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A MULTIVARIATE INVESTIGATION OF PREFERENCES[1]

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ABSTRACT

A new metric multidimensional scaling procedure is used to scale similarities evaluations and evaluations of the strength of preferences for nine common soft drinks for a group of subjects. The similarities data are then analyzed using a three-mode extension of the individual differences model for multidimensional scaling. The same style analysis is done on the preferences. The two analyses are related through interpretation in an attempt to gain insight into the psychological nature of preference.

INTRODUCTION

The concept of preference is of primary importance in psychology. It has had an implicit role in almost every psychological theory, but no major efforts have been directed toward the explication of preference as a psychological concept. "Why is one object preferred to another?" is a question which has remained unanswered, at least to the extent that the psychological nature of preference has remained subservient to the other purposes of investigators.

The origin of the scientific or quasi-scientific uses of preference is most often attributed to Jeremy Bentham (1789) and his pronouncements on the principle of seeking to maximize utility. The intermingling of preference and utility theory continued in the works of Pareto (1906) on ordinal utility functions, and Wold and Jureen (1953) and Uzawa (1960) on commodity bundle analysis. All these algebraic choice type of theories have a common basis in relation to preference. They assert preference as a basically unknowable black box process and axiomatize its function. The basic axioms of commodity bundle analysis serve well to illustrate the process. In Luce and Suppes (1965) is the following preliminary material on commodity bundle analysis:

> Definition 1. A relation R on a set of all commodity bundles (n-dimensional vectors) is a preference relation if the following axioms are satisfied for any bundles x, y, and z.
> 1. Transitivity: if $x\ R\ y$ and $y\ R\ z$ then $x\ R\ z$.
> 2. Connectivity: $x\ R\ y$ or $y\ R\ x$.
> 3. Nonsatiety: if $x > y$ then $x\ P\ y$.
> 4. Continuity: if $x\ R\ y$ and $y\ R\ z$ then there is a real number μ such that $0 \leq \mu \leq 1$ and $(\mu x + (1 - \mu z))\ I\ y$.

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Here $x\ P\ y$ stands for x is preferred to y; $x\ I\ y$ stands for the equivalence or indifference of x and y; and $x\ R\ y$ stands for the relation that x is preferred or indifferent to y.

The axiom of transitivity is basic to this type of analysis. For example, Guthrie, Becker and Siegel (1961) report eliminating of 15 of the 92 subjects from their study of political preferences due to intransitivities in their responses. But this is symptomatic of treating preference as an unknowable black box process. The psychological nature of preference cannot be viewed in isolation from an interaction with people. Preference is a psychological concept because of this interaction. It may well be that individual differences in preference, in relation to certain domains, are related partially to intransitivities in responding. The point is not to aggrandize intransitivities in response, but to emphasize that preference as a concept exists in isolation from the transitivity or intransitivity. The axiom of transitivity as a requisite for the existence of preference seems to be a carry-over from a strictly normative approach to psychological investigation.

The axiom of connectivity is non-controversial. But the axiom of nonsatiety enjoys a much different status. The work of MacCrimmon and Toda (1969) on the experimental determination of indifference curves, shows that this axiom is inapplicable, even from the economist's point of view. According to this axiom, since commodities are desirable in any amount, then in order to get more of a commodity a subject should be willing to give up some amount of another commodity. This should lead to negatively sloping indifference curves. In part of their study, MacCrimmon and Toda allowed their subjects to establish well defined preferences of the domain of outcomes. They made payoffs contingent on each subject's indifference curve to insure that real preferences were reported. The commodities were money and French pastries. The female subjects showed indifference curves which were positively sloping from the beginning. This indicates that you had to offer them money in order for them to eat even part of a pastry—a definite violation of the nonsatiety axiom. The male subjects had indifference curves which were negatively sloping for small amounts of pastries, but became positively sloping for more pastries. Some economists attempt to deal with these inconsistencies by asserting that in such cases the commodities are not economic goods, but rather economic bads. This would mean that for the male subjects a little pastry is an economic good, but a lot of

pastry is an economic bad. Either this is an explicit violation of the nonsatiety axiom, or the economist's argument is completely circular.

The continuity axiom, like the transitivity axiom, seems to be a carry-over from strictly normative approaches to psychological theory. As long as the numerical range of μ includes zero and one, it is reasonable to assume that most people in most preference domains exhibit preference relations which are consistent with the requirements of this axiom. The problem with this axiom is that it asserts that indifference, as a concept, must exist whenever preference exists. Certainly these two concepts have interrelations. It is, however, psychologically unrealistic to assert that in order to have preferences you must have indifferences. A traditional example of preference without indifference centers on a lexicographical ordering of commodities (cf. Luce & Suppes, 1965, p. 261). When such an ordering is established, there are definite preferences but no indifferences. This example is usually cited to show that utility functions cannot, in general, be established without the assumption of continuity. Its function here is two-fold. First, since preferences can sometimes be manifested in a lexicographical ordering, this axiom is not a necessary condition for the existence of preference. Second, since utility functions cannot be established for complete lexicographical orderings of commodities, preference and utility are not synonomous. It would be worthwhile to investigate the interrelations of preferences and indifferences as part of the development of a theory of preference, but the assertion of the necessity of mutual existence is, at least, a disservice to the process of theory development.

