FOREWORD

Peter Gould presented a most stimulating lecture to the Michigan Inter-University Community of Mathematical Geographers seminar in Brighton, on the evening of the thirteenth of April, 1966. We succeeded in convincing Professor Gould that he should prepare these materials for the larger discussion paper audience, and are pleased to present the results.

The paper unquestionably falls within the field of cultural geography; not the cultural geography of the unique or esoteric, but a cultural geography which is concerned with the structuring of evidence in s manner which is consistent with the scientific criteria of generality and parsimony. Examining numerous questionnaires Gould finds that personal idiosyncracies, the residuals from the components analyses, cannot account for more than fifty percent of the variability contained in the data; in most cases they account for considerably less than fifty percent. People have a great deal in common. This suggests that empirically valid general models of geographical perception are feasible. One of the models implied in the paper relates migration to gradients of perception surfaces. It is then interesting to speculate on the degree to which perception and behavior are related.

The greatest compliment which any of our readers can accord the author will be to build upon the foundation provided. Will you be the one to take up this challenge?

ON MENTAL MAPS

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

in Luigi Barzini, The Italians
(New York: Bantam Books, Inc.,
1965), p. 58.

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 stake 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.[1] 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 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

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[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.

regular surface of equal opportunity or desirability, but in a world often perceived in an extreme, differential manner.[2] 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,[3] 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.[4] 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,[5] 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

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[2]Julian Wolpert, "Distance and Directional Bias in Interurban Migratory Streams", paper presented to the annual meeting of the Association of American Geographers, Columbus, Ohio, 1965.

[3]Gunnar Törnqvist, Aktiv Lokaliseringspolitik (Stockholm: Iduns Trycker iaktiebolag Esselte ab, 1963), pp. 215-292. See also his "Transport Costs as a Location Factor for Manufacturing Industry", Lund Studies in Geography, Series C. General and Mathematical Geography, No. 2. 1962.

[4]Chauncy Harris, "The Market as a Factor in the Localization of Industry in the United States", Annals of the Association of American Geographers, Vol. 44, December 1954.

[5]Rufus Isaacs, Differential Games (New York: John Wiley and Sons, Inc., 1965).

the minds of a few key people?[6] 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 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 loadstones 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

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[6] Andrew Wilson, "The Impact of Climate on Industrial Growth: Tucson, Arizona: A Case Study", Chapter 17 in W. R. Derrick Sewell (ed.), Human Dimensions of Weather Modification (Chicago: University of Chicago Department of Geography Research Series, No. 105, 1966), p. 249.

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,[7] but his basic concern was for the mental transformations of distance that people make. Lowenthal and Prince have discussed the attitudes of a people towards the visual landscape,[8] while the former, in a synthesis that has yet to be equalled, has examined the relevance of the psychological literature in this area.[9] A number of other geographers have focussed upon the perception of environmental hazard and the spatial implications that such images have for locational decisions.[10] 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.[11] Occasionally maps such as the "New Yorker's View of the

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[7] Waldo Tobler, Map Transformations of Geographic Space, Ph.D. thesis, Department of Geography, University of Washington, 1961, pp. 111-113.

[8] David Lowenthal and Hugh Prince, "English Landscape Tastes", The Geographical Review, Vol. LV, No. 2, April 1965, pp. 186-222.

[9] David Lowenthal, "Geography, Experience, and Imagination: Towards a Geographical Epistemology", Annals of the Association of American Geographers, Vol. 51, No. 3, September 1961, pp. 241-260.

[10] Ian Burton and Robert Kates, "The Perception of Natural Hazards in Resource Management", Natural Resources Journal, Vol. 3, No. 3, January 1964, pp. 412-441.

[11] Theodore Herman, "Group Values Towards the National Space: The Case of China", The Geographical Review, Vol. XLIX, No.2, April 1959, pp. 164-182.

United States" appear, but their humorous context actually obscures the fact that such cartograms of mental images can be extremely illuminating if properly used. Getis has shown how shape distortions can focus the eye upon a particular portion of the map,[12] and Mackay had a map in the late fifties showing Canada through French-Canadian eyes. Unfortunately, it was never published.[13] 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.[14]

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,[15] 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

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[12] In William Bunge, Theoretical Geography (Lund: C.W.K. Gleerup, 1962), Lund Studies in Geography, Series C. General and Mathematical Geography, No. 1, p. 43.

[13] Forrest Pitts, private communication.

[14] Kevin Lynch, The Image of the City (Cambridge: MIT Press, 1961).

