PREDICTING CONSUMER BRAND CHOICE FROM DISTANCE RELATIONS: A Laboratory Study

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The study tries to relate consumer brand choice to the ideal-stimulus distance in a laboratory experiment. Four distance models are used to derive the ideal-stimulus distances. The results show that all four models seem to be capable of predicting with reasonable accuracy the consumer brand choice in a two-choice task.

I. INTRODUCTION

Nonmetric multidimensional scaling primarily concerns the spatial representation of relationships among stimuli. The spatial representation obtained through nonmetric scaling is referred to as a "configuration". In a joint space configuration, points representing stimuli are located in a distance relation to each other. Distances between points are presumably indicative of degrees of similarity between stimuli. Each subject's point in the configuration may be thought of as his "ideal point". The ideal represents a hypothetical "most preferred" stimulus. The distance from the ideal point to a stimulus represents the distance of the stimulus from the hypothetical "most preferred" stimulus. Presumably preference is maximum at the ideal point and declines symmetrically in all directions as one moves away from the ideal.[1] It seems reasonable to expect that one can predict the preference for the stimuli from the stimulusideal distances in a joint-space configuration. Lehmann, among others, has found that the model of preferences provided substantial predictive improvement over others based on demographics and other variables.[2]

From the standpoint of marketing strategy formulation, one must be able to predict the consumer brand choice from the distance relations in the joint-space configuration. In an unpublished, field level study, Narayana found that an inverse relationship exists between probability of "average" subject buying a brand of soft drink and the distance of the brand from the "average" subject's ideal point.[3] In

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view of the fact that the field level experiment might, as noted by Green and Rao,[4] raise serious questions of retaining experimental control over the influence of other marketing variables on the choice of brand and the stability of estimated choice probability over time, the study tries to relate consumer brand choice to the ideal-stimulus distance in a laboratory experiment. The Narayana model was an aggregated model in which the use of aggregated data mask individual differences of responses. The model investigated here is on the individual basis since we expect that the distance-choice relationship, if exists, may differ between individuals.

This study concerns predicting brand choices from the ideal-stimulus distances in the joint-space. Given the use of two metric functions and two types of weights, four distance models are used to derive the ideal-stimulus distances. The results of the study indicate that all four models predict reasonably well the individual subject's brand choice in a two-choice task.

II. DISTANCE MODELS

The hypothesis investigated here stipulates that in a two-choice task the subject will choose the alternative which is closer to the ideal brand. Stated mathematically,

$$A(i,j) \Leftrightarrow D(I,i) < D(I,j)$$

where

$A(i,j)$: Stimulus i is chosen over stimulus j.

$D(I,h)$: Derived distance of stimulus h from the ideal stimulus I. $(h=i,j)$

For each subject an ideal point is derived from the individual's ratings of a hypothetical ideal stimulus on identified dimensions.

As to the distance measures, most applications have involved the Euclidean metric.[5] The city block metric has also been commonly used in measuring distance between a pair of points. The city block and Euclidean metrics are special cases of the Minkowski p-metric. While many nonmetric scaling programs provide the flexibility of fitting any type of the Minkowski p-metric to the data, only the city block and the Euclidean metrics are employed in this study because of their common usage.

Another problem concerns the use of equal or differential dimension weights in the distance models. Several recent studies have found that the inclusion of differential weights only slightly improved the predictive power of the model for consumer attitudes toward products.[6] Some studies, hovever, observed that the models with equal weights predicted the affect and intent-to-buy better than the models with differential weights.[7] In view of the controvercies over the use of differential weights, it was decided to use both equal and differential weights here in the distance measures.

Given the use of two metric functions and two types of weights, the following four distance models are used to derive the inter-stimulus distances in order to see which models have better predictive power.

(1) $D_1(I,h) = \Sigma_k \mid X_{hk} - I_k \mid$

(2) $D_2(I,h) = \Sigma_k (X_{hk} - I_k)^2]^{1/2}$

(3) $D_3(I,h) = \Sigma_k w_k \mid X_{hk} - I_k \mid$

(4) $D_4(I,h) = [\Sigma_k w_k (X_{hk} - I_k)^2]^{1/2}$

where $D_j(I,h)$: Derived distance of stimulus h from I.

X_{hk} : Scale value of stimulus h on kth dimension.

