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AN EMPIRICAL COMPARISON OF SIMILARITY AND PREFERENCE JUDGMENTS IN A UNIDIMENSIONAL CONTEXT

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by

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BACKGROUND OF THIS PAPER

This article is based on research sponsored by the Bureau of Business Research. The findings of this research were presented at the 16th International Meeting of the Institute of Management Sciences, March 27th, 1969, New York City.

Introduction

Professor Coombs, of the University of Michigan, suggests in A Theory of Data that a person can make two types of judgments about stimuli.[1/] A person may respond to a stimulus with reference to another stimulus (product A is very similar to product B) or with reference to himself (I prefer product A over product B). These two judgments are called similarity and preference judgments respectively. Algorithms for the analysis of preference and similarity judgments have been developed by Professor Coombs and are presented in A Theory of Data. These algorithms involve ordinal input data and result in output that is at least a partially ordered metric scale.

The purpose of this paper is twofold: (1) to illustrate the application of Coombsian methodology to the analysis of preference and similarity judgments in a one-dimensional situation, and (2) to present the findings of this analysis.

The Coombsian algorithm for the analysis of preference data is called unfolding theory. This technique is the basic tool used in constructing a preference distribution on the basis of product attributes.

Coombs' unfolding theory states that buyers and products can be characterized as points in a "psychological space" of one or more dimensions. For example, assume that only one dimension exists in a market for candy bars, and that it varies from a low to high concentration of sugar. Each candy bar in the market can be visualized as a point somewhere on this sugar dimension. Each buyer can also be visualized as

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[1/] Clyde H. Coombs, A Theory of Data (New York: John Wiley & Sons, Inc., 1964).

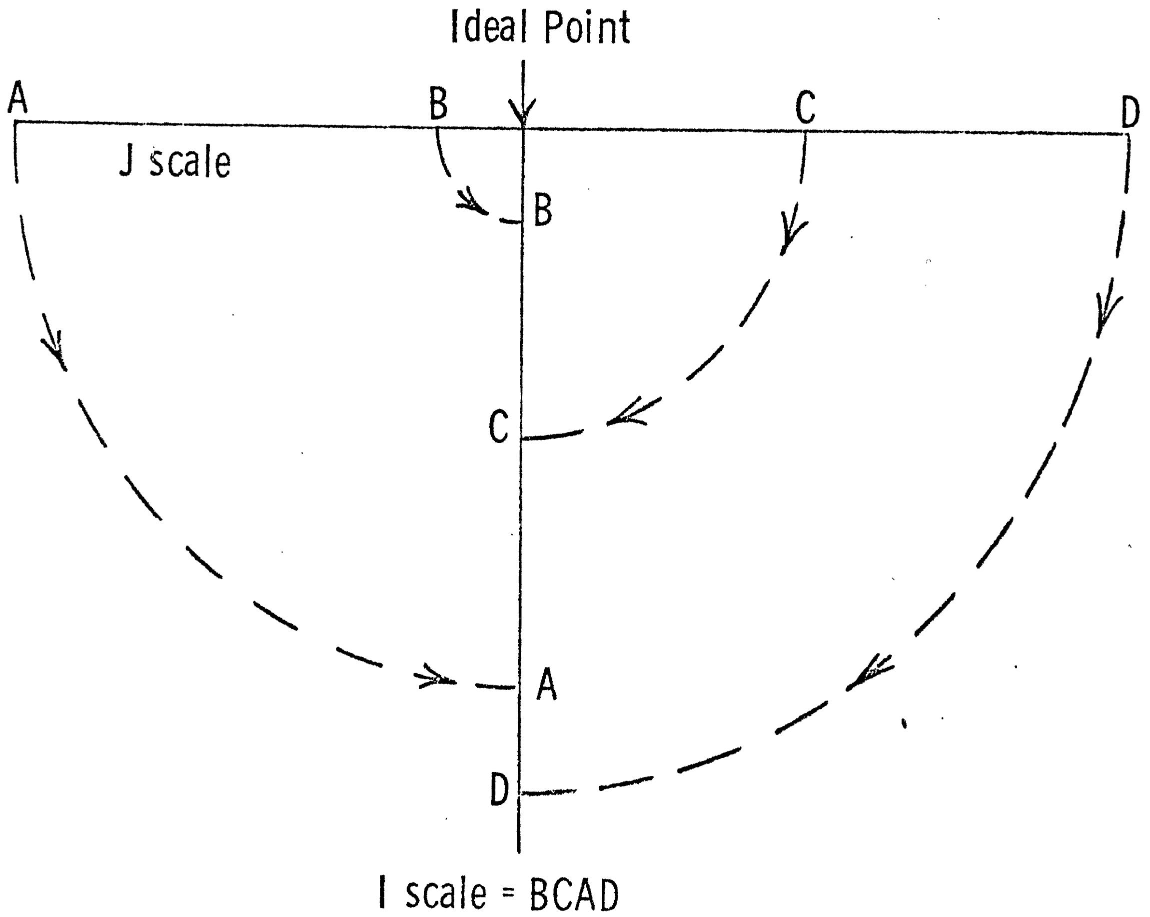
a point on the dimension. A buyer's location on the dimension is referred to as his "ideal" point. This ideal point represents the sugar concentration which the buyer prefers over all other sugar concentrations on the dimension. Consequently, some candy bars are closer to a buyer's ideal point than other candy bars.

Since buyer's tastes are usually heterogeneous, it would be expected that the ideal points for a group of buyers would be found at various locations on the dimension. This implies that there is a distribution of ideal points on the dimension. Thus, for a certain segment of buyers, a candy bar containing a low concentration of sugar might be closest to the ideal point for the segment as a whole, while for another group of buyers, a candy bar with a high concentration might be closest to the ideal points contained in the segment. This leads to the proposition that each buyer's preference ordering of products reflects how near the product points are to his ideal point.

