ON MENTAL MAPS

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"Can geography be mixed up with psychology...?"

Luigi Barzini, The Italians

At the start of this limited enquiry into the mental images that men have of geographic space I offer you no theories or even explicit hypotheses. On the contrary, you will find only unstructured, intuitive hunches, and interpretations pushed, in many cases, beyond the limits that the data allow. Of these speculations, for, indeed, this is what they are, many will undoubtedly be wrong. They will have served their purpose, and more, if they stimulate others to replace them with better notions. As usual, what we really need are more penetrating questions, but before these can be asked we must record what we do and do not know. The boundary of ignorance is not very far away, but it seems only sensible to stoke it out before we try to cross it. We know so very little about the spatial images, the mental maps, that are in the minds of men. We know even less about how they are formed, the degree to which they are unique or general, and the way they impinge upon, and are reflected in, the decisions that men make. As human geographers reach out across traditional disciplinary boundaries to the other social and behavioral sciences, it is increasingly apparent that the truly satisfying explanation they seek is going to come from emphasizing the human as much as the geography. We may, perhaps, define our subject as essentially that which tries to understand the spatial aspects of Man's behavior. If we grant that spatial behavior is our concern, then the mental images that men hold of the space around them may provide a key to some of the structures, patterns, and processes of Man's work on the face of the earth. The emphasis upon the conditional tense is quite deliberate, and is only partly a result of intellectual cowardice and a general propensity to broadcast caveats in lieu of signing academic insurance policies. The other reason is that we really do not know

1. For an interesting and rather similar view in history see: Lee Benson, "Causation and the American Civil War: Two Appraisals," History and Theory, Vol. 1, 1961, p. 163.

whether mental maps are relevant to our problems. But the suspicion that they are is strong, and at the very least it seems worthwhile making some tentative probes along these lines.

**Images and Decisions**

The human landscape, in reality, or abstracted and modelled as a map, is nothing more, but equally nothing less, than the spatial expression of the decisions of men. As we examine even the most apparently superficial spatial patterns and processes that are a reflection of these decisions, we quickly become aware of the extreme complexity that underlies them, the myriad of variables that compete for attention, and the way in which these form interlocking and convoluted structures that are numbing in their difficulty. Many of the decisions that men make seem to be related, at least in part, to the way in which they perceive the space around them and to the differential evaluations they place upon various portions of it. For the moment this is a bald and unsupported assertion, but it seems reasonable that the manner in which men view their spatial matrix impinges upon and affects their judgements to some degree. For example, men decide to migrate, not on a regular surface of equal opportunity or desirability, but in a world often perceived in an extreme, differential manner. Men decide to grow crops and raise animals for their sustenance, not in an arbitrary way, but in part according to their particular views of the space around them. Men decide to locate their industries and business activities, and with more and more "footloose" industries coming onto the scene we are finding that traditional location factors are declining in importance. Törnqvist, for example, has indicated the virtual irrelevance of distance for some industries in Sweden, and in this country Harris's classic paper indicated the vast area in the American Manufacturing Belt that lies around the point of minimum transport cost with only slightly higher access costs to the market. Even traditional Weberian analysis discloses a basic characteristic of many extremum problems, with a large area of only slightly higher aggregate cost around the minimum point. What Rufus Isaacs has termed the "principle of flat laxity" seems to be operating extensively in geographic space, and takes on new meaning as we become critically aware of what satisficing behavior in a spatial context implies. Thus, in view of the decline in importance of the more traditional location factors, might not the decision to locate be increasingly related to the image an area has in the minds of a few key people? More and more the quaternary industries, the research and development companies, look to the scenic and recreational facilities, cultural assets and intellectual resources of an area. Snow and mountains are not essential.

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has shown how shape distortions can focus the eye upon a particular portion of the map, and Mackay had a map in the late fifties showing Canada through French-Canadian eyes. Unfortunately, it was never published. In a related field, only Lynch, as an urban planner truly concerned with the city as the home of man, has systematically investigated the differential images of the urban landscape, and in his most imaginative series of maps we have our only notions of these mental pictures.

