

*Neuendorf*

## **Multidimensional Scaling**

### Model:

I can't draw it! The output is essentially concepts plotted in (multidimensional) space.

### Assumptions:

1. The decomposition approach (the focus here) assumes that you want to uncover dimensions of discrimination/differentiation among concepts or "objects." These concepts can be anything you wish--countries, brand names, racial groups, attributes (e.g., "expensive," "intelligent"). Typically, data are collected by simple paired comparisons, asking respondents to indicate perceived similarities or relative preferences between concepts, and the dimensions emerge from these data. Thus, ordinarily, the dimensions that are discovered are data-based, and not defined by the researcher. More generally, we assume that people (respondents) can and do think about a pool of concepts in a multidimensional fashion, either observing Euclidean geometry (e.g., SPSS's ALSCAL, found under Analyze → Scale → Multidimensional Scaling) or not (e.g., the GALILEO program). (SPSS also offers another procedure, PROXSCAL, written by faculty at Leiden University in The Netherlands.) SPSS has a variation on ALSCAL called INDSCAL that examines individual cognitive spaces.
2. Any level of measurement will do if you use SPSS's ALSCAL procedure. The statistical procedure itself asks for ordinal, interval, or ratio. GALILEO assumes metric (interval/ratio) data.
3. Whether participants' judgments are assumed to adhere to Euclidean geometry. ALSCAL does assume this, and also for some reason limits the MDS solution to 6 dimensions. The program GALILEO will assess as many dimensions as you have concepts, will account for non-Euclidean judgments (via imaginary dimensions).
 

--STOP HERE TO DISCUSS EUCLIDEAN VS. NON-EUCLIDEAN JUDGMENTS--

CAT and PET	_____	Units
DOG and PET	_____	Units
CAT and DOG	_____	Units
4. Homogeneity of respondents' comparisons. Usually (but not always), data are aggregated across respondents, by using their mean (or geometric mean, i.e., the average of the logarithmic values, converted back to a base 10 number) distances between concepts. GALILEO does not test for homogeneity. If using the INDSCAL option in SPSS's MDS, the output will give a measure of fit for each respondent.
5. Dimensions [in real space] will be orthogonal.

### Decisions to Make:

1. Which program? In the School of Communication at CSU, you can choose between SPSS's ALSCAL/INDSCAL, SPSS's PROXSCAL, and GALILEO. GALILEO is installed on only a

small number of machines, as needed, and is a very old program.

2. What concepts will be included. Usually decided by theory, by researcher fiat, or via pilot testing (e.g., "What are the most important political issues in American today?"). Some researchers choose to include only object-type concepts (e.g., brands), while others mix object-type concepts and attribute-type concepts (e.g., brands, plus "expensive," "sweet-tasting," etc.). Caution--in the latter case, you sometimes get two bunches of concepts: The objects and the attributes.
3. Whether or not to use an ideal point in the data collection (e.g., Me, My purchase, My preference, My vacation, The Best, Good, etc.). The choice of wording of this ideal point matters (Neuendorf et al., 1987).
4. Whether to collect data as similarities or preferences. This decision may be related to #3. See Hair et al. p. 559 for a discussion.
5. What measure of proximity/similarity/preference will be used--bounded paired comparison, unbounded paired comparison, "confusion" data, correlations, etc.
6. In collecting the data, you may choose between decompositional (attribute-free) and compositional (attribute-based) approaches (see Hair p. 555). The compositional way is, in my opinion, flawed, and rather defeats the whole idea of MDS.
7. In collecting the data, whether to also measure "external" attributes that can then be correlated with the emergent dimensions to help you "make sense" out of the dimensions. This introduces a little of the value of the compositional method, without contaminating the paired-comparison ratings with the researcher's judgments. The external attribute measures should *follow* the paired-comparison ratings in the questionnaire.
8. Whether or not to aggregate the data. MDS is unique in its ability to provide single-case solutions. However, aggregating the data is most common.
9. In GALILEO, if you have more than one "space," whether to rotate them to congruence in order to see a conservative indication of how concepts have "moved" between the spaces. GALILEO even allows you to specify "stable" and "free" concepts for such a rotation.
10. In SPSS, how many dimensions to specify (max=6). You may use a dimension-by-stress evaluation, much like a scree test.

Statistics: (There are few "real" numeric statistics.)

1. The perceptual map--not really a statistic, but it's the main feature of MDS.

For SPSS, you need to copy the 3-dimensional coordinates to a new data set, and then run Graphs → Interactive → Scatterplot in SPSS 12 or Graphs → Legacy → Interactive in SPSS 13 through 17. For SPSS 18 and beyond, run Graphs → Legacy Dialogs → Scatter/Dot → 3D Scatter (you can move the graph around by using "Rotating 3D Chart" in Chart Editor, using a little "hand" to

manually move the map).