Figure 1 presents a one-dimensional diagram illustrating the main aspects of the unfolding technique. This example can be considered a graphic picture of the decision process for the single buyer. Unfolding theory was developed to explain the preference behavior of each buyer separately.

In Figure 1, four candy bars (A,B,C, and D) are arrayed on the sugar dimension from low to high concentration. In addition to the stimuli points (candy bars), a single buyer's ideal point (ideal candy bar) is located just to the right of candy bar B. The sugar dimension is referred to as a joint scale or J scale, in that both stimuli and people (ideal points) are jointly represented on a common attribute or dimension. According to Coombsian propositions, a buyer's order of preference from

Figure I
COOMBSIAN UNFOLDING
THEORY



most to least corresponds to the rank order of the absolute distance of the stimuli points from the ideal point, the nearest being the most preferred. The unfolding technique was developed to determine geometrically the rank order of the absolute distance of the stimuli points to the ideal point. This is diagrammed in Figure 1 as a perpendicular line to the J scale at the ideal point. This perpendicular might be conceptualized as the J scale folded at the ideal point so that the products are now arrayed in a rank order representing their absolute distance from the ideal point. This rank order is called the buyer's I scale and is the preference ordering he would be expected to yield, i.e. BCAD.

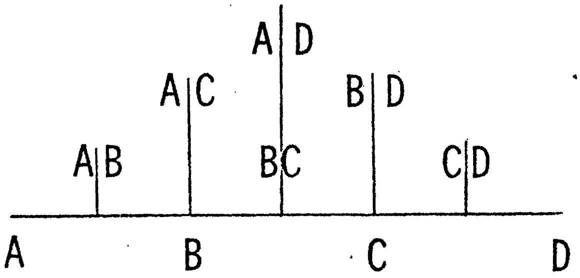
The preference orderings from a number of buyers now can be thought of as I scales which differ because of the location of their ideal points on the J scale. For example, assume that buyer X has an I scale of ABCD while buyer Y has an I scale of DCBA. These I scales imply that buyer X's ideal point is to the extreme left of the J scale, while buyer Y's ideal point is to the extreme right of the J scale. The analytical problem for the unfolding technique is to unfold a particular set of I scales to recover a J scale which best summarizes the I scales.

A central concept in the unfolding technique is the concept of a midpoint. Figure 2 illustrates the six midpoints in a situation having four stimuli. The midpoints between every pair of the stimuli divide the dimension into seven segments. Seven unique orderings of the products or I scales correspond to each of the seven segments. For example, all of the ideal points which fall within segment 3 have a preference ordering of BCAD (Case AB CD). This ordering reflects the J scale folded at any point within this segment. Note that of the twenty-four permutations possible only seven meet the requirements of this one-dimensional situation. If the preference orderings of a sample of buyers are found to

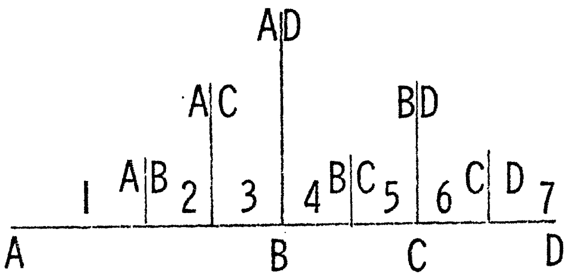
Figure 2

METRIC INFORMATION

Case $\overline{AB} = \overline{BC} = \overline{CD}$



Case $\overline{AB} > \overline{CD}$



Scale No.	I Scale	Lower Bounding Midpoints	Metric Information
1	ABCD		
2	BACD	AB	
3	BCAD	AC	
4	BCDA	AD	AD, BC $\Rightarrow \overline{AB} > \overline{CD}$
5	CBDA	BC	
6	CDBA	BD	
7	DCBA	CD	

fit such a unique set of I scales, then an underlying dimension or J scale can be used to summarize the preference data.

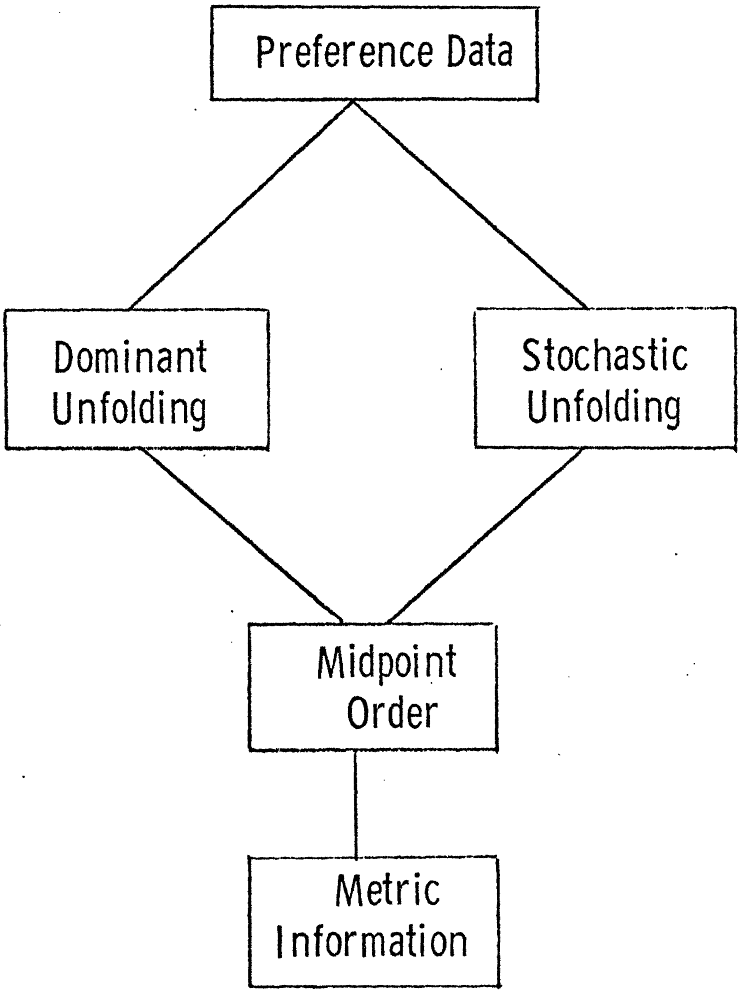
The ordering of certain midpoints from left to right on the dimension implies information about the perceived distances between certain stimuli. In the case where the stimuli are equally spaced (see Figure 2), the midpoints which imply metric information are found to overlap. In this figure, the ordering of midpoints AD and BC implies information about the perceived distance between the stimuli. Figure 2 presents the case where the distance between A and B is greater than C and D. In this situation, the AD midpoint is to the left of the BC midpoint. This ordinal information implies information about the ordered metric scaling of the stimuli. In shorthand form, AD, BC $\Rightarrow \overline{AB} > \overline{CD}$, and BC, AD $\Rightarrow \overline{CD} > \overline{AB}$. The source of the information about the ordering of midpoints is implied by the unique set of I scales. Thus, buyers' ordinal preference judgments indirectly imply information about the rank order of the distance between certain pairs of stimuli on the J scale.

