure activities. However, increasing the number of activities increases the number of comparisons subjects must make. Thus, it would be of interest to determine whether a more "economical" data collection method for multidimensional scaling could be used with a larger

number of activities, and still retain all the information necessary for adequate solutions and structures. There are two such methods that might be used.

The method of partitioning described earlier is one method of handling large numbers of stimuli. The paired-comparison procedure can also be used when not all possible pairs of stimuli are presented. Gabriel (1974) produced evidence suggesting that the number of dimensions and structures using varying sizes of subsets of pairs was the same as with all pairs used. The overall "fit" as measured by stress was not as good but the solutions remained very nearly the same.

In addition to a need for further research on the similarity of leisure activities, particularly a larger set of activities than previously used, there is another area that might be profitably studied. Other research approaches, as outlined above, have focused on participation. Little attention has been given to the question of to what extent leisure activities are perceived as interchangeable or substitutable, and how this relates to perceptions of them as similar or dissimilar. If people are asked to what degree activities are interchangeable via a structured M.D.S. task, then the analysis of such a set of comparisons should provide a structure describing the distance between activities as based on substitutability. This structure could then be compared with one found from people's simila-

rity ratings. This comparison could be enlightening in terms of the relative positions of a given activity in each structure.

A number of questions about the relationships among leisure activities have been raised above, and the present research attempts to deal with them. Specifically, it was asked whether leisure activities can be consistently classified in meaningful ways. M.D.S. would appear to provide a basis for doing this. It has the advantages of not focusing on participation and not relying on a typology or classification predetermined by the investigator. With respect to M.D.S. procedures, it would be of interest to know whether subsets of large numbers of pairs of activities generate the same structures as complete sets of pairs, and if partitioning methods can reproduce solutions found using the paired-comparison methods. Also, the extent to which leisure activities are substitutable has received little research attention. Information on the substitutability of leisure activities would be of use in generating a more complete classification system.

The present research, therefore, dealt with these questions by:

1. determining if a M.D.S. structure, involving both orientation of activities in the scaling space and dimension names, similar to that found by Ritchie (1975) can be obtained with a larger set of leisure activities, and a different sample of people,

2. investigating the use of M.D.S. in relation to substitutability of leisure activities, and the relationships between structures based on similarity and substitutability, and
3. comparing different methods of obtaining M.D.S. data with a view to the use of larger sets of stimuli and economy of time in data collection.

Chapter 2

METHOD

Although two methods of data collection, paired-comparison and sorting, and two instruction sets, similarity and substitutability, were varied, the experimental design of the present research is not truly factorial. It may best be described as three two-session experiments. The first experiment involved the paired-comparison methodology for comparing similarity and substitutability of 190 pairs of 20 leisure activity stimuli. It will be described in detail. The second experiment used the same methodology as the first for both similarity and substitutability but not all of the 190 possible pairs of activities were presented to each subject. Instead, a subset of 60% of them, that is, 114, were presented. The third experiment used the sorting method of data collection for comparisons of stimuli on the basis of both similarity and substitutability. There were, therefore, three experiments, each involving two different scenarios. In the discussion of Experiments 2 and 3 only rationale and changes in procedure will be presented.

Experiment 1

The data obtained from the two groups in this experiment, referred to as the 100% Similarity and 100% Substitutability Groups, is used to:

1. describe how undergraduate college students evaluated leisure activities, that is, construct M.D.S. structures based on complete sets of paired-comparisons of activities,
2. provide a set of comparison data to evaluate the M.D.S. structures obtained from a subset of pairs in Experiment 2 and by the sorting method in Experiment 3,
3. name the dimensions found, and
4. determine the reliability of subjects' judgements.

Subjects. Undergraduate University of Manitoba students enrolled in Introductory Psychology in the Spring term of 1976 served as subjects in all experiments. They participated for course credit. In order to increase the probability of students being familiar with the leisure activities used as stimuli, only those students having spent five or more years in Manitoba or having spent five years or more in Canada, at least two of which were in Manitoba, were included in the sample. After application of these criteria 12 of 13 males and 14 females constituted the 100% Similarity Group, and 10 of 12 males and 14 of 16 females remained in the 100% Substitutability Group. Therefore, there were 26 students in the former group and 24 students in the latter.

Stimuli. McKechnie (1974) records 121 activities in his "Leisure Activities Blank" and notes that some possible leisure activities are not included. A subset of 20 of

these activities were selected as stimuli such that as a group they would fulfill the following criteria:

1. activities should be definable by name, and there should be a high probability that all subjects will know what the name stands for. Where possible activities were drawn from a list produced by Bishop, Jeanrenaud, and Lawson (1975) which records the participation of college students in a number of leisure activities,
2. some activities included in Ritchie's (1975) study and which reliably occur in factor analytic research should be included, and
3. winter rather than summer outdoor activities should be included in deference to the season in which the research was conducted.

The list of activities used is presented below.

- | | |
|-----------------------|-----------------------------|
| 1. Listen to music | 11. Attend sports events |
| 2. Crosscountry ski | 12. Play musical instrument |
| 3. Visit with friends | 13. Attend concerts/plays |
| 4. Television | 14. Badminton |
| 5. Movies | 15. Swim indoors |
| 6. Snowmobile | 16. Sew |
| 7. Read for pleasure | 17. Basketball |
| 8. Window shop | 18. Ice skating |
| 9. Volleyball | 19. Downhill ski |
| 10. Play cards | 20. Dancing/partying |

Procedure. Students in Experiment 1 participated in 50 minute testing sessions, with each Group being tested on a different occasion. After all subjects had been seated the experimenter asked them to fill out a question sheet, a Personal Data section. See Appendix A for a copy of materials

given to students. Data concerning age, gender, length of residence in Canada, etc. were collected by having subjects check or write in appropriate responses on a question sheet. Written instructions indicated that subjects should turn the page when they were finished this and read the instructions on the next page carefully. If there were any questions students were asked to raise their hands and the experimenter tried to answer them.

The comparison instructions indicated that the names of two leisure activities were printed on computer cards in the deck on each subject's desk. These activities were to be compared on their similarity for one group, substitutability in the other, as defined by the subject, and placed in one of nine piles along an ordered continuum. Nine numbered cards, 1=extremely similar to 9=extremely dissimilar, were included to help the subject order his/her piles. Subjects were asked to work quickly, not to change the placement of any card after having it placed in a pile, or to check back to see what past comparisons they had made. The 20 stimuli used produced ${}_{20}C_2=190$ pairs of activities to be compared. Each subject rated 170 pairs once and, to provide a check on intrasubject reliability, 20 pairs twice. This resulted in each subject making the same 210 comparisons. The 20 pairs to be compared twice were selected randomly from the 190 pairs possible. The set of pairs was constructed such that, as nearly as possible, each activity appeared first through-

out all pairs an equal number of times. All subjects were asked to write down the time at which he/she was finished all comparisons.

Subjects in the substitutability group were given the following written statement about what was meant by the term "substitutability." Then they were asked to place cards into piles along a continuum, 1=Not at all substitutable to 9=Extremely substitutable. The statement given to subjects was:

For the purposes of this task, substitutability is defined as when, for example, on a particular occasion you would like to engage in the first activity, but cannot for some reason, the second activity can be interchanged or substituted for the first.

When subjects were finished the next page held written instructions introducing another task. Subjects were asked to write down those attributes of activities, methods, etc., they used to compare or determine magnitude of similarity or substitutability. The task following this was used to assess the familiarity with leisure activities with some uniformity in judgement criteria. Two anchor points were introduced into the rating task. Seven point bipolar scale with 1="Not at all familiar" and 7="Very familiar" as endpoints were used. The anchor points were described to students as "1 when the activity is not even known to the subject by name," and "7 when the subject has either engaged in the activity on more than one occasion or seen it done

more than once." Subjects were asked to circle numbers corresponding to their judgements for each of the 20 activities, and then to continue with the next task.

In the next task students were asked to rate each leisure activity on six seven-point bipolar scales. The endpoints of the scales, numbered 1 and 7 respectively, were:

1. passive - active,
2. indoor - outdoor,
3. simple - difficult,
4. group - individual,
5. enjoy - do not enjoy, and
6. mental involvement - no mental involvement.

At the conclusion of this task subjects were thanked and dismissed.

Experiment 2.

A 60% Similarity Group and a 60% Substitutability made up Experiment 2, which was conducted to:

1. compare the ability of an incomplete set of all paired-comparisons, that is, 60% of 190 pairs, in producing M.D.S. structures congruent with those produced in Experiment 1, and
2. compare the similarity and substitutability structures of Experiment 3 using the sorting method with the two structures obtained in this experiment. Both visual means and a statistical procedure, described later, will

be used to make these comparisons.

Procedure. Subjects were Introductory Psychology students selected under the same criteria as those in Experiment 1. A number of testing sessions were run in order to get as many subjects as possible. But only 6 of 7 males and 7 of 9 females constitute the 60% Similarity Group and 5 males and 9 of 10 females in the 60% Substitutability Group. The procedure for these groups was the same as for the 100% groups of Experiment 1 except that subjects did not rate 210 pairs of activities, only 114. A Fortran computer program, written and made available by Dr. R.M. Gabriel, University of Manitoba, was used to produce each subject's card deck. The program randomly deleted 40% of the pairs in the complete set for each subject, with the restriction that across a specified sample size (25) all 190 pairs were seen equally often. Each subject rated 114 pairs, and, because of the small sample sizes, each of the 190 pairs was seen not less than five times. The 60% Substitutability Group received the same written definition as the other substitutability groups did. All procedures and instructions to subjects were the same as in the 100% Groups.

Experiment 3

Experiment 3, composed of a Sort-Similarity Group and a Sort-Substitutability Group, was conducted to collect data from subjects by using a sorting method.

These were used to:

1. determine the M.D.S. structure of activities compared on the basis of similarity and substitutability using a sorting methodology, and
2. to compare these structures visually and analytically to those found in Experiments 1 and 2 using paired-comparison methods.

Procedure. After application of the sampling criteria 4 males and 17 of 18 females formed the Sort Similarity Group while 8 of 9 males and 17 females constituted the Sort Substitutability Group. Subjects in this experiment followed the same procedure as those in Experiments 1 and 2 with one major exception. The sorting method, described earlier, was used to collect similarity and substitutability data. After the Personal Data section a different set of instructions were given. The Sort Similarity Group was informed that the names of 20 leisure activities were printed on computer cards which were on their table. They were asked to sort these into not more than nine piles such that activities that seemed similar, as defined by the individual, were in the same pile. The Sort Substitutability Group was also informed about the 20 cards but were asked to sort them on the basis of substitutability. This was defined for them in the same way as was done in Experiments 1 and 2.

Analyses

In this section a brief description of the data used, procedures and computer programs used, and output information

will be given for M.D.S. related analyses. For each of the paired-comparison groups, that is, 100% and 60% Similarity and 100% and 60% Substitutability, the mean of subjects' data for each one of the 190 pairs of activities was computed. Two aggregate matrices were computed for each of the Sort Groups. The first contained the similarity measures calculated following Burton's (1972) method and is called Log Transform data. The second similarity matrix was composed of the frequency count of the joint occurrence of two activities in a sort pile across all individuals in the group and is called the Frequency data. In total eight aggregate or average data matrices were available for analyses.

The non-metric M.D.S. computer program KYST (Kruskal, Young, and Seery, 1972) was used to analyse the aggregate paired-comparison and sorting data. All standard options and the maximum number of iterations (50) were selected for all runs. Six solutions were computed, starting from one with six dimensions and down to a one dimension case. Stimuli dimension weights, plots of stimuli for all pairs of dimensions, stress values, and a stress-by-dimension graph were output for each of the eight data matrices.

Disaggregate analyses of the two 100% Groups was done with Chang and Carroll's (1972) INDSCAL computer program, described earlier. Using the corresponding four dimension KYST stimuli loading matrices as starting configurations in order to decrease computer running time, solutions were

found in each of four, three, and two dimensions. The parameters of "maximum iterations" and "criterion value" were set at 25 and .001, respectively. In addition to giving stimuli by dimension loading matrices and plots of stimuli by pairs of dimensions, INDSICAL output includes the correlation between input and distances for each subject, and subject dimension salience matrices. The correlation between YDATA and YHAT, a measure which when squared is the percentage of variance in the data accounted for by the solution, and data to compute the variance accounted for by each dimension in each solution is also available.

Rating scale data for each activity on each scale, familiarity, for example, is averaged over subjects in each of the six groups, and is used as external information for interpretation of solutions. This data is used in a method called property-fitting implemented by the computer program PROFIT (Chang & Carroll, 1964) using a procedure based on linear regression. Projections of each rating scale vector, that is, the mean score on the scale for each activity are found in the n-dimensional space defined by a M.D.S. stimuli dimension loading matrix from either an aggregate or disaggregate analysis. Two sets of data computed are valuable aids in interpreting the dimensions of the solution input. The maximum correlation between the property and the projections on the fitted vectors gives a correlational index of how well the rating

scale fits or relates to the n-dimensional structure as a whole. The cosines between the fitted vectors and dimensions are the correlations between each rating scale vector and each dimension. When the former index indicates a "good fit" of the property to the structure, the correlations between the property and individual dimensions can be interpreted.

A procedure used for comparing two factor analytic solutions' factor structures will be used to compare M.D.S. structures' dimensions. The procedure, implemented by the computer program FACT06 (University of Alberta) is described by Kaiser, Hunka, and Bianchini (1971) and Gorsuch (1974). The FACT06 program gives an analytical comparison between two different M.D.S. structures, for example, obtained from two different data collections methods or by different tasks, rather than just a visual comparison between the two. Since solutions' dimension positions can be defined in a n-dimensional space through the loadings of stimuli on them, when two structures have the same variables each one's dimensions can be projected into a common space. The cosines of the angles among the dimensions are the correlations among dimensions. The procedure defines the space from the first matrix of variable dimension loadings entered, projects the second matrix's variables in the space and rotates them such that the cosine between a given variable's vector in each structure is maximized. The dimensions of each structure are then projected into the space because the relationship between dimensions and variables is known.

The cosines of the angles between the two sets of dimensions can be computed and represent the relationship between two structures' dimensions.

Euclidean distance measures between all activities were computed for the n-dimensional stimuli loading matrices output from both KYST and INDSCAL programs using the program MINKDIST from the Institute of Behavioural Research, York University. These distances were input into the program MOC (Gruvaeus & Wainer, 1972), a hierarchical clustering program implementing a variant of Johnson's (1967) procedure. Output from this program consists of a tree-diagram indicating the clustering of activities from each activity being in a separate cluster to the case in which all activities are in the same cluster. At each clustering step an "effectiveness measure" is printed which is the distance between two activities that are being joined which is found in the raw input Euclidean distance data, or the distance between an activity and the closest activity of a cluster to which it is joined. This computational procedure corresponds to the "nearest neighbour" or "connectedness" method.

In summary, the data analytic techniques discussed in this section have two purposes. The first is to provide a spatial configuration displaying the inter-relationships of a number of stimuli, this being M.D.S. by either the KYST or INDSCAL procedures. The other is to

provide information aiding the interpretation of the M.D.S. configurations. PROFIT, MOC, and FACT06 all implement procedures used for interpretation and explanation of M.D.S. results. Since all analyses can not be conducted or discussed simultaneously, they were conducted in a sequence and are discussed in that way. But, the understanding of results is more from a global interpretation of all information rather than by reference to one of a series of discrete analyses.

As discussed earlier, INDSCAL configurations are output in their most interpretable form, whereas KYST solutions are not. Therefore, to aid in interpretation, all KYST configurations discussed are those after rotation (by FACT06) to their respective 100% Group's INDSCAL solution. This should result in the KYST solutions being in their most interpretable form.

Chapter 3

RESULTS

100% Similarity Results

Each of the 26 subjects in the 100% Similarity Group rated 20 pairs of leisure activities twice for intrasubject reliability purposes. The 26 correlation coefficients computed on these data are presented in a frequency distribution in Table 1. With a mean of .84, and no individual subject's correlation below .54, this distribution indicates substantial reliability and, therefore, all subjects' data were used.

The non-metric M.D.S. program KYST was used to find configurations for the 100% Similarity Group's aggregate data in one through six dimensions. The stress values computed for these solutions are listed in Table 2, and plotted against dimensionality in Figure 2. No distinct "elbow" or "break" is apparent which might indicate the underlying dimensionality of the data. The three and four dimension solutions have stress values of .097 and .067, respectively, which suggests a reasonable fit of either relatively low dimension solution to the data.

Aggregate M.D.S. solutions were also produced through the use of INDSCAL in two through four dimensions. This program finds solutions using composite values from individual subject's data weighted to reflect the importance

Table 1
Frequency Distribution of 100% Groups' Intrasubject
Reliability Correlations

Correlation	Similarity	Substitutability
.91 and over	5	6
.81 - .90	8	8
.71 - .80	8	7
.61 - .70	2	2
.54 - .60	3	1
Mean	.837	.852
Median	.845	.850

Table 2
Stress Data for Similarity Groups'
KYST Solutions

Number of Dimensions	Group			Frequency
	100%	60%	Log Transform	
6	.038	.070	.015	.010
5	.049	.077	.034	.020
4	.067	.101	.051	.031
3	.097	.140	.086	.064
2	.140	.223	.142	.119
1	.208	.345	.211	.172

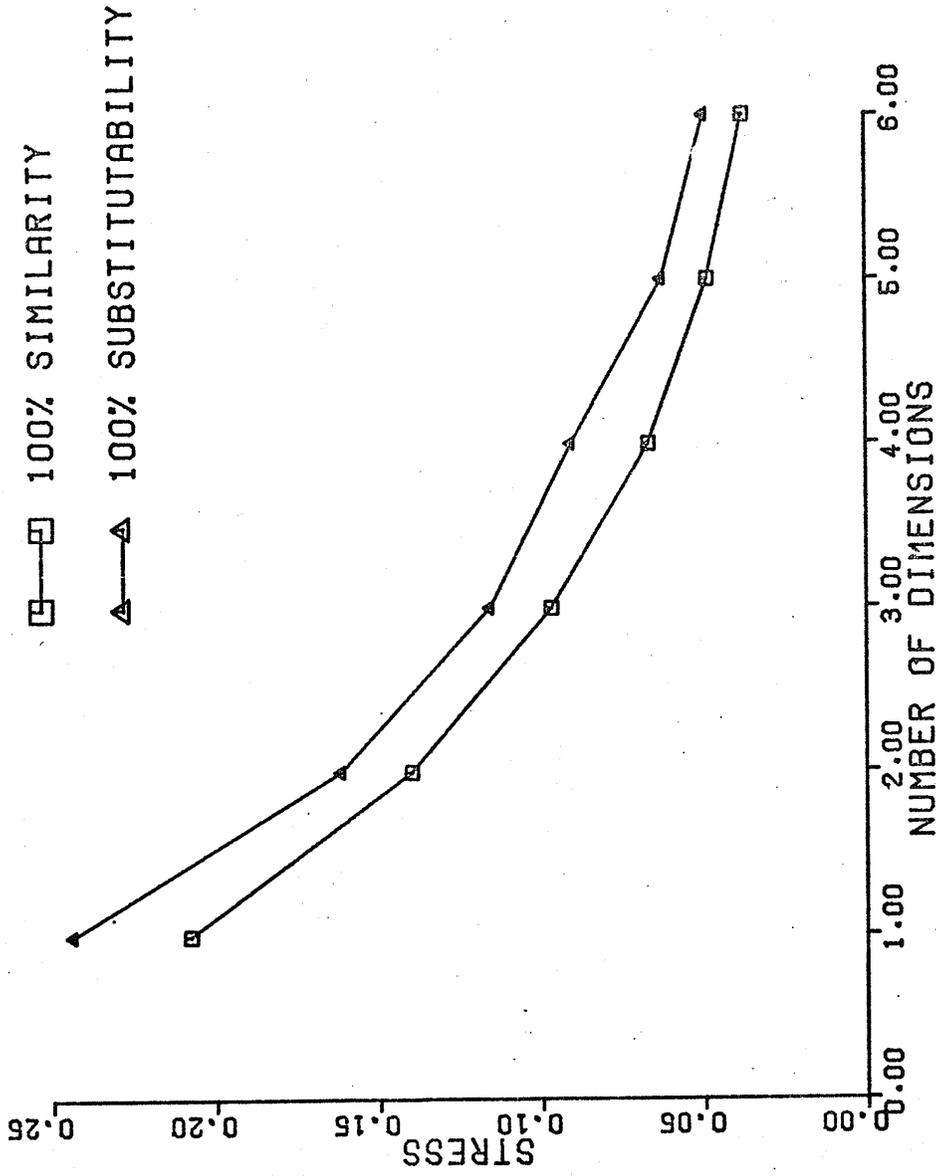


Figure 2

Stress Curves for the 100% Similarity and 100% Substitutability Groups' KYST Analyses

of different dimensions. It is not an "average" solution but a "weighted-best fit" solution, and therefore, may represent the "real" configuration better than an aggregate KYST solution.