[15] Carl Sandstrom, Orientation in the Present Space (Stockholm: Almqvist and Wiksell, 1951), pp. 138-147.

space of the earth's surface.[16] 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,[17] 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,[18] 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,[19] and the Weltanschauungen, or world views that have been discussed by other philosophers may be splendid flowers of many hues, but they are

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[16]Clark L. Hull, A Behavior System: An Introduction to Behavior Theory Concerning the Individual Organism (New York: John Wiley and Sons, Inc., 1964), pp. 215-274.

[17]Jean Piaget and Barbel Inhelder, The Child's Conception of Space (London: Routledge and Paul, 1956); Jean Piaget, Barbel Inhelder and Alina Szeminska, The Child's Conception of Geometry (New York: Harper Torchbooks, 1964); Jean Piaget, The Child's Conception of the World (Patterson, N.J.: Littlefield, Adams and Co., 1963).

[18]C. C. Trowbridge, "On Fundamental Methods of Orientation and Imaginary Maps", Science, Vol. 38, No. 990, 1913, pp. 888-897.

[19]Ernst Cassirer, The Philosophy of Symbolic Forms: Volume II: Mythical Thought (New Haven: Yale University Press, 1955), pp. 83-94.

difficult to transplant into the hard earth with which the geographer deals.

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]

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[20] Many standard works are now available. A good introduction to basic notions is Raymond Cattell, "Factor Analysis: An Introduction to Essentials, I. The Purpose and Underlying Models", Biometrics, March 1965, pp. 190-215, and " . . . II. The Role of Factor Analysis in Research", Biometrics, June 1965, pp. 405-435. Full reference works include H. H. Harman, Modern Factor Analysis (Chicago: Chicago University Press, 1960), and Paul Horst, Factor Analysis of Data Matrices (New York: Holt, Rinehart and Winston, Inc., 1965).

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. The question was similarly posed in Europe and Africa, with only minor modifications to adapt it to local circumstances. Thus the basic data consisted of a matrix whose rows represented areas (states in the U.S.A., countries in Europe, and administrative districts in Africa), 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 their 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 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

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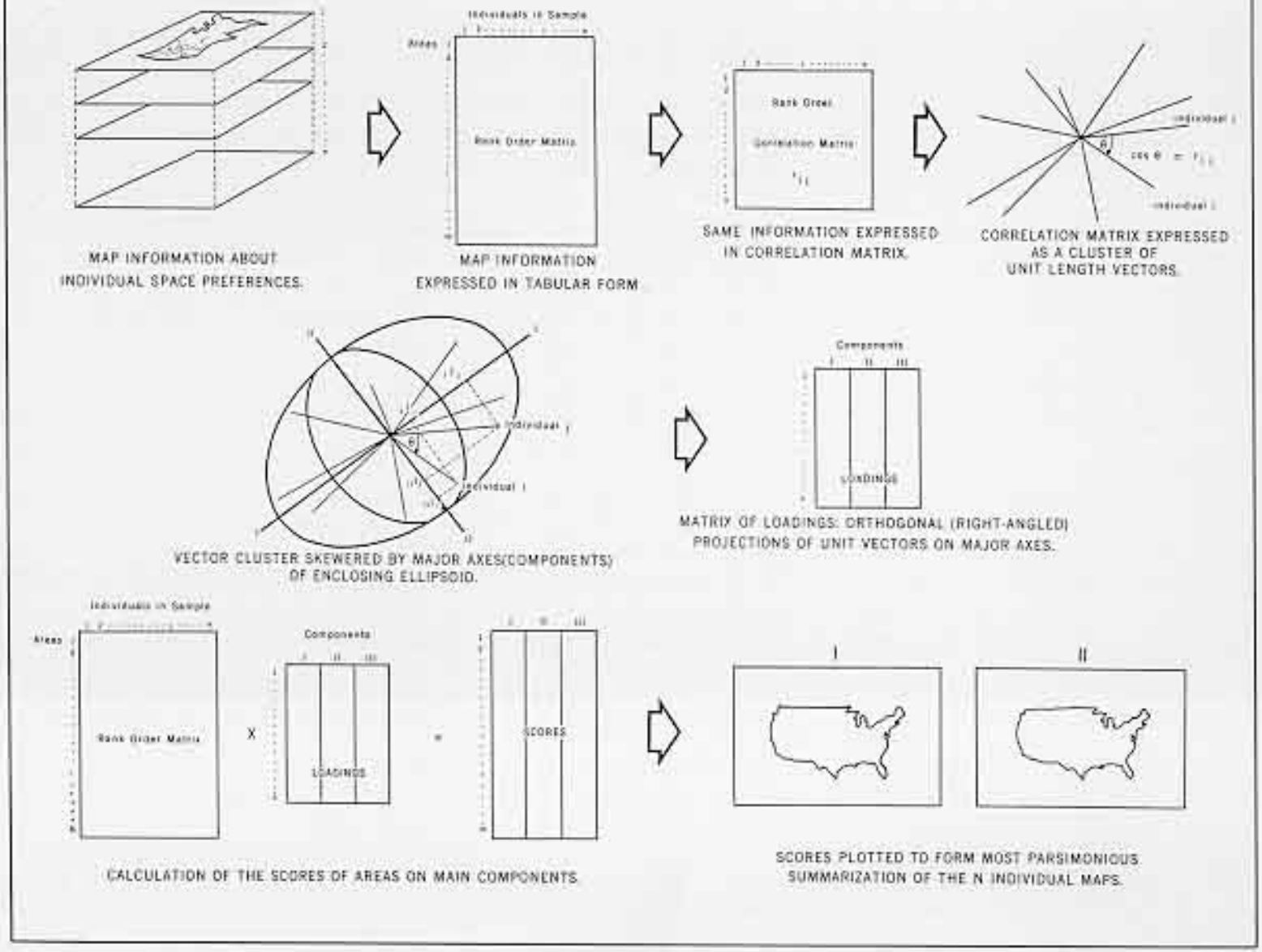
[21] Rotations can be performed, but the standardized criteria seem a bit simple-minded for this problem. What we really need is a physical structure in a two or three dimensional space which is attached, via a computer, to an oscilloscope displaying the map with a contoured "perception surface". Actual rotation of the structure by the investigator would almost instantaneously produce the new surface interpolated from the new scores based on the new loadings. Our "simple structure" criterion would then become truly spatial, which, after all, is what it should be.