The probabilistic or stochastic theories of preference, utility, and choice have, for the most part, done away with the undesirable axioms underlying the algebraic theories. But the probabilistic approaches have not offered insight into why certain objects are preferred to others. This was, however, not their purpose. Nor was it the purpose of the algebraic choice type of theories. The argument is not that these theories have failed, but rather that there is an important domain which they have left uninvestigated—the domain of preference as a psychological concept.

Preference should not be operationally defined. The requirements that such a definition be complete, context-free, and stipulative are far too restrictive and unrealistic to properly handle such a broad concept. Nor can Bergmann's (1951) "chains of meaning" provide much insight into the meaning of preference.

Bergmann's approach results in a closed meaning; whereas the concept of preference is open, and its meaning is modified or expanded as more information about it is gained. The most viable approach to the understanding of the nature of preference is most likely through construct validation (Cronbach & Meehl, 1955), in which the relation of this concept to other concepts is explicated.

Preference and Similarity

In the area of paired preference evaluation, one of the concepts which should be closely related to preference is the concept of similarity. It seems reasonable that when you are asked to evaluate the similarity of pairs of stimulus-objects that the evaluation is made in terms of some set of characteristics you consider relevant to the groups of stimulus-objects under consideration. If you were then asked which object you preferred in each pair, it would seem extremely unusual to make these judgments in terms of characteristics which you did not consider relevant to the evaluation of similarity. Each of the characteristics might very well have different importance in the determination of preference than it did in the evaluation of similarity, but the same basic set of characteristics should be used. This does not necessarily mean that the multidimensional space in which the preference relation could be displayed is a subspace of the multidimensional space of similarities. But it does indicate that there should be investigable relations between the two spaces. This position has recently received some empirical support in a study by Green and Carmone (1969). In investigating the relations among several nonmetric multidimensional scaling procedures, they found that the multidimensional space of similarities obtained from Kruskal's (1964 a, b) nonmetric scaling was related to the multidimensional preference space obtained by unfolding procedures (Coombs, 1964; Carroll & Chang, 1967). The relations involved differential shrinking and stretching of the similarity dimensions and rotation, but the same basic dimensions seemed to appear in both analyses.

This research is designed to delineate more explicitly the relations between the concepts of similarity and preference.

Method and Result

The domain of soft drink preferences can provide a beginning to the study of the relations between similarity evaluations and preferences. They are familiar to most domestic subjects; so that even if a subject has not tasted a particular soft drink he most likely has some opinion regarding it. Further, the physiology of

taste will have a role in determining preferences and similarities, but this role should not be completely dominant. Psychological factors could enter strongly into the determination of preferences and similarities.

The stimuli chosen for this investigation are nine common soft drinks: (1) Coca Cola; (2) Pepsi Cola; (3) Seven Up; (4) Squirt; (5) Like; (6) Fresca; (7) Diet Rite Cola; (8) Tab; (9) Mountain Dew. These stimuli are readily amenable to pairwise judgments of both similarity and preference. They incorporate obvious dimensions of difference, such as: cola-noncola, dietetic-nondietetic, and traditional-novel. They also have potential for differences in terms of less obvious dimensions.

Since pairwise evaluations of both preferences and similarities were to be collected, the order of presentation of these tasks was a matter of concern. Pretesting revealed that when preferences were collected first, a response set was established and the similarity evaluations were strongly biased. It was decided, therefore, to have the subjects evaluate the pairwise similarities first, without the knowledge that they would subsequently evaluate preferences. The idea of counterbalancing was rejected since this would entail bias for half of the subjects. Also, counterbalancing always has the effect of running part of the subject group in a different experiment from another part. This would unbeneficially complicate the analysis, making comparisons extremely difficult, if not impossible.

Ss were 70 beginning graduate students in business administration at the University of California, Los Angeles. They were told that they were participating in a study of the perceived similarity among common soft drinks. Their first task was to evaluate how familiar they were with the soft drinks on a scale from 0 (extremely unfamiliar) to 9 (extremely familiar). This task served to acquaint *Ss* with the stimuli they would later evaluate and to help screen out any subjects who were familiar with none of the soft drinks. There were 14 foreign nationals who were excluded from the analysis on the bases of extreme unfamiliarity with the stimuli and incomplete responding. Four additional *Ss* were excluded because of incomplete responding. Thus, 52 *Ss* adequately completed all tasks and were included in the analysis.

Ss were next presented all possible distinct pairs of the nine soft drinks. Both the order of presentation and the position of the soft drink in each pair were randomized. Each *S* received the same random ordering as the other *Ss*. They were instructed to evaluate the similarity of the soft drinks in each pair on a scale

from 0 (extremely similar) to 9 (extremely dissimilar). After these questionnaires were completed and collected, they received another questionnaire. On this one the same 36 distinct pairs of soft drinks appeared in the same order. *Ss* were asked to circle the soft drink in each pair which they most preferred and indicate the strength of their preference on a scale from 0 (very weak preference) to 9 (very strong preference).