The literature in other fields is equally sparse. The psychologists, in their concern for "Perception," have barely touched upon the investigation of mental pictures of geographic space, for many of their efforts have concentrated upon the physics and physiology of the senses, often within highly controlled laboratory conditions. For example, the space with which Sandström was concerned was far removed in scale from geographical space, and his insights on disorientation and loss of criteria for making locational judgements under formal experimental situations is hard to carry over in any meaningful sense to world scales. Even Hull's work, though a source of extremely stimulating analogy, does not deal with the larger space of the earth's surface. Nor did the swing of some psychologists to the Gestalt outlook produce a shift in the focus of their concern, and the discussions of space by this particular school do not really deal with the larger area of the earth's surface which is the geographer's realm. Though the pioneering work of the child psychologists Piaget and Inhelder is directly concerned with the way in which children learn about space, the world around them, and geometrical and topological concepts, it does not deal with the essentially geographic images that children hold or the way they learn about them. Only Trowbridge's paper on imaginary maps, written half a century ago, specifically raises the question of the spatial images people carry around in their heads. Unfortunately, this line of investigation was never followed up, and his paper represents the solitary gold nugget at the bottom of the psychological pan. The rest is a residue of vaguely structured insight that hardly rewards the effort of panning it out from the ground material.

In other areas the prospect is equally bleak. The mythical space of Cassirer, though treated as a mental construct, seems less than useful to the geographer, and the Weltanschauungen or world views that have been discussed by other philosophers may be splendid flowers of many hues, but they are difficult to transplant into the hard earth with which the geographer deals.

13. Forrest Pitts, private communication.
to certain well-known electronic companies, but New Hampshire and Colorado are undoubtedly grateful for their physiographic and climatological inheritance. Similarly, large universities in pleasant surroundings are the locational roadstones for the research and development consultants. It is not difficult to think of many other examples where the maps that are carried in men's heads might be relevant in quite crucial ways.

What Do We Know About Mental Maps?

Man's view of geographic space is extremely varied, and the views of individual men are always in part unique. Entering into the particular outlook of a particular man are a host of experiences, prejudices and desires, some shared widely with others, some quite specific to the individual. The Northerner is reluctant to be assigned by his company to the South, for he holds to a mental picture that is part of his northern cultural inheritance—an inheritance absorbed in childhood, and reinforced by his daily sources of information. The townsman, comfortable and safe amidst the roar of traffic and bustle of urban life, is reluctant to live in the green peace of the country, which he associates with the stillness of bucolic decay. The New England family, suddenly presented with greater economic opportunity amongst the tall trees of Oregon, decides to stay with the known view and the familiar friends, for "Oregon is such a long way from civilization." Thus, the political, social, cultural and economic values held by a man blend into an overall image about the space around him, an image whose components may be particular to him or held in common by many.

It hardly seems necessary to add that we know very little about these spatial images in the minds of men. While a concern for the mental maps of geographic space is nothing new, the literature is extremely sparse. We only have a very small number of examples where they are discussed at all, usually as interesting, but definitely peripheral points in larger investigations. For example, Tobler explicitly raised the question of the mental images that people have of their environment, but his basic concern was for the mental transformations of distance that people make. Lowenthal and Prince have discussed the attitudes of people towards the visual landscape, while the former, in a synthesis that has yet to be equalled, has examined the relevance of the psychological literature in this area. A number of other geographers have focussed upon the perception of environmental hazard and the spatial implications that such images have for locational decisions. In political geography, only Herman seems to have moved beyond fuzzy speculation to investigate truly the changing values and attitudes of a people towards the national space. Occasionally maps such as the "New Yorker's View of the United States" appear, but their humorous context actually obscures the fact that such cartograms of mental images can be extremely illuminating if properly used.

The Question of Uniqueness and Generality of Viewpoint

Because the total experiences of individual men are unique it might seem, at first glance, that they perceive the world around them in quite distinct, totally individualistic ways. But, if this were really so, it would be impossible to say anything of general, and therefore, of scientific worth about their spatial perception. Though this statement may sound almost tautological, it does raise, by jarring our commonsense experience, the notion that the views of men are not, in fact, totally disparate. We may disagree with some about the desirability or undesirability, the beauty or ugliness, of a particular place, but we can be almost certain of finding someone whose "view from the bridge" closely parallels our own. Perhaps, then, this is the key: a portion of our viewpoint is quite particular to ourselves, while another part is shared, or held in common, with many of our fellows.

Given some information about the preferences of a group of people for various portions of an area, we require a way of separating out the general or shared portion of their perception from that which is quite specific to them individually. Putting it another way, we would like to partition the total variation in space preferences for a given sample of people into those portions that indicate general or common viewpoints, and those that represent unique portions that may be assigned to individuals themselves. It is for this reason that the problem has been approached through principal components analysis.²⁰

In all the examples that follow, people were asked to provide rank order listings of their preferences for various areas. The question was posed in the context of residential desirability with "all other things being equal." For example, in the United States, students were asked to imagine themselves married and settling down with a family with complete freedom of location according to their own particular views as to what was desirable. Thus the basic data consisted of a matrix whose rows represented the states—while the columns represented people. Each column contained the rank order values that a particular person had assigned to places in the rows, so that in a crude sense each person became a variable upon which the residential desirability of a place was measured.