Figure 1: Steps in the Construction of the Component Maps



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, 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

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[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 Messers Marich, Bigelow and Knighton, graduate students in geography at the Pennsylvania State University, for providing me with their seminar exercise results.

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 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),[25] 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

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[24] In later work, still on-going, people have been 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).

[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.

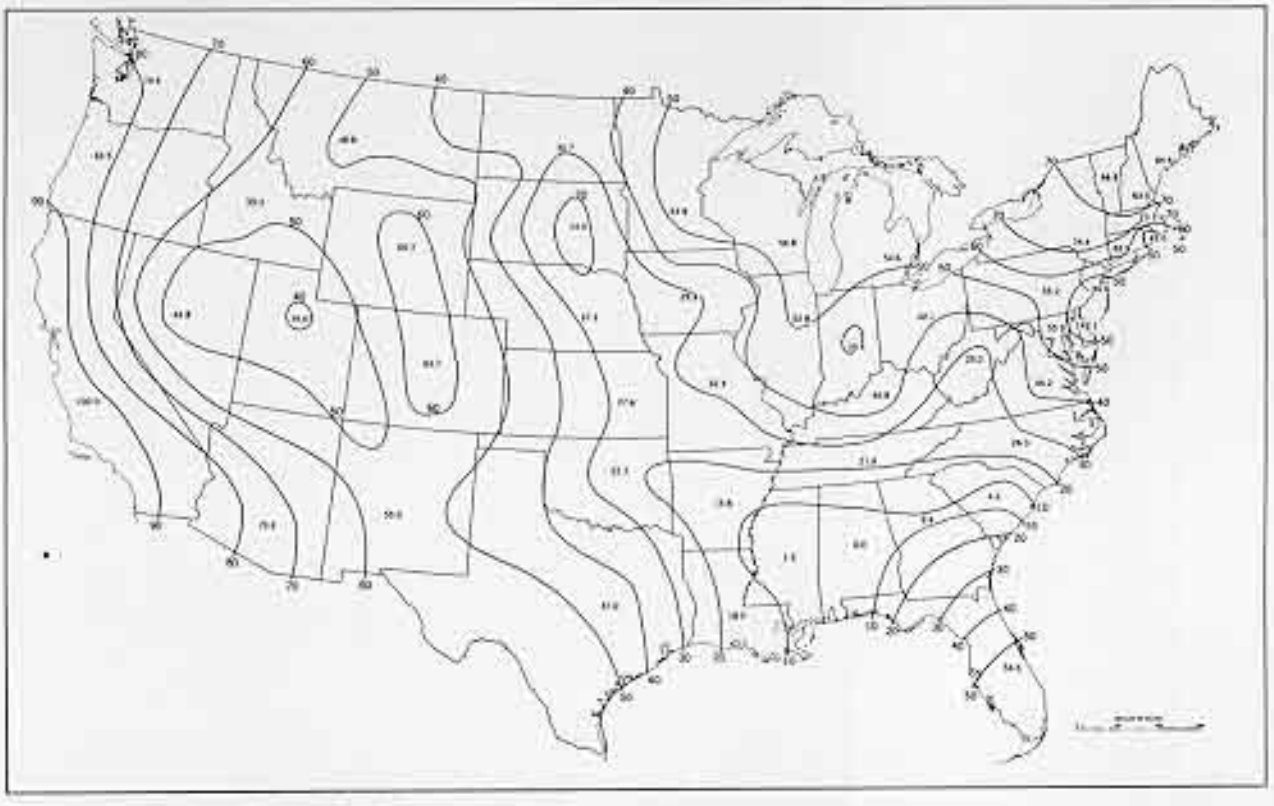

Figure 2: The View From California: The First Dimension

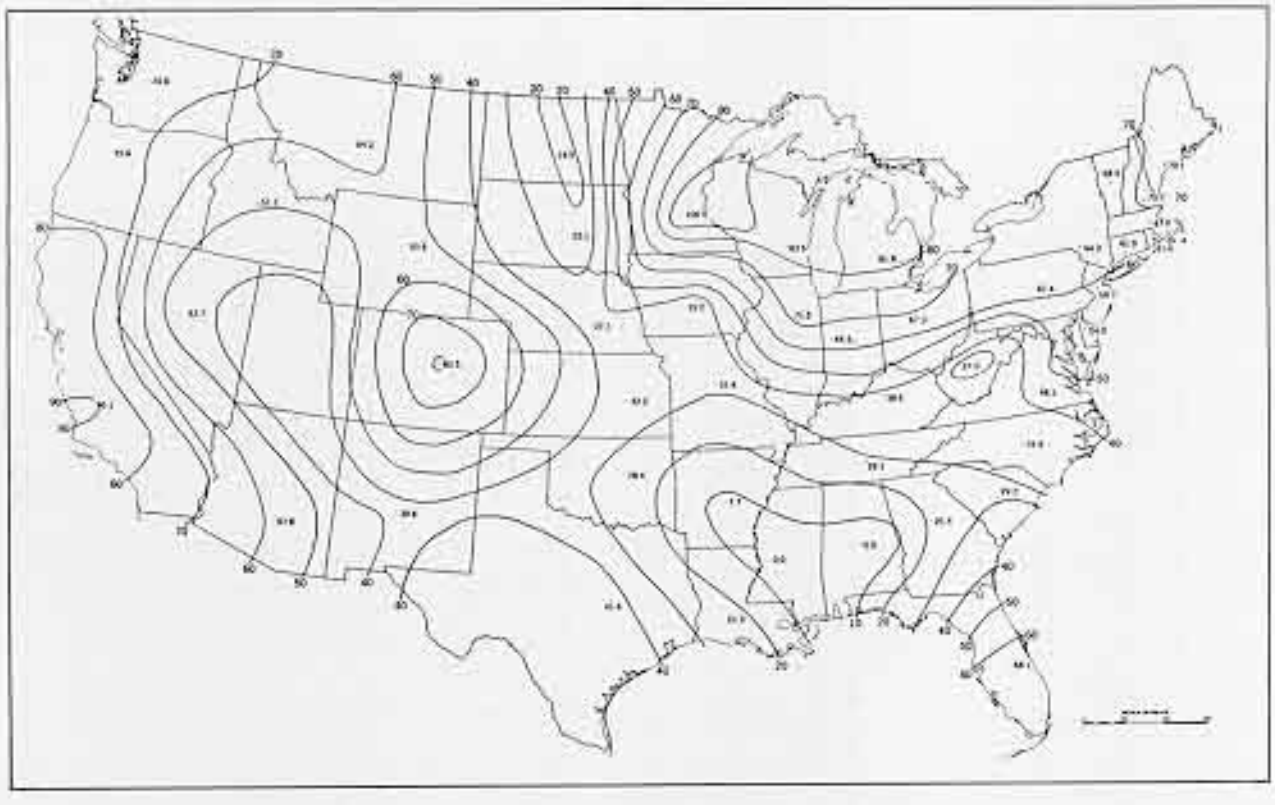

Figure 3: The View From Minnesota: The First Dimension