Summary statistics for the variance accounted for by solutions and dimensions are tabulated in Table 3. The three and four dimension solutions account for 44% and 48% of the variance in subjects' data respectively. The first dimension of each accounts for approximately 63% of the common variance, and reflects the extent to which most subjects used this dimension relative to others. The four dimension solution does not account for substantially more variance than the three, and also only spreads out variance not accounted for by the first dimension. Although the INDSICAL procedure computes orthogonal dimensions, the projections of stimuli on these dimensions may be correlated. These correlations from the three dimension solution are listed in Table 4. Only three subjects weighted this fourth dimension more heavily than any of the other three. The variance gained for each of these three subjects through the inclusion of the fourth dimension was small (.125, .069, .118). Since these subjects data were not accounted for well even in the four dimension solution ($r^2 = .51, .17, .29$) it is apparent that this dimension is not particularly informative or necessary in representing the group structure.

In addition to these data, Shepard (1974) indicates that

Table 3

Variance Accounted for by Solutions and Dimensions
in 100% Groups' INDSCAL Analyses

100% Similarity						
Number of Dimensions	R^2	Increment in R^2	Dimension			
			1	2	3	4
2	39.6		69.4	30.3		
3	43.9	4.3	63.2	26.5	11.8	
4	47.6	3.7	63.6	17.4	9.6	9.4
100% Substitutability						
2	30.2		77.4	22.6		
3	36.1	5.9	64.3	18.3	17.4	
4	40.1	4.0	57.0	15.8	15.4	11.8

Table 4
 Correlations among INDSCAL Dimensions' Stimulus
 Loadings in 100% Groups' Analyses

100% Similarity			
Three Dimension Solution			
	1	2	3
1			
2	-.400		
3	-.194	.097	
Four Dimension Solution			
	1	2	3
1			
2	-.323		
3	-.127	.122	
4	.031	.071	.005
100% Substitutability			
Three Dimension Solution			
	1	2	3
1			
2	-.289		
3	.098	-.077	
Four Dimension Solution			
	1	2	3
1			
2	-.295		
3	.071	-.085	
4	.214	-.013	.108

researchers should "always try for a solution in a space of three or, preferably, fewer dimensions where the spatial structure of the entire configuration can be seen and interpreted directly (rather than through the coordinates of points on arbitrary axes) (p. 383)." In light of this suggestion and because there is no indication that a higher dimensionality is necessary, a three dimension configuration shall be taken to represent the dimensionality of comparisons of dissimilarity among leisure activities obtained from this sample of students.

The positions of the 20 leisure activities in a schematic three dimension space, as determined by the KYST analysis, are presented in Figure 3. This KYST solution was previously rotated, using Kaiser's procedure as implemented by FACT06, to maximum agreement with the three dimension INDSCAL solution diagrammed in Figure 4. (The stimulus coordinates of all solutions are presented in Appendix B.) The cosines of the angles among the dimensions of these two solutions, as seen in Table 5, indicate good agreement between the first, second and third dimensions of each solution, with few cross dimension relationships appearing.

In conjunction with the visual inspection of the relative positions of stimulus points in solution spaces, and to aid in understanding and interpreting the sources of dimensional variation of the solution, PROFIT analyses were conducted. Using the linear correlation method, this

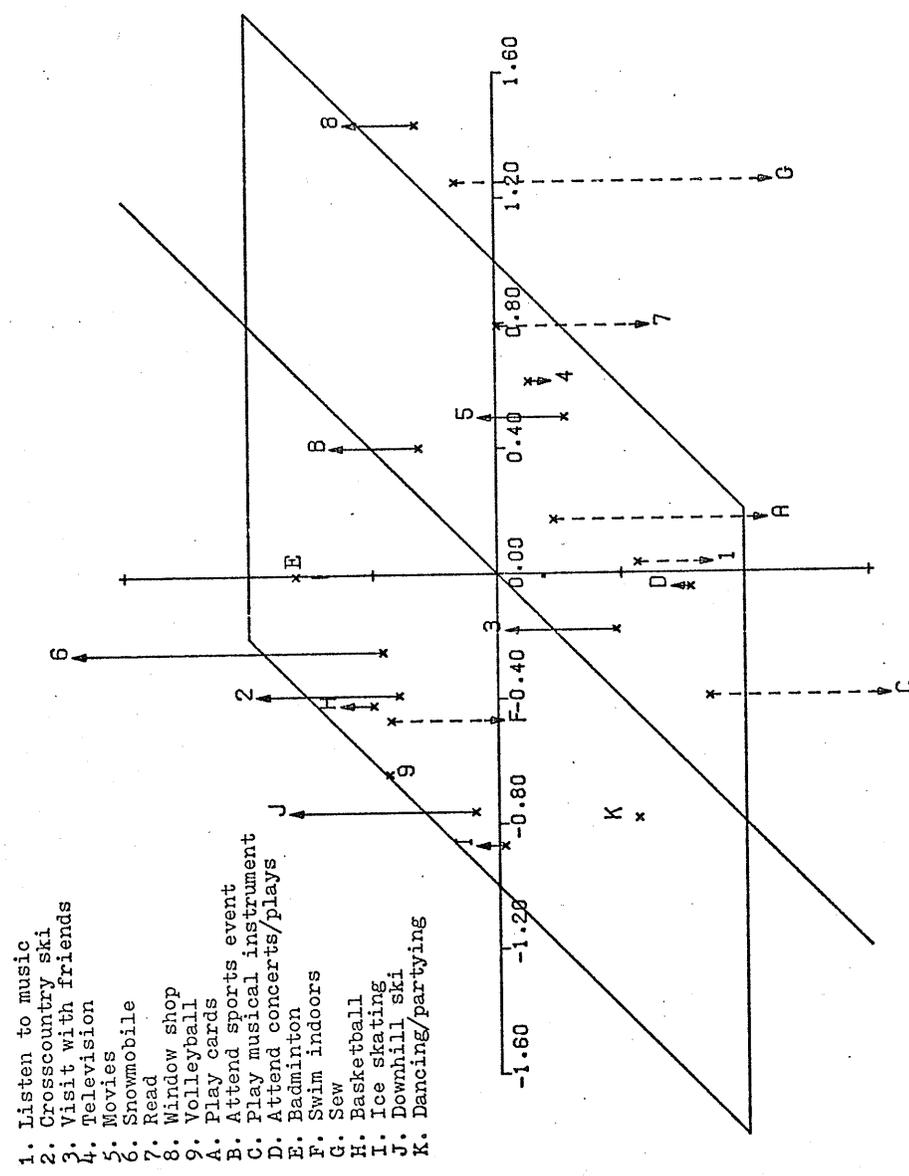


Figure 3
 Three Dimension Rotated KYST Solution
 for the 100% Similarity Group

- 1. Listen to music
- 2. Crosscountry ski
- 3. Visit with friends
- 4. Television
- 5. Movies
- 6. Snowmobile
- 7. Read
- 8. Window shop
- 9. Volleyball
- A. Play cards
- B. Attend sports event
- C. Play musical instrument
- D. Attend concerts/plays
- E. Badminton
- F. Swim indoors
- G. Sew
- H. Basketball
- I. Ice skating
- J. Downhill ski
- K. Dancing/partying

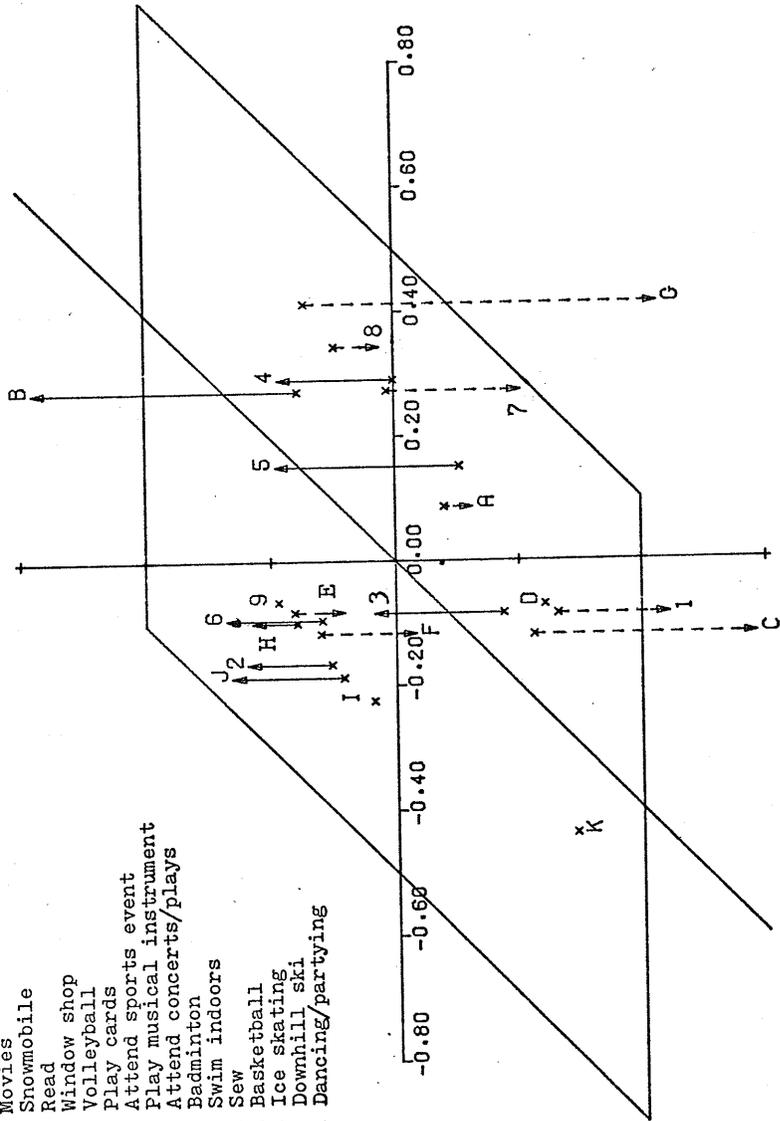


Figure 4

Three Dimension INDSCAL Solution
for the Similarity Group

Table 5

Cosines of Angles among the Three Dimension Axes
of the 100% Similarity INDSCAL and Rotated
100% Similarity KYST Solutions

		100% Similarity INDSCAL		
		1	2	3
100% Similarity KYST	1	.845	-.425	-.324
	2	-.320	-.888	.332
	3	.429	.177	.886

procedure fits rating scale vectors, for example, passive-active, indoor-outdoor, into the three dimension spaces and computes the cosines of the angles (correlations) among all the vectors and dimensions. A measure, called Rho, which indicates how well the rating scale was able to be fitted into the solution, was also determined for each of the seven rating scales used. Tables 6 and 7 present PROFIT analyses results for the 100% Similarity KYST and INDSCAL solutions respectively.

The first dimension of the KYST solution reflects a strong correlation with the passive-active rating scale. The second dimension seems to involve variation related to mental involvement, enjoyment, and familiarity. The third KYST dimension is highly correlated with the indoor-outdoor property vector.

Although it appeared in the FACT06 results of Table 5 that the KYST solution was related to the INDSCAL solution, this is not strongly apparent in a comparison of the PROFIT analyses of these solutions. Whereas the first dimension of KYST solution is most strongly related to the passive-active property, the first INDSCAL dimension reflects a number of properties including the passive-active one but also the simple-difficult, indoor-outdoor, and mental involvement properties. The indoor-outdoor scale would appear to be almost coincident with the first dimension and is not at all related to the third dimension as in the KYST results.

Table 6

Maximum Correlation (Rho) and Direction Cosines of
 Properties with 100% Similarity Group's
 Three Dimension KYST^a Solution

Property	Rho	Dimension		
		1	2	3
Passive-Active	.876	.945	.326	-.016
Indoor-Outdoor	.773	-.062	.281	.958
Mental Involvement	.720	.312	.828	.465
Group-Individual	.646	.700	.337	-.630
Enjoyment	.645	.172	.821	-.544
Simple-Difficult	.632	-.610	.230	-.759
Familiarity	.543	.007	-.883	.468

^aRotated to 100% Similarity INDSCAL solution.

Table 7

Maximum Correlation (Rho) and Direction Cosines of
 Properties with 100% Similarity Group's
 Three Dimension INDSCAL Solution

Property	Rho	Dimension		
		1	2	3
Passive-Active	.850	.753	-.650	-.098
Group-Individual	.816	.146	-.930	.337
Simple-Difficult	.723	-.871	.459	.177
Indoor-Outdoor	.642	-.998	-.061	-.025
Familiarity	.609	.716	.694	.075
Enjoyment	.591	-.490	-.867	-.087
Mental Involvement	.293	-.821	-.348	-.452

The group-individual property correlates with the second dimension of the INDSICAL solution but not the KYST solution. The enjoyment property does relate well to both solutions however. The third dimension, interpreted as reflecting indoor-outdoor variation in the KYST solution does not seem to be reflected in any property in the INDSICAL solution.

A visual inspection of both solutions suggests why these inconsistencies might be. In the INDSICAL solution a set of eight activities form a very discrete cluster and do not display any appreciable dimensional variation among themselves. This is not so readily apparent in the KYST solutions, where for example, snowmobiling, cross country and downhill skiing all load highly on Dimension 3. There is much less remarkable variation in these activities in the INDSICAL solution. The eight activities might be all classed as sports or athletic activities. To investigate this clustering in each of the solutions analytically and to determine the extent to which it is, or is not, apparent in the aggregate dissimilarity matrix on which the KYST solution is based, three hierarchical cluster analyses were done.

Euclidean distance matrices, computed from the two M.D.S. solutions, and the mean dissimilarity matrix were clustered using the MOC program, (Gruvaeus & Wainer, 1972). It can be seen from the tree diagrams of Figures 5, 6, and 7,