The essential purpose of the unfolding algorithm is to determine the rank order of midpoints. There are two approaches to this problem. In Figure 3, these two approaches are identified as dominant and stochastic unfolding.

In dominant unfolding, each subject's complete rank order of stimuli is determined. In a situation with four stimuli, twenty-four permutations are possible. However, only seven met the metric requirements of the one-dimensional situation in Figure 2. Thus, if the preference orderings of a sample of buyers are found to fit a unique

Figure 3

TWO TYPES OF UNFOLDING THEORY



set of I scales, then an underlying dimension or J scale may be used to summarize the data. From this preference ordering the rank order of midpoints which implies the metric information is determined.

Dr. Marshal G. Greenberg summarizes the limitations of the dominant unfolding method as follows:

> The unfolding technique has been somewhat limited in its application in that it requires a complete preference ordering for every individual in order to obtain the inter-stimulus midpoint order. While the method can be modified to treat data in which individuals order k of n stimuli where $3 \leq k < n - 1$, less information about the midpoint order is obtained with a consequent loss of metric information. If the number of stimuli is great and pair comparisons are employed, it may require considerable effort on the part of each judge to produce the data necessary to generate a complete rank order of his preferences. Furthermore, the method of analysis becomes quite tedious if several hundred judges are employed as may be required for some applications.2/

Dr. Greenberg goes on to propose the stochastic unfolding method:

> The present model offers an alternative method for determining the ordering of the interstimulus midpoints on the scale. It is computationally simple for large amounts of data and requires as few as one pair comparison per judge, while also being able to treat complete sets of pair comparisons for all judges. Given the midpoint order one may employ the procedures suggested by Coombs to obtain the partially ordered scale and to subsequently assign a set of scale values to the stimuli.3/

Figure 4 presents the essential elements of stochastic unfolding. It shows a joint scale of stimuli and subjects in which the distance between A and B is greater than C and D. If we assume that the stimuli are randomly presented in pairs to members of the population and that preference judgments are made without error, then a portion of the

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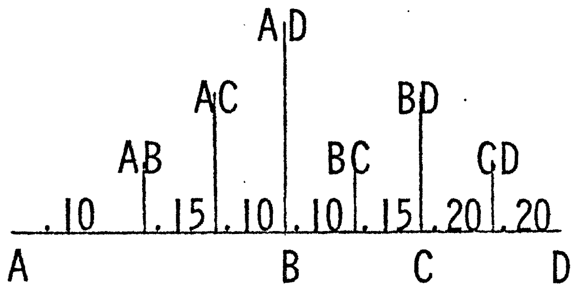
2/ Marshall G. Greenberg, "A Method of Successive Cumulations for the Scaling of Pair-Comparison Preference Judgments," Psychometrika, XXX (Dec., 1965).

3/ Ibid.

Figure 4
STOCHASTIC UNFOLDING



Assume: Stimuli are presented pairwise to members of the population and preference judgments are made without error.

Then:

		Midpoints
Pr. AB =	.10	AB
Pr. AC =	.25	AC
Pr. AD =	.35	AD
Pr. BC =	.45	BC
Pr. BD =	.60	BD
Pr. CD =	.80	CD

AD, BC $\Rightarrow$ $\overline{AB} > \overline{CD}$

population choosing A over B equals .10, A over C equals .25 and so on. Note that there is a perfect correlation between the midpoint order and the cumulated paired preferences. This relation allows the midpoints to be ordered and thus to yield the metric information.

Method

Figure 5 illustrates the flow of data analysis. Preference data were analyzed with the use of the stochastic unfolding technique, while the similarities data were analyzed using triangular analysis. (Triangular analysis will be explained later in this paper.)

The aim of the design is to create a one-dimensional situation which would allow empirical evaluation of preference and similarities data in the Coombsian tradition. Figure 6 presents the single-factor experimental design involving five levels of sugar concentration (zero to four cubes in hot coffee.)

By physically controlling a dimension, it was assumed that the subjects perceived the ordinal relationships as identical to the physical ordinal relationships. This assumption was tested by having ten subjects order the five levels of coffee from low to high concentration of sugar. Results of this test clearly supported the ordinal assumption. The empirical question to be explored in the design has a relation to whether or not the subjects perceive the stimuli as equally spaced.