Clearly, if two people held very similar views that rank order lists would match quite closely. Thus, the whole basic data matrix may be summarized by a smaller matrix of rank correlations (Figure 1). It is upon such matrices that the principal components analyses are performed to break out the underlying structures of space preferences in terms of a smaller number of dimensions or components. By definition, such dimensions are unrelated to one another, because we are imposing an orthogonal structure upon the data;²¹ and they may be


Figure 1: Steps in the construction of the component maps.

1. Map Information About Individual Space Preferences
2. Rank Order Matrix
3. Same Information Expressed in Correlation Matrix as a Cluster of Unit Length Vectors
4. Correlation Matrix Expressed as a Cluster of Unit Length Vectors
5. Vector Cluster Skewed by Major Axes (Components) of Enclosing Ellipsoid
6. Matrix of Loadings: Orthogonal (Right-Angled) Projections of Unit Vectors on Major Axes
7. Calculation of the Scores of Areas on Main Components
8. Scores Plotted To Form Most Parsimonious Summarization of the N Individual Maps
thought of as independent scales upon which the areas have particular values or component scores. Thus, to summarize, the maps are constructed from scores on an orthogonal principal components structure, which is merely used descriptively as a statistical summary device, to see if we can break apart and simplify the structure underlying the views and values men hold and place upon geographic space.

The Perception of Residential Desirability in the United States

Apart from turning their attention temporarily on particular places during times of physical or human crisis, perhaps most people in our highly mobile society perceive and think about the geographic space called the United States in terms of residential desirability. At the state universities of California (Berkeley), Minnesota, Pennsylvania, and Alabama,22 students in beginning geography courses were asked to provide rank order lists of the forty-eight contiguous states in terms of their own, quite personal preferences.23

Two problems were recognized. First, the state units were quite gross, and any analysis must be made at an extremely general criterion would then become truly spatial, which, after all, is what it should be.

22. I would like to thank Professors Alan Pred, University of California, Berkeley, Philip Porter, University of Minnesota, and Eugene Wilson, University of Alabama, for distributing the questionnaires to their students.

23. Sample sizes varied from about twenty-five to fifty. While the lower bound constitutes quite a small sample, repeated samples of this size taken at the Pennsylvania State University have indicated an extremely high degree of consistency in the preferences and in the appearance of the final maps. I would like to thank Messrs Marich, Bigelow and Knighton, graduate students in geography at the Pennsylvania State University, for providing me with their seminar exercise results.

macro-level. While it might be better to make the mesh of perception a finer one, either by using county units, or gridding the map with 100 mile squares, such a notion can be quickly dismissed when we realize that people would have to rank literally thousands of areas defined in terms quite unlike those with which they were familiar. At least states, while gross areal units, are familiar objects with quasi-collective images. Secondly, most people faced with the problem of ranking items in order of preference have some immediate, and usually quite strong, likes and dislikes, but there may be a large number of items "in the middle" to which they are more or less indifferent. Thus, instructions were given that where difficulty was experienced in assigning a rank order to a state, that it should be matched against the others in succession with the question in mind "If I had to choose, which would I prefer?" 24 It should be recognized, though, that the middle area rankings will be less valid, although there is little reason to suspect any systematic bias and we can probably regard the effect of

24. In later work people were asked to include and rank in their lists Neutral Points. As an individual compiles a list of states, starting with the most desirable, his initial feelings are positive—he would like to live in the areas he most prefers. Further on down the list, however, his feelings become indifferent, at which point he injects the Neutral Point, assigning it the next rank in the list. Thus the Neutral Point provides a base point for any subsequent scales derived from a principal components analysis. See Harold Gulliksen, "Intercultural Studies of Attitudes," in Harold Gulliksen (ed.), Contributions to Mathematical Psychology (New York: Holt, Rinehart and Winston, Inc., 1964), pp. 62-108. See too his contribution "The Structure of Individual Differences in Optimality Judgements," and Ledyard Tucker, "Systematic Differences Between Individuals in Perceptual Judgements," both contained in Maynard W. Shelley and Glenn Bryan (eds.), Human Judgements and Optimality (New York: John Wiley and Sons, Inc., 1964).
indifference quite legitimately as random noise injected into the data.