100% SIMILARITY AGGREGATE MATRIX

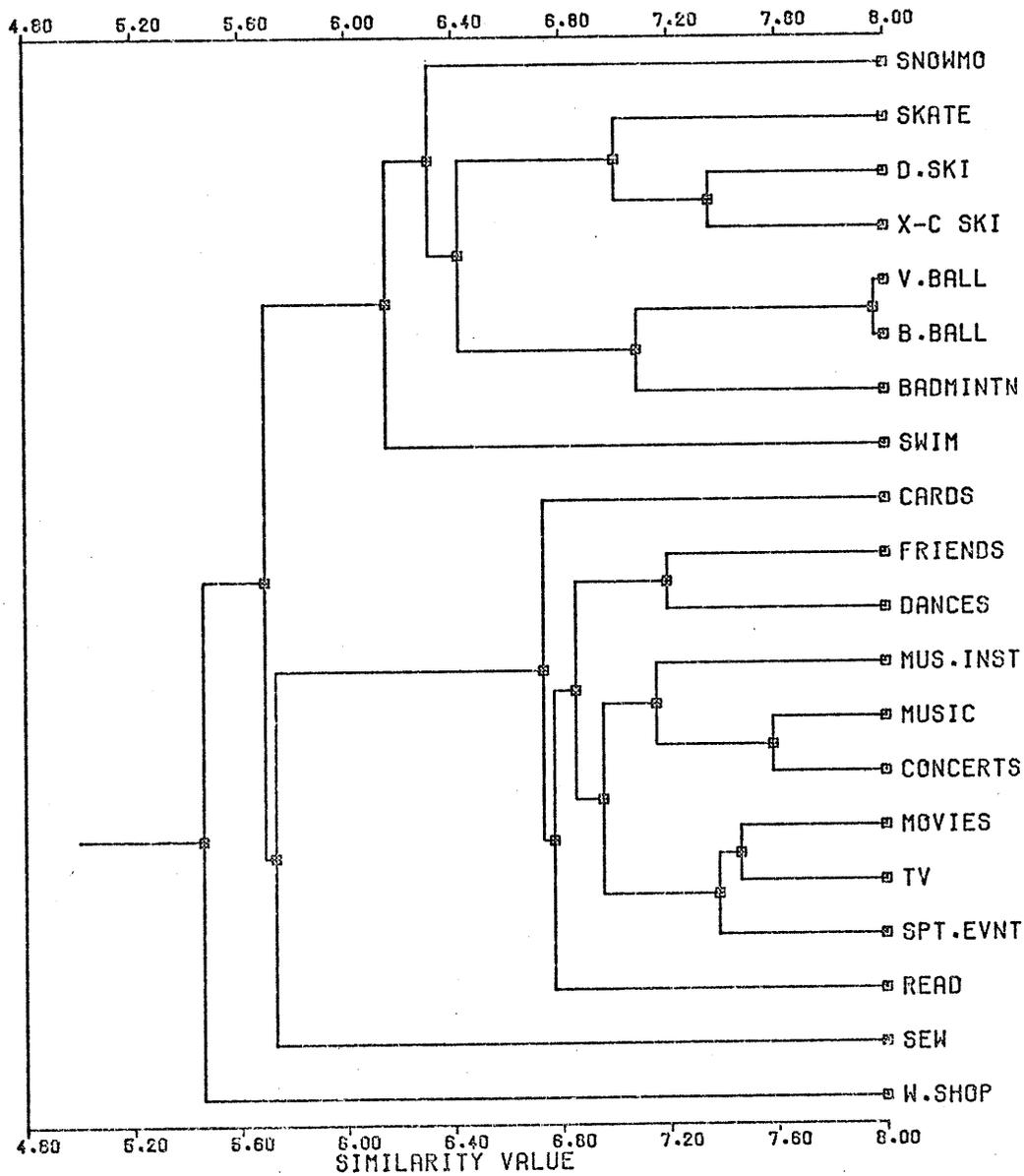


Figure 5

Hierarchical Clustering Diagram from 100%
Similarity Group's Aggregate Matrix

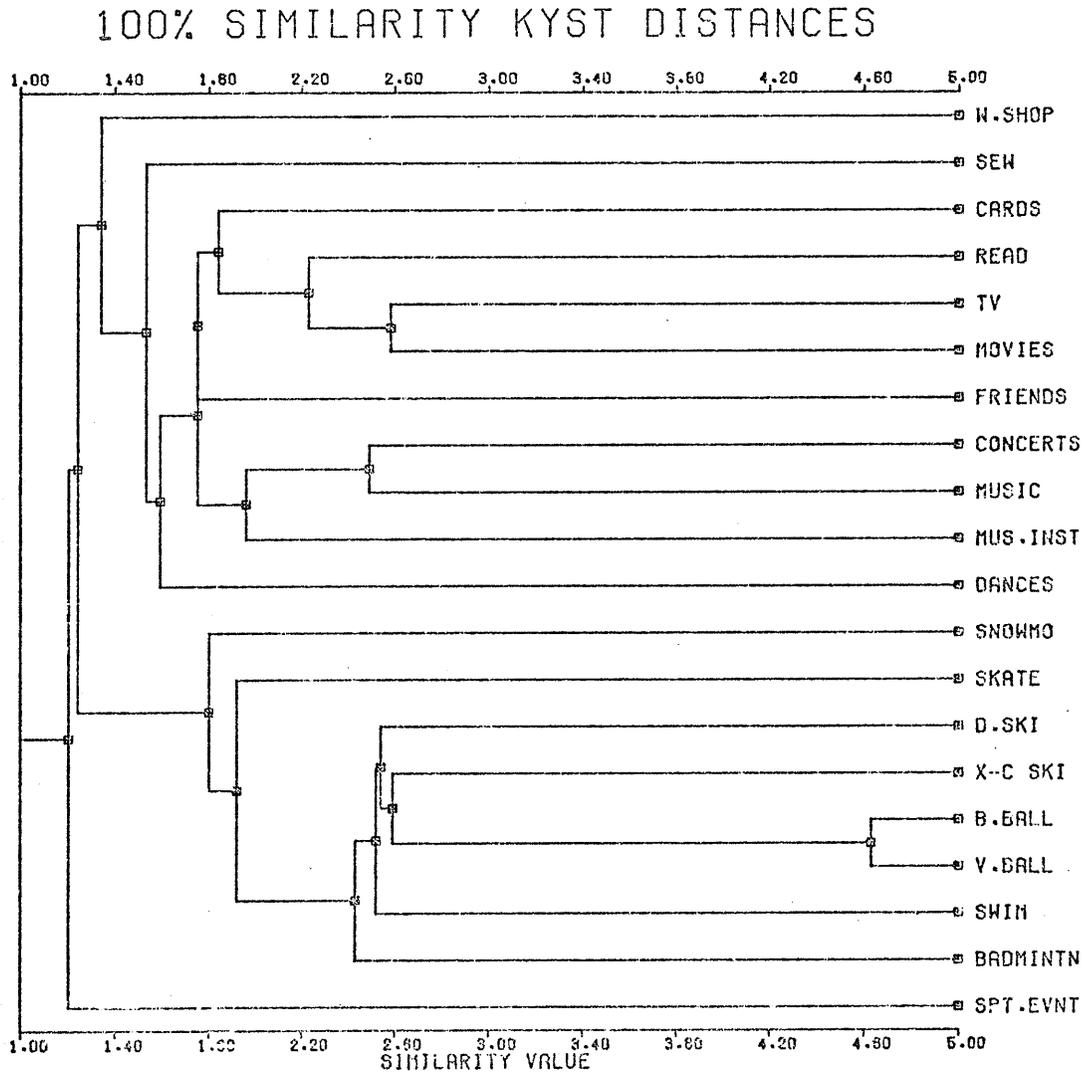


Figure 6

Hierarchical Clustering Diagram for Euclidean Distances
 Computed from 100% Similarity Group's
 Three Dimension KYST Solution

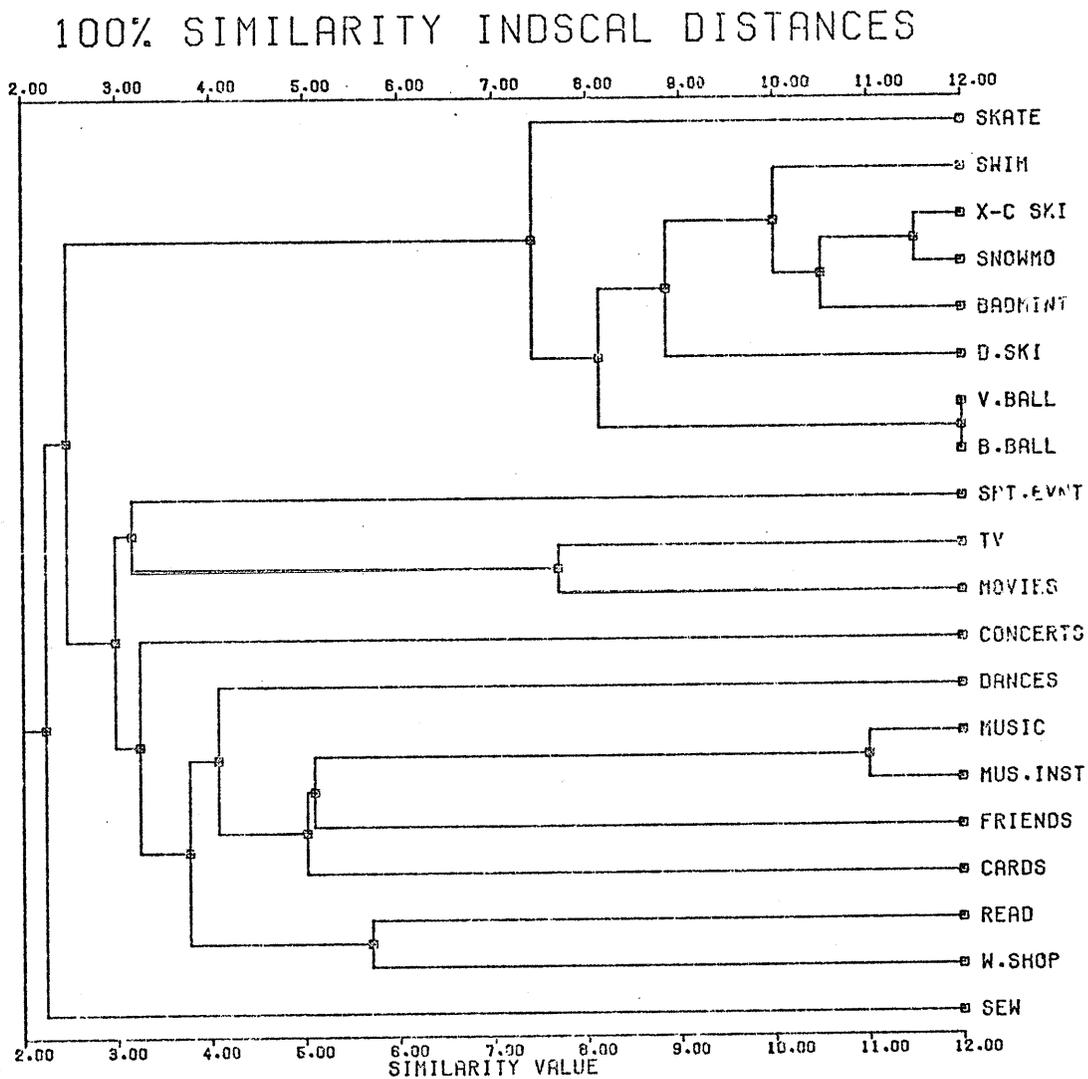


Figure 7

Hierarchical Clustering Diagram for Euclidean Distances
 Computed from 100% Similarity Group's
 Three Dimension INDSCAL Solution

representing clustering from the aggregate matrix, KYST solution, and INDESCAL solution respectively, that there is a very strong clustering of eight athletic activities in the INDESCAL space relative to the other data sets. When these eight activities have been formed into a cluster, eight single activities and two pairs of activities remain separate and ungrouped in the INDESCAL hierarchy. These eight activities do form clusters in the other data sets, but another large cluster is formed first in the tree structure from the aggregate data. At that point at which the eight athletic activities form a cluster in the KYST solution five individual activities and two clusters of activities remain. This is not as extreme a separation as exists in the INDESCAL hierarchy but is much more so than in the aggregate case. These clustering results, therefore, do strengthen the observation that the INDESCAL solution shows tighter clustering. The KYST solution was computed from the mean values of all subjects' data, and, possibly, the strength of similarity among the eight activities was decreased due to extreme scores. The INDESCAL process does not use mean values, and, therefore, might not have used these extreme values, resulting in greater similarity among activities and a "different" solution.

The dimensions found in these data seem to reflect, therefore, an athletic/non-athletic activity continuum which is reflected in the passive-active, group-individual,

and indoor-outdoor properties. The second dimension would seem to represent a "weak" group - individual pattern, for example, basketball, volleyball, to read and play musical instrument. The third dimension seems to reflect a social/entertainment - individualistic pursuits arrangement, for example, movies, and visiting friends to sew and play a musical instrument, although an indoor-outdoor pattern is seen in the KYST configuration.

The "goodness" of the INDSCAL solution may be reflected to some extent by the variance it accounts for in each subject's data. This information, presented in Table 8, is available by squaring a set of correlation coefficients produced by INDSCAL. Variation in these values indicates that the solution was quite good for some subjects ($r^2 = .81, .76$) not good at all for others ($r^2 = .10, .11, .13$), but on the average fairly reasonable, $.44$. Dimension saliences, or the importance attached to each dimension, for each subject, are tabulated in Table 9, and reflect the proportion of variance (63%) which the first dimension accounted for in the solution. Most subjects (16 of 26) used it more than others, and, to quite a substantial degree.

100% Substitutability Results

Intrasubject reliability coefficients for the 24 subjects of the 100% Substitutability Group, which are recorded in Table 1 which was presented earlier, indicate reliabilities as good as those in the 100% Similarity Group.

Table 8
 Frequency Distribution of Individual - Subjects'
 Squared Correlations from 100% Groups'
 Three Dimension INDSCAL Solutions

Squared Correlation	Similarity	Substitutability
.81 and over	1	0
.61 - .80	4	4
.41 - .60	11	5
.21 - .40	6	10
.04 - .20	4	5
Mean	.437	.349
Median	.440	.361

Table 9

Individual-Subject Dimension Saliences from 100%
Similarity Group's INDSCAL Analysis

Subject	Dimension		
	1	2	3
1	.28	.41	.30
2	.69	.38	.19
3	.31	.49	.20
4	.42	.25	.17
5	.31	.44	.29
6	.14	.11	.25
7	.79	.24	.09
8	.49	.15	.21
9	.20	.16	.19
10	.19	.29	.26
11	.42	.54	.16
12	.53	.17	.10
13	.53	.33	.10
14	.63	.42	.23
15	.86	.14	.10
16	.78	.18	.10
17	-.22	-.25	.03
18	.23	.25	.14
19	.41	.40	.17
20	.50	.34	.23
21	.52	.31	.32
22	.56	.26	.09
23	.37	.49	.24
24	.42	.36	.32
25	.52	.23	.38
26	.40	.25	.20

The mean value of .85 indicates a generally high level of reliability in students' rating of leisure activity substitutability, and since only one subject had a value as low as .55, all subjects' data was retained for further analysis.

The KYST computer program was used to find M.D.S. solutions in one through six dimensions for the aggregate substitutability matrix of this group. Stress values that were observed are recorded in Table 10, and are plotted in Figure 2, for a comparison with the 100% Similarity Group's data. These values are larger, at each given dimensionality, than the corresponding 100% Similarity Group's stress. They also indicate that a three dimension solution with stress equal to .116 does not fit these data as well as the three dimension stress of .097 for the 100% Similarity Group. A higher dimensionality solution would be required if stress were to be used as a criterion of goodness-of-fit.

INDSCAL was used to find "weighted" group solutions in two through four dimension spaces. The summary information for these solutions was presented in Table 3 with comparable information from the 100% Similarity Group's INDSCAL analyses. The three and four dimension solutions account for 36% and 40% of the variance, respectively. Both of these values are lower than the three dimension Similarity solution, and are only as good as the two dimension solution for that data. The first dimension of the three dimension Substitutability

Table 10
 Stress Data for Substitutability Groups'
 KYST Solutions

Number of Dimensions	Group			Frequency
	100%	60%	Log Transform	
6	.050	.082	.011	.013
5	.063	.104	.015	.017
4	.091	.137	.028	.026
3	.116	.181	.041	.040
2	.162	.262	.084	.099
1	.244	.436	.172	.165

solution accounts for 64% of the common variance, a figure consistent with the 63% found in the comparable Similarity case. The dimensions of the Substitutability solution are not correlated to any substantial degree, as shown in Table 4 presented earlier, and suggest, just as in the Similarity solutions, that all dimensions reflect differing sources of variation. Only three subjects in this group used the fourth dimension more than any other, and they also displayed below average correspondence to the group solution, even in the four dimension case with r^2 of .30, .09, and .37. Although a three dimension space does not provide a particularly good fit to the data, neither does a four dimension solution. In light of this, and since a three dimension configuration was already chosen to represent the Similarity space, a three dimension solution will also be taken to represent this Substitutability data. This not only provides for direct visual interpretation of the whole configuration but also allows more realistic comparisons to be made with the Similarity structure. Some analyses of the three dimension solution were also done on the four dimension INDSCAL solution to determine if it provides any reasonable interpretational advantage in discussing leisure activity substitutability.

The three dimension KYST and INDSCAL configurations are presented in Figures 8 and 9 respectively. The KYST solution has been rotated to the INDSCAL solution and, as Table 11 indicates, it is very similar to that solution.

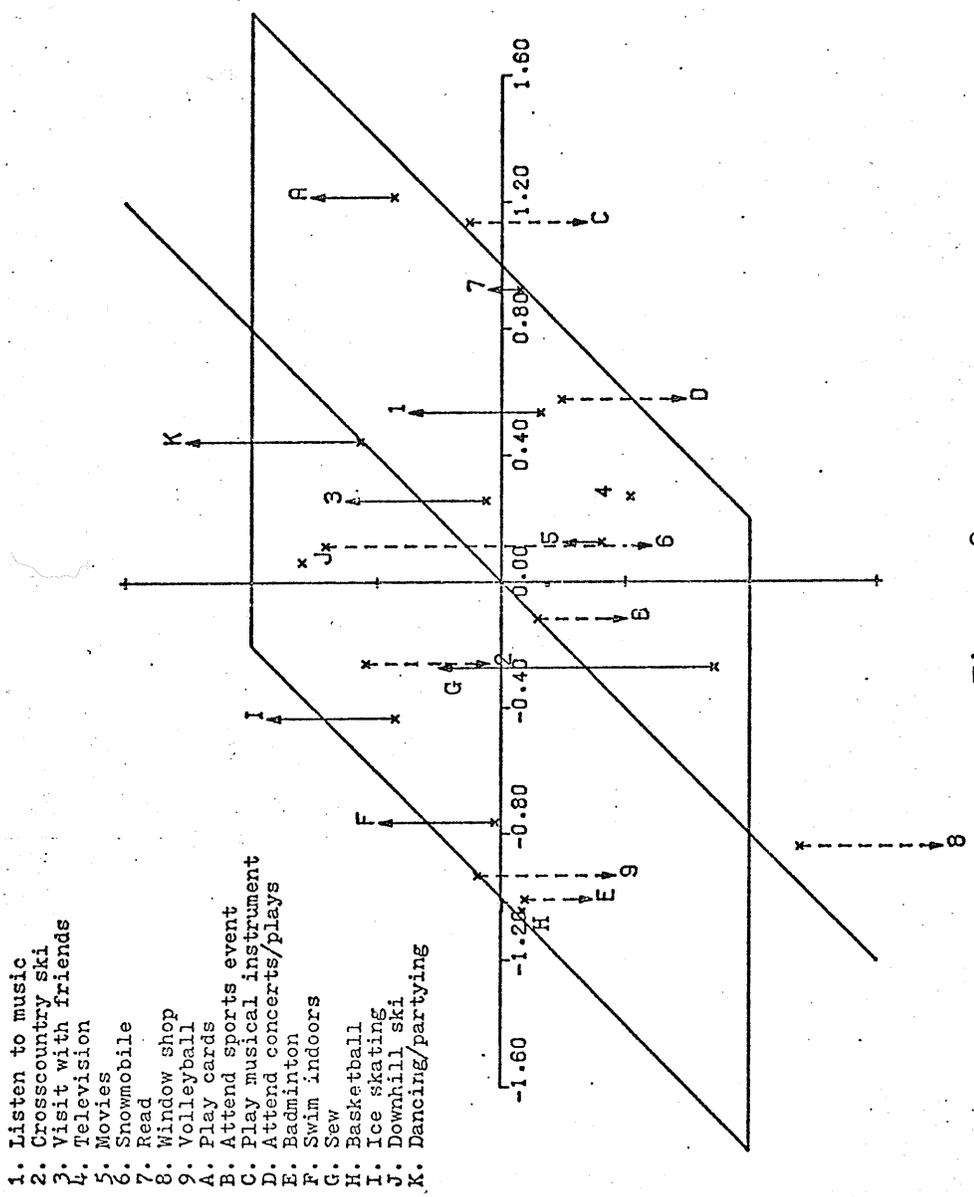


Figure 8
 Three Dimension Rotated KYST Solution for
 the 100% Substitutability Group

- 1. Listen to music
- 2. Crosscountry ski
- 3. Visit with friends
- 4. Television
- 5. Movies
- 6. Snowmobile
- 7. Read
- 8. Window shop
- 9. Volleyball
- A. Play cards
- B. Attend sports event
- C. Play musical instrument
- D. Attend concerts/plays
- E. Badminton
- F. Swim indoors
- G. Sew
- H. Basketball
- I. Ice skating
- J. Downhill ski
- K. Dancing/partying

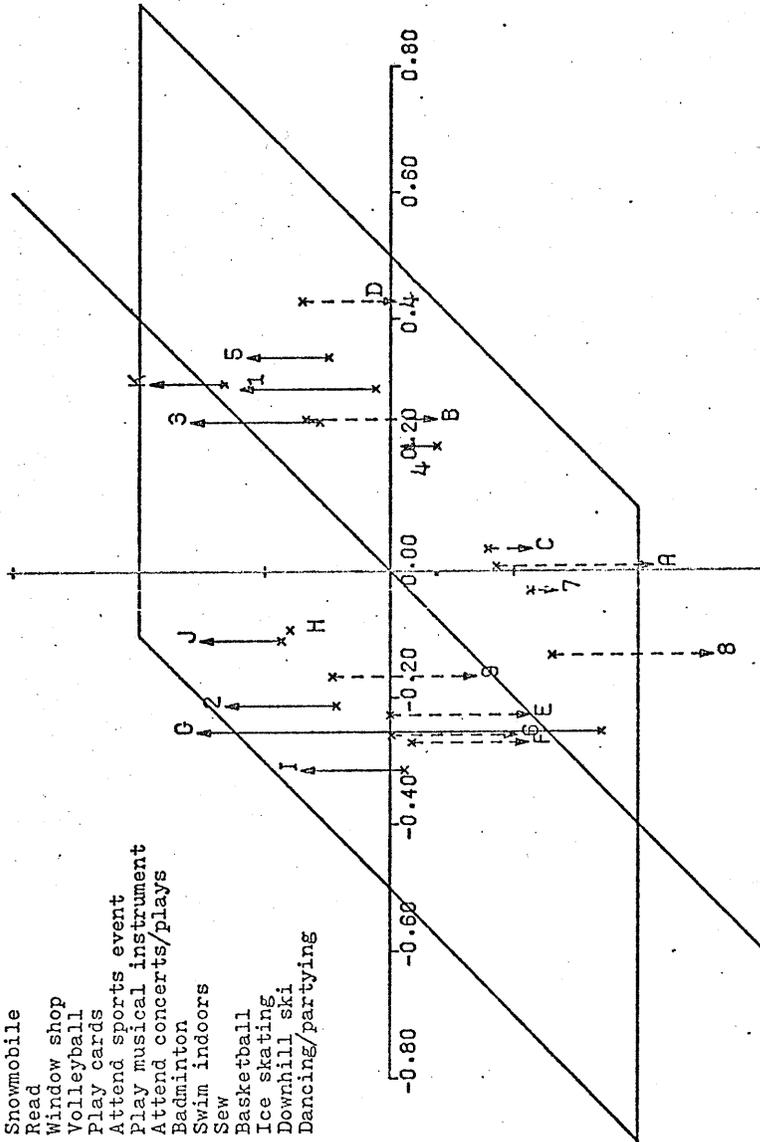


Figure 9

Three Dimension INDSICAL Solution for the
100% Substitutability Group

Table 11

Cosines of Angles among the Three Dimension Axes of the
 100% Substitutability INDSCAL and Rotated
 100% Substitutability KYST Solutions

		100% Substitutability INDSCAL			
		1	2	3	
100% Substitutability KYST	1	.867	-.463	.183	
	2	.480	.875	-.061	
	3	.132	-.141	-.981	

PROFIT analyses were done for the three dimension KYST solution and the three and four dimension INSCAL solutions of this group. The results of these are presented in Tables 12 and 13, respectively. Dimension 1 of the KYST solution is highly correlated with the passive-active, group-individual, and simple-difficult properties. As seen in Figure 8, this reflects the same athletic activity- non-athletic activity continuum found for the 100% Similarity solutions. This dimension is also apparent in the configuration for the INSCAL space of this Substitutability Group which is in Figure 9. The PROFIT analysis of both the three and four dimension INSCAL configurations also reflect these properties' correlation with Dimension 1 with the exception of the group-individual property, but most highly with the indoor-outdoor property. Dimension 2 of both the KYST and INSCAL solutions correlates with the group-individual property. This group-individual variation can be seen when, for example, sewing, reading, and window shopping are at one end of the dimension while dancing, attending sports events, and basketball are at the other. Dimension 3 of the KYST solution is correlated with the familiarity, indoor-outdoor and enjoyment property vectors, but from an inspection of the configuration none of these properties seems to account for most of the variation along the dimension. The third INSCAL dimension in the three dimension solution correlates with the mental involvement property.