Separate, though identical, analyses were performed on the similarities evaluations and the preferences evaluations. First, a metric multidimensional scaling (Cooper, 1970, 1972) was performed on the data for each subject. The appropriate number of dimensions in each multidimensional space was selected subject by subject. Although the resulting configurations were retained for interpretive purposes, the important components for the subsequent analyses are merely the additive constants. These are used to convert each *S*'s original comparative interpoint distances into absolute interpoint distances, which are, in turn, converted into scalar products according to the formula given by Torgerson (1958, p. 258). Scalar products could have been calculated from the stimulus configurations for each *S*. But scalar products calculated from the original data and the additive constants contain variability which may be meaningful and common over *Ss*. Such variability might well have been lost if the scalar products had been computed from a stimulus configuration of reduced dimensionality.

By entering subsequent individual differences analyses with scalar products computed by the procedure advocated here, one maintains the clearest possible relations between the original data and the final solution (cf. Cooper, 1970, 1972; Tucker, 1972). Consequently, these scalar products were used as input to a three-mode, factor analytic extension of the individual differences model for multidimensional scaling (Tucker, 1972). The analysis yields basically four results: (1) a common scaling space which provides an amalgam representation of the perceived interrelations among the stimuli; (2) a person space which represents the distribution of individual differences in perception; (3) parameters which show the extent to which differential shrinking and stretching of the dimensions of the common scaling space is necessary to represent the perceptions of each individual; and (4) parameters which show the degree to which the axes of the common scaling space must be correlated in order to represent the perceptions of each individual.

It was difficult to judge, using analytical procedures, whether or not two dimensions were sufficient to represent the common scaling space for the similarities data. It was therefore decided to use the criterion of interpretability to choose between a two and three dimensional common scaling space. For this purpose the first three dimensions for the similarities data were plotted pairwise and appear in Figures 1, 2 and 3.

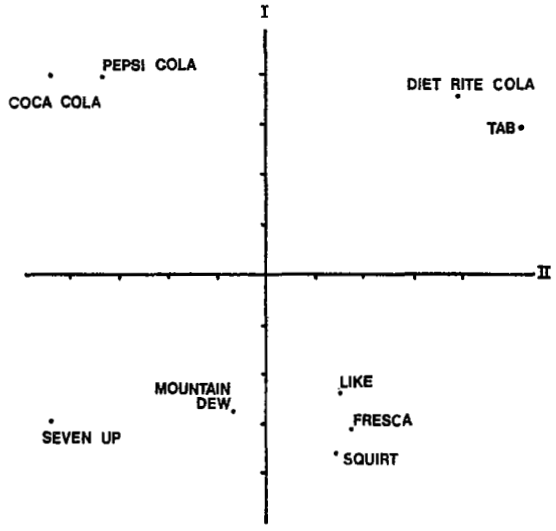

Fig. 1. The common scaling space—Dimensions I and II. Similarities analysis.

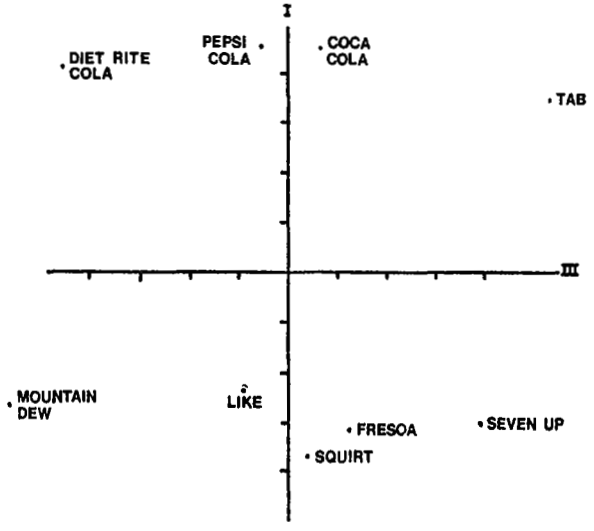

Fig. 2. The common scaling space—Dimensions I and III. Similarities analysis.

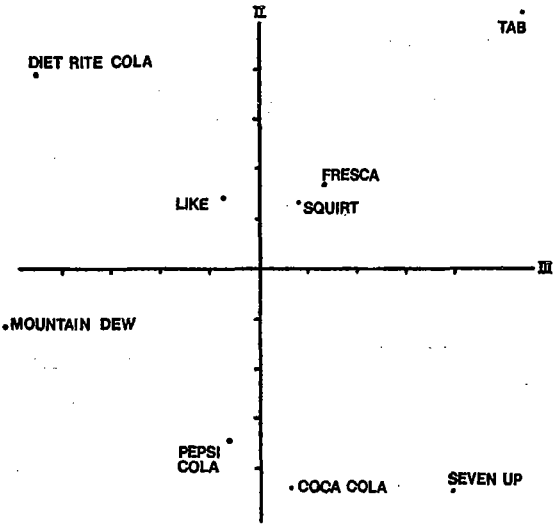

Fig. 3. The common scaling space—Dimensions II and III. Similarities analysis.