A total of ninety-two subjects participated in the evaluations. The subjects were male and female college juniors and seniors in the Graduate School of Business Administration at the University of Michigan. The sample included only subjects who were coffee drinkers.

Figure 5

DATA COLLECTION METHODS USED

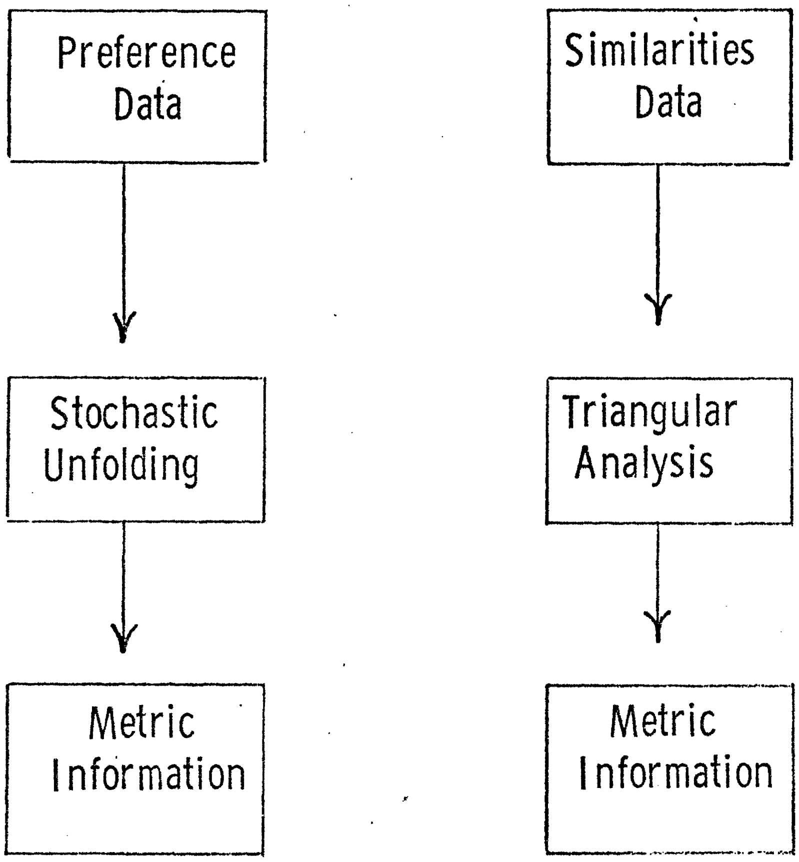
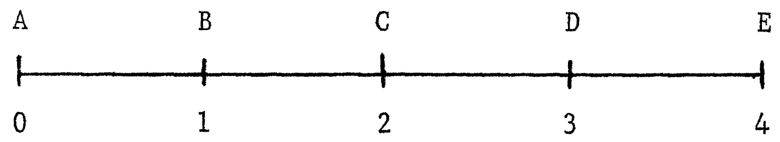


FIGURE 6

Design



(Number of cubes of sugar in 175 milliliters of coffee)

The coffee was made from an instant freeze-dried coffee. Coffee was drawn from a coffee warmer into five 300 milliliter beakers. Each beaker contained 300 milliliters of coffee and was placed on a hot tray which maintained the coffee at a constant 140°F. The beakers received from 0 to 4 lumbs of one-half inch cubes of cane sugar, the amount of sugar depending upon the treatment level.

In both the preference and similarity judgments, 50 milliliters of coffee were transferred from the beakers to the serving cups. Code letters were used to identify serving cups and were assigned randomly throughout the tests.

The test sessions lasted approximately one hour. The subjects were brought into the testing room and seated at a table on which were several cups of water, napkins, pencils, and an instruction sheet. The instruction sheets briefly explained that the subjects were to evaluate several cups of coffee at a time, that the test would consist of three parts, and that they would have to taste a total of thirteen cups. After the experimenter had answered any questions, the subjects were given cups of coffee relating to the first preference condition. (See the questionnaires in the Appendix.)

Results

Preference data

Table 1 presents the results of the paired preference judgments. The majority of subjects made three paired judgments. The pairs to be evaluated were randomly selected from the ten possible combinations.

In Table 2 the paired judgments are ranked. Three sets of orderings violate the ordering implicit in the ordinal assumption, i.e., ABCDE$\Rightarrow$midpoint AB is to the left of midpoint AC, midpoint BD is to

PAIRWISE PREFERENCE JUDGMENTS
(92 subjects)

	N	%
A	5	.151
B	28	
	33	
A	4	.138
C	25	
	29	
A	11	.393
D	17	
	28	
A	12	.428
E	16	
	28	
B	15	.517
C	14	
	29	
B	14	.539
D	12	
	26	
B	16	.533
E	14	
	30	
C	18	.562
D	14	
	32	
C	18	.581
E	13	
	31	
D	19	.576
E	14	
	33	

Table 2
METRIC INFORMATION
(Preference Data)

Proportion Prefering i to j	Midpoint Order	
Pr. AB = .151	AB	
Pr. AC = .138	AC	
Pr. AD = .393	AD	
Pr. AE = .428	AE	AE, BC $\Rightarrow \overline{AB} > \overline{CE}$
Pr. BC = .517	BC	
Pr. BD = .539	BD	
Pr. BE = .533	BE	BE, CD $\Rightarrow \overline{BC} > \overline{DE}$
Pr. CD = .562	CD	
Pr. CE = .581	CE	
Pr. DE = .576	DE	

the left of midpoint BE, and midpoint CE is to the left of midpoint DE. These orderings were corrected in Table 2.

From the ordering of the paired judgments the ordering of the midpoints is determined. This follows from the previous discussion of stochastic unfolding. Given the midpoint order, Coombsian unfolding theory suggests that the critical midpoints of AE, BC and BE, CD imply metric information.