Table 12

Maximum Correlation (Rho) and Direction Cosines of
 Properties with 100% Substitutability Group's
 Three Dimension KYST^a Solution

Property	Rho	Dimension		
		1	2	3
Passive-Active	.879	.801	-.510	-.312
Indoor-Outdoor	.660	-.319	.486	-.814
Group-Individual	.610	.660	-.750	-.040
Simple-Difficult	.571	-.782	.615	.100
Mental Involvement	.469	-.419	-.603	-.679
Familiarity	.413	.281	-.056	.958
Enjoyment	.370	-.302	-.513	-.803

^aRotated to 100% Substitutability INDSCAL solution.

Table 13

Maximum Correlation (Rho) and Direction Cosines of
 Properties with 100% Substitutability Group's
 Three and Four Dimension INDSCAL Solutions

Property	Rho	Dimension			
		1	2	3	
Passive-Active	.873	.825	-.557	.097	
Group-Individual	.806	.216	-.922	.322	
Simple-Difficult	.759	-.934	-.266	.237	
Enjoyment	.678	-.606	-.789	.102	
Familiarity	.597	.791	.593	-.149	
Indoor-Outdoor	.561	-.998	-.028	.048	
Mental Involvement	.173	-.496	.178	-.850	
		1	2	3	4
Passive-Active	.875	.815	-.558	.071	.140
Group-Individual	.818	.189	-.936	.254	.157
Simple-Difficult	.780	-.925	-.326	.189	.050
Enjoyment	.689	-.509	-.790	.147	-.309
Familiarity	.628	.770	.628	-.096	-.054
Indoor-Outdoor	.627	-.945	-.160	-.050	.279
Mental Involvement	.297	.067	.337	-.263	-.902

Hierarchical cluster analyses were done on the aggregate substitutability matrix and on two Euclidean distance matrices computed from the KYST and INDSCAL three dimension solutions. This was done in order to document the extent to which athletic activities grouped together, as in the 100% Similarity solutions. This strong athletic activity clustering is not apparent in the tree diagrams of the aggregate matrix (Fig. 10), of KYST Euclidean distances matrix (Fig. 11) but does appear in the tree diagram of the distances computed from the INDSCAL solution as seen in Figure 12. In this latter diagram, another clustering emerges, which includes, for example, such activities as movies, T.V., visiting friends, and playing cards. But this is not reflected in the M.D.S. configuration.

The three dimension INDSCAL solution accounts for an average of 36.1% of subjects variance in ratings. The upper range of individual r^2 values, seen in Table 8, is not as high as for the Similarity Group, with values of .74, .73 and .68 with the lower values being smaller, .04, .08, and .10. Table 14 lists the dimension saliences of the 24 subjects in this group. Fifteen of these subjects weighted Dimension 1 most heavily, while four and five subjects stressed Dimensions 2 and 3, respectively.

This Substitutability solution not only accounts for less variance than the corresponding Similarity solution, but is less interpretable as well. Two FACT06 analyses were

100% SUBSTITUTABILITY AGGREGATE

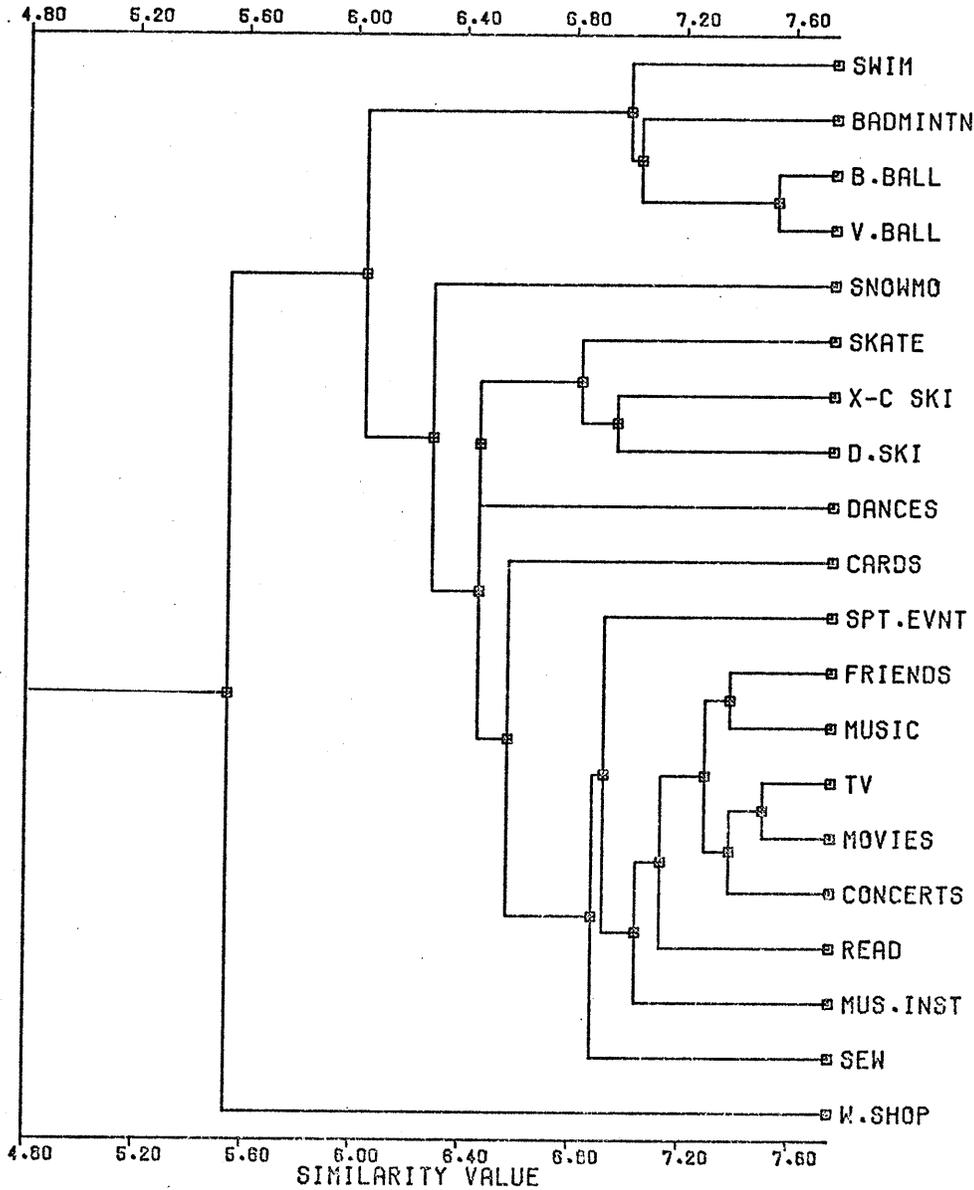


Figure 10

Hierarchical Clustering Diagram from 100%
Substitutability Group's Aggregate Matrix

100% SUBSTITUTABILITY KYST DISTANCES

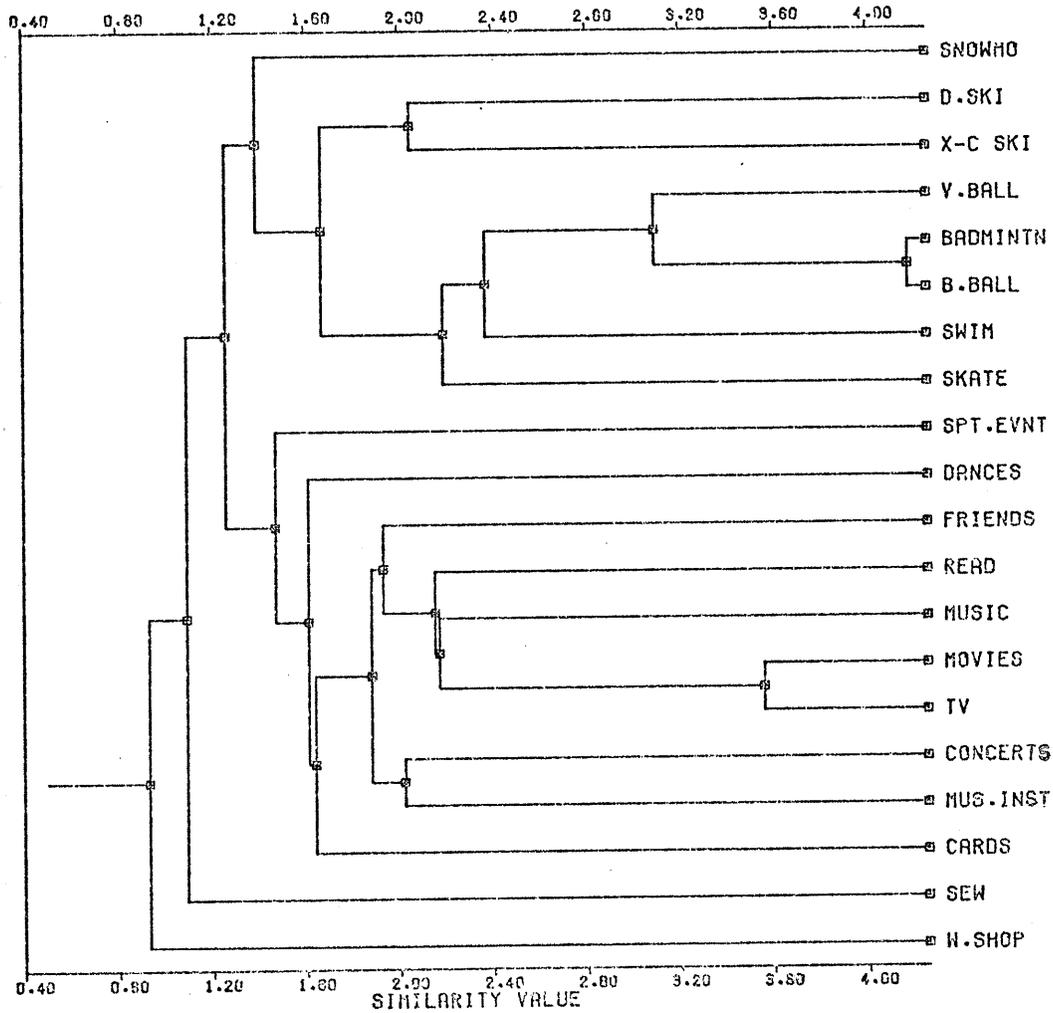


Figure 11

Hierarchical Clustering Diagram for Euclidean Distances
 Computed from 100% Substitutability Group's
 Three Dimension **KYST** Solution

100% SUBSTITUTABILITY INDSCAL

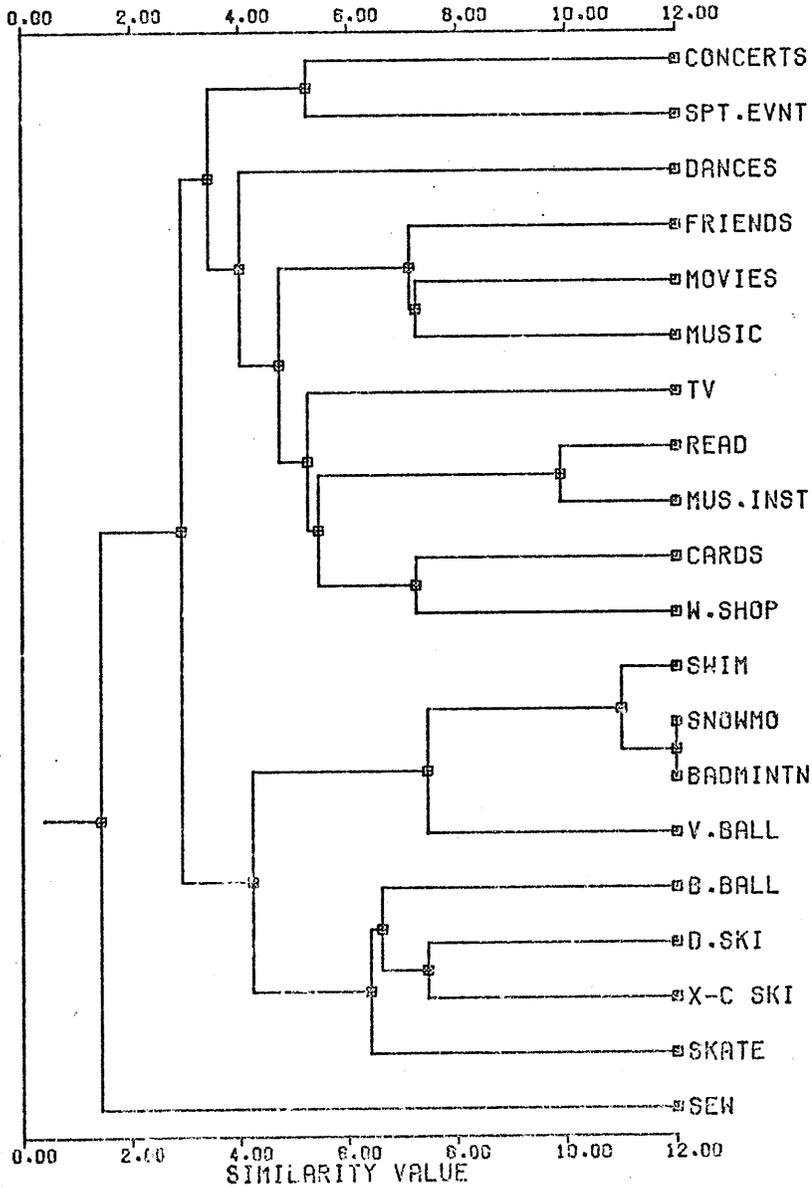


Figure 12

Hierarchical Clustering Diagram for Euclidean Distances
 Computed from 100% Substitutability Group's
 Three Dimension INDSCAL Solution

Table 14

Individual-Subject Dimension Saliences from 100%
Substitutability Group's INDSCAL Analysis

Subject	Dimension		
	1	2	3
1	.34	.24	.19
2	.84	.07	.08
3	.43	.15	.34
4	.42	.38	.09
5	.08	.02	.31
6	.08	.14	.10
7	.63	.13	.02
8	.29	.12	.14
9	.31	.22	.05
10	.53	.26	.14
11	.13	.11	.49
12	.19	.04	.57
13	.71	.31	.20
14	-.03	-.15	.46
15	.37	.24	.18
16	.57	.31	.21
17	.42	.50	.12
18	.78	.30	.09
19	.19	.48	.10
20	.62	.17	.18
21	.60	.22	.04
22	.74	.21	.05
23	.28	.30	.37
24	.15	.18	.13

conducted to see to what extent the three and four dimension Substitutability solutions could correspond to the comparable Similarity solutions given a rotation to maximal congruence in each case. Table 15 indicates that the first dimension of both four dimension solutions are highly correlated. After that it is apparent that the extraction of dimensions is different in each solution with the second, third and fourth Similarity dimensions correlating most highly with the fourth, second, and third Substitutability dimensions, respectively. The results of the comparison of the three dimension solutions in Table 16 indicate that the configurations do not bear a one-to-one relationship. Although the first dimension of the Similarity solution correlates most highly with the first dimension of the Substitutability solution, the second dimension correlates to approximately the same degree with all three dimensions of the Substitutability solution. The actual correlations between dimensions, computed across the 20 stimulus loadings of the two solutions are .941, -.189, and -.280 representing the first, second and third dimensions' correlations with each other. The FACT06 comparison of the two KYST structures in Table 17 indicates that an almost perfect one-to-one relationship could be achieved through rotation of the Substitutability solution to the Similarity solution. The actual correlations of these solutions' dimensions, when both have been rotated to their respective 100% Group's INDSCAL solution, are

Table 15

Cosines of Angles among the Four Dimension Axes
of the 100% Similarity INDSICAL and Rotated
100% Substitutability INDSICAL Solutions

		100% Similarity INDSICAL			
		1	2	3	4
	1	.905	-.290	.308	-.041
100%	2	-.328	-.274	.766	.480
Substitutability	3	.260	.415	-.260	.832
INDSICAL	4	-.280	-.817	-.500	.277

Table 16

Cosines of Angles among the Three Dimension Axes
of the 100% Similarity INDSCAL and Rotated
100% Substitutability INDSCAL Solutions

	100% Similarity INDSCAL		
	1	2	3
100% Substitutability INDSCAL	1 .812	-.567	.139
	2 -.484	-.520	.703
	3 -.326	-.638	-.697

Table 17

Cosines of Angles among the Three Dimension Axes
of the 100% Similarity KYST and Rotated
100% Substitutability KYST Solutions

		100% Similarity KYST		
		1	2	3
100% Substitutability KYST	1	.999	-.024	.027
	2	.026	.996	-.088
	3	-.024	.088	.996

.838, -.028, and -.573 for the first, second and third dimensions respectively. The large correlation between the first dimensions of the Similarity and Substitutability INDSICAL solutions may be accounted for by the athletic activity clustering, strongly present in the former and not quite so strongly present in the latter case.

60% and Sort Similarity Results

The time to complete task measures when averaged across subjects in each group indicates that the 60% Paired-Comparison and Sort methods require less time than the 100% Paired Comparison task. The mean values for the 100%, 60%, and Sort Similarity groups are 18.52, 11.85, and 5.14 minutes respectively. The corresponding values for the Substitutability groups are 21.74, 12.14, and 5.88 minutes. The summary table of an analysis of variance computed is presented in Table 18. The method of data collection results in a statistically significant difference in scores ($F_{2,115}=137.55, p<.001$), while the difference between Similarity Groups and Substitutability Groups ($F_{1,115}=4.36, p<.037$) contributes to a much smaller difference, albeit a statistically reliable one when using $\alpha = .05$ as a reference point. The different methods used to collect M.D.S. data do require differing amounts of time with the 100% Groups needing the most and the Sort methods the least. Scheffè's multiple comparison procedure was used to follow this significant Method main effect and it was determined

Table 18

Analysis of Variance Summary Table for the
Time to Complete Task Measure

Source	SS	DF	MS	F	p value
Method ^a	5026.52	2	2513.26	137.55	.001
Set ^b	79.60	1	79.60	4.36	.037
Method X Set	51.34	2	25.67	1.40	.248
Within	2101.22	115	18.27		
Total ^c	7202.98	120	60.02		

^a100% Paired-Comparison, 60% Paired-Comparison, and Sort data collection methods.