The View from California. The surface of perception derived from the first dimension (Figure 2), may be considered a general, overall view of the residential desirability of the United States as seen from California. A ridge of high desirability extends along the entire west coast, with the highest peak of the whole perception surface in California itself. However, the gradient to the east is very steep and there is a clear “Perceptual”

25. Factor scores have been transformed to percentage values relative to the highest score to make comparisons easier. These values were plotted at the approximate center of population of each state, and isolines added to form a three-dimensional “surface of perception”–a useful, if somewhat pretentious notion. This is sheer cartographic license, used without apology, to heighten the visual effect and to provide the concept of gradient.

as well as “Great” Basin with a low point in Utah. Overall, as the view moves eastwards, there is a steady decline in desirability to the Great Plains, with the exception of a local peak in Colorado, and a quite definite “sink-hole” in South Dakota. However, upon reaching the ninety-fifth meridian, the general east-west trend of the perception surface changes radically, for the overall orientation shifts by ninety degrees and a very clear discrimination is made in a north-south direction between the Midwest and the Northeast, where the surface begins to rise once more, and the South, which forms the lowest perceptual trough of the entire surface. Alabama, Mississippi, Georgia, and South Carolina, with their images of civil and social unrest, are the last places in the country for California’s students. Only Louisiana is perceived as a slightly more desirable place of residence, but even here
Indeed, the Minnesotan seems all too aware of his western neighbor, and is most reluctant to trade his "land of sky-blue waters" for the dry flat dreariness a few miles to the west. The steep decline in the surface to the flat country of Iowa reinforces an impression of spatial chauvinism, although to the east Wisconsin appears quite acceptable for residential purposes. Once again, the general west to east trend shifts ninety degrees around the one hundredth meridian, and a low trough, centered in Mississippi and Alabama, blankets the South. Florida is again an exception. Northwards the isopleths rise, twisted by the West Virginia (Appalachia) distortion, and the Midwestern and New England states bask in residential acceptability with almost uniform values in the sixties.

**The View from Pennsylvania.** Perhaps more cosmopolitan than the Minnesotans, or set on edge by their rural location at the point of maximum inaccessibility, students at the Pennsylvania State University are seduced by the Californian siren to form the only sample in which the perception point is not the most preferred (Figure 4). Otherwise the surface is almost identical in general form to the Californian and Minnesotan examples. Once again, the perceptual ridges and basins of the West are repeated, and the South is the lowest, or least desired part of the country.

**Alabama: Different Values and Different Views.** Apart from local peaks of desirability, the three northern and western viewpoints are virtually identical. It is almost as though we had the same perception surface drawn for all three upon a rubber sheet and could reproduce the exact surface by moving a tennis ball beneath it to form, or reinforce, the local point. However, the view of the college student from Alabama, while sharing one or two points of similarity in the West,
is generally quite different (Figure 5). The high peak of the surface is centered at the point of perception once again, but whereas the previous three samples tended to lump the "South" into a single low trough, Southerners appear to perceive the area with a high degree of spatial discrimination. Most noticeable is the very steep gradient down to Mississippi in the west: there seems to be little love lost between the two states that Northerners tend to place together, possibly because of the extreme violence associated with the civil rights movement in that state. A fairly high degree of discrimination is also apparent between South Carolina and North Carolina. While California's politically and socially concerned students did tend to single out the former, generally the difference in desirability perceived by the northern students between these two states was not marked. Southerners, on the other hand, with a more intimate knowledge of this area, place North Carolina on par with gentle-manly Virginia and Kentucky, while assigning the southern neighbor the next-to-lowest score in the whole South. With the effect of the Civil War still being handed down in the minds of men one hundred years later, the surface falls away rapidly to the northeast, with a very steep gradient along the Mason-Dixon line. North of this historic divide, there is considerable perceptual homogeneity with all the Yankees lumped together in Southern minds, just as the Northern viewpoints blotted out and homogenized possible differences in the South. Such disparagement is shared by the Midwest and the whole set of northern states as far as Washington and Oregon on the Pacific. Northern, remote and blizzard-ridden, with only eye-straining horizons of waving wheat, the Dakotas are the last place in America for the college-bound Alabaman. In the West, only the Californian ridge and

Figure 5. The view from Alabama: the first dimension.
the Colorado peak appear, though less strongly than in the other examples. It is interesting to speculate upon the reason for the sinkhole in New Mexico, compared with the high value of Texas (still in the South), and Arizona (Goldwater country in the election year, shortly after which the sample was taken). What mental image does the word “Mexico” conjure up for the white Southerner that so reduces the desirability of this state far below its neighbors?