Figure 7 summarizes the metric information from Table 2. A partial ordering of the distances is presented.

Similarity judgments

Coombs proposes triangular analysis as a method for determining the rank of interpoint distances.[4/] With five stimuli there are ten interpoint distances or paired comparisons. Table 3 presents a perfect triangular pattern in that there are no intransitivities in the forty-five interpoint distance comparisons. Here, the ordered relation between each paired distance is entered in a matrix of distances. By permuting rows and corresponding columns, one tries to arrive at a perfect triangular pattern. A perfect pattern means that the data are transitive.

The previous assumption that the ordinal relationship between the stimuli is known (ABCDE), implies the ordered relation between certain pairs of interpoint distances. For example, the interpoint distance $\overline{AE}$ is greater than the remaining nine interpoint distances in that $\overline{AE}$ envelopes the other nine distances. As illustrated in Table 4, there are twenty-five such known relationships because of the phenomenon of enveloping.

4/ Coombs, A Theory of Data.

Figure 7
Metric Relationships

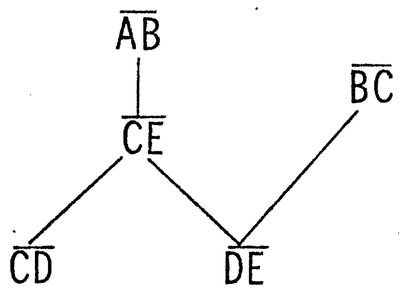


Table 3

COOMBSIAN TRIANGULAR ANALYSIS
(Similarity Judgments)

	$\overline{AE}$	$\overline{AD}$	$\overline{AC}$	$\overline{BE}$	$\overline{BD}$	$\overline{AB}$	$\overline{CE}$	$\overline{BC}$	$\overline{CD}$	$\overline{DE}$
$\overline{AE}$		I	I	I	I	I	I	I	I	I
$\overline{AD}$			I	I	I	I	I	I	I	I
$\overline{AC}$				I	I	I	I	I	I	I
$\overline{BE}$					I	I	I	I	I	I
$\overline{BD}$						I	I	I	I	I
$\overline{AB}$							I	I	I	I
$\overline{CE}$								I	I	I
$\overline{BC}$									I	I
$\overline{CD}$										I
$\overline{DE}$										

Code: I = Row dominates column or row interpoint distance greater than column interpoint distance

Table 4

COOMBSIAN TRIANGULAR ANALYSIS
(Similarity Judgments)

	$\overline{AE}$	$\overline{AD}$	$\overline{AC}$	$\overline{BE}$	$\overline{BD}$	$\overline{AB}$	$\overline{CE}$	$\overline{BC}$	$\overline{CD}$	$\overline{DE}$
$\overline{AE}$		X	X	X	X	X	X	X	X	X
$\overline{AD}$			X		X	X		X	X	
$\overline{AC}$						X		X		
$\overline{BE}$					X		X	X	X	X
$\overline{BD}$								X	X	
$\overline{AB}$										
$\overline{CE}$									X	X
$\overline{BC}$										
$\overline{CD}$										
$\overline{DE}$										

Code: X = Implied by ordinal assumption

Of the remaining twenty unknown ordered relationships eight were empirically determined. The empirical testing was done sequentially. This sequencing is identified in Table 5 by E_1 which represents the first set of empirical observations. The E_2 and then the E_3 comparisons were determined on the basis of these outcomes.

The E_1 comparisons represent ordered relationships between the four adjacent stimuli pairs, i.e., AB, BC, CD, and DE. As illustrated in Table 6 , there are six empirical ordered relationships which need to be determined. Three of these relationships involve a common stimuli and are identified by T in Table 6 . The T comparisons are called triad comparisons because three stimuli are involved. The remaining three ordered relationships do not involve a common stimuli and are identified by a D in Table 6 . The D comparisons are called dyad comparisons because two pairs of different stimuli are involved. The similarity questionnaires (see the Appendix) explain how the triad and dyad judgments were elicited from the subjects.

Table 7 presents the results of the E_1 similarity judgments. The cell entries represent the portion of subjects who judged the row distance to be more similar (smaller) than the column distance. The matrix has been permuted so that the four paired distances are ranked from largest to smallest: $\overline{AB} > \overline{BC} > \overline{CD} > \overline{DE}$. The outcome of these comparisons suggests that the next empirical comparisons should be the $\overline{AB}$, $\overline{CE}$ and $\overline{BC}$, $\overline{CE}$ orderings.

Table 8 presents the results of the E_2 comparisons. Here, $\overline{AB}$, was judged greater than $\overline{CE}$ while $\overline{CE}$ was judged greater than $\overline{BC}$. The remaining empirical comparison is the $\overline{AB}$, $\overline{BD}$ ordering.

Table 5

COOMBSIAN TRIANGULAR ANALYSIS
(Similarity Judgments)

	$\overline{AE}$	$\overline{AD}$	$\overline{AC}$	$\overline{BE}$	$\overline{BD}$	$\overline{AB}$	$\overline{CE}$	$\overline{BC}$	$\overline{CD}$	$\overline{DE}$
$\overline{AE}$	—	X	X	X	X	X	X	X	X	X
$\overline{AD}$		—	X		X	X		X	X	
$\overline{AC}$			—			X		X		
$\overline{BE}$				—	X		X	X	X	X
$\overline{BD}$					—	E_3		X	X	
$\overline{AB}$						—	E_2	E_1	E_1	E_1
$\overline{CE}$							—	E_2	X	X
$\overline{BC}$								—	E_1	E_1
$\overline{CD}$									—	E_1
$\overline{DE}$										—