In GALILEO, you must submit the saved .CRD file to TV32 (Thought View 32), another program produced by the Galileo Co. TV32 allows on-screen manipulation of the map's orientation, and even has a 3-D option (bring your 3-D glasses).

2. The map's dimensionality (decompositional model)--Hair et al. call the interpretation of dimensions "more an art than a science," a subjective judgment based on common knowledge about the concepts in the map. If "external" attribute variables have been measured, you may examine correlations between the "external" variables and concept coordinates on each dimension. This makes the interpretation of dimensions more "objective," according to Hair et al.
3. Stress measure--available in SPSS, not in GALILEO. Indicates the proportion of the variance of the interconcept distances that is not accounted for by the MDS solution (with its certain number of dimensions). In GALILEO, the proportion would be 0%, because it calculates as many dimensions as concepts, and accounts for 100%.
4. Warp factor (yes, a la Star Trek)--available in GALILEO, not in SPSS. Larger values indicate a greater importance or presence of imaginary dimensions (those dimensions with negative eigenvalues, accounting for non-Euclidean relationships among concepts). Warp is calculated by dividing the sum of the real eigenvalues by the sum of all eigenvalues (real and imaginary).

#### Selected references:

Kruskal, J. B., & Wish, M. (1991). *Multidimensional scaling*. Beverly Hills, CA: Sage.

Neuendorf, K. A., Kaplowitz, S. A., Fink, E. L., & Armstrong, G. B. (1987). Assessment of the use of self-referent concepts for the measurement of cognition and affect. In M. McLaughlin (Ed.), *Communication Yearbook 10* (pp. 183-199). Beverly Hills, CA: Sage.

Woelfel, J., & Fink, E. L. (1980). *The measurement of communication processes: Galileo theory and method*. New York: Academic Press.

Sample MDS paired-comparison questionnaire page :

For each pair of concepts below, please indicate how far apart or near to one another you perceive them to be. If you feel they are identical, put a zero. You may put any number you wish.

Use as a reference the concepts "red" and "white". If these two colors are 100 units apart, how far apart do you perceive the following concepts to be? Remember you can use any number you wish (i.e., it can be above 100).

America	&	capitalism	_____	units
forefathers	&	hero	_____	units
democracy	&	militia groups	_____	units
revolution	&	capitalism	_____	units
corrupt	&	America	_____	units
criminal	&	militia groups	_____	units
hero	&	capitalism	_____	units
America	&	democracy	_____	units
capitalism	&	forefathers	_____	units
militia groups	&	America	_____	units
hero	&	revolution	_____	units
criminal	&	capitalism	_____	units
forefathers	&	corrupt	_____	units
capitalism	&	democracy	_____	units
militia groups	&	revolution	_____	units
hero	&	criminal	_____	units
criminal	&	forefathers	_____	units
corrupt	&	militia groups	_____	units
revolution	&	criminal	_____	units
democracy	&	hero	_____	units
capitalism	&	corrupt	_____	units
forefathers	&	democracy	_____	units
revolution	&	America	_____	units
democracy	&	corrupt	_____	units
capitalism	&	militia groups	_____	units
hero	&	corrupt	_____	units
militia groups	&	forefathers	_____	units
forefathers	&	revolution	_____	units
democracy	&	criminal	_____	units
America	&	hero	_____	units
corrupt	&	revolution	_____	units
revolution	&	democracy	_____	units
America	&	forefathers	_____	units
militia groups	&	hero	_____	units
criminal	&	America	_____	units
corrupt	&	criminal	_____	units