Interpretation of the first and the second dimension is relatively clear and straightforward. Quadrant I contains Diet Rite Cola and Tab, both dietetic colas, in relatively close proximity to one another. Quadrant II contains Coca Cola and Pepsi Cola, both nondietetic colas, in close association. Quadrant III contains two nondietetic-noncolas, Seven Up and Mountain Dew, separated by some distance, as might well be expected. Quadrant IV, with the exception of Squirt, contains the dietetic-noncolas, Like and Fresca. Squirt, which is nondietetic, most likely appears in this quadrant due to its close association with Fresca. In addition to splitting the soft drinks into groups, these dimensions also indicate extent or degree. That is, Coca Cola and Pepsi Cola are perceived as having approximately the same degree of colaness, with a slight edge going to Coca Cola, and Coca Cola is perceived as being more purely a nondietetic cola, further away from the dietetic colas, than is Pepsi Cola. Tab is viewed as being both somewhat less of a cola than Diet Rite Cola, and somewhat more dietetic. Diet Rite Cola is somewhat closer to both Pepsi Cola and Coca Cola in both these aspects. Seven Up is viewed as being approximately as nondietetic as Coca Cola, but also is somewhat less of a pure noncola than Coca Cola is a pure cola. Like, Fresca, and Squirt are viewed as being less purely dietetic than the dietetic colas. Squirt is even more noncola-like than Seven Up. Fresca is on

about the same level as Seven Up, and Like slightly more neutral. Mountain Dew is somewhat neutral on the dietetic dimension and is perceived as a less extreme noncola than are Seven Up, Squirt, or Fresca. Mountain Dew was the least familiar of all the soft drinks, and its position might well be unstable.

The third dimension has no clear interpretation. In relation to both the first and second dimensions, it placed Tab, Diet Rite Cola, Mountain Dew, and Seven Up at the corners of the four quadrants, respectively. The five other soft drinks do not project strongly on the third dimension. This dimension seems to add no new information which is interpretable, nor is any rotation envisioned which would increase the interpretability of this dimension, especially one which would not destroy the relatively clear interpretation of the first two dimensions. Therefore two dimensions, accounting for 71.25% of the variation, were retained to represent the common scaling space for the similarities data.

Because this analysis is based on three-mode factor analysis, there is no requirement that the person space be of the same dimensionality as the common scaling space. However, there were clear indications that a two-dimensional person space, accounting for 78.13% of the variation, was appropriate to represent the individual differences in the similarities data. This is plotted in Figure 4.

At first, small, tightly clustered groups of individuals were sought and identified, but patternistic relations became apparent among *S*s from various clusters. It was discovered that, when using this individual differences analysis, homogeneous groupings of individuals do not occur in circular or quasi-circular clusters of individuals. Rather, homogeneity occurs in thin, pie-slice-shaped spokes from the origin of the space to the extremes. This can be more readily understood by briefly considering what differences could be allowed in the scaling spaces of two individuals if they are still to be considered members of a homogeneous group.

First, the degree to which the axes of the common scaling space must be correlated to approximate the individual scaling spaces must be about the same for each individual. Second, the relative importance of each dimension in the common scaling space (i.e., differential shrinking and stretching) must be approximately the same. That is, in the two dimensional case, the ratio of the weights for the dimensions must be the same. Thus, the only substantial differences which can be tolerated within a homogeneous

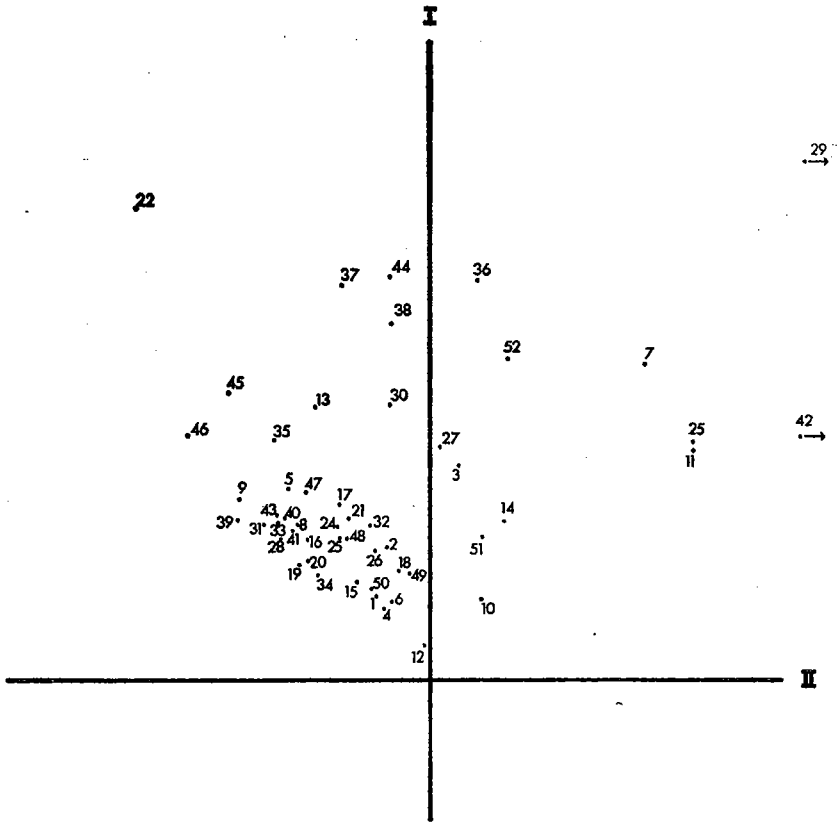

Fig. 4. The person space. Similarities analysis.

group are differences in the absolute magnitude of weights given to each dimension of the common scaling space—the ratio of these weights must remain approximately constant.