Code: X = Implied by ordinal assumption
E = Empirical observation

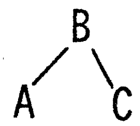
Table 6

E_I COMPARISONS

ADJACENT STIMULI

	$\overline{AB}$	$\overline{BC}$	$\overline{CD}$	$\overline{DE}$
$\overline{AB}$	\	T	D	D
$\overline{BC}$		\	T	D
$\overline{CD}$			\	T
$\overline{DE}$				\

Code: T = triad comparison



D = dyad comparison

A—B C—D

Table 7

E_1 DATA

	$\overline{AB}$	$\overline{BC}$	$\overline{CD}$	$\overline{DE}$
$\overline{AB}$		.29	.34	.19
$\overline{BC}$	.71		.38	.27
$\overline{CD}$	.66	.62		.19
$\overline{DE}$	.81	.73	.81	

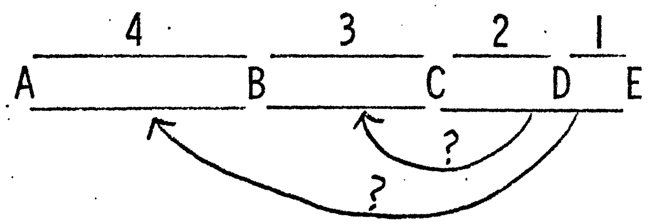


Table 8

E_2 DATA

$\overline{CE}$ relative to $\overline{AB}$ and $\overline{BC}$

	N	%		N	%
$\overline{AB}$	12	.43	$\overline{CE}$	6	.33
$\overline{CE}$	16	.56	$\overline{BC}$	12	.67
	28			18	

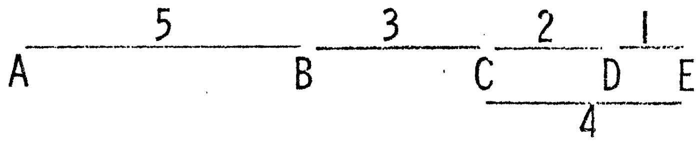


Table 9 presents the results of the E_3 comparison. $\overline{BD}$ was found to be greater than $\overline{AB}$. These findings result in the following ordering of interpoint distances: $\overline{BD} > \overline{AB} > \overline{CE} > \overline{BC} > \overline{CD} > \overline{DE}$.

Table 10 indicates that a perfect triangular analysis was obtained. The remaining eleven cell entries (1 through 11) were implied by the empirical observations. Consequently, a complete ordering of interpoint distances is determined from the triangular analysis algorithm.

Figure 8 presents a comparison of the complete ordered metric similarity scale and the partial ordered metric preference scale. The two scales are compatible in that the partial order can be derived from the complete order.

Interval scale

Frank Goode has developed a method for the conversion of an ordered metric scale to an interval scale.[5/] Given the similarity metric order of pairs in Figure 8, this method consists of setting the smallest interval ($\overline{DE}$) equal to some positive but unknown quantity. Successively larger distances are obtained by introducing additional unknown positive changes.

Goode's method is illustrated in Table 11 by the use of the constant change assumption to obtain an interval scale. In this analysis, Δ_1 is the width of the smallest interval between two stimuli. Under the constant change assumption successive differences in the rank order of distances, when unknown, are assumed to be constant and set equal to 1. Hence, $\overline{CD}$, next in order over $\overline{DE}$, is given the value $\Delta_1 + 1$. The next distance, $\overline{BC}$, is equal to the $\overline{CD}$ distance plus one, or $\Delta_1 + 2$.

5/ Ibid.

Table 9

E_3 DATA

$\overline{AB}$ relative to $\overline{BD}$

	N	%
$\overline{BD}$	6	.32
$\overline{AB}$	13	.68
	19	

$\overline{BD}$
|
$\overline{AB}$
|
$\overline{CE}$
|
$\overline{BC}$
|
$\overline{CD}$
|
$\overline{DE}$

Table 10

COOMBSIAN TRIANGULAR ANALYSIS
(Similarity Judgments)

	$\overline{AE}$	$\overline{AD}$	$\overline{AC}$	$\overline{BE}$	$\overline{BD}$	$\overline{AB}$	$\overline{CE}$	$\overline{BC}$	$\overline{CD}$	$\overline{DE}$
$\overline{AE}$		X	X	X	X	X	X	X	X	X
$\overline{AD}$			X	1	X	X	2	X	X	3
$\overline{AC}$				4	5	X	6	X	7	8
$\overline{BE}$					X	9	X	X	X	X
$\overline{BD}$						E_3	10	X	X	11
$\overline{AB}$							E_2	E_1	E_1	E_1
$\overline{CE}$								E_2	X	X
$\overline{BC}$									E_1	E_1
$\overline{CD}$										E_1
$\overline{DE}$										

Code: X = Implied by Ordinal assumption
E = Empirical observation
1- 11 = Implied from empirical observation

1. $\overline{AB} > \overline{DE} \Rightarrow \overline{AD} > \overline{BE}$
2. $\overline{BC} > \overline{DE} \Rightarrow \overline{AD} > \overline{CE}$
3. $\overline{BC} > \overline{DE} \Rightarrow \overline{AD} > \overline{DE}$
4. $\overline{AB} > \overline{CE} \Rightarrow \overline{AC} > \overline{BE}$
5. $\overline{AB} > \overline{CE} \Rightarrow \overline{AC} > \overline{BD}$
6. $\overline{AB} > \overline{CE} \Rightarrow \overline{AC} > \overline{CE}$
7. $\overline{AB} > \overline{CD} \Rightarrow \overline{AC} > \overline{CD}$
8. $\overline{AB} > \overline{DE} \Rightarrow \overline{AC} > \overline{DE}$
9. $\overline{BD} > \overline{AB} \Rightarrow \overline{BE} > \overline{AB}$
10. $\overline{BC} > \overline{DE} \Rightarrow \overline{BD} > \overline{CE}$
11. $\overline{BC} > \overline{DE} \Rightarrow \overline{BD} > \overline{DE}$