Questions and Speculations

The remarkable degree of similarity in the mental maps held by the Californian, Minnesotan and Pennsylvanian samples raises the question of the degree of perceptual homogeneity within the groups themselves. The proportion of the total variation explained in each case by the first component does not vary radically (Table 1), but the differences, if they do not simply arise from sampling fluctuations, are intriguing. Pennsylvania possesses the highest degree of perceptual homogeneity, closely followed by Minnesota, while Californian students appear to agree the least about places of residence. Perhaps this is because the University of California at Berkeley draws upon a more heterogeneous population for its student body, while the state of California itself receives large numbers of migrants from other states in the Union. Surprisingly, the sample with the least homogeneity of outlook is Alabama, and we might postulate a sort of spatial schizophrenia, for while the most dominant portion clings tightly to Alabama, and shares a mental map that discloses all the century-old cliches about “Yankeeism,” the rest are split in their views with little agreement between their mental images.26

Other questions also emerge from an examination of the maps based upon the first component scores. One of these is the effect of size on the ordering process. While it has been postulated that in viewing a map our minds act as a high pass filter, so that small-scale features are accentuated,22 it is worth noting that Rhode Island is consistently lower in overall score than its New England neighbors. Does it really have the image of a less pleasant place to live than nearby Massachusetts and Connecticut? Or is it, in fact, so small that people tend to forget about it, and in partially overlooking it assign a lower rank to it than it might otherwise receive?

Another source of possible bias could result from the propensity for people to group together things that are spatially contiguous.28 It would be difficult to design a watertight experiment to get at this effect if it existed, but one approach might be as follows. Identical maps of the United States could be given to two groups (one the sample, the other a control), and data obtained on the space preferences. At a later time, the experiment could be repeated with the control group getting the same map as on the first run, while the sample group would receive a “map” showing the outlines

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26. Since the sample was confined to white students it would be highly desirable to examine the mental maps of negro students in the same area. The viewpoints might not be identical.
of the states located in a random, and non-contiguous fashion. The successive canonical correlations between the control groups' data sets should be very high, while the same correlations between the sample groups' contiguous and non-contiguous sets should be significantly lower if a contiguity effect is operating. The inferential question of the significance of the difference between two successive canonical correlation analyses, even if the usual statistical assumptions are regarded as plausible, seems worth pushing.

Finally, the question of indifference must be raised once again. By requiring each person to insert and rank a Neutral Point in his list of preferences we may obtain at least some notion of the severity of the problem. In the one example presently available for Pennsylvanian students, the overall score of the Neutral Point on the first component places it in the twenty-third rank. Thus nearly one-half of the states are generally perceived as positively desirable to live in; a remarkable comment upon the spatial mobility of the present college population. Indeed, the level at which a Neutral Point appears on the overall scale represented by the first dimension may be considered as a measure of the degree of parochialism of the sample group. A Neutral Point high on the first dimension, indicating that people are positively inclined to only a few states, might measure either a high degree of parochialism or a high level of discrimination, depending upon one's own attitudes towards such value-loaded words. We might hypothesize that the degree of parochialism, as measured by the position of the Neutral Point, would be directly related to the average age of the group, and the degree of social and cultural isolation experienced by the people in it.

**The Rise and Fall of a Hypothesis**

Our assumption that indifference exists in the rank orders as random noise makes the interpretation of further components somewhat hazardous. Nevertheless, the remarkable consistency (Table 1) in the proportion of the variance explained by these second scales invites interpretation.

Remembering that the dimensions or scales that we impose in a principal components analysis are orthogonal, and, therefore, unrelated to one another, we might expect that successive maps of perception surfaces should illustrate quite independent concepts about the mental images that men have of geographic space. The view from California on the second dimension (Figure 6) immediately suggests that underlying the overall, general surface (Figure 2), there is another surface, quite independent of the first, that is strongly related to distance away from the point of perception. In fact, apart from a rather awkward contretemps around Oregon and Washington, and small distorting pockets in the Ohio, Kentucky and West Virginia areas, the correlation of the scores with raw, crow-flying distance from California is remarkably high (r = .90). Thus, there appears to be some strong evidence that a distance component is present in mental maps, and that mental images of the differential desirability of geographic space cannot be meaningfully represented on a single, general scale.