Table 1 lists for each individual the correlation between axes, listed as cosines; the weights assigned to the axes; and the ratio of the weights. *S*s are roughly grouped into homogeneous units on the basis of these measures. By refering back to the illustration of the person space for the similarities data (Figure 4), it can be noted that two individuals with identical cosines and weight ratios fall on lines extending from the origin of the person space. Thus homogeneity is represented linearly when using this individual differences model for multidimensional scaling, rather than circularly as is the case for other clustering methods. The differences between two people on a line from the origin is not in terms of the perceptual interrelations they see in the stimuli, but merely in the polarity of the original responses.

Table 1
Cosines, Weights, and Weight Ratios.
Similarities Analysis.

Subject no.	Cos	D_1	D_2	$\frac{D_2}{D_1}$	Subject no.	Cos	D_1	D_2	$\frac{D_2}{D_1}$
I					III				
34	.17	9.4	3.3	.35	12	.05	4.9	2.4	.49
19	.19	9.9	3.3	.33	18	.04	9.1	4.5	.49
20	.17	10.0	3.5	.35	49	.03	9.2	4.7	.51
16	.15	10.4	3.9	.38	26	.06	9.9	4.6	.46
28	.18	10.7	3.7	.35	2	.04	9.9	4.8	.50
41	.16	10.4	3.8	.37	32	.05	10.8	5.1	.47
8	.14	11.1	4.2	.38	21	.07	11.6	5.2	.45
33	.16	11.2	4.0	.36	17	.07	12.1	5.5	.45
40	.12	11.9	4.8	.40	13	.06	14.7	6.9	.47
43	.15	11.5	4.3	.37	30	.02	14.4	7.5	.52
31	.19	11.7	3.9	.33	38	.02	16.4	8.6	.52
39	.19	12.0	4.0	.33	37	.03	17.4	8.8	.51
9	.16	12.6	4.5	.36	44	.01	17.5	9.2	.53
46	.14	14.9	5.6	.38					
					IV				
II					3	−.01	12.4	7.1	.57
4	.10	7.5	3.2	.43	27	−.00	12.9	7.0	.54
6	.07	7.7	3.5	.45	52	−.02	15.4	9.0	.58
1	.10	8.1	3.5	.43	36	−.01	17.0	9.6	.56
50	.09	8.8	3.8	.43					
15	.12	8.9	3.6	.42	51	−.04	10.0	6.1	.61
48	.09	10.6	4.6	.43					
23	.11	10.5	4.3	.41	V				
24	.10	11.3	4.8	.42	10	−.07	7.4	4.8	.65
5	.09	12.4	5.3	.43	14	−.05	10.7	6.6	.62
47	.09	12.4	5.3	.43	7	−.07	14.3	9.4	.66
35	.11	12.9	5.3	.41					
45	.10	14.9	5.6	.38	VI				
22	.09	19.3	8.4	.44	11	−.12	11.9	8.8	.74
					25	−.11	12.0	8.8	.73
					29	−.12	17.9	13.3	.74
					42	−.53	7.4	12.8	1.73

Further, if we can imagine a line from the origin rotating clockwise from the nine o'clock position to the three o'clock position, we can note a very regular change in both the cosines and the weight ratios associated with people located in various positions in the person space. The first *S* encountered is number 39. For the person space of similarities, this *S* has a cosine of approximately .19, which corresponds to an angle of about 79° between the dimensions of the common scaling space. The cosines decrease as the clockwise rotation continues, but are positive until reaching *S* 27, just to the right of the first axis. This *S* has a very small negative cosine. The cosines become increasingly negative as the spanning continues. The most extreme negative cosine for

the person space of similarities is associated with *S* 42, who could not be adequately plotted on the scale of this figure. For this *S* the dimensions of the common scaling space are utilized as if there were approximately one third as much weight on the second dimension as on the first. *S* 27 places somewhat more than half as much emphasis on the second dimension as he does on the first. And *S* 42 places 1.73 times more emphasis on the second than on the first.

Although Tucker (1972) indicates that different positions in the person space are associated with both changes in the weights given to the dimensions of the common scaling space and changes in the angles between dimensions in this space, it was not expected that the changes would be so regular. Although no attempt is made here to prove the assertion, it is plausible that the person space representation of higher dimensionality, using this particular model of three-mode factor analysis, might almost always have two dimensions which correspond to those encountered in these data. If this were the case, it might substantially aid the interpretation of the person space.