Figure 8

COMPARISON OF PREFERENCE AND SIMILARITY DATA

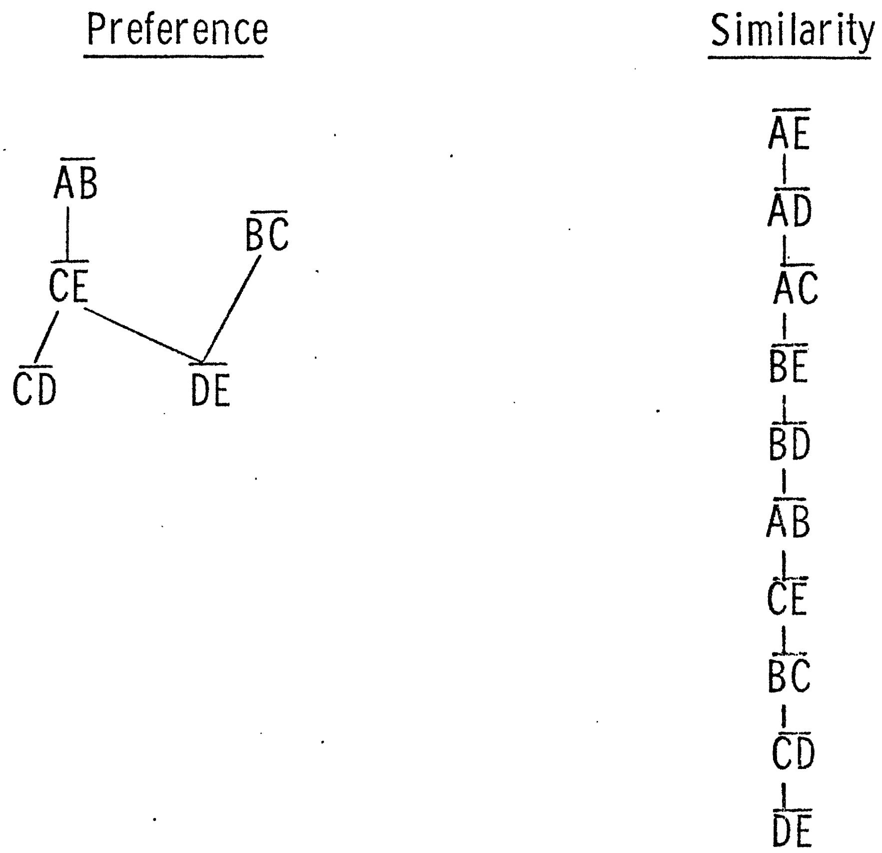


Table II
COMPUTATION OF SCALE VALUES USING GOODE'S METHOD
(Similarity data)

Rank Order of Distances	Distances Under Constant Δ Assumption	Scale Values: General Expression	Scale Values: Scales From 0 to 100
$\overline{AE}$	$5\Delta_1 + 5$		
$\overline{AD}$	$4\Delta_1 + 5$	A = 0	A = 0
$\overline{AC}$	$3\Delta_1 + 4$		
$\overline{BE}$	$3\Delta_1 + 3$		$B = \frac{2\Delta_1 + 2}{5\Delta_1 + 5}$
$\overline{BD}$	$2\Delta_1 + 3$		
$\overline{AB}$	$2\Delta_1 + 2$	$B = 2\Delta_1 + 2$	$C = \frac{3\Delta_1 + 4}{5\Delta_1 + 5}$
$\overline{CE}$	$2\Delta_1 + 1$		
$\overline{BC}$	$\Delta_1 + 2$	$C = 3\Delta_1 + 4$	$D = \frac{4\Delta_1 + 5}{5\Delta_1 + 5}$
$\overline{CD}$	$\Delta_1 + 1$	$D = 4\Delta_1 + 5$	
$\overline{DE}$	Δ_1	$E = 5\Delta_1 + 5$	E = 100

The next distance of $\overline{CE}$ equals $\overline{CD}$ plus $\overline{DE}$, or $2\Delta_1 + 1$. The remaining distances are additive combinations of the preceding distances. From these values for the interpoint distances, it is possible to obtain expressions for the scale values of the stimuli by setting A equal to 0. Given these calculations, the expressions for the scale values, on a scale from 0 to 100, are presented in Table 11. Table 12 presents the scale values of the stimuli for different values of (0, 1, 10, ∞) to indicate the general effect of the magnitude of Δ_1. The smaller the value of Δ_1 that is chosen, the more dramatic are the metric relationships. In the limit, as $\Delta_1 \rightarrow 0$, the scale value for D approaches 100. As Δ_1 is increased, differences in the interpoint distances are diminished. Consequently, any distortions because of the constant change assumption are diminished.

The constant change assumption of one was chosen because it seems to yield a reasonably representative and stable scale and because at the same time, it makes clearly visable the differences in metric relationships. Figure 9 presents the interval scale for the tests on the basis of the above assumptions.