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29. I would like to thank Mr. Bruce Marich, NDEA Fellow in Geography at the Pennsylvania State University, for allowing me to use the results of his paper "Space Speaks: Some Metaphysical Roots of Spatial Decomposition," p. 15. In the West, California, Washington and Texas were above the Neutral Point; in the South only Florida was so perceived; while all the states east of Wisconsin and north of the Ohio River were seen as positively desirable.

30. Implying that the rank of the correlation matrix is greater than one. For readers unfamiliar with the geometry of such a notion, there is an
The second perception surface for Pennsylvania (Figure 7) holsters the idea that a distance component is present. Once again the west coast states prove to be exceptions, destroying the fairly regular march of the isopercepts with distance away from Pennsylvania, but even so the correlation with raw distance is significantly high ($r_s = .64$). New England, too, distorts the distance effect and lowers the overall relationship, but the scores vary with such regularity that one has the feeling that if the map were drawn upon a rubber sheet, mere stretching of the space, rather than tearing or inverting it, could raise the correlation significantly. In other words, a spatial transformation, with some rather interesting psychological implications, could disclose a much stronger distance effect than the one crudely indicated by the actual association between component scores and straight geographic proximity.\(^{31}\)

The hypothesis that a distance effect is another dimension to the mental map appears tenable so far. Unfortunately, it is exploded by the next example: Minnesota, true to form, and ever willing to demonstrate geographical inconsistencies, does not fit! If the scores of states on the second component of Minnesota are related to distance (Figure 8), the correlation is virtu-

\(^{31}\) Other samples, taken by participants in a seminar at the Pennsylvania State University, confirm the general "east-west" effect of the second component scores.
Figure 7. The view from Pennsylvania: the second dimension.

Figure 8. The view from Minnesota: the second dimension.
ally zero, and no amount of stretching of a rubberized surface would appear to make this dimension conform to our distance hypothesis.

But another question now appears worth considering. In all three of the second component maps (Figures 6-8), there appears to be some propensity for the isolines to run generally north and south. In the case of California, the surface is high in the west, dipping to low values over the Great Basin and Mountain states, and rising again slowly at the Great Plains to another high, though convoluted plateau in the east. Similarly, the second perception surface of Minnesota is moderately high in the west, dips to a low trough and rises again with considerable regularity eastwards from the Great Plains only to dip again finally in the New England area. Pennsylvania's second surface also displays the east-west effect to a marked degree, although the shape appears to be the negative image of California and Minnesota. However, the reversal of the surface raises the question of the mathematical structure of the component model which has been imposed upon the data. If we remember that the loadings of the unit person vectors upon the second component are the elements of the corresponding normalized eigenvector weighted by the square root of the eigenvalue (namely, the length of the second axis of the ellipsoid), then the positive and negative signs may be reversed without changing (1) the variance accounted for by the dimension or (2) the position of the eigenvector in the hyperspace. In other words, the structure of the model is quite unchanged by consistently reversing the positive and negative signs of the loadings. When this is done, the Pennsylvanian surface corresponds closely to those of California and Minnesota, with a high western ridge and a low trough over the Basin and Mountain states which

![Figure 9. The view from Pennsylvania: the inverted surface on the second dimension.](image)
rises to the eastern plateau to dip, finally, over New England. We might hypothesize, therefore, that there is a second dimension to the mental maps that illustrates a propensity to perceive and evaluate the geographic space of the United States in a fairly consistent east-west direction. Thus, when the point of perception is on the “edge” of the rectangular space, such as in California and to a lesser extent in Pennsylvania, an apparent though spurious distance effect appears reasonably tenable. Only when the perception point moves to the center of the space, as in the case of Minnesota, must the distance hypothesis be discarded to be replaced by an east-west interpretation that is much less intellectually satisfying because it is difficult to relate to any other insights we have. We do know that east-westness in travel produces distinct psychological and physiological effects compared to north-south movement, but this observation provides little confirmation that we are on the right track and the hypothesis awaits much more study with larger and more numerous samples. For example, if one looks at the map of Alabama (Figure 10), through reasonably charitable eyes some confirmation of the east-west hypothesis is obtained. Moving west to east, the high Pacific ridge dips to a north-south trending trough at the 110 meridian followed by a rise in the eastern part of the country. But severe local anomalies, such as Arkansas, occur and the surface appears equivocal in


Figure 10. The view from Alabama: the second dimension.
its ability to support or deny the rather clear configurations of the other three examples.