^bSimilarity or substitutability instruction set.

^cN=121 rather than 123 due to non-response.

that all three mean values are significantly different from one another $\alpha \leq .05$.

The nature of individual subjects' data sets in the 60% and Sort Similarity groups is such that only aggregate KYST analyses were conducted. INDSCAL is a metric procedure for complete data sets, and because INDSCALM, capable of handling missing data, and NINDSCAL, for non-metric individual M.D.S. were not available, only KYST solutions could be found. Stress data from KYST analyses for solutions in one through six dimensions for the 60% Similarity Group, and the Log and Frequency data sets of the Sort Group were presented earlier in Table 2. These are graphed with the 100% Similarity Group's stress data in Figure 13. The 60% Group's stress values are higher at every dimension than the other stress values, while the two Sort curves are lower at almost all points. No distinct elbows are present in any curve although at both the three and four dimension points "bends" occur. The stress values in three dimensions are .140, .086, and .064 for the 60%, Log, and Frequency solutions respectively. The first value does not indicate very good fit while the latter two do. The three dimension solution will be presented and interpreted as they are included primarily for their comparison with the 100% Similarity Group's configuration which was already chosen to be three dimensional.

The three dimension 60% Similarity solution, after rotation to the 100% Group's INDSCAL configuration, is

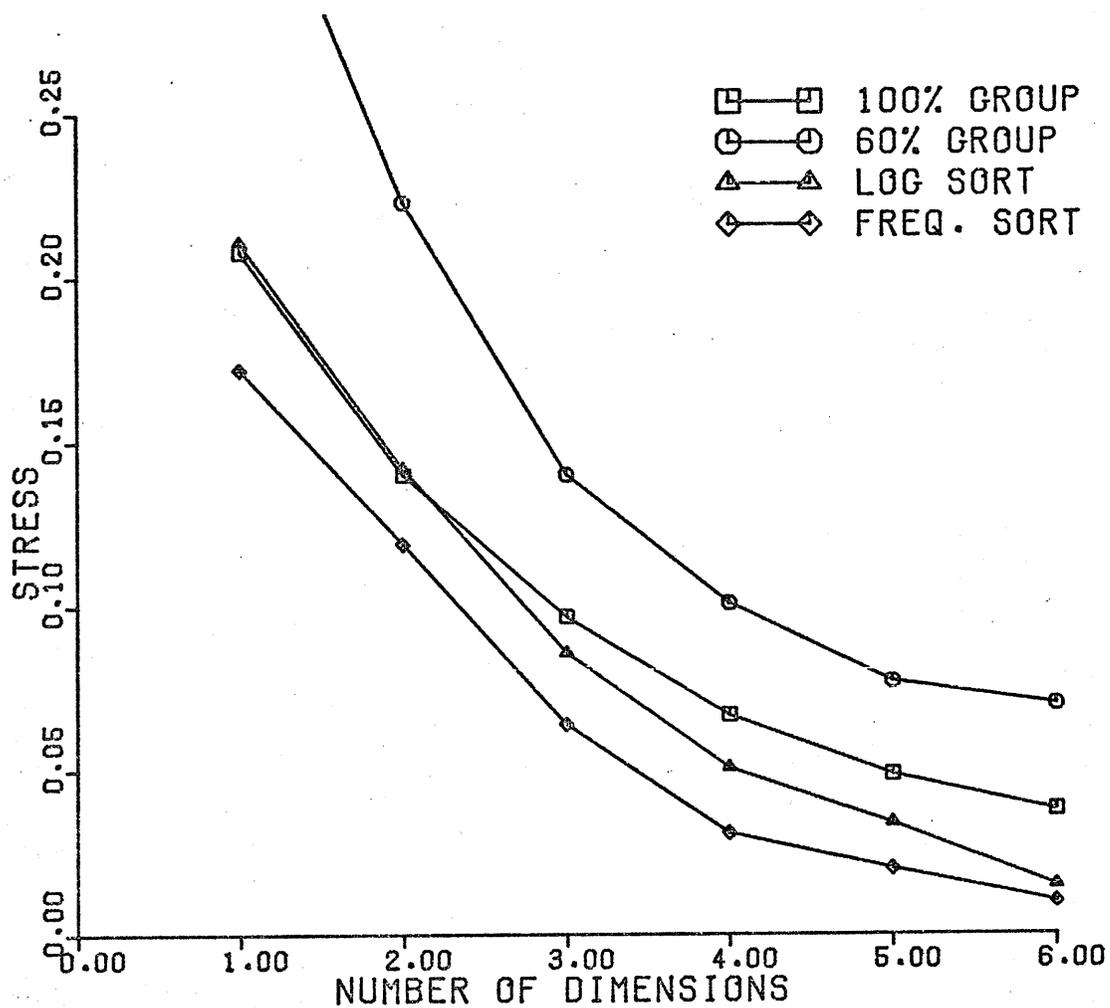


Figure 13

Stress Curves from Similarity
Groups' KYST Analyses

presented in Figure 14. A PROFIT analysis, Table 19, indicates that:

1. Dimension 1 correlates with the passive-active, indoor-outdoor, and simple-difficult property vectors,
2. Dimension 2 correlates most highly with the enjoyment, familiarity and mental involvement property vectors, and
3. the indoor-outdoor property has the largest correlation with the third dimension but this is not a large value.

A FACT06 comparison of the 60% solution with the 100% solution, to which it was rotated which is shown in Table 20, indicates that the first, second and third dimensions of each solution do correspond although not extremely so. The 60% Similarity configuration does reflect the athletic activity - non-athletic activity separation seen in earlier solutions but much greater variation than in the 100% Similarity INDSICAL is present all dimensions. The second dimension is correlated less highly with the group-individual property than is the case in the 100% INDSICAL analysis and although it is reflected in the configuration not strongly so. The third dimension displays moderate indoor-outdoor variation as did the 100% KYST solution.

The rotated three dimension Similarity Sort Log configuration is presented in Figure 15. The PROFIT analysis of this solution in Table 21 indicates that Dimension 1 is highly correlated with the passive-active property. Dimension 2 is correlated with the familiarity and indoor-outdoor

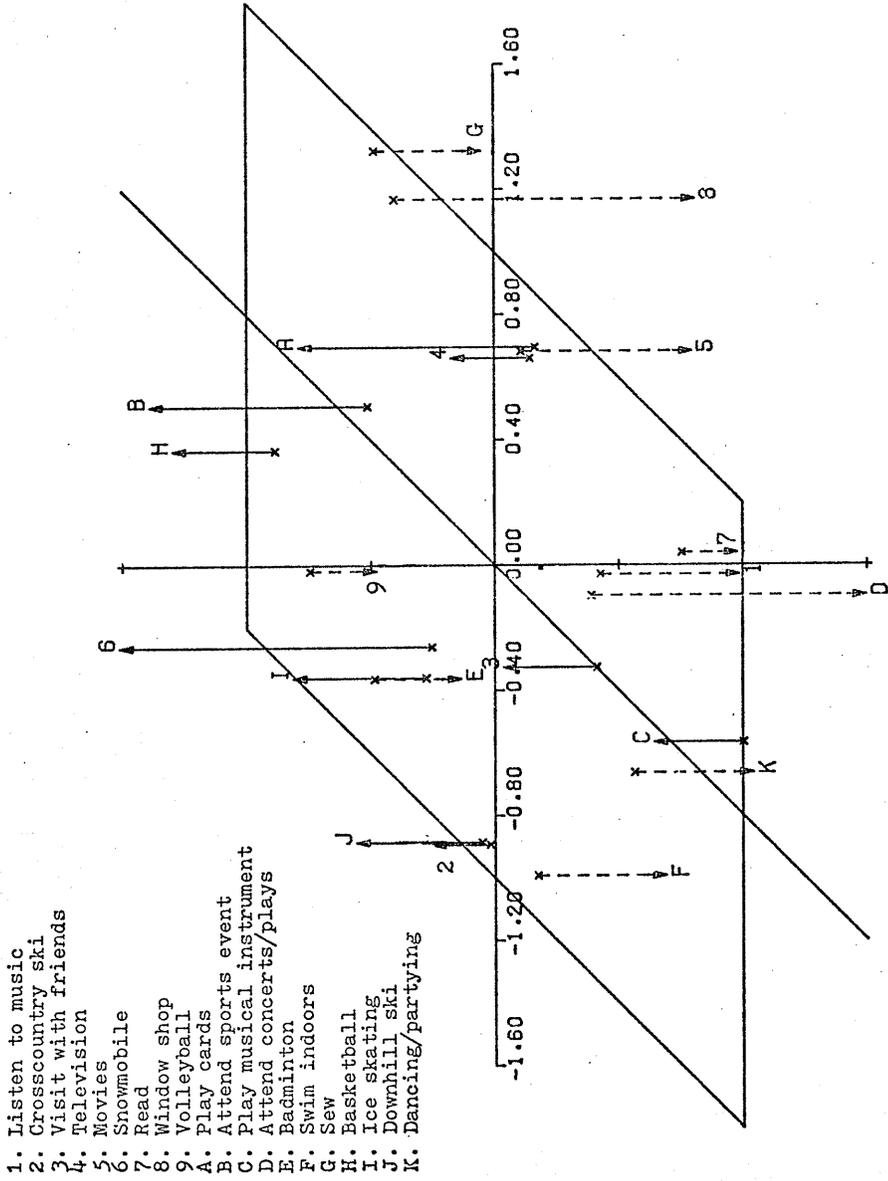


Figure 14
 Three Dimension Rotated KYST Solution
 for the 60% Similarity Group

Table 19

Maximum Correlation (Rho) and Direction Cosines of
 Properties with 60% Similarity Group's
 Three Dimension KYST^a Solution

Property	Rho	Dimension		
		1	2	3
Passive-Active	.846	.998	.014	.068
Indoor-Outdoor	.604	-.752	.313	.580
Enjoyment	.602	.340	.893	.295
Familiarity	.580	.150	-.975	-.166
Mental Involvement	.567	.171	.983	.063
Group-Individual	.547	.600	-.772	-.222
Simple-Difficult	.543	-.860	.372	.350

^aRotated to 100% Similarity INDSCAL solution.

Table 20

Cosines of Angles among the Three Dimension Axes
of the 100% Similarity INDSICAL and Rotated
60% Similarity KYST Solutions

		100% Similarity INDSICAL		
		1	2	3
60% Similarity KYST	1	.801	-.465	-.378
	2	-.259	.838	.480
	3	-.540	-.286	-.792

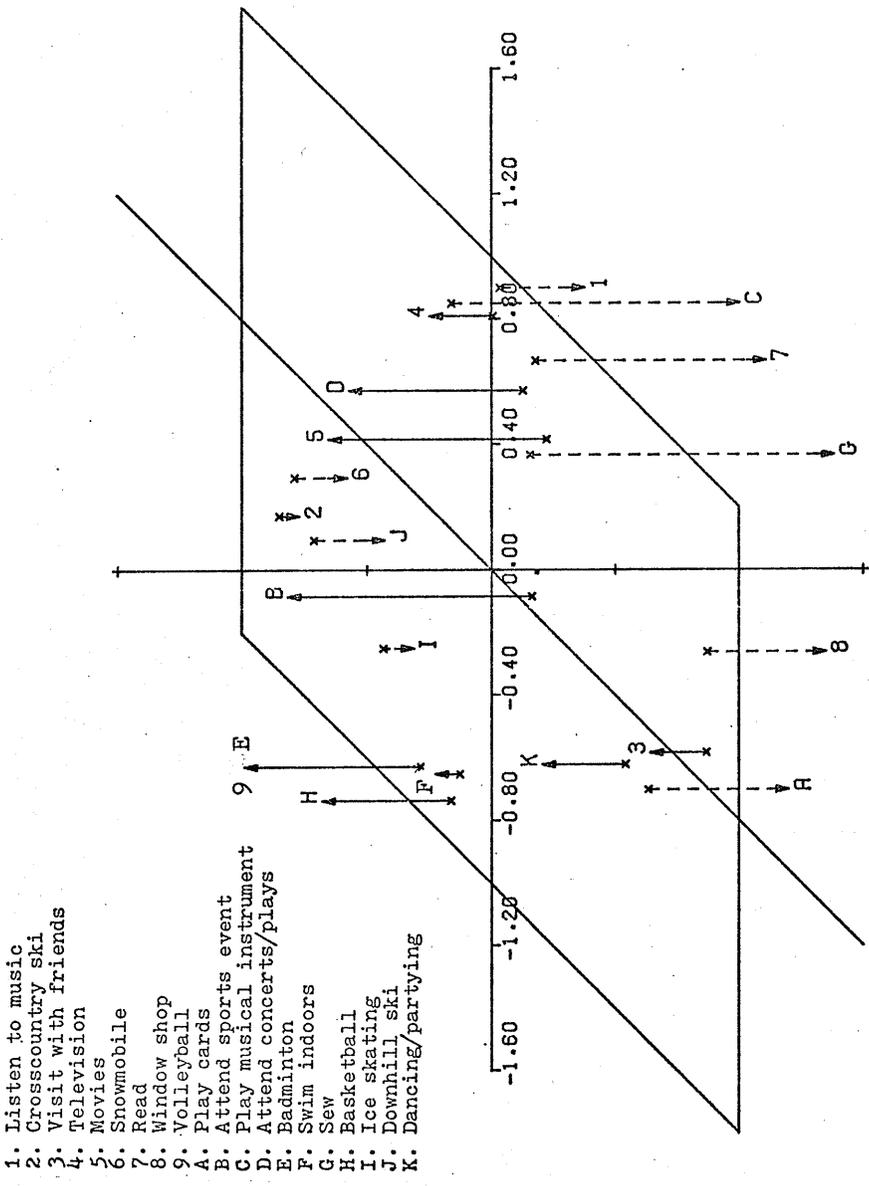


Figure 15
Three Dimension Rotated KYST Solution for the
Similarity Sort Group's Log Data

Table 21

Maximum Correlation (Rho) and Direction Cosines of
 Properties with Similarity Sort Log Transform
 Three Dimension KYST^a Solution

Property	Rho	Dimension		
		1	2	3
Simple-Difficult	.916	-.614	.548	-.568
Group-Individual	.887	.662	.410	-.627
Passive-Active	.831	.973	.095	.212
Familiarity	.745	.538	-.723	.432
Enjoyment	.637	-.729	.489	-.480
Indoor-Outdoor	.541	-.459	.751	-.475
Mental Involvement	.415	-.367	-.151	.918

^aRotated to 100% Similarity INDSCAL solution.

properties while Dimension 3 is only moderately correlated with the group-individual property. Table 22 indicates that the Log dimensions do not correlate on a one-to-one basis with the INDSICAL dimensions. The first dimensions are correlated with each other, but each of the second and third INDSICAL dimensions correlate with two Log dimensions. The dimension "labels", as suggested by the PROFIT analysis do indeed seem to reflect the pattern of the configuration as seen in Figure 15. Athletic, that is, active, activities are at one end of Dimension 1 with passive activities such as reading, T.V., listening to music, at the other. The second dimension does reflect the indoor-outdoor property, with cross-country skiing and snowmobiling at one end and playing cards and visiting friends at the other, for example. The third dimension reflects an individual-group variation with attending sports events, movies, concerts, volleyball at one extreme and sewing, reading and playing a musical instrument at the other. The 100% Similarity INDSICAL solution generally reflects these same dimensions but in a different order, and not to the extremes of this solution.

The Frequency configuration of the Similarity Sort Group is graphed in Figure 16. The corresponding PROFIT analysis is in Table 23. This analysis indicates that the simple-difficult, passive-active and group-individual properties correlate most highly with Dimensions 1, 2, and 3, respectively. Table 24 indicates that the Similarity Sort

Table 22

Cosines of Angles among the Three Dimension Axes
of the 100% Similarity INDSCAL and Rotated
Similarity Sort Log Solutions

		100% Similarity INDSCAL		
		1	2	3
	1	.769	.542	.328
Similarity	2	-.219	-.648	.684
Sort	3	.570	.328	.641
Log Transform				

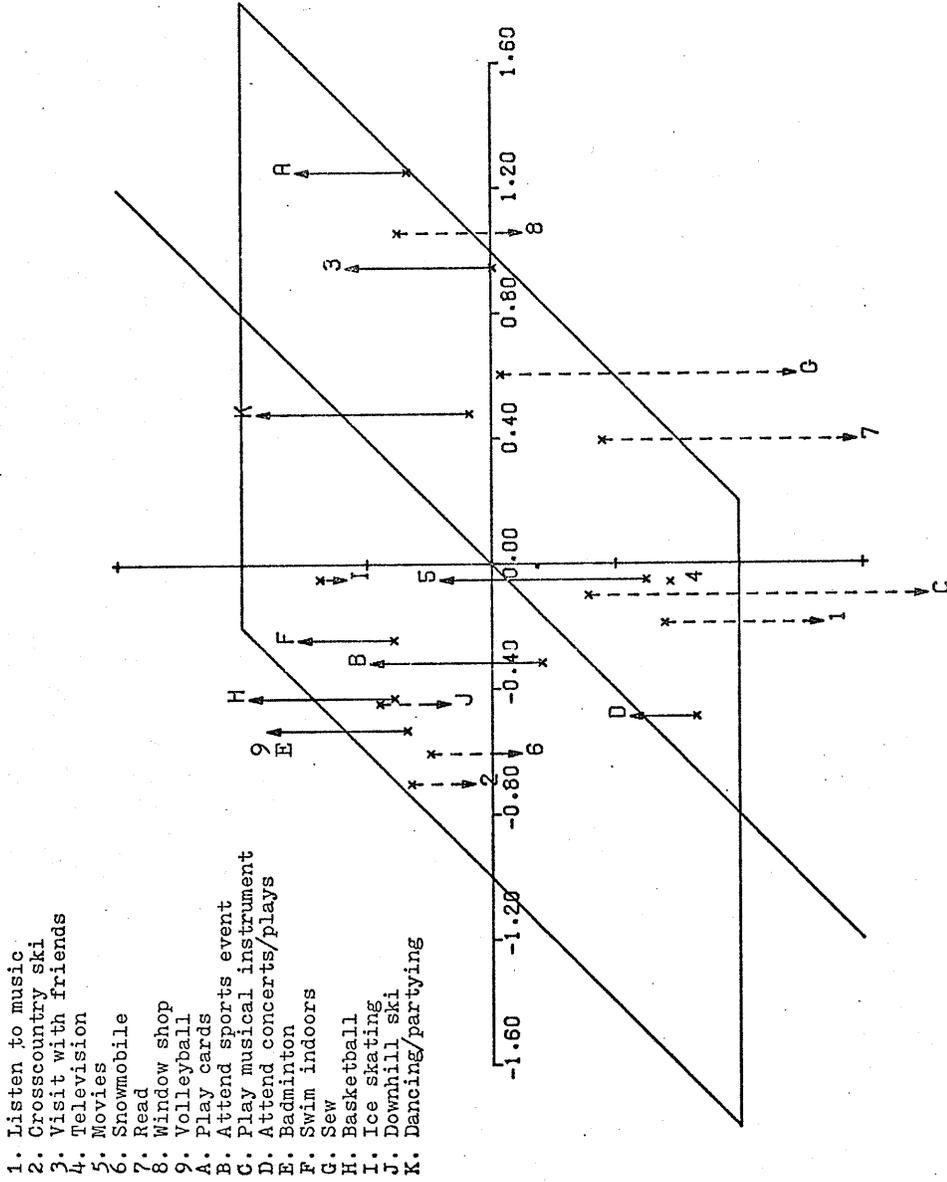


Figure 16
 Three Dimension Rotated KYST Solution for the
 Similarity Sort Group's Frequency Data

Table 23

Maximum Correlation (Rho) and Direction Cosines of
 Properties with Similarity Sort Frequency
 Three Dimension KYST^a Solution

Property	Rho	Dimension		
		1	2	3
Group-Individual	.902	.058	-.297	-.953
Simple-Difficult	.881	-.638	.554	-.534
Passive-Active	.803	.372	-.900	-.227
Familiarity	.780	.644	-.571	.509
Enjoyment	.697	-.504	.743	-.439
Indoor-Outdoor	.645	-.426	.738	-.523
Mental Involvement	.414	-.142	.618	.773

^aRotated to 100% Similarity INDSCAL solution.