Six homogeneous clusters of individuals were subjectively identified using this interpretation of the person space for similarities. The only substantial within-cluster differences were in the scalar factor. The clusters are listed according to their clockwise appearance starting at the nine o'clock position. Within clusters, the *S*s are listed from the one closest to the origin to the one most extreme. Note that within clusters all cosines are approximately the same, differing from cluster to cluster; and the weight ratios are approximately equal, differing from cluster to cluster. As the clusters progress clockwise, the cosines decrease and the weight ratios increase.

The first cluster of *S*s perceived the dimensions of the common scaling space as if they were about 80° apart and give the first dimension just under three times as much weight as they do the second dimension. This leads to a perceptual relation in which cola vs. noncola is of major importance in determining similarities. The dietetic and nondietetic soft drinks are relatively much closer together, seen as much more similar relative to the total dispersion than in the common scaling space. Cluster II seems to represent a point of view in which the dietetic vs. nondietetic dimension gains a little in importance over the weight given to it by the *S*s in the first cluster. Cola vs. noncola is still the major distinguishing component of the similarities perceptions. Members

of Cluster III perceive the dimensions almost orthogonally. The weight ratios indicate still further decrease in the dominance of the cola vs. noncola dimension. These first three clusters represent the vast majority of the *S*s, nearly 77%. Clusters IV, V, and VI represent much more minor points of view. The *S*s in Cluster IV perceive the dimensions as if they were more than 90° apart. They also continue to decrease the weight dominance of the cola vs. noncola dimension. This trend is continued in Clusters V and VI.

One great advantage to this type of clustering description is its ability to place into clusters those *S*s who would normally be considered outliers. Only two of the *S*s did not fall into clusters in the person space of similarities. *S* 51 really represents a transition from Cluster IV to Cluster V. Further, his position is not really extreme. It just happens to fall in between two clusters and would mildly distort the within-cluster homogeneity if included in either cluster. *S* 42 was so extreme that he could not be adequately plotted in the person space. Yet his utilization of the common scaling space can be viewed as a natural extention of the progression from cluster to cluster. He perceives the dimensions of the common scaling space as if they are about 122° apart and puts much more emphasis on the dietetic vs. nondietetic dimension than anyone else.

The data from the evaluations of pairwise preference were analyzed in a similar manner. The strength of preference evaluations data were used in this stage of the analysis, just as in the multidimensional scaling stage. As was the case in the similarities analysis, the three-dimensional solution was not directly interpretable. Addition of a fourth dimension did not increase the interpretability, so that a two-dimensional solution was chosen to represent the common scaling space for preferences.

Inspection of the original common scaling space indicates that a small orthogonal rotation could be developed which would lead to a more reasonable quadrant alignment for the soft drinks. An orthonormal rotation was developed which moved Squirt into the same quadrant as Seven Up without causing major changes in the interpretation of the common scaling space. The transformed common scaling space for preferences is plotted in Figure 5. Here the first dimension splits the dietetic soft drinks from the nondietetic soft drinks, with the exception of Mountain Dew, whose position is relatively unstable. The second dimension splits the colas from the noncolas. Within each quadrant, increasing preference seems to run in general according to the absolute value of the

stimulus projection on the first dimension. The preference relations among elements positive on the first dimension and others which are negative on this dimension are difficult to assess in isolation from the utilization of the space by individual.

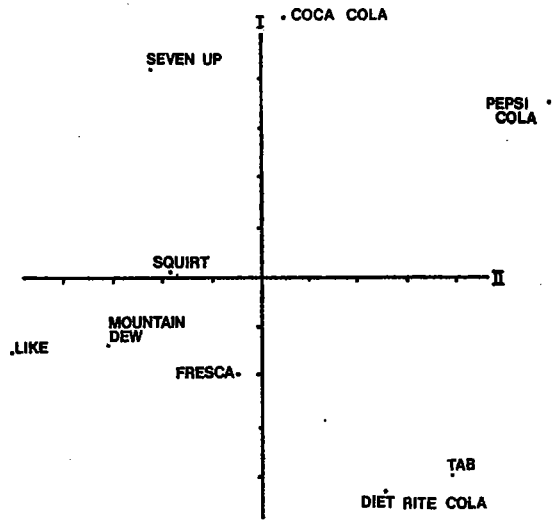

Fig. 5. The transformed common scaling space. Preferences analysis.

There is a very clear two-dimensional solution for the person space for preferences, which accounts for 68.95% of the variation. Figure 6 represents a plot of the person space for the preferences data. Again homogeneous groups of individuals were formed according to spokes from the origin of the person space. Table 2 lists for each individual the correlation between axes; listed as cosines, the weights assigned to the axes; and the ratio of the weights for the person space of preferences. There were seven dominant clusters, three doublets of *S*s who represent transitions from one cluster to another, and three unclustered individuals who fit the pattern of the person space but do not belong to any established cluster. *S* 21 appears at the ten o'clock position in the person space. He perceives the dimensions of the common scaling space as if they were almost 45° apart. He also places somewhat less than three times as much emphasis on the first dimension as he does on the second dimension. This has the effect of pulling Seven Up, Coca Cola, and Pepsi Cola relatively closer together, and separating them from the other soft drinks by quite a dis-

Table 2
Cosines, Weights, and Weight Ratios.
Preferences Analysis.