I_k : Rating of the ideal brand I on kth dimension.

W_k : Weight attached to kth dimension.

Unequal weights are derived from the categorical judgments of the importance of the attributes in perceived similarity and preference of the stimuli. Subjects are asked to indicate how important each attribute is to them personally in their perceptions of the stimuli. The four categories to choose from are (1) very important, (2) important, (3) slightly important, and (4) not important at all. A dimension rated "very important" is given a weight of three, and so on, so that a dimension rated "not important at all" is given a weight of zero. It should be noted that the weight is arbitrarily assigned to each category. The results may be sensitive to different weight assignments.

III. EXPERIMENTAL DESIGN

A laboratory experiment with sixty randomly selected students of a U.S. university as subjects was designed and implemented. The stimulus set includes six "imaginary" brands of soft drink. These imaginary brands were presented to each subject graphically in terms of their scale values on two prespecified dimensions (calorie and flavor) on cards.

The purpose of the experiment was disguised as a comparison of perceptions of soft drinks between different sex and age groups and between students and housewives. For disguise purpose some demographic data were collected including sex and age.

Each subject was instructed to imagine a hypothetical ideal brand which was his/her most preferred brand. The subject was then asked to rate this ideal brand on calorie and flavor, using the following 21-point equal-interval format.

	low										high
Calorie	• •	• •	• •	• •	• •	• •	• •	• •	• •	• •	•
	0	1	2	3	4	5	6	7	8	9	10

	noncola										cola
Flavor	• •	• •	• •	• •	• •	• •	• •	• •	• •	• •	•
	0	1	2	3	4	5	6	7	8	9	10

Each subject was given 15 coupons, each having a value of 20 cents, and presented with a 15-page computer printout. (See Appendix I.) The subject was then instructed to buy one can of either brand from the two alternatives on each page of the computer printout. The price was 20 cents per can regardless of the brand selected. The selection was made by affixing one coupon to the chosen brand on each page.

IV. ANALYSIS OF RESULTS

Each of the 60 subjects was instructed to make a total of 15 choices. The number of times and proportion that the observed choices are consistent with the predicted ones are summarized in Table I. The average numbers of choices consistent with the predicted choices for D1, D2, D3, and D4 were 12.2667(81.78% of total choices), 11.9333(79.56%), 12.55(83.67%) and 12.6667(84.44%) respectively. The number of subjects whose actual choices consistent with predicted ones were 12 (80% of total choices) or higher is 42 (70% of total subjects) for D1, 39 (65%) for D2, 44 (73.33%) for D3 and 47 (78.33%) for D4. For each of the four models, all except one or two subjects made at least 50 per cent of brand choices consistent with predicted ones. Based on the information contained in Table I, all four models seem to predict resonably well the individual subject's brand choices in a two-choice task.

Judging from the mean numbers of choices consistent with the predicted ones, D4 seems to have the best predictive power, followed by D3, D1 and D2 in that order. An AxS (treatment by subject) analysis of variance was then conducted, using each model as a different treatment as tests of difference between models. The result of the analysis of variance is shown in table II. The required F for 3 and 177 degrees of freedom at 0.05 level of significance is approximately 2.66. The obtained F-ratio is 3.4150, indicating that the over-all F is significant at 0.05 level.