Table 24

Cosines of Angles among the Three Dimension Axes
of the 100% Similarity INDSCAL and Rotated
Similarity Sort Frequency Solutions

	100% Similarity INDSCAL			
	1	2	3	
Similarity	1	-.825	.506	.252
Sort	2	.256	-.062	.965
Frequency	3	-.504	-.860	.074

Frequency solution corresponds very closely to the 100% Similarity INDSICAL, much more so than the Log solution did. The order of extraction of dimensions is not consistent but the individual-group dimension (#2) of the INDSICAL solution does correspond to the individual-group dimension (#3) of the Frequency solution. Although the PROFIT analysis suggests that the first dimension is not a passive-active one, inspection of Figure 16 makes it apparent that it is there, at least as reflected in an athletic activity - non-athletic activity separation. The second dimension of the Frequency solution correlates highly with the third dimension of the INDSICAL solution as seen in the FACT06 comparison, but whereas an indoor-outdoor dimension is seen in the former, this is not reflected in the latter. An indoor-outdoor dimension was observed in the 100% Similarity KYST solution, and is thus congruent with this solution.

Since the Log solution and Frequency solution are arrived at through M.D.S. of matrices derived from the same data source, people's sorting of activities, they should be very similar. A comparison of them, as done by FACT06, is presented in Table 25 and indicates that excellent congruence could be obtained through an appropriate rotation. The actual correlation between stimulus coordinates of the first, second and third dimensions of each solution are .696, .412, and .881, and indicate that the results are in the expected direction. The correlations are not higher

Table 25

Cosines of Angles among the Three Dimension Axes
of the Similarity Sort Log and Rotated
Similarity Sort Frequency Solutions

	Similarity Sort Log			
	1	2	3	
Similarity	1	-.993	-.025	-.116
Sort	2	-.043	.987	.155
Frequency	3	-.110	-.158	.981

because these solutions were both rotated to the INDSCAL solution, and, therefore, their fit to each other was not maximized.

60% and Sort Substitutability Results

Just as was the case for the 60% and Sort Similarity Groups' data, only KYST analyses are appropriate to the 60% and Sort Substitutability data. Stress data from KYST solutions in one through six dimensions for the 60% Substitutability Group's data and the Log and Frequency matrices computed from the Sort Group's data were presented earlier in Table 10. They indicate that the three dimension 60% solution fits the data quite poorly (stress = .181) and that only in six dimensions does the value of stress for this group go below .100. Both Sort Group's three dimension solutions provide a good fit to the data with stress equal to .041 and .040 for the Log and Frequency solutions, respectively. In the stress curves for this data in Figure 17, the elbows in the Sort Group's solutions' curves at the three dimension point are the only indication in all stress data presented of the underlying dimensionality of a configuration. There are no breaks in the other curves plotted. Three dimension configurations will be presented and interpreted for all of the following Substitutability Solutions.

The three dimension 60% Substitutability KYST solution, after rotation to the 100% Substitutability INDSCAL configuration, is presented in Figure 18. The PROFIT analysis for

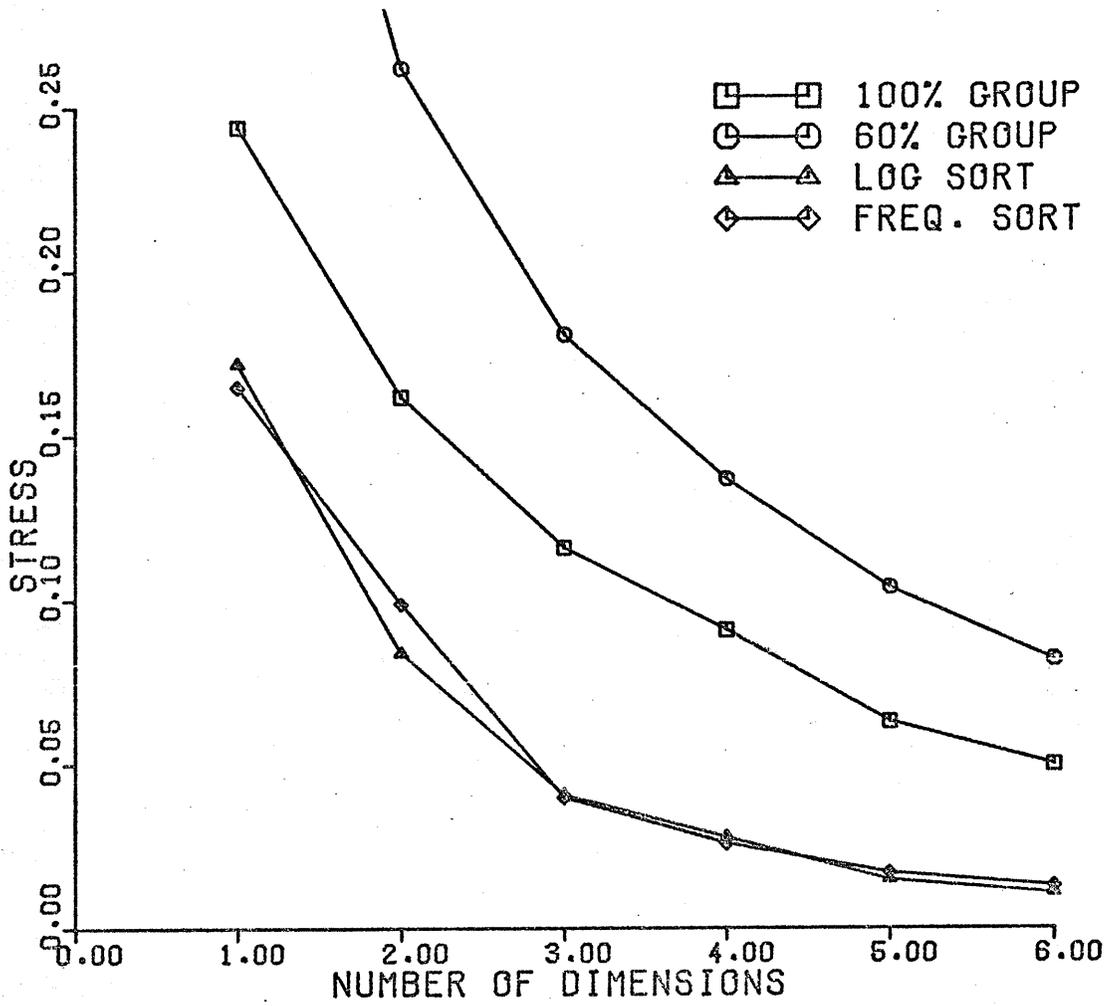


Figure 17

Stress Curves from Substitutability
Groups' KYST Analyses

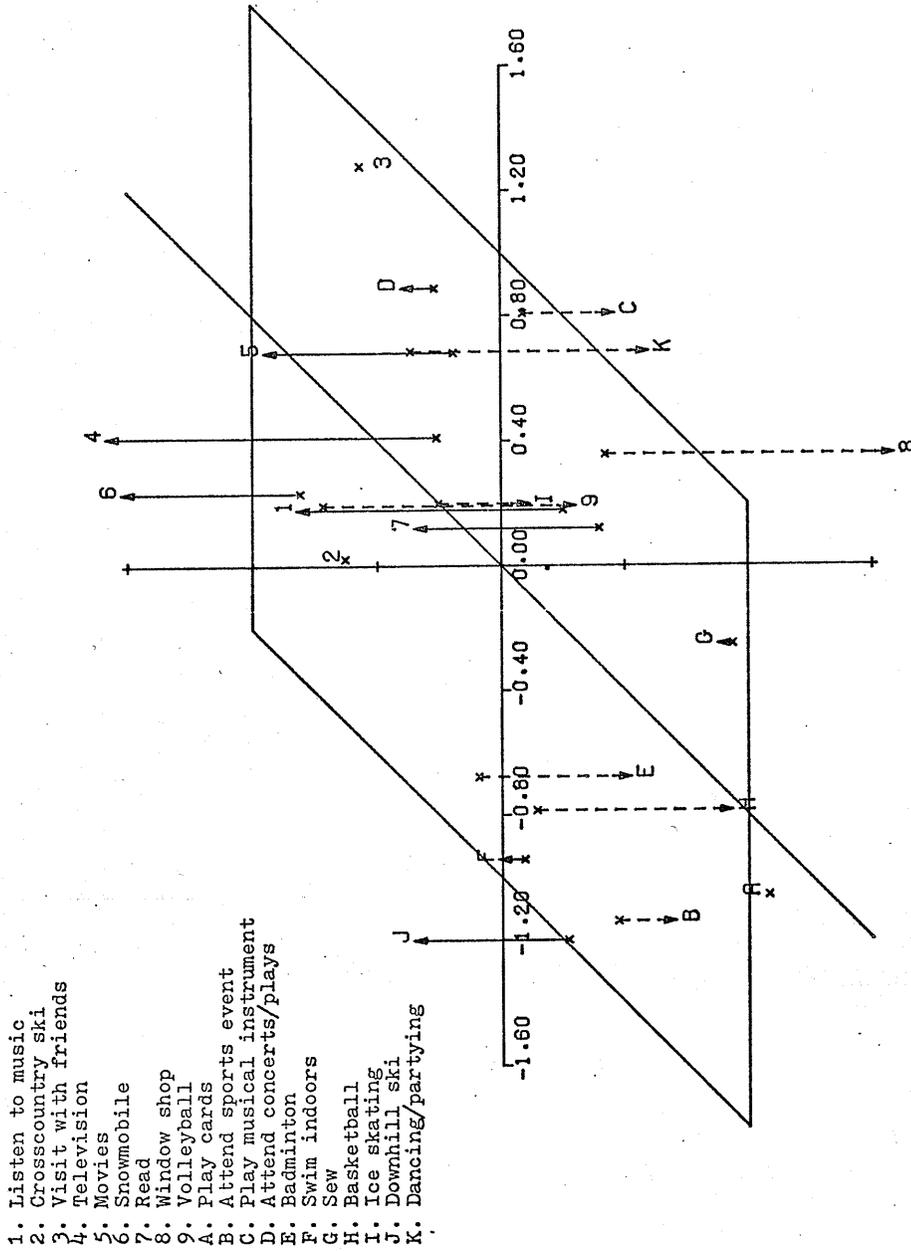


Figure 18
 Three Dimension Rotated KYST Solution for the
 60% Substitutability Group

this solution, the summary of which is in Table 26 indicates:

1. That the first dimension correlates with the simple-difficult, familiarity and group-individual properties,
2. Dimension 2 correlates with the mental involvement, passive-active and enjoyment properties, and that
3. Dimension 3 does not correlate highly with any property.

These relationships do not correspond to those appearing in the 100% Substitutability INDSICAL solutions which might have been expected as a result of the good fit between these solutions as indicated by FACT06 results in Table 27. An inspection of the configuration in Figure 18 suggests that the athletic - non-athletic dimension which has been presented in all solutions to this point is there as well, but with more variance associated with it. The athletic activity clustering previously seen is not so obvious, and, therefore, properties such as indoor-outdoor and familiarity correlate more highly with it while other properties correlate less well. The group-individual variation previously seen is not readily apparent in Dimension 2, for which there is no obvious label. The third dimension seems to reflect a simple-difficult continuum with activities such as T.V., movies, listening to music at the simple end and basketball, playing musical instrument, volleyball at the difficult end. There are some activities that would seem to be out of place, such as downhill skiing at the "simple" end and dancing/partying at the "difficult" end. This solution does not

Table 26

Maximum Correlation (Rho) and Direction Cosines of
 Properties with 60% Substitutability Group's
 Three Dimension KYST^a Solution

Property	Rho	Dimension		
		1	2	3
Group-Individual	.693	.620	-.597	.510
Passive-Active	.688	.558	-.794	.240
Enjoyment	.670	-.291	-.782	-.551
Simple-Difficult	.592	-.831	-.055	-.553
Familiarity	.489	.726	.487	.486
Indoor-Outdoor	.458	-.587	.753	-.298
Mental Involvement	.132	.050	.911	.409

^aRotated to 100% Substitutability INDSCAL solution.

Table 27

Cosines of Angles among the Three Dimension Axes
of the 100% Substitutability INDSCAL and
Rotated 60% Substitutability Solutions

		100% Substitutability INDSCAL		
		1	2	3
60% Substitutability KYST	1	-.926	.191	-.324
	2	-.280	-.926	.254
	3	.251	-.326	-.911

correspond well with the INDESCAL or KYST substitutability solutions interpreted earlier.

The rotated three dimension Substitutability Sort Log configuration is presented in Figure 19. The corresponding PROFIT analysis results are in Table 28. Inspection of it indicates that Dimension 1 is correlated with the passive-active familiarity, simple-difficult, and indoor-outdoor properties. Visual inspection of the configuration makes it apparent that this is due to the athletic activities loading at one end of that dimension. The second dimension is highly correlated with the group-individual property. This is consistent with the 100% Group's solutions but is contrary to the FACT06 results, Table 29, which suggest that group-individual variation of the 100% INDESCAL solution should appear in the third Log dimension. The third dimension of the Log solution reflects some distinct clusterings of activities which correspond to an indoor-outdoor variation but overall this is not readily apparent. Four winter - outdoor activities, that is, skating, snowmobiling, cross-country skiing, and downhill skiing, cluster together at one extreme portion of the dimension, with other activities such as window shopping, attending concerts/plays, and T.V. also being at that end of the dimension. Four other sports activities, generally performed indoors, that is, basketball, badminton, swimming indoors, and volleyball, cluster together at the other extreme of the third dimension with activities

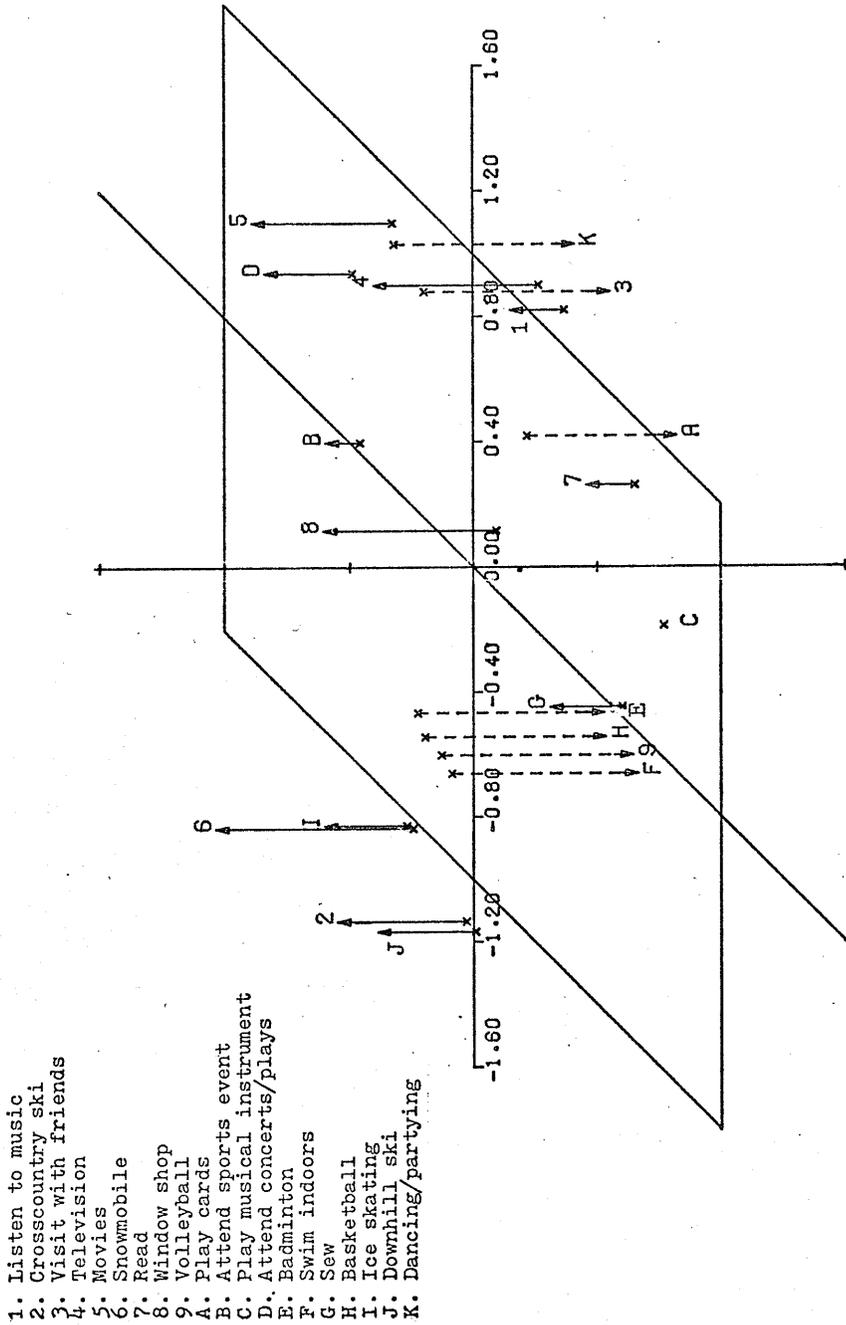


Figure 19
 Three Dimension Rotated KYST Solution for the
 Substitutability Sort Group's Log Data

Table 28

Maximum Correlation (Rho) and Direction Cosines of
 Properties with Substitutability Sort Log
 Transform Three Dimension KYST^a Solution

Property	Rho	Dimension		
		1	2	3
Passive-Active	.931	.753	-.208	.624
Simple-Difficult	.911	-.664	-.653	-.364
Group-Individual	.892	-.001	-.877	.480
Indoor-Outdoor	.750	-.678	.171	.715
Familiarity	.713	.753	.263	-.603
Mental Involvement	.583	.092	.750	.655
Enjoyment	.461	-.543	-.739	.400

^aRotated to 100% Substitutability INDSCAL solution.

Table 29

Cosines of Angles among the Three Dimension Axes of the
 100% Substitutability INDSICAL and Rotated
 Substitutability Sort Log Solutions

		100% Substitutability INDSICAL		
		1	2	3
Substitutability Sort Log Transform	1	.978	-.204	.043
	2	.107	.316	-.943
	3	.178	.927	.331

such as playing cards, visiting friends, and dancing/partying also at that end. The splitting up of the athletic activities into two clusters would seem to have caused the apparent indoor-outdoor relationship with this dimension.

The three dimension Substitutability Sort Frequency configuration is presented in Figure 20. The PROFIT analysis for this solution is summarized in Table 30. Inspection of this table again reflects the athletic activity defining passive-active, and simple-difficult properties but not the group-individual property. This property is correlated with the second dimension, and inspection of the configuration indicates that the clusterings in the Log solution are present and even more distinctly separate and that the other activities have been aligned into a clear group-individual continuum as well. The third dimension of this solution displays the two athletic activity groupings which correspond to an indoor-outdoor difference but the other activities do not appear to vary in any obvious way. This Substitutability Sort Frequency solution does bear a strong resemblance to the Substitutability INDSICAL solution to which it was rotated, also as indicated by the FACT06 results presented in Table 31.