Subject no.	Cos	D_1	D_2	$\frac{D_2}{D_1}$	Subject no.	Cos	D_1	D_2	$\frac{D_2}{D_1}$
21	.71	8.6	3.1	.36	37	.24	5.6	3.9	.70
34	.51	11.5	5.2	.45	IV				
23	.52	11.4	5.1	.45	45	.19	5.7	4.4	.77
					1	.20	6.5	4.9	.75
I					19	.21	7.1	5.1	.72
36	.40	5.0	2.7	.54	50	.19	8.8	6.7	.76
35	.35	7.6	4.4	.58	46	.20	9.8	7.4	.76
40	.49	8.1	4.4	.54					
30	.35	8.2	4.8	.59	33	.17	12.2	9.7	.80
8	.43	9.0	4.6	.51	5	.16	17.9	14.4	.80
49	.38	9.5	5.3	.56					
48	.41	11.3	6.0	.53	V				
14	.37	11.1	6.3	.57	27	.13	5.3	4.5	.85
16	.33	11.7	7.0	.60	39	.13	5.7	4.8	.84
47	.40	13.5	7.2	.53	12	.12	8.3	7.1	.86
17	.41	14.6	7.7	.53	22	.14	12.2	10.2	.84
13	.34	9.3	5.4	.58	VI				
3	.34	12.2	7.1	.58	32	.08	3.0	2.8	.93
					2	.09	3.4	3.1	.91
II					15	.09	9.3	8.5	.91
11	.31	8.4	.2	.62	25	.10	12.0	10.9	.91
41	.29	9.9	6.3	.64					
24	.30	10.2	6.4	.63	VII				
43	.31	11.8	7.2	.61	42	.03	5.1	5.2	1.02
4	.31	12.3	7.6	.62	6	.07	5.7	5.5	.97
38	.30	21.1	13.2	.63	28	.08	5.8	5.5	.95
					10	.03	5.7	5.9	1.09
III					18	.05	9.1	9.2	1.01
20	.25	8.5	5.8	.69	31	.04	11.1	11.3	1.02
9	.24	8.9	6.2	.70					
26	.23	9.1	6.5	.71	29	−.52	6.5	17.4	2.68
52	.23	10.6	7.5	.71					
44	.23	11.5	7.9	.69					
7	.26	14.4	9.7	.67					
51	.26	14.9	10.1	.68					

tance. He seems to represent the extreme of a trend to emphasize preference of the three traditional leaders among soft drinks. The first cluster is a more moderate version of this trend. These *S*s predominantly emphasize the three leaders, but the other soft drinks are more differentiable and minor preferences among them do have a notable effect. The trend toward decreased cosines and increased weight ratios continues in Clusters III, IV, V and VI. The *S*s in Cluster VII use the transformed common scaling space almost as it appears in Figure 5. There is, of course, a rescaling

from subject to subject to indicate the overall strength or polarity of the original responses. *S* 29 is the only individual who perceives the dimensions to be more than 90° apart. He also weights the second dimension much more heavily than the first, so that Seven Up and to a lesser extent Squirt are pushed away from Coca Cola and Pepsi Cola; and the dietetic noncolas are also pushed away from the dietetic colas. This indicates preferences running along the dimension of cola vs. noncola.

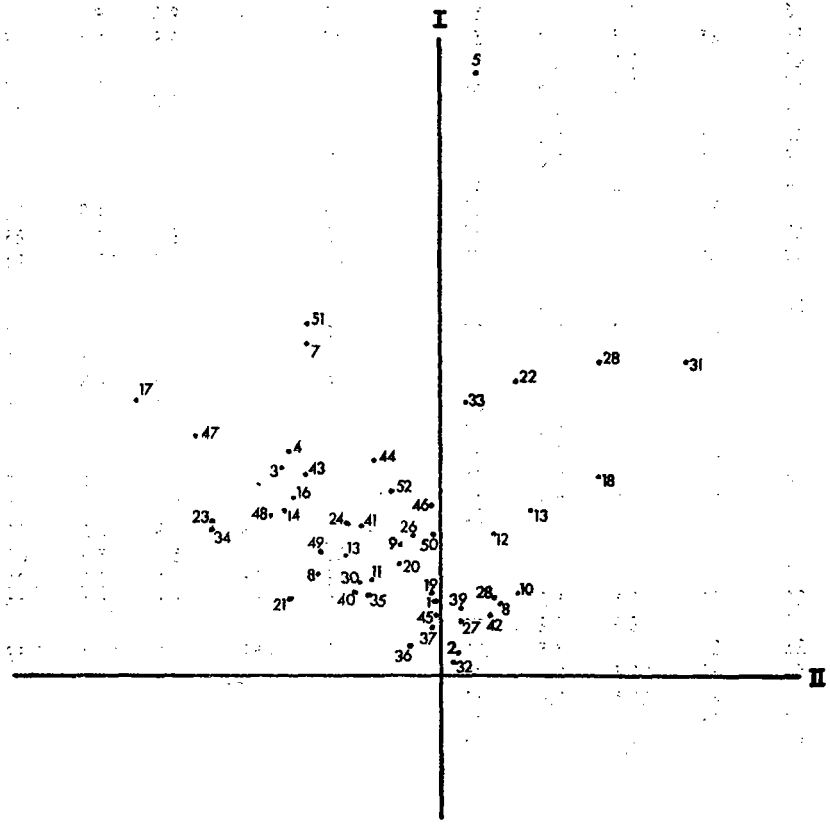

Fig. 6. The person space. Preference analysis.