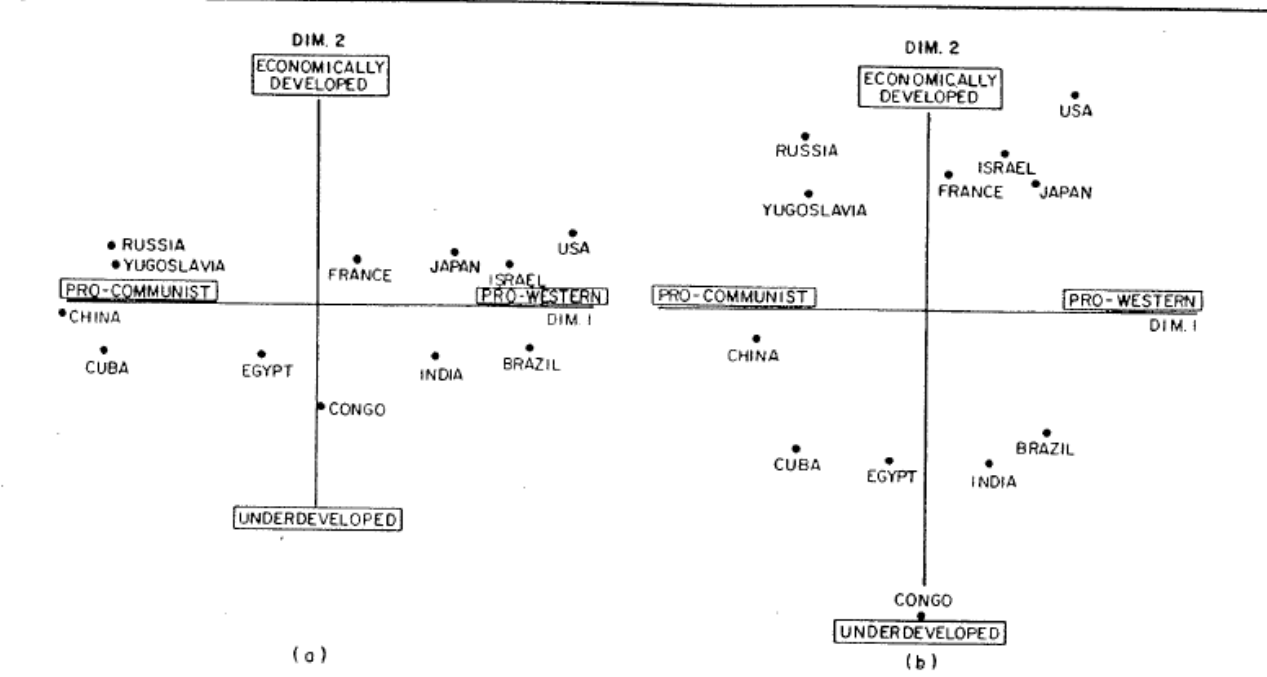


Figure 21: "Private" Perceptual Spaces for Subjects 17, a "Hawk," and 4, a "Dove" are shown in (a) and (b) Respectively. They were Obtained by Applying their Weights on Dimensions 1 and 2 to the Dimensions of the "Group Stimulus Space" (Figure 20).

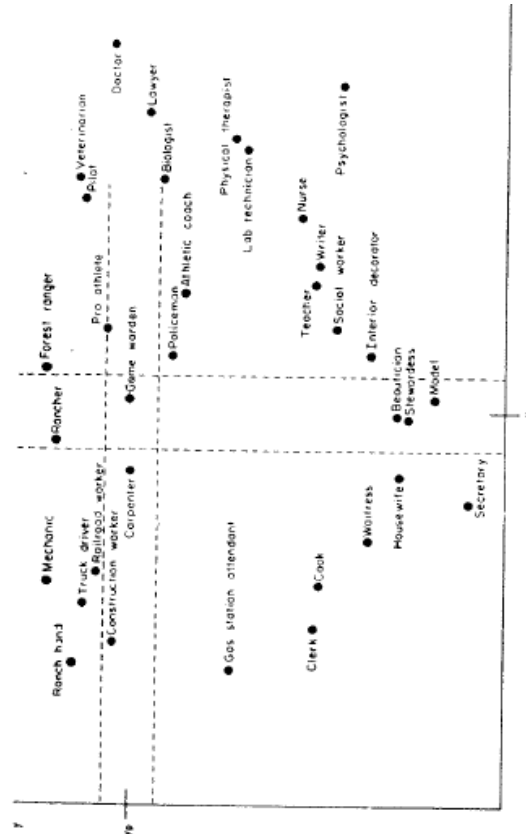


FIGURE 9.2 First principal plane of a set of occupations (following Saltiel, 1978).  
 $x_p = \sum_j b_j x_j + \epsilon_x$ ;  $y_p = \sum_j b_j y_j + \epsilon_y$ .

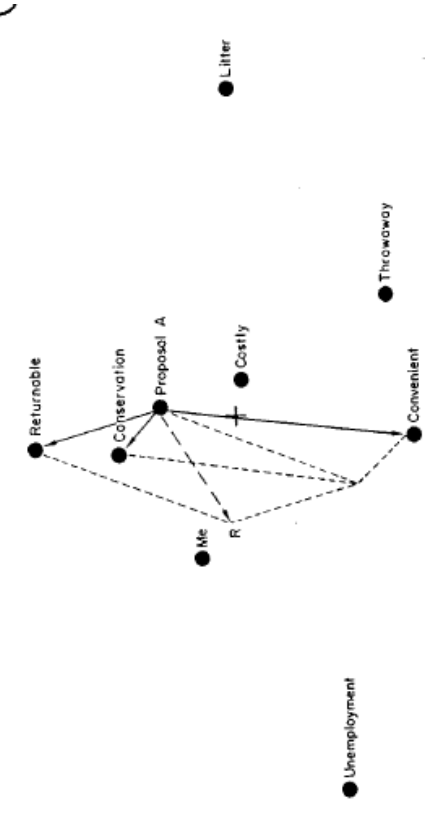


FIGURE 9.5 Best messages for a referendum.

Sources: Figure 21 taken from Kruskal and Wish (1991); Figures 9.2 and 9.5 taken from Woelfel and Fink (1980)