Table I : NUMBER AND PROPORTION OF CHOICES

CONSISTENT WITH PREDICTION

Subject	D1	D2	D3	D4
1	12(0.8000)	12(0.8000)	10(0.6667)	12(0.8000)
2	13(0.8667)	13(0.8667)	14(0.9333)	14(0.9333)
3	15(1.0000)	15(1.0000)	15(1.0000)	15(1.0000)
4	12(0.8000)	10(0.6667)	11(0.7333)	10(0.6667)
5	11(0.7333)	13(0.8667)	11(0.7333)	13(0.8667)
6	15(1.0000)	14(0.9333)	14(0.9333)	14(0.9333)
7	14(0.9333)	12(0.8000)	14(0.9333)	14(0.9333)
8	12(0.8000)	11(0.7333)	14(0.9333)	13(0.8667)
9	7(0.4667)	8(0.5333)	15(1.0000)	15(1.0000)
10	11(0.7333)	9(0.6000)	14(0.9333)	12(0.8000)
11	14(0.9333)	14(0.9333)	13(0.8667)	14(0.9333)
12	12(0.8000)	11(0.7333)	14(0.9333)	13(0.8667)
13	10(0.6667)	8(0.5333)	10(0.6667)	8(0.5333)
14	11(0.7333)	13(0.8667)	13(0.8667)	13(0.8667)
15	13(0.8667)	13(0.8667)	15(1.0000)	15(1.0000)
16	14(0.9333)	14(0.9333)	12(0.8000)	12(0.8000)
17	14(0.9333)	14(0.9333)	14(0.9333)	14(0.9333)
18	9(0.6000)	10(0.6667)	9(0.6000)	10(0.6667)
19	14(0.9333)	13(0.8667)	14(0.9333)	14(0.9333)
20	14(0.9333)	14(0.9333)	14(0.9333)	15(1.0000)
21	14(0.9333)	14(0.9333)	14(0.9333)	14(0.9333)
22	13(0.8667)	14(0.9333)	7(0.4667)	7(0.4667)
23	15(1.0000)	14(0.9333)	15(1.0000)	15(1.0000)
24	11(0.7333)	10(0.6667)	11(0.7333)	10(0.6667)
25	10(0.6667)	10(0.6667)	13(0.8667)	12(0.8000)
26	13(0.8667)	13(0.8667)	12(0.8000)	12(0.8000)
27	7(0.4667)	4(0.2667)	11(0.7333)	11(0.7333)
28	13(0.8667)	13(0.8667)	15(1.0000)	15(1.0000)
29	11(0.7333)	8(0.5333)	13(0.8667)	12(0.8000)
30	15(1.0000)	15(1.0000)	15(1.0000)	15(1.0000)
31	9(0.6000)	9(0.6000)	8(0.5333)	8(0.5333)
32	13(0.8667)	14(0.9333)	11(0.7333)	14(0.9333)
33	15(1.0000)	13(0.8667)	12(0.8000)	12(0.8000)
34	13(0.8667)	13(0.8667)	14(0.9333)	14(0.9333)
35	10(0.6667)	12(0.8000)	12(0.8000)	13(0.8667)
36	11(0.7333)	10(0.6667)	15(1.0000)	14(0.9333)
37	15(1.0000)	15(1.0000)	14(0.9333)	14(0.9333)
38	13(0.8667)	13(0.8667)	13(0.8667)	13(0.8667)
39	10(0.6667)	8(0.5333)	15(1.0000)	15(1.0000)
40	13(0.8667)	13(0.8667)	13(0.8667)	13(0.8667)
41	13(0.8667)	12(0.8000)	11(0.7333)	13(0.8667)
42	15(1.0000)	15(1.0000)	15(1.0000)	15(1.0000)
43	12(0.8000)	13(0.8667)	12(0.8000)	14(0.9333)
44	14(0.9333)	14(0.9333)	12(0.8000)	14(0.9333)

45	12(0.8000)	9(0.6000)	14(0.9333	11(0.7333)
46	12(0.8000)	11(0.7333)	12(0.8000)	12(0.8000)
47	12(0.8000)	12(0.8000)	12(0.8000)	12(0.8000)
48	13(0.8667)	13(0.8667)	12(0.8000)	12(0.8000)
49	9(0.6000)	9(0.6000)	12(0.8000)	12(0.8000)
50	10(0.6667)	10(0.6667)	8(0.5333)	8(0.5333)
51	13(0.8667)	13(0.8667)	12(0.8000)	12(0.8000)
52	13(0.8667)	13(0.8667)	14(0.9333)	14(0.9333)
53	13(0.8667)	12(0.8000)	9(0.6000)	11(0.7333)
54	11(0.7333)	11(0.7333)	11(0.7333)	11(0.7333)
55	9(0.6000)	10(0.6667)	9(0.6000)	10(0.6667)
56	13(0.8667)	13(0.8667)	15(1.0000)	15(1.0000)
57	12(0.8000)	13(0.8667)	12(0.8000)	12(0.8000)
58	14(0.9333)	14(0.9333)	14(0.9333)	14(0.9333)
59	13(0.8667)	14(0.9333)	14(0.9333)	15(1.0000)
60	12(0.8000)	9(0.6000)	10(0.6667)	11(0.7333)
Mean	12.2667	11.9333	12.5500	12.6667
proportion	.8178	.7956	.8367	.8444

