APPENDIX

A Strategy for Dimensional Analyses

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There are numerous approaches to the problem of data reduction, that is, to reducing the data collected from a long list of variables (items, scenes, etc.) to a more manageable set of grouped variables or domains. One reasonable and popular approach is based on one's a priori notions of the topics under investigation. One might, for example, give each resident a score for those items dealing with "privacy," based on the criteria that were used to construct the questionnaire in the first place. A rather different set of approaches is often called "empirical," that is, based on the responses that were obtained. These empirical procedures are the objects of much debate and the recipients of considerable mathematically sophisticated attention. Whether they be called "factor analysis," or "multidimensional scaling," or variants of these, they share certain properties: they start from the collected data, transform these by a series of mathematical steps (algorithms), and yield groupings of items (or of whatever the "variables" of the data set were). The bases for the groupings are the consequences of the algorithms, and can therefore differ considerably as a function of the dimensional procedure that is used. It is little wonder that a considerable debate has arisen around the issues of the differences among the available procedures. This is not the place for an explanation of these analytic procedures. Among others, Shepard (1972) and Golledge and Rushton (1972) provide recent and illuminating discussions along these lines. It is, however, appropriate to point out that any particular analytic method cannot reveal the whole "truth." Especially because the mathematics of these procedures is well beyond the comprehension of most of their users, faith becomes an important component of the data analysis process. But faith and truth may not be perfectly correlated!

One way to keep sight of the fact that dimensional procedures are only approximations to "truth," is to use more than one of these procedures. By selectingtwo procedures that use distinctly different algorithms and attempting to resolve conflicting messages in the ensuing solutions, one cannot help but remember that any procedure is dependent on its rule system. Of course such a procedure raises several new problems and we do not now have a well-formulated rule system to guide the ultimate selection of dimensions from these diverging sources. Having followed this procedure for some time (cf., Kaplan, 1972; 1974), certain criteria have evolved: (1) any particular item should be included in no more than one dimension. (Ideally, items that seem to "fit" more than one dimension are included in none of them since they would introduce nonindependence.) (2) each of the dimensions should "hang together." One useful measure of this criterion, Cronbach's coefficient alpha, is an index of "internal consistency" (cf. Nunnally, 1967; Scott, 1968). (3) the dimensions should be meaningful to the investigator. No amount of mathematical "magic" must be permitted to replace the investigator's use of his own head. If the dimensions are not reasonable to him, it may well be an indication that the variables sampled in the study were inadequate; perhaps one should start over. Regardless of how elegant and well-formulated the mathematical procedure is, the interpretation of the groupings of variables is necessarily left for the investigator.

In a sense this is a heretical view. But in another sense, it is no more heretical than the construct validation position (Cronbach & Meehl, 1955; Bohrnstedt, 1970). In research dealing with environmental design (and more generally, in much of the behavioral science field), the purpose of each study is to increment our knowledge and understanding; not only do few studies serve to disprove a specific "strong inference" (Platt, 1964), but it would be inappropriate to expect them to. The concepts under study are generally broad, multi-faceted entities for which a single operational definition is out of the question. The very multidimensionality of these constructs leads to the need for a range of measures and consequently to the use of multidimensional scaling procedures. But the use of these methods is no substitute for external validity and that, necessarily, requires a series of studies rather than a single, vast one.

By advocating the use of two different procedures and the consequent tension they create in suggesting "truths," I do not mean to imply that any two methods are equally useful. Many criteria enter the decision as to which dimensional procedures are appropriate. The most compelling criterion for me has been the most pragmatic one: Across a very divergent set of studies, using a great variety of stimuli, the two procedures described here have led to meaningful, understandable dimensionalizations. Many other procedures have not withstood this test. In particular, conventional factor analytic procedures have often failed to yield meaningful results, and worse yet, have led to extremely different results with minimal changes in the set of variables.

The Guttman-Lingoes Smallest Space Analysis (SSA-III) is a nonmetric factor analytic procedure. As Lingoes (1972) describes it, it is a "monotone vector analysis." Both in that paper and in the many others he cites there, Lingoes has provided a mathematical glimpse of the algorithm. At a more intuitive level, the SSA-III transforms the correlation matrix based on the data to a rank-order matrix. In other words, this procedure "throws away" available metric information and proceeds through basically factor analytic steps using the ordinal data. The effect of this process, in my experience, has been greatly increased stability in the solution: Using the same instrument (questionnaire, set of slides, etc.) with differing samples of people, the dimensional solutions have shown marked stability.

The other procedure we have used is a hierarchical cluster analysis named ICLUST by its originators (Kulik, Revelle & Kulik, 1970). It is a metric procedure, transposing the original correlations to proximity coefficients (coefficients of collinearity, Tryon & Bailey, 1970), which reflect a correlation pattern or profile of two variables. Among the advantages of this procedure are its efficiency (uses very little computer time), its spatial display, and that it provides information about the alpha coefficient of internal consistency.

The intent of this brief description is to provide the rationale for an approach to data analysis that is intuitively meaningful and general enough to be applicable to a wide range of research problems. Many important issues dealing with multidimensional scaling and factor analysis are not touched upon, and the algorithms for the two methods that are favored are also not done justice. For these the reader will have to look elsewhere.

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