Summary

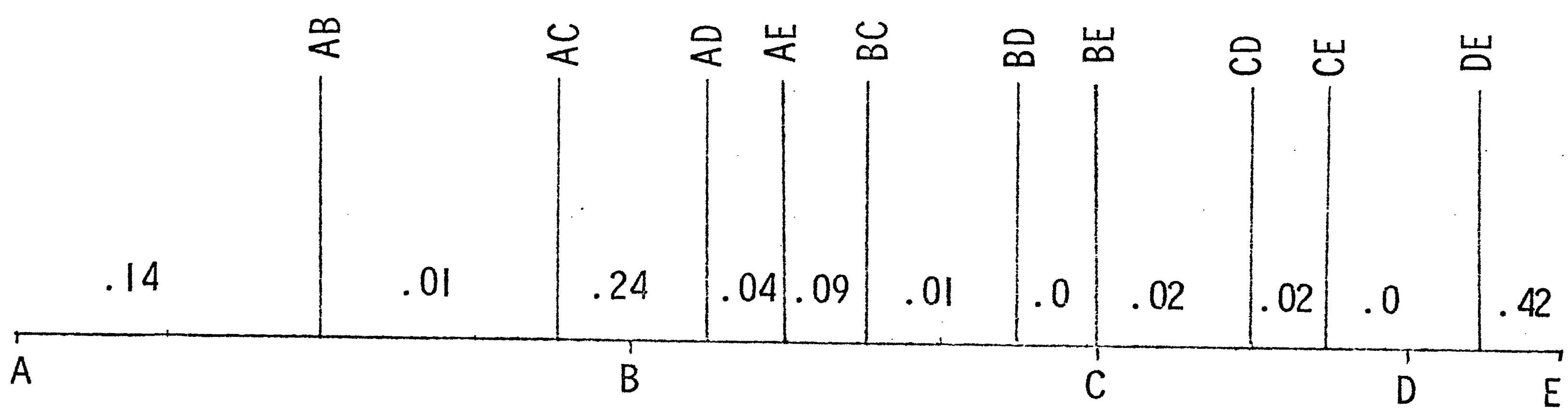
The purpose of this paper was to illustrate the application of Coombsian methodology to the analysis of preference and similarity judgments and to present empirical findings resulting from the use of this methodology. The findings of the study suggest compatibility between the metric relationships of the preference and similarity scales. The reader is referred to the text, A Theory of Data, for a comprehensive discussion of the methodology presented in this paper.

Table 12

SCALE VALUES OF THE STIMULI FOR VARIOUS VALUES OF Δ_1

	$\Delta_1 = 0$	$\Delta_1 = 1$	$\Delta_1 = 10$	$\Delta_1 = \infty$
A	0	0	0	0
B	.40	.40	.40	.40
C	.80	.70	.62	.60
D	1.00	.90	.82	.82
E	1.00	1.00	1.00	1.00

Figure 9
INTERVAL SCALING OF STIMULI
($\Delta_i = 1$)



APPENDIX

Instructions

Name ________________________________

Marketing 300, 301 (Circle one)
Section 1, 2, 3, 4 (Circle one)

The purpose of this test is for you to evaluate several cups of coffee The test will consist of three parts and will require you to taste a total of thirteen cups of coffee It is recommended that you only taste enough of the coffee such that you can confidently evaluate each cup.

In your evaluations be sure to take an adequate amount of time and carefully note the differences in the cups of coffee. Each cup of coffee will be different from every other cup However, some of the differences will be small and may require that you retaste the samples a number of times.

If there are any questions at this point please raise them before we proceed with the first part of the evaluation.

Part I

Preference Evaluation

In this part of the evaluation you will be given two cups of coffee each having a code letter written on the side of the cup. First, we would like to have you rinse your mouth out with the water provided in front of you. Next, select one of the cups of coffee and taste enough of the coffee such that you can evaluate it. After you have tasted the first cup, proceed to an evaluation of the second cup of coffee. Remember, after you taste a cup of coffee be sure to rinse your mouth with water. This will help you to detect the differences in the two cups of coffee.

After you have tasted the two cups of coffee determine which cup you prefer the most. Record the code letter of the preferred cup (and nonpreferred cup) on your questionnaire (next page). In making your preference decision you will want to retaste them to be definitely sure that your choice is the correct one. Feel free to take as much time as you need in making this evaluation.

Preference Questionnaire

First Pair

(Code Letter)

Most Preferred ______

Least Preferred ______

Second Pair

(Code Letter)

Most Preferred ______

Least Preferred ______

Third Pair

(Code Letter)

Most Preferred ______

Least Preferred ______

Part II

Similarity Evaluation (Triads)

In this part of the evaluation you will be given three cups of coffee each having a code letter written on the side of the cup. One cup of coffee will be marked HUB. Please note the code letter on the cup marked HUB and record this code letter on your questionnaire (next page) before you taste the cups of coffee.

After you have recorded the code letter of the HUB on your questionnaire, taste the HUB cup of coffee After rinsing your mouth with water next determine which of the remaining two cups of coffee is most similar to the HUB and which is least similar to the HUB. Feel free to retaste the cups of coffee to be sure your choice is correct.

Similarity Questionnaire (Triads)

(Code Letter)
HUB --- _____

(Code Letter)
Cup most similar to HUB --- _____

(Code Letter)
Cup least similar to HUB --- _____

Part III

Similarity Evaluation (Dyads)

In this part of the evaluation you will be given four cups of coffee each having a code letter written on the side of the cup. The experimenter will identify two cups as SET #1 and two cups as SET #2. Please record the code letters of SET #1 and SET #2 on your questionnaire (next page) before you taste them.

Taste the two cups of coffee in SET #1 keeping in mind their differences. Next, taste the two cups of coffee in SET #2 and note their differences. After you are familiar with the differences within SET #1 and SET #2, judge which set is more similar. Record your response on the questionnaire by circling the set which is more similar. Feel free to retaste the cups of coffee to be sure your choice is correct.

Similarity Questionnaire (Dyads)

SET #1	SET #2
(Code Letters)	(Code Letters)
_____---_____	_____---_____

Circle the set which is more similar.

Final Questions

1. What do you think were the main differences in the cups of coffee you tasted?

2 Do you smoke cigarettes?

___ Yes   ___ No

Final Note

Other students in your class will be participating in this test. Please do not tell them about the test since your comments could influence their judgments during the test.

At the end of the semester, your instructor will discuss the purpose of the test and its relevance to marketing.

Thank you for your cooperation.