Since it was apparent that the Similarity Sort Log and Frequency solutions could be matched almost perfectly and in fact were highly correlated, the two Substitutability Sort solutions were compared to assess their similarity. FACT06 results (Table 32) indicate that these solutions could be

- 1. Listen to music
- 2. Crosscountry ski
- 3. Visit with friends
- 4. Television
- 5. Movies
- 6. Snowmobile
- 7. Read
- 8. Window shop
- 9. Volleyball
- A. Play cards
- B. Attend sports event
- C. Play musical instrument
- D. Attend concerts/plays
- E. Badminton
- F. Swim indoors
- G. Sew
- H. Basketball
- I. Ice skating
- J. Downhill ski
- K. Dancing/partying

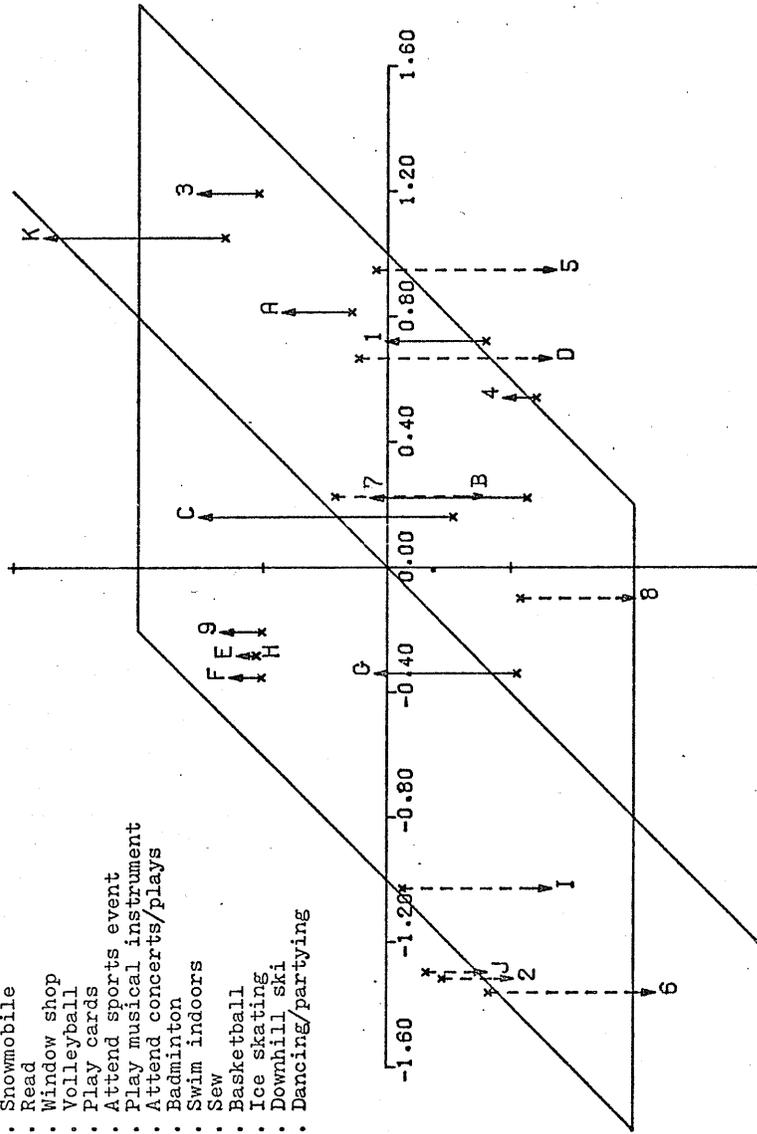


Figure 20

Three Dimension Rotated KYST Solution for the Substitutability Sort Group's Frequency Data

Table 30

Maximum Correlation (Rho) and Direction Cosines of
 Properties with Substitutability Sort Frequency
 Three Dimension KYST^a Solution

Property	Rho	Dimension		
		1	2	3
Passive-Active	.959	.764	-.581	-.280
Simple-Difficult	.880	-.746	-.016	.666
Group-Individual	.856	-.012	-.922	.388
Indoor-Outdoor	.741	-.702	-.548	-.455
Familiarity	.691	.755	.608	.245
Mental Involvement	.551	.145	-.187	-.972
Enjoyment	.423	-.520	-.854	-.017

^aRotated to 100% Substitutability INDSCAL solution.

Table 31

Cosines of Angles among the Three Dimension Axes of
the 100% Substitutability INDSCAL and Rotated
Substitutability Sort Frequency Solutions

	100% Substitutability INDSCAL			
	1	2	3	
Substitutability	1	.963	-.168	.211
Sort	2	-.106	-.955	-.277
Frequency	3	.248	.244	-.938

Table 32

Cosines of Angles among the Three Dimension Axes
of the Substitutability Sort Log and Rotated
Substitutability Sort Frequency Solutions

		Substitutability Sort Log		
		1	2	3
Substitutability Sort Frequency	1	1.000	-.017	-.005
	2	-.017	-.999	-.030
	3	.004	.030	1.000

rotated to a perfect fit with one another. The actual correlations between the corresponding dimensions of these solutions after their rotation to the 100% INDSCAL solution are .940, .733, and -.595. The only apparent visual difference between the configurations is the more distinct clustering of activities in the Frequency solution.

Groups' Solution Space

It is apparent in all the preceding solutions that the first dimension of each is related to an athletic - non-athletic continuum. The other dimensions do not reflect such a strong resemblance, at least across sets of solutions, that is, Similarity versus Substitutability. Two INDSCAL analyses were conducted to determine how dimensions of the 100% Similarity and 100% Substitutability INDSCAL configurations were weighted, that is, to find dimension saliences, by different three dimension group solutions. Euclidean distance matrices were computed for all 10 three dimension M.D.S. solutions. These matrices formed pseudo subjects in INDSCAL analyses, in which dimension saliences were found for them which best fitted their solutions to either of the "target" three dimension INDSCAL solutions. The squared correlations between the pseudo subjects' matrices and the input configurations are listed in Table 33. Inspection of these indicates that the 100% Similarity solution accounts for over 60% of eight solutions' variance with the exceptions being the 100% Substitutability INDSCAL and 60% Substituta-

Table 33

Variance Accounted for in Ten Solutions' Euclidean Distance
Matrices by the 100% Similarity and Substitutability
Three Dimension INDSCAL Solutions

Solution	100% Similarity	100% Substitutability
100% Sim INDSCAL	1.00	.64
100% Sim KYST	.89	.78
60% Sim KYST	.63	.53
Sim Sort Log	.67	.67
Sim Sort Freq	.72	.75
100% Sub INDSCAL	.54	1.00
100% Sub KYST	.76	.71
60% Sub KYST	.36	.30
Sub Sort Log	.66	.74
Sub Sort Freq	.69	.75

bility KYST solutions. The 100% Substitutability configuration also accounts for over 60% of each of eight solutions' variance, with the exception of the 60% Similarity KYST, and 60% Substitutability KYST solutions. This latter finding is consistent with the lack of similarity in their PROFIT results. Both Sort Groups' solutions were accounted for almost equally well by either target solution whereas the 60% Substitutability solution was accounted for equally poorly. The 100% Similarity configuration accounts for both 100% KYST solutions better than does the Substitutability solution. The dimension saliences of these solutions are indicated in Table 34. The first, second and third dimensions of the Similarity configuration account for 75.0, 15.4, and 9.6% of the common variance respectively. These dimension figures in the Substitutability solution are 82.9, 12.5, and 5.6%. Inspection of these saliences would suggest that the second and third dimensions are not important ones, except in a few solutions. The third Substitutability dimension, in particular, accounts for very little of all but its own solution. This general pattern indicates that the athletic/non-athletic activity split of the first dimensions is the most pervasive relationship present in the data.

Table 34

Ten Solutions' Dimension Saliences from INDSCAL
Analyses using 100% Groups' Solutions

Solution	100% Similarity			100% Substitutability		
	Dimension			Dimension		
	1	2	3	1	2	3
100% Sim INDSCAL	.54	.54	.54	.68	.35	.07
100% Sim KYST	.80	.32	.22	.81	.29	.06
60% Sim KYST	.66	.32	.10	.70	.17	.02
Sim Sort Log	.72	.18	.24	.73	.30	.08
Sim Sort Freq	.74	.23	.20	.79	.27	.07
100% Sub INDSCAL	.62	.17	.29	.56	.56	.56
100% Sub KYST	.80	.22	.10	.79	.19	.14
60% Sub KYST	.47	.25	.17	.47	.21	.10
Sub Sort Log	.67	.35	.11	.84	.11	.04
Sub Sort Freq	.71	.32	.11	.84	.13	.04

Chapter 4

DISCUSSION

This research was designed to identify aspects or attributes of leisure activities which individuals use in their assessment of these activities' similarity and substitutability. Three data collection procedures were used to determine their differential ability to produce similar multidimensional scaling solutions, and, therefore, similar conclusions.

Evidence relating to the M.D.S. solutions of the 100% Similarity Group indicates an acceptable recovery of the original data by the solutions in a reasonably low dimension space. Although there is good agreement between the KYST and INDSCAL solutions, there are distinct differences as well, which are readily seen in the PROFIT results. The nature of the two procedures is such that INDSCAL solutions should better reflect consensus of perceptions and be most accurate. INDSCAL data indicates that the first dimension of the three dimension solution accounts for the major portion of variance recovered by this solution, and that the many subjects who used it did so to a great extent. Both visual interpretation of the KYST and INDSCAL solutions and evidence from external information, that is, PROFIT results, suggests that an active-passive property is predominant in the first dimension. A more discrete

classification of athletic and non-athletic activities accounts for the high correlation between the first dimension and the active-passive property and the simple-difficult and indoor-outdoor properties' correlations as well. Cluster analytic results suggest that although the INDSCAL solution intensifies the athletic activity grouping, it is present in the aggregate group matrix of dissimilarities. The extremely high inter-similarity of eight athletic activities has resulted in such little dimensional variance that interpretation is much more difficult for the INDSCAL solution than the KYST. Although these activities are tightly clustered in the INDSCAL solution, this should reflect most accurately individuals' ratings of similarity. What would appear to have happened is that people rated the eight activities as very similar to each other, and not similar to most other activities. They seem to have generally ignored more subtle distinctions among the athletic activities such as competitive/non-competitive, or organized/non-organized, for example, or not found them important. The second dimension of the two solutions corresponds with an individual-group continuum, and is reflected in activities such as basketball, and volleyball being at one end and reading and playing a musical instrument at the other. The third dimension of the KYST solution is correlated with an indoor-outdoor scale but this is not reflected in the INDSCAL solution. The third INDSCAL dimension is difficult to interpret, although social-

entertainment/individual involvement variation might be reflected.

The interpretation of M.D.S. dimensions is not so easy to do as determining the fit of the solutions to the data, with such aids available as "stress" and "percentage of variance accounted for." The labels attached to the dimensions are of course arbitrary and do not reflect all sources of variance along dimensions. The correlations between activity properties and projections on the perceptual dimensions hopefully give some credence to the labels which have been selected.

Even though the athletic/non-athletic comparison would seem to be the overriding source of variance present, other sources of variance did appear. These are, in fact, remarkably similar to those found by Ritchie (1974) in his analysis of housewives' comparisons of 12 leisure activities. Ritchie chose a four dimension solution to represent the group configuration, and from information presented in the 1975 article, the common variance accounted for by these dimensions could be found. The dimensions, labelled active/passive, individual/group, simple/difficult, and involving/time filling, accounted for 62, 18, 11, and 9 percent of the variance explained, respectively. These correspond extremely well with a comparable four dimension INDSCAL solution in this data. The first two dimensions of Ritchie's study, at least as labelled, do seem to correspond with the

first two dimensions of the present Similarity solution. Neither of Ritchie's latter two dimensions seem to be reflected in the third INDSICAL dimension. The present research, with more activities and different subjects, partially substantiates Ritchie's findings.

Ritchie chose a four dimension solution even though the three dimension solution accounted for 55% of the variance with stress of .045 . Since the fourth dimension did not greatly add to the fit and because it resulted in a solution which could not be interpreted directly, it probably should not be interpreted. Although stress figures for the Similarity solutions of this research were higher than those found by Ritchie, and variance accounted for lower, this can be accounted for, in part by research (Young, 1970) indicating that with more stimuli being scaled, stress increases even though the solution may be relatively better in recovering original information.

Neither Ritchie's dimensions or the Similarity dimensions of this research correspond with Becker's (1976) description of the dimensions found in his study. Only two or three of the activities used by Becker may be classed as "passive" and this same number again as "indoor". It is not surprising then that these dimensions are not reflected in the configuration presented. An individual-group distinction is very hard to make for most of the activities of this study, for example, boat racing involves individuals but requires a

group and, therefore, this would not seem to be "available" as an interpretable dimension. Becker's configuration was derived from an aggregate level analysis so that potentially valuable information about individual differences in perception is not available from it.

The dimensions of importance found in the configuration of the 100% Similarity Group correspond well with the important classificatory dimensions postulated by de Grazia (1962). The active-passive and group-individual dimensions of the INDSICAL solution and the indoor-outdoor dimension of the KYST solution are identical to de Grazia's active-passive, social-solitary, and indoor-outdoor dimensions. His "at home - away from home" and "participant-spectator" dimensions are not reflected to any major degree in the present data.

Kaplan (1960) developed classes of leisure activities by using dimensions derived from three seemingly important aspects of activities; the involvement of people, the role of rules, and the level of movement necessary to gain experiences. If these are transformed into the terms of the present research, the involvement of people might become a group-individual scale, while the level of movement would become an active-passive dimension. Two of these dimensions as stated were observed, but the organization or rules dimension was not. Unfortunately, activities on these dimensions would not be grouped into classes along the same lines as Kaplan's groups. They are arranged at a very

"concrete" level whereas Kaplan's arrangement is much more abstract. This reflects, therefore, the obvious differences between those configurations of leisure activities constructed by researchers or theorists and "lay-persons", that is, housewives, students, etc.

Approximately half of all students tested in this research rated leisure activities not on the basis of similarity but on the loosely defined term, substitutability. This was done for two inter-related reasons. Past researchers (Hendee & Burdge, 1974; Moss & Lamphear, 1970) have suggested "substitute" activities may be derived from factor-analytic studies based on participation rates, when, in fact, this is not theoretically or practically obvious. M.D.S. offers a way of determining how activities fit into a space based on substitutability criteria, however that may be defined by the individual. Other researchers have assumed or implied that M.D.S. solutions of leisure activities compared on similarity based are the same as solutions from substitutability comparisons. This possibility was tested in the present research.

Although subjects' judgements of substitutability of leisure activities proved to be generally reliable, it appears that the relations among activities are much more complex and susceptible to individual differences than those found with similarity comparisons. This seems a reasonable statement since higher stress values, lower overall variance

accounted for, and lower individual subjects' accounted for variance figures for all Substitutability Groups' solutions were observed. The first dimension of the three dimension KYST and INDSICAL solutions was correlated with the active-passive and simple-difficult properties of activities. This dimension is weighted most heavily by subjects and, therefore, does account for most of the common variance. They also do not reflect an extreme athletic activity clustering, although the athletic/non-athletic label would in fact describe the variance of Dimension 1 quite well. The second dimension correlates with an individual-group orientation, although much more so for the INDSICAL solution than the KYST solution. The third dimensions of both solutions do not seem to reflect any obvious source of variation, even though it is highly correlated with the indoor-outdoor property in the KYST solution.

The results of this research have shown that the three dimension 100% Similarity and 100% Substitutability INDSICAL solutions are only generally comparable except for the first dimensions of each, which are extremely similar. In the four dimension analysis this appears to be because dimensions were extracted differently while in the three dimension case the second and third dimensions of each solution are all inter-correlated. The three dimension KYST solutions might be considered similar if rotated to congruence but when rotated to their respective INDSICAL solutions, there are only

moderate relationships between dimensions. What this indicates, therefore, is that except for the use of the athletic/non-athletic activity grouping, which is much more evident in the Similarity solution, comparisons of activities on these two bases do not result in the exact same configurations. Substitutability of leisure activities is not synonymous with similarity of those activities. Unfortunately, the present research does not preclude the possibility of such factors as scale orientation, or more importantly, instructions, being related to this lack of correspondence. The "definition" of substitutability might have led people to use personal preference and participation as the basis for their ratings. In addition, it might be that activities are intransitive in relation to substitutability, that is, a person might feel an activity is substitutable for another but not visa versa. This possibility requires the collection of full matrices of paired-comparisons for study, and further research.

The present research suggests that when actually asked to compare leisure activities on the basis of substitutability, people use many different dimensions. So many, in fact, that a low dimension M.D.S. solution which is desired does not explain much of the variance involved in these comparisons. Inspection of the M.D.S. solutions obtained suggests that many activities do not have substitutes in the absolute sense of small Euclidean distances between them, and that

even in a relative framework some activities, such as sewing, are vastly different from all others. This is, of course, only within the set of activities used in the present study. It is likely that knitting, crocheting, and weaving might all be considered as substitutes for sewing. Some activities do seem to cluster in the three dimension space, T.V., movies and listening to music, for example. The Substitutability Sort Frequency solution suggests how a clearer picture of substitutable activities might appear. Swimming, basketball, badminton and volleyball fit into a very small portion of this solution's space, while four winter athletic activities fill another portion of that space, for example.

The inability to interpret the dimensional variance present, and the high information value of clusterings found suggests that the multidimensional model used, which assumes more or less continuous variation along dimensions, is not in fact the most appropriate one possible. The cluster analysis model as used in this study and in other studies is also not the solution. The hierarchical model, as diagrammed by a tree structure, assumes some patterning or grouping along linear dimensions. This can not give information about dimensions of importance in comparisons. All clustering method solutions are in fact highly dependent upon the type of data used, the number of clusters wanted, overlap permitted between clusters and the

amount of error in assignment of objects to clusters. This and the lack of inferential statistics available to quantify clusters and their reliability makes cluster analysis results usually very subjective. A procedure for the use of cluster analysis in conjunction with M.D.S. may provide a means of describing substitutable activities within a dimensional space. Degerman (1970) proposed a rotation procedure which allows for interpretation of both class and quantitative variation in stimuli, simultaneously. Aiken (1972) used this procedure with success in describing structure and classification of patterns. Further research is necessary to determine how substitutable activities may be most accurately described.

The average time to complete the paired-comparison task for all pairs in the two 100% Groups' testing did not prove to be as long in this research as has been the case in other reported studies. Two alternative data collection methods had been included to determine if they would require less of subjects' time than the 100% paired-comparison task but result in comparable M.D.S. solutions. Both the 60% paired-comparison task and the sorting task required significantly less time than the 100% paired-comparison task across both the Similarity and Substitutability instruction sets. The sorting task also required less time than the 60% paired-comparison task. Assessment of the congruence of solutions, however, proved to be much more equivocal.

Within the Similarity Groups it is apparent that the first dimension of all five solutions reflects the active-passive property, and to some extent other properties such as simple-difficult and indoor-outdoor. This is accounted for in all cases by the appearance of an athletic activity clustering. The composition or "variance source" of the second and third dimension across all solutions proved to be much more variable. Although the third dimension of the 100% Group's INDSICAL solution is not readily interpretable that dimension in the KYST solution does correspond to indoor-outdoor variation. The 60% Group's solution compares fairly well with the 100% Solutions but has very high stress values. The first dimension is an athletic activity continuum and the third dimension reflects a general indoor-outdoor order. But, the second dimension does not reflect a group-individual pattern, or any other interpretable pattern. This is not consistent with the analytical comparison of the INDSICAL and 60% solutions. The two Sort solutions which have very small stress values are readily interpretable as having active-passive, indoor-outdoor and group-individual dimensions. These latter two dimensions are not in the same order as the INDSICAL and KYST solutions of the 100% Group, but are present.

