

A Technique for Comparing Mental Maps*

Peter D. Killworth**
Cambridge University

H. Russell Bernard†
University of Florida

1. Introduction

What do social networks *look* like, and how do we find out? How do people store their social networks in their minds, and how do we find out? In our recent experiments (Killworth and Bernard 1978; Bernard *et al.* 1982) we found that only six pieces of information were useful for defining network connections between an individual in the U.S. and the rest of the world. Predominant amongst this information was the geographical location of the members of any individual's network. This effect was so striking that we concluded that people store their social networks at least partly on the basis of location or geography. One way to find out if this is the case is to somehow draw a 'mental map' of people's networks.

The most common technique for 'mental mapping' is to actually ask people to draw a map (see Saarinen 1973). In a recent review of the literature on environmental cognition, Evans (1980) has noted that drawing tasks are difficult to work with. Nevertheless, pencil and paper techniques do produce a great deal of inferential data; Saarinen found, for example, that the respondent's own country was emphasized in size, centrality or detail.

In spite of this, Evans' critique remains valid; furthermore, as Robinson and Dicken have pointed out, maps drawn by respondents are not strictly comparable to one another. They proposed using a completion test (the Cloze procedure) because such tests are "better suited to the examination of specific elements in the image than to its holistic reproduction" (Robinson and Dicken 1979:353). In any event, none of these techniques produces a map which is intended to represent how people store their social networks.

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**Department of Theoretical Physics and Applied Mathematics, Cambridge University, Cambridge, England CB3 9EW.

†Department of Anthropology, University of Florida, Gainesville, Florida 32611, U.S.A.

In this paper we present a technique that allows mental maps of the world to be drawn from data on people's cognition about network relations. The technique produces both a 'holistic reproduction' as well as specific elements that can be strictly (that is, numerically) compared. We have produced two social network maps so far, one based on networks within the U.S., and the other based on informants' world networks. The U.S.-based network picture strongly resembles a geographic map of the U.S. Similarly, the world network map, to be discussed in this note, looks like a Mercator projection. Both maps are distorted. But the technique we present permits the systematic study of distortion in mental maps. That is, the difference between any mental map and any objective map (a Mercator projection, for example), or the difference between two or more mental maps (where both, presumably are distorted) may be observed. This opens the way to a systematic, cross-cultural study of how people store their complex social networks in their minds.

2. Construction of the map

Robinson and Hefner (1967), in a little-appreciated but excellent article, compared the 'perception of nations' among academics (University of Michigan) and the general public (a sample of the Detroit Area Survey). Their results showed that both groups conceived of nations along the same dimensions (communist-noncommunist, developed-underdeveloped, etc.) but that the groups differed in the prominence of the dimensions. Their data consisted of "assessments of 'similarity' between seventeen countries of the world" (Robinson and Hefner 1968:274). Thus it is not surprising that there was no spatial significance to their results. However, even if we obtained data on cognized 'distances' between selected pairs of points (countries, for example), we should not expect much spatial significance to emerge. Respondents' estimates of distances between countries are likely to differ violently from one another.

After all, few Europeans or Americans are likely to be able to estimate the distance from Moscow to Peking within a thousand miles. The errors involved, therefore, in constructing a world mental map are likely to be larger than those for a mental map of a city or a single country, at least in absolute terms and possibly in fractional terms. In other words, an error of 100 miles in an estimate of New York-Chicago distance (about a 12% error) is less than a 1000 mile error for Moscow-Peking, as well as being less than the fractional error (about 25%). On the other hand, it would certainly be interesting to generate a series of mental maps of the world in this way, and to compare them between cultures.

As an initial step, we used a technique first introduced in a paper concerned with who people know and why they know them. Our population consisted of 58 persons (solicited by newspaper advertisements) in Morgantown, West Virginia. Details of the sample are provided in Killworth and

Bernard (1978). In the conclusion of that paper, we constructed a map of 100 *people* (not places) in the U.S., and then interpreted the map as a collection of places, by simply identifying each of the 100 people with the location in the U.S. where he or she lived. Indeed, it was those successful results which prompted this note, since the resulting map had closely resembled a distorted map of the U.S.

The idea is straightforward. Suppose that we have a list of people ('targets') living around the world. The list may be of existing (ordinary) people, or of fictitious (ordinary) people. For obvious reasons, famous names are excluded. Each person on the list is specified by a name, a location (town and country) and an occupation. This list is presented to a collection of informants. For each name on the list, each informant specifies a 'choice', whom he or she knows, who is most likely to know the target by name, or most likely to know someone who knows the target by name, or ..., etc., with the projected chain being as long as necessary. The selected name is recorded. (In the 1978 experiment, more information was recorded. We are here simplifying the information necessary for the map.)