On the Reconstruction of Perception Surfaces

On the assumption that people’s actions in an area may be partially related to their perception of the space and the differential evaluations they place upon various portions of it, it is possible that by working backwards we can make some rough reconstructions of the mental images held by men long ago. For example, in a recent study of the process of historical settlement in western New York State just after the revolution, trend surface analyses up to the cubic were carried out in which dates of first settlement in an area (time dimension) were related to the geographical locations (two space dimensions). 33

We might consider the even march of the isochrones defining the simplest, or linear surface (Figure 11), as indicative of the waves of settlers that might have moved across the country from east to west if the area had been perceived as a uniform transport surface completely isotropic in all the opportunities it presented to settlers at that time. However, such an assumption is obviously not tenable. Roads and tracks were beginning to lace the area at this time, making it easier to travel in some directions than others, and the information people had about different portions of the space varied and was strengthened by differential feedback processes. While analogies may be

33. I would like to thank Mr. Gary Fuller, NDEA Fellow in Geography, The Pennsylvania State University, for giving me permission to use the maps and information from his seminar paper “Western New York: A Culture Hearth?,” June, 1966, to which reference should be made for a much fuller [sic] discussion than is possible here.

34. The idea comes from Peter Haggett and Richard Chorley, “Trend Surface Mapping . . . .,” op. cit., p. 64.
dangerous, I agree wholeheartedly with Bauer that they "...may play two roles: the scientific role of developing generalized knowledge and the practical role of illuminating other events." 35 Thus, in the same way a submarine valley can distort an evenly spaced wave train (Figure 12),36 so we might think of the underlying surface of perception distorting the even waves of settlement over the land. Fitting the qua-

dratic surface (Figure 13), which represents the next level of accurate description gained at the least expense of complexity,37 provides us with some notion of the ease of travel in certain directions, the information flowing back to the points of origin, and the way opportunities were perceived by the people at the time. The even settlement waves are pulled along the main route to the west, and the lakes to the north and south of this main corridor are marked. Describing the time and space relationships with the next most complex surface, the cubic (Figure 14) indicates even more strongly the way in which the Lake Ontario plain was per-

37. Sums of squares increased from 36% to 49%.

Figure 13. Western New York State: the quadratic surface.

cieved as a less desirable area for settlement, for the time gradient is extremely steep to the north as the settlers by-passed it in their push westwards along the Lake Erie corridor to the new opportunities in Ohio. This was also an area of military activity where towns were frequently raided by the British in the early years of the nineteenth century. 38

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38. Fuller, op. cit., p. 11.

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Figure 14. Western New York State: the cubic surface.
Similarly, the southwestern corner forms a pocket of late settlement in an area of rougher terrain that was filled in after the initial waves of settlers had pushed into the new lands of the west. 39

To separate out the broad regional regularities and trends from the smaller local effects has always been a challenging task for the geographer. Where a dynamic spatial process such as pioneer settlement is going on, the use of trend surface analysis, combining space and time, may not only allow us to achieve such a goal in an efficient and objective manner but to obtain, in addition, some insight into the mental images that men held at the time. If such a notion is valid, we may be able to examine the way in which such mental maps change through time, and so trace the line of inheritance for these images. Perhaps a series of careful content analyses may allow us to observe which areas maintain their brightness in the minds of men, and which are quickly tarnished as new opportunities, new technologies and new values change the very matrix in which they are evaluated and perceived. 40

Some Implications of Mental Maps

What are some of the implications of these mental maps, and what lines of further investigation seem worth pursuing? I hope the examples have indicated that there may be an area of inquiry here that is not only geographically intriguing, but one that smears the line between pure and applied research. For perhaps the most obvious implications lie in the broad area of planning, whether this is undertaken by governments or individuals. Many locational decisions in industry are going to be influenced by the mental maps of a few key people. We can see this in the choices of many footloose industries in this country, while in England the image of the southeast is becoming a source of continuing frustration for planners trying to disperse new factories away from the London “magnet” to relieve congestion and to pump-prime other areas that are in need of additional employment opportunities. Even the channel tunnel, which will simply bolster the locational advantage of the southeast, is receiving criticism on the grounds that it will reinforce the pull of the area. 41

In much of the underdeveloped world, the allocation of social investment is still of critical concern as many countries try to forge the basic infrastructure of transport, education, sanitation, and health facilities. Are the areas that are already “mentally bright” going to receive a large share because they are prominent already in the minds of men? Would an awareness and self-knowledge of this tendency have any beneficial influence? The stricture “Unto them that hath shall be given” seems to describe the basic features of a system of allocation with strong feedback features to produce the agglomerations and clusters of goods and people that are the main feature of the urban revolution.