The actual interpretability of the Similarity Groups' solutions is the most important test of congruence of solutions but the results of the pseudo subjects' INDSICAL

analysis gives further credence to these findings. The actual three dimension INDSICAL configuration accounts for over 60% of the variance of each of the 60%, Sort Log and Sort Frequency solutions. The first dimension accounts for the largest proportion of this variance. The two dimension INDSICAL solution would probably account almost as well for these solutions' variance as the three. The test of the 60% paired-comparison method in this research is, in fact, a poor one. Only half as many subjects as the 100% Group were tested, with the result that each stimulus pair was only seen from 25% to 40% as often. This means that the aggregate matrix probably has much more variability and error in it than the 100% Groups.

The pattern of correspondence within the Substitutability Groups is very similar to that of the Similarity Groups. The exception to this is the 60% paired-comparison group. Not only was stress very high, and recovery of the solution by the Substitutability INDSICAL configuration extremely low, but the interpretation of this solution did not lead to similar conclusions about the sources of variation, that the other groups did. As in the Similarity Groups' case, the number of subjects in the 60% Substitutability Group was small, and, given the generally greater variance that occurred in these groups in general, this poor fit is understandable. Both Sort Group's solutions reflected the first two INDSICAL dimensions quite well and also suggest

that the third dimension might reflect an indoor-outdoor pattern.

Although it appears in the comparison of the 100% Group's solution that they are not in fact similar, the solutions of the Similarity and Substitutability Sort Groups are such that, except for differences in extraction and magnitude of effects, they would lead to the same conclusions in all cases. Active-passive, group-individual, and indoor-outdoor variation is present in all four Sort solutions. The solutions are not visually identical but general agreement is very apparent. One quite noticeable difference is the splitting up of the athletic activities cluster in the Substitutability Group into an outdoor, winter cluster of four activities and an indoor cluster of activities. The Sort method of gathering data, in the general sense, would appear to result in more "typal", as opposed to dimensional, variance in stimuli. Burton (1075) discusses this indirectly when addressing the problem of degenerate M.D.S. solutions caused by sorting dissimilarity measures which do not contain enough information about size, number and composition from a given subject's partition. He indicates the the Log measure, as used in this research, is less prone to degenerate solutions than the Frequency measure used. The Frequency data did not seem to produce degenerate solutions, and, in fact, were accounted for as well

or better than the Log data.

One shortcoming of the present research which is related to the type of data provided by the 60% and Sort methods is the total lack of information about individual differences obtained from these data bases. This does in fact relate to the availability, or rather lack thereof, of computer programs appropriate for disaggregate analyses of data with many missing values, or in which the assumptions of interval properties do not seem tenable. There are such computer programs which might be obtained, but this was beyond both the scope and resources of this research.

Although this research has provided some further information about people's perceptions of leisure activity similarity, and has extended the use of M.D.S. to leisure activity substitutability, there are many questions to be answered, and fruitful avenues of research to be explored. The most obvious need is one of research scope, that is, sampling of subjects. Many and diverse people must be sampled in order to determine if there are general modes of responding to the question of leisure activity similarity, and what, if any, are different subgroup styles of response. Another important area of research relates to the set of leisure activity stimuli used. This research found that athletic activities cluster together, in varying degrees, in different M.D.S. solutions. The effect of such a core set of activities on the arrangement of other activities in space is one that merits attention. Is, for example, the

active-passive dimension found by Ritchie and this research present when no athletic activities are included, although when there are other active leisure activities, such as fishing, hiking, and dancing? Can fine distinctions among a set of activities, such as athletic activities, be made, and what dimensions of variation appear? M.D.S. is appropriate for preference as well as similarity judgements. The relationships between preference structures and similarity or substitutability structures may be enlightening in relation to individual differences and relationships among stimuli.

There are many important methodological problems that should be investigated. Although the present research suggests that sorting methods do seem to provide aggregate M.D.S. solutions similar to a complete set of paired-comparisons, other research is not in agreement with this or does not address the situation. Solutions from Sorting data with many stimuli should be compared with solutions derived from more methodologically sound incomplete paired-comparison data sets. Rao and Katz (1971) have suggested that sorting data may be transformed into "second-order distances" which are appropriate for INDSCAL, for example. If this is possible and meaningful solutions can be derived, it removes a very serious shortcoming of this method of data collection, that is, the aggregation of individual differences. Burton's (1975) Log measure for sorting data should be investigated

further to determine if it has properties such that sorting data can be input into metric scaling algorithms, in particular INDSCAL. Another area of research is created through the availability of interactive computer facilities. Young and Cliff (1972) and Girard and Cliff (1976) have shown that excellent M.D.S. solutions can be found, with many stimuli and with relatively few comparisons being made, through the use of on-line computer terminals and an interactive M.D.S. program. This line of research should prove to be valuable for scaling large sets of stimuli.

Although the present research attempted to clarify the relationship between similarity and substitutability of leisure activities, more questions and problems were created than answers. The problem of the appropriate methodological procedure to use, be it M.D.S., cluster analysis, or a procedure using both techniques, needs to be resolved before questions relating to the substitutability of leisure activities can be answered.

The present research was initiated to further clarify the area of leisure activity description, classification, and substitutability. Much more research, which will hopefully be forthcoming, is needed before any adequate conclusions can be reached.

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APPENDIX A

Sample Instructions and Rating Scales

EXPERIMENT ZOWIE

The research you are about to participate in is related to leisure activities. In order to help me better understand the basic data you will furnish, would you please first fill out the section marked INFORMATION. When you have finished it, please continue.

INFORMATION

Age: _____
Gender: Male _____ Female _____
Marital Status: Single _____ Married _____ Other _____
Faculty: Arts _____ Science _____ Commerce _____ Phys. Ed. _____
Other _____

Year in University: 1. _____ 2. _____ 3. _____ 4. _____
Length of Residence in Canada: _____ years
Length of Residence in Manitoba: _____ years
Number of Winters spent in Manitoba (including this one) _____
Country of Birth: _____
Country of Citizenship: _____
Native Language: _____
Current Place of Residence: House _____ Apartment _____
University Residence _____
Do you have a part-time job? Yes _____ No _____

Take a moment and read through the list of leisure activities listed below.

1. Listen to music
2. Crosscountry ski
3. Visit with friends
4. Television
5. Movies
6. Snowmobile
7. Read for pleasure
8. Window shop
9. Volleyball
10. Play cards
11. Attend sports event
12. Play musical instrument
13. Attend concerts/plays
14. Badminton
15. Swim indoors
16. Sew
17. Basketball
18. Ice skating
19. Downhill ski
20. Dancing/partying

PLEASE TURN THE PAGE AND READ THE INSTRUCTIONS CAREFULLY.

PLEASE TURN THE PAGE AND CONTINUE

JUDGEMENTS

In this exercise you will be asked to compare the leisure activities you have just seen with each other in a specific way.

The stack of computer cards you have at your desk have the names of these activities written on them in pairs--two activities per card. The task asked of you is, for each pair of activities, to indicate how similar the two activities are on a scale ranging from 1 = Extremely similar to 9 = Extremely dissimilar. Make this judgement on any basis you choose. That is, use any criteria for similarity which seem relevant to you in rating each pair.

The first nine cards in the pile are numbered to help you order your judgements. These should be placed in a line in front of you so that you can see them throughout the task. When your judgement is made for a given card, place it on one of the nine piles in front of you. Remember, the number 1 represents Extremely similar, the number 9 represents Extremely dissimilar, while the numbers in between correspond to degrees of similarity.

Please do not turn the page until you have finished making your judgements on all pairs of activities, that is, until you have gone through the entire stack of computer cards.

If you have any questions raise your hand and the experimenter will try to help you.

If not, or when your question is answered, begin making your similarity judgements on the activities. Work quickly, relying on your first impression. Do not go back and change any previous judgements during the course of the task.

WHEN YOU HAVE FINISHED YOUR JUDGEMENTS, PUSH THE PILES TO THE FRONT OF THE DESK, TURN THE PAGE AND CONTINUE...

Please write down in the space provided the time right now.

The time is _____.

When you were comparing the activities on the computer cards, you made a judgement as to how similar they were. Now, list the way(s) in which you made these judgements. That is what methods, criteria, characteristics of activities, etc. did you use.

1. _____
2. _____
3. _____
4. _____

PLEASE TURN THE PAGE AND CONTINUE.

RATINGS TASK

I would like your judgements of the following leisure activities on each of the following bipolar scales.

1. Active / Passive
2. Indoor / Outdoor
3. Simple / Difficult to perform
4. Group / Individual
5. Enjoy / Do not enjoy
6. Mental / No mental involvement

In each case one of the bipolar scales will be presented. Rate each of the leisure activities on the 7-point intensity scale. For example, the first scale would range from "Extremely active" to "Extremely passive". The full scale of degrees of intensity (illustrated for the first pair of phrases) is to be interpreted as:

- 1 = Extremely active
- 2 = Very active
- 3 = Slightly active
- 4 = Neither active nor passive
- 5 = Slightly passive
- 6 = Very passive
- 7 = Extremely passive

Try to cover the range of each scale in making your intensity judgements. Merely circle the direction and intensity level that best reflects your judgement regarding each activity on the scales on the following pages.

CONTINUE

FAMILIARITY

On the numbered scales below would you please circle that number which corresponds to how familiar you feel you are with each leisure activity listed. A value of 1 indicates no familiarity, meaning that you do not know what the name stands for. A value of 7 indicates high familiarity, meaning that you have engaged in the activity on more than one occasion or seen it done more than once. The numbers 2 - 6 indicate varying degrees of familiarity.

	NOT AT ALL FAMILIAR	1	2	3	4	5	6	7	VERY FAMILIAR
Listen to music	1	2	3	4	5	6	7		
Crosscountry ski	1	2	3	4	5	6	7		
Visit with friends	1	2	3	4	5	6	7		
Television	1	2	3	4	5	6	7		
Movies	1	2	3	4	5	6	7		
Snowmobile	1	2	3	4	5	6	7		
Read for pleasure	1	2	3	4	5	6	7		
Window shop	1	2	3	4	5	6	7		
Volleyball	1	2	3	4	5	6	7		
Play cards	1	2	3	4	5	6	7		
Attend sports event	1	2	3	4	5	6	7		
Play musical instrument	1	2	3	4	5	6	7		
Attend concerts/play	1	2	3	4	5	6	7		
Badminton	1	2	3	4	5	6	7		
Swim indoors	1	2	3	4	5	6	7		
Sew	1	2	3	4	5	6	7		
Basketball	1	2	3	4	5	6	7		
Ice skating	1	2	3	4	5	6	7		
Downhill ski	1	2	3	4	5	6	7		
Dancing/partying	1	2	3	4	5	6	7		

PLEASE TURN THE PAGE AND CONTINUE

ACTIVE			PASSIVE			INDOOR			OUTDOOR				
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Listen to music							Listen to music						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Crosscountry ski							Crosscountry ski						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Visit with friends							Visit with friends						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Television							Television						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Movies							Movies						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Snowmobile							Snowmobile						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Read for pleasure							Read for pleasure						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Window shop							Window shop						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Volleyball							Volleyball						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Play cards							Play cards						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Attend sports event							Attend sports event						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Play musical instrument							Play musical instrument						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Attend concerts or plays							Attend concerts or plays						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Badminton							Badminton						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Swim indoors							Swim indoors						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Sew							Sew						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Basketball							Basketball						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Ice skating							Ice skating						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Downhill ski							Downhill ski						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Dancing / partying							Dancing / partying						
1	2	3	4	5	6	7	1	2	3	4	5	6	7

CONTINUE

CONTINUE

APPENDIX B

Stimulus Loadings for M.D.S. Solutions

Table 35
 Stimulus Coordinates from 100% Similarity Group's
 Three Dimension INDSCAL Solution

Stimulus	Dimension		
	1	2	3
1	.177	-.372	-.181
2	-.269	.147	.134
3	.091	-.247	.209
4	.289	.002	.186
5	.256	-.148	.297
6	-.213	.167	.153
7	.261	.017	-.216
8	.248	.135	-.073
9	-.253	.266	.011
10	.165	-.111	-.047
11	.117	.220	.425
12	.105	-.317	-.361
13	.172	-.343	.005
14	-.244	.229	-.080
15	-.238	.171	-.153
16	.269	.203	-.572
17	-.258	.224	.071
18	-.260	.050	.018
19	-.271	.119	.178
20	-.145	-.413	-.003

Table 36

Stimulus Coordinates from 100% Similarity Group's
Rotated Three Dimension KYST Solution

Stimulus	Dimension		
	1	2	3
1	.488	-.642	-.242
2	-.706	.451	.457
3	.204	-.543	.359
4	.718	-.147	-.073
5	.719	-.312	.277
6	-.617	.522	1.001
7	.796	-.007	-.492
8	1.183	.357	.229
9	-.990	.496	-.006
10	.355	-.259	-.690
11	.154	.353	.284
12	.290	-.969	-.582
13	.581	-.885	.063
14	-.650	.915	-.033
15	-.812	.488	-.361
16	1.124	.179	-1.026
17	-.818	.565	.106
18	-.850	-.027	.092
19	-.836	.107	.596
20	-.331	-.641	.043

Table 37

Stimulus Coordinates from 60% Similarity Group's
Rotated Three Dimension KYST Solution

Stimulus	Dimension		
	1	2	3
1	.312	-.483	-.445
2	-.909	.023	.187
3	.004	-.467	.302
4	.775	-.160	.253
5	.767	-.119	-.551
6	-.465	.290	1.005
7	.643	-.852	-.178
8	.844	.458	-.970
9	-.614	.843	-.212
10	.826	-.184	.761
11	.097	.580	.701
12	.236	-1.133	.287
13	.216	-.441	-.278
14	-.752	.551	-.278
15	-.854	-.195	-.413
16	.934	.550	-.346
17	-.342	1.001	.329
18	-.582	.315	.427
19	-.927	.060	.404
20	-.211	-.639	-.381

Table 38

Stimulus Coordinates from Similarity Sort Log
Three Dimension Rotated KYST Solution

Stimulus	Dimension		
	1	2	3
1	.928	-.039	-.274
2	-.508	.962	-.063
3	.111	-.983	.181
4	.815	-.006	.203
5	.597	-.254	.703
6	-.339	.894	-.167
7	.810	-.202	-.744
8	.435	-.987	-.382
9	-.856	.323	.563
10	-.193	-.719	-.451
11	.047	-.186	.785
12	.722	.183	-.931
13	.674	-.144	.561
14	-.856	.322	.563
15	-.752	.143	.080
16	.492	-.177	-.981
17	-.866	.184	.413
18	-.598	.492	-.098
19	-.474	.806	-.227
20	-.187	-.613	.267

Table 39

Stimulus Coordinates from Similarity Sort Frequency
Rotated Three Dimension KYST Solution

Stimulus	Dimension		
	1	2	3
1	.370	-.790	-.511
2	-.960	.366	-.201
3	.951	-.007	.470
4	.518	-.816	.030
5	.450	-.708	.665
6	-.803	.280	-.291
7	.753	-.507	-.822
8	.758	.424	-.400
9	-.803	.384	.448
10	.984	.378	.357
11	-.152	-.232	.554
12	.213	-.443	-1.094
13	.175	-.937	.216
14	-.802	.384	.448
15	-.556	.443	.306
16	.637	-.044	-.955
17	-.740	.441	.465
18	-.599	.779	-.083
19	-.807	.510	-.225
20	.411	.098	.680

Table 40

Stimulus Coordinates from 100% Substitutability
Group's Three Dimension INDSCAL Solution

Stimulus	Dimension		
	1	2	3
1	.265	.034	.216
2	-.298	.122	.177
3	.123	.160	.205
4	.273	-.106	.057
5	.240	.140	.131
6	-.257	-.003	-.201
7	.195	-.319	-.044
8	.128	-.370	-.258
9	-.259	.130	-.230
10	.179	-.241	-.252
11	.105	.192	-.209
12	.192	-.222	-.070
13	.286	.200	-.150
14	-.227	.000	-.225
15	-.236	-.049	-.188
16	.087	-.482	.648
17	-.253	.226	-.018
18	-.290	-.033	.165
19	-.284	.246	.128
20	.032	.375	.118

Table 41

Stimulus Coordinates from 100% Substitutability Group's
Rotated Three Dimension KYST Solution

Stimulus	Dimension		
	1	2	3
1	.663	-.179	.423
2	-.692	.614	-.395
3	.209	.070	.447
4	.687	-.589	.046
5	.490	-.459	.125
6	-.450	.798	-1.048
7	.983	-.083	.101
8	.118	-1.356	-.452
9	-1.008	.107	-.446
10	.869	.491	.264
11	-.001	-.164	-.288
12	1.031	.149	-.376
13	.771	-.273	-.398
14	-.930	-.109	-.218
15	-.783	.028	.371
16	.416	-.973	.888
17	-.975	-.097	.018
18	-.774	.484	.404
19	-.574	.902	-.020
20	-.008	.642	.553

Table 42

Stimulus Coordinates from 60% Substitutability Group's
Rotated Three Dimension KYST Solution

Stimulus	Dimension		
	1	2	3
1	.380	-.283	.858
2	-.480	.710	.002
3	.825	.641	-.031
4	.202	.296	1.060
5	.528	.217	.609
6	-.414	.913	.574
7	.438	-.450	.600
8	.693	-.477	-.934
9	-.381	.811	-.815
10	-.192	-1.224	.016
11	-.762	-.534	-.187
12	.879	-.101	-.298
13	.673	.304	.109
14	-.751	.105	-.495
15	-.868	-.104	.086
16	.499	-1.061	.049
17	-.673	-.159	-.636
18	-.003	.287	-.296
19	-.985	-.303	.502
20	.394	.413	-.773

Table 43

Stimulus Coordinates from Substitutability Sort
Log Three Dimension Rotated KYST Solution

Stimulus	Dimension		
	1	2	3
1	1.115	-.417	.175
2	-1.157	.032	.416
3	.721	.225	-.602
4	1.112	-.299	.533
5	.837	.370	.449
6	-1.031	.276	.631
7	.784	-.738	.156
8	.191	-.105	.557
9	-.705	.147	-.620
10	.593	-.244	-.485
11	.032	.518	.110
12	.428	-.870	-.038
13	.548	.552	.279
14	-.646	.255	-.604
15	-.730	.099	-.602
16	.034	-.682	.234
17	-.699	.222	-.585
18	-1.043	.305	.264
19	-1.160	-.009	.316
20	.775	.363	-.584

Table 44

Stimulus Coordinates from Substitutability Sort Frequency
Three Dimension Rotated KYST Solution

Stimulus	Dimension		
	1	2	3
1	1.041	-.451	.326
2	-1.137	-.253	-.232
3	.779	.587	.195
4	1.024	-.0682	.108
5	.912	.053	-.581
6	-1.030	-.467	-.539
7	.675	-.610	-.371
8	.333	-.610	-.371
9	-.610	.571	.131
10	.699	.164	.224
11	.058	.239	-.486
12	.373	-.300	.817
13	.574	.132	-.623
14	-.702	.594	.064
15	-.756	.572	.102
16	.082	-.595	.460
17	-.704	.599	-.002
18	-.977	-.071	-.484
19	-1.169	-.180	-.198
20	.531	.739	.580