DISCUSSION

The interrelations between the similarities analysis and the preferences analysis are of considerable interest and importance. Only one *S*, 42, views similarities and preferences in approximately the same manner. For him the dimensions of the common scaling space for similarities are separated by substantially more than

90°. This has the effect of drawing Coca Cola and Pepsi Cola closer to Seven Up, and drawing Tab and Diet Rite Cola closer to Like, Fresca and Squirt. These two clusters of soft drinks are then separated from one another by increased weight on the second dimension. The resulting pattern of similarities is relatively similar to the transformed common scaling space for preferences. He perceives the preference space almost as appears in Figure 5, except for scaling. All the other *Ss* used the spaces differently.

The overall relations seem to be that the dimensions of the similarities space are perceived as if they were less correlated than those of the preferences space. Also, the differential weighting emphasized the cola vs. noncola dimension in similarity much more than the dietetic vs. nondietetic; whereas differential weighting in the preferences space tended to draw out the three leading soft drinks. The preferences dimensions were perceived as if they were more correlated than the similarities dimensions, which augmented the trend established by differential weighting. In general, however, the differential weighting was less extreme in the perferences space than in the similarities space. Going from the lower numbered clusters in the person space for similarities to the higher numbered clusters, the trend toward differential weighting had less and less effect. Going from lower numbered clusters in the preferences person space to higher numbered clusters, the trend toward separating Seven Up, Coca Cola, and Pepsi Cola from the others is de-emphasized, although it is still apparent even in those *Ss* who perceived the dimensions of the common scaling space for preferences as they appear in Figure 5.

It seems that the evaluations of preferences are highly influenced by the high popularity of three soft drinks. The similarities are less influenced by specific soft drinks than by soft drink classes. It is almost as if the similarities evaluations are performed more objectively or impersonally along obvious dimensions. The preferences evaluations, on the other hand, tend to de-emphasize, to a certain extent, the dimensions of the similarities space in favor of grouping the most popular drinks with one another and the least popular drinks with one another.

One of the relations which could not be established by the analysis was the extent to which generally conceived preferences influence the personal preference evaluations. The sample of *Ss*, being predominantly male and mid-twenties in age, was too homogeneous to really establish this. If the preferences were predominantly personal, rather than evaluated stereotypically, a more

heterogeneous sample should have *S*s in it with more negative cosines, and, in general, more spread in their weight ratios. Also, higher than two-dimensional person spaces for preferences might indicate more specific and personalized preferences. Common scaling spaces for preferences of greater dimensionality, as may have been appropriate for these data, would probably increase the chances that preferences were more personalized than stereotypic.

The dimensions of similarity in soft drinks seem to be clearly related to the basic characteristic of cola, noncola, dietetic, and nondietetic. The dimensions of preference for soft drinks also utilize these characteristics. But the assertion that in general the characteristics used in the evaluation of preferences will be a subset of the characteristics used in the evaluation of similarity is most likely incorrect. There is too great a chance that stimulus-specific factors will influence preferences.

The differences between the common scaling spaces for preferences and similarities raise some interesting speculations concerning some of the logical foundations of multidimensional unfolding (Bennett & Hays, 1960; Hays & Bennett, 1961; Coombs, 1964). As originally formulated, it was required that *S*s substantially agree on the structure of the multidimensional space and only disagree on their preferences for objects in the space, although some latitude existed due to the nonmetric nature of the original formulation. It would seem that the kind of agreement which is in line with the unfolding model exists in the common scaling space of similarities, but not in the preferences space. So there is the possibility that it is preferable to attempt to imbed ideal preference points in a space of similarities rather than a space of preferences. This is in line with the procedures proposed by Carroll and Chang (1967). However, Schönemann (1970), in his discussion of his metric multidimensional unfolding model, points out that the Carroll and Chang procedure is not in line with the spirit of the original unfolding model.

The type of analysis used here for describing individual differences seems both appropriate and powerful. It is possibly too powerful to be used in this type of application without additional guideposts for interpretation. The interpretation of common scaling spaces would be greatly aided, especially ones of higher dimensionality, if adjectival descriptions of properties of the stimuli (e.g., soft drinks in this example) had been evaluated along with the stimuli themselves. If adjective descriptions such as light, strong, lively, refreshing, etc., had been placed through the analy-

sis at various, subject-determined positions in the multidimensional space, the more subtle relations which may exist in these data would have probably been more obvious and interpretable.

If the adjective descriptions do make further relations apparent, a parallel investigation, in which the importance of cola, noncola, dietetic, nondietetic, and the adjective characteristics are directly assessed, would greatly aid the development of a theory of preference in this domain, and even more clearly specify the interrelations between similarities evaluations and preferences evaluation.

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