People often specified the same acquaintance as most likely to know several different targets: on average, informants generated 35 different people known to them for a list of 100 foreign targets. This degree of overlap suggests that much of the world population is viewed as 'equivalent' or 'similar', at least by our informants. Furthermore, this overlap allows us to create a symmetric matrix of similarity coefficients S_{ij} between each of the $\binom{100}{2} = 4950$ pairs of targets i and j . These coefficients are defined to lie between zero (for a pair of targets perceived as quite dissimilar) and unity (for a pair of targets perceived as identical) by

$$S_{ij} = (\text{number of informants who make the same choice of person for target } i \text{ and target } j) / N$$

where N is the total number of informants in the experiment, here 58.

The matrix S is now processed by using a multidimensional scaling routine, which allocates the targets' coordinates in a two-dimensional space, so that similar targets (for which S_{ij} is high) are close together, in a Euclidean sense, and dissimilar targets (for which S_{ij} is low) are far apart. The result, after 50 iterations, is shown in Fig. 1.

3. Results

In Fig. 1, the *country* of each target name has been plotted in the location allocated by the multidimensional scaling routine. Remarkably, targets living in each major geographical area of the world have been assigned clearly distinct sub-areas of the two-dimensional space, as indicated by the dividing lines sketched in Fig. 1. The placement of the dividing lines is, of course, subjective, and there are a number of minor inconsistencies. But no matter how an analyst might place those lines, the spatial significance of the map is

clear. There is only one major 'exception' among the 100 targets: one of the four instances of Iran is placed to the 'east' of Vietnam. (The experiment was performed before American hostages were taken in Iran. Would the misplacement of this Iran target occur today?) The omission of Australia and Scandinavia, and the overappearance of certain countries in Fig. 1 results from a flaw in the original experiment (Killworth and Bernard 1978), which was designed to concentrate mainly on U.S. targets. We shall comment on the role of the U.S. targets below.

The resemblance of the 'map' in Fig. 1 to a traditional Mercator projection is rather striking. There are distortions, of course. There appears to be a hefty intervening Atlantic between South America and Africa (joined at their N.E. and N.W. corners), but there is a band of Eastern European countries (a quasi-Iron Curtain?) between West Germany and other Western European countries. (This may indicate the perception of strong military ties between the U.S. and West Germany through NATO, and the presence of many U.S. citizens in West Germany.)

Within each major world area, the scatter of placement of countries is quite large: Chile is placed 'north' of Venezuela; and all five occurrences of France are 'east' of all seven occurrences of West Germany. However, there is a strong tendency for the targets in north African countries (Egypt, Algeria, etc.) to appear generally 'north' and 'east' of other targets in Africa. Targets in Africa and Asia are very compressed (that is, perceived as similar), whereas those in the European and Far Eastern areas are more widely scattered (that is, less similar).

Overall, then, there is a strong suggestion that people in the U.S. perceive the rest of the world in a manner consistent with a Mercator projection. In this projection the U.S. is on the left, and the Far East is on the right. This ceases to be the case, however, if targets in the U.S. are included in the multidimensional scaling. When we added 50 U.S. targets to the 100 foreign targets, and recomputed the 150×150 matrix S , the results were very different. Because of the strong differentiation between U.S. targets (where location *and* occupation are important variables in allocating a 'choice' of intermediary) these targets are perceived as 'more dissimilar' than the foreign targets. The 'map' thus produced resembles a capital C, comprised entirely of a wide band of U.S. targets, and a central mass of 100 foreign targets within the 'jaws' of the C. There is, furthermore, little observable structure within the foreign targets; this is because the scaling routine is forced to place the fairly similar collection of foreign targets close together in order to be able to reflect the widely differing U.S. targets properly. As a result, the differentiation within the foreign targets is largely lost.

4. Discussion

This mental map raises some interesting questions about the way in which informants may store some aspects of their social networks. The map

suggests a direct way to create a measure of the difference in the way social networks are stored by informant aggregates in different cultures. First, we would create a list of 100 targets, each from a different country, now including the U.S. Then we would perform the experiment described in this note, using such a list, on informants from various cultures around the world. Each experiment would produce a single map, and it is safe to assume that all the maps would be distorted. Presumably, the distortion is not random but is systematically related to differences in human populations. What are the significant differences? Language? Geographical location? Level of literacy? Population density? Milgram (1973) notes that we do not learn what the world looks like from our experience of it, "but by formal schemata of it as represented in maps and atlases". Children in the U.S., Britain, South Africa and New Zealand are all taught geography in English; but the 'objective' maps they are shown in school may place their own country in the center. Does this result in systematic differences in mental maps of social networks? The possibilities are intriguing. Any of these factors may be related to how people store their social networks. But no matter which of these factors accounts for how people *do* store their networks, those networks must be learned in the first place.

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