There are also some implications for administrative planning. In much of the

39. Maps of residuals highlight the areas that were perceived as particularly attractive or repellent. See Fuller, op. cit., p. 14.
underdeveloped world particularly, mental maps may closely correspond to the accessible, modernized areas illuminated by the bright lights of the cities and towns. Yet one of the great needs in most of these countries is to get people, particularly teachers of all kinds, into the "bush" areas that are so disparagingly viewed. Are there not some implications here for incentive allowances that might be inversely related to the perceptual scores that various areas receive? Of course, this is not a problem unique to Africa. Salaries for teachers in Alaska are incentively inspired beyond the difference in the cost of living, and the Soviet Union is using very high incentive pay to lure her people into the new and dynamic lands of Siberia.42

In the area of migration, too, mental maps may shed some light on the gross and long-term movements of people. Thomlinson, for example,43 after trying to estimate the effect of many variables on migration in the United States, comments upon the high residual variation of the Pacific states. Interestingly enough, they are all part of a prominent ridge of desirability that is consistent across all the mental maps of the students sampled. Similarly, the areas of marked migrational loss in this country, the Great Plains in particular, are low troughs and sinkholes. The implications for depressed areas are obvious, and in some of the backward pockets of Appalachia it would be useful to know about the mental maps of the young and the old.44 In England, work on the mental maps of pupils about to leave school has shed some light on the migrational streams of young people that are causing such concern to regional planners.45

At the more academic level, the mental maps raise the question of the geographical implications of the informational flows to which people are subjected. Many writers, across a range of disciplines and concerns, have commented upon the way in which viewpoints are molded by the available information. As Herbert Simon notes in a critique of some common cliches:

Does a man live for months or years in a particular position in an organization, exposed to some streams of communication, shielded from others, without the most profound effects upon what he knows, believes, attends to, hopes, wishes, emphasizes, fears and proposes?46

What are the flows of information that form and mold the surfaces of mental maps? All other things being equal, do they change in content and intensity as one moves up the ladder of central places to the critical nodes of connectivity in an interurban network? St. Paul's migration to Rome may well have been influenced by his mental map of the geographic space that comprised his "world." Surely, by his demonstrated awareness of the relationships between location, information and space, modern geographers can claim him as one of their own! After all, they claim the best of everything else!

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42. Some investigations are proceeding in New Guinea on the mental maps of district officers for administrative assignments.
44. Two thousand questionnaires were recently obtained from high school students by Mr. Robert Ziegenfus, Department of Geography, The Pennsylvania State University, on this topic.
45. In cooperation with Mr. Peter Haggart, the author is receiving returns from thirty schools widely scattered throughout England, Wales, and Scotland. The results will be used in the 1966 Madingley Lectures at Cambridge University, and will be reported upon at the NSF-sponsored symposium on Advances in Cultural Geography, Columbus, Ohio, November, 1966.
In Western New York, it was noted that differential flows of information may have had a profound influence upon the rate and direction of pioneer settlement. At a later time, and a little further west, Cochran has described the psychological effect of the railway in altering geographic horizons, and the way the “big city” newspapers raised the information level of the rural population and altered their consciousness of time and space.

Finally, there is the question of the information available to one generation, and the way it is filtered through the minds of the last. To what extent do we inherit our mental maps? It would be interesting to sample the geographic images in successive generations to see what significant changes existed between them. As Happold notes in a different context:

One cannot stress too strongly the extent to which our world view has been conditioned by our mental history and development.

Using the notion of the positions of neutral points as indices of parochialism, we may be able to measure, crudely to be sure, but measure nevertheless, the changes in mental images from one generation to the next. As Mencius noted more than two millennia ago:

By weighing, we know what things are light, and what heavy. By measuring, we know what things are long, and what short. The relations of all things may thus be determined, and it is of the greatest importance to measure the motions of the mind. I beg your Majesty to measure it.

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48. Ibid., p. 178.

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THE PERCEPTION OF NATURAL HAZARDS IN RESOURCE MANAGEMENT

Ian Burton and Robert W. Kates

"What region of the earth is not full of our calamities?" Virgil

To the Englishman on his island, earthquakes are disasters that happen to others. It is recognized that “while the ground is liable to open up at any moment beneath the feet of foreigners, the English are safe because 'it can’t happen here.'” Thus is described a not uncommon attitude to natural hazards in England; its parallels are universal.

Notwithstanding this human incapacity


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