Table II : ANALYSIS OF VARIANCE (FOR DISTANCE MODELS)

Source	d.f.	Mean Square	F-ratio
Treatment (A)	3	6.41527778	3.41500
Subject (S)	59	11.54484463	
A x S	177	1.87855461	

The Scheffe method of post-hoc comparison[8] was used to examine all pair-wise differences between average numbers of choices consistent with the prediction. The critical value by Scheffe method is given by:

$$\sqrt{(J-1)F_{.05}} \times \sqrt{MS_e \times W_g}$$

$$=\sqrt{3 \times 2.66} \times \sqrt{1.87855461 \times (1/60)(1+1)}$$

$$=.708066$$

Table III: PAIRWISE DIFFERENCES IN NUMBER OF CHOICES CONSISTENT WITH PREDICTION

Mean	Mean	D2 11.9333	D3 12.5500	D4 12.6667
D1	12.2667	.3334	-.2833	.4000
D2	11.9333		-.6167	-.7334*
D3	12.5500			.1167

* Significant at .05 level

A pair-wise comparison of average number of choices consistent with the predicted ones is shown in Table Ⅲ. The result indicates that only one of the differences (between D2 and D4) is significant at .05 level. We can say that the difference between D2 and D4 contributes to the over-all significance of F. In other words, D4 has a better predictive power than D2 so far as the number of choices consistent with predicted ones is concerned. The differences between other pairwise comparisons are not significant at .05 level according to theS cheffe method.

Among the four distance models, two of them (D3 and D4) include differential weights while the other two models (D1 and D2) use the equal weights. We have found that when associated with the Euclidean metric, the inclusion of differential weights did significantly improve the predictive power of the medel for brand choice. When associated with the city block metric, the use of differential weights produced only limited and insignificant benefits to the model's predictive power. The findings here contradict the reports by Churchill,[9] Lutz and Howard,[10] Moinpour and MacLachlan,[11] Sheth,[12] and Sheth and Talarzyk[13] which assert that the inclusion of differential weights was detrimental to the correlations of attitude scores with the respondent's brand preference and choice. The results here are, however, somewhat in agreement with the reports by Bass, Pessemier and Lehmann,[14] Beckwith and Lehmann,[15] Hansen,[16] and Lehmann[17] which argue that the inclusion of differential weights provided modest improvements for predicting consumer attitude and preference.

V. SUMMARY

The laboratory study concerns the prediction of brand choices from the distance relations in the joint space. Four distance models were employed. The average proportions of choices consistent with predicted ones for the four models were

81.78%, 79.53% 83.67% and 84.44% respectively. The results show that all four models seem to be capable of predicting with reasonable accuracy the individual subject's brand choices in two-choice task.

It was found that when associated with the Euclidean metric, the use of differential weights significantly impoved the predictive power of the distance model for brand choices. When associated with the city block metric, the inclusion of differential weights produces only limited benefits to the predictive power of the models. The findings contradict the reports by Churchill, Lutz and Howard, Moinpour and MacLachlan, Sheth and Talarzyk which argue that the use of differential weights was detrimental to the ability of the model to predict consumer preference and choice, but are somewhat in agreement with the reports by Bass, Pessemier and Lehmann, Hansen, Beckwith and Lehmann which assert that the inclusion of differential weights provided modest improvements for the predictive power of the model.

APPENDIX I

GRAPHIC PRESENTATION OF TWO BRANDS (A AND B) ON CALORIE AND FLAVOR

BRAND A VS BRAND B

CALORIE	LOW										HIGH
BRAND A	++										
BRAND B	....										
	0	1	2	3	4	5	6	7	8	9	10

FLAVOR	NONCOLA										COLA
BRAND A	+++										
BRAND B	....										
	0	1	2	3	4	5	6	7	8	9	10

WHICH BRAND DO YOU WANT TO BUY?
PLEASE INDICATE YOUR SELECTION BY ADHERING ONE COUPON TO THE BRAND OF YOUR CHOICE (BRANDS ARE SHOWN BELOW).

A A A A A A A A A A A A A A A A	B B B B B B B B B B B B B B B B

FOOTNOTES

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