California itself. However, the gradient to the east is very steep and there is a clear "Perceptual" 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 "sinkhole" 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 the gilding is somewhat tarnished and worn. Florida escapes the general Southern trend, and while Californians are not prepared to place this state as high as some other groups, possibly because of an old rivalry for the title of America's premier place in the sun, the gradient is steep from the low point in Alabama. To the north, the surface trends upwards all the way to New England. Noticeable, however, is the way West Virginia distorts the even march of the iso-percepts, possibly because of the recent emphasis upon the problems of poverty in Appalachia and the high social awareness usually ascribed to California's students. Thus, much of Kentucky may be in a similar economic plight, but her image and her value on this first, general dimension of perception is bolstered to almost twice that of her well-publicized eastern neighbor. Perhaps white-fenced, bluegrass pastures and sour-mash bourbon with pretensions to spiritous greatness, familiar themes in many advertisements, have conveyed an image brighter than the purely economic facts over much of the state would warrant! From Pennsylvania northeast to New England the rise is very rapid, reflecting an image that appears to include more than the bright lights of Megalopolis. The view of the northeastern "cultural hearth" seems to carry visions of the mountains and lakes of Vermont and New Hampshire and the quiet, rock-strewn coasts of Maine.

The View From Minnesota

From Minnesota the view of the United States is almost the same as that from California (Figure 3). True, the highest peak on the perception surface has shifted to the point from which the perception took place, but the high west coast ridge is still very much in evidence, together with the steep gradient to the Utah perceptual basin, the rise to the Colorado high and the fall to the Dakota sinkhole. 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 iso-percepts 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 gentlemanly 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 the Colorado peak appear, though less

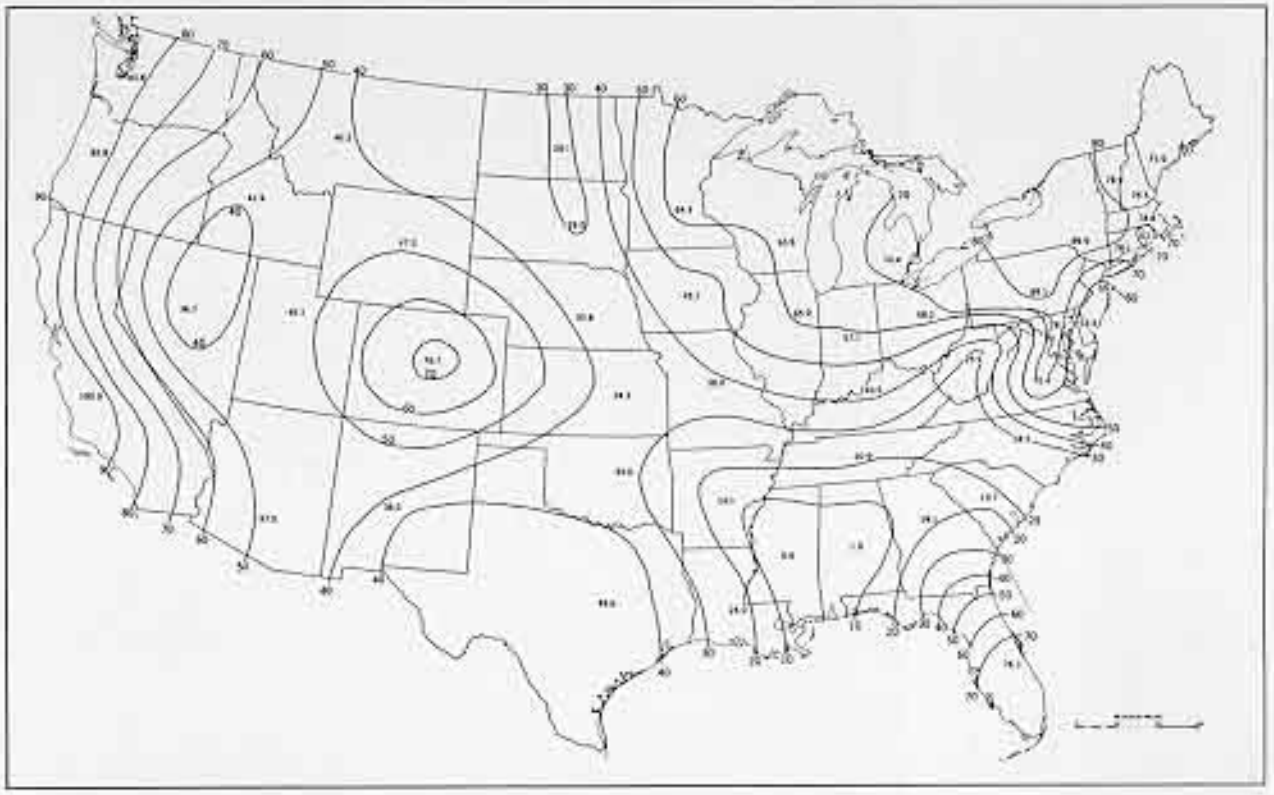

Figure 4: The View From Pennsylvania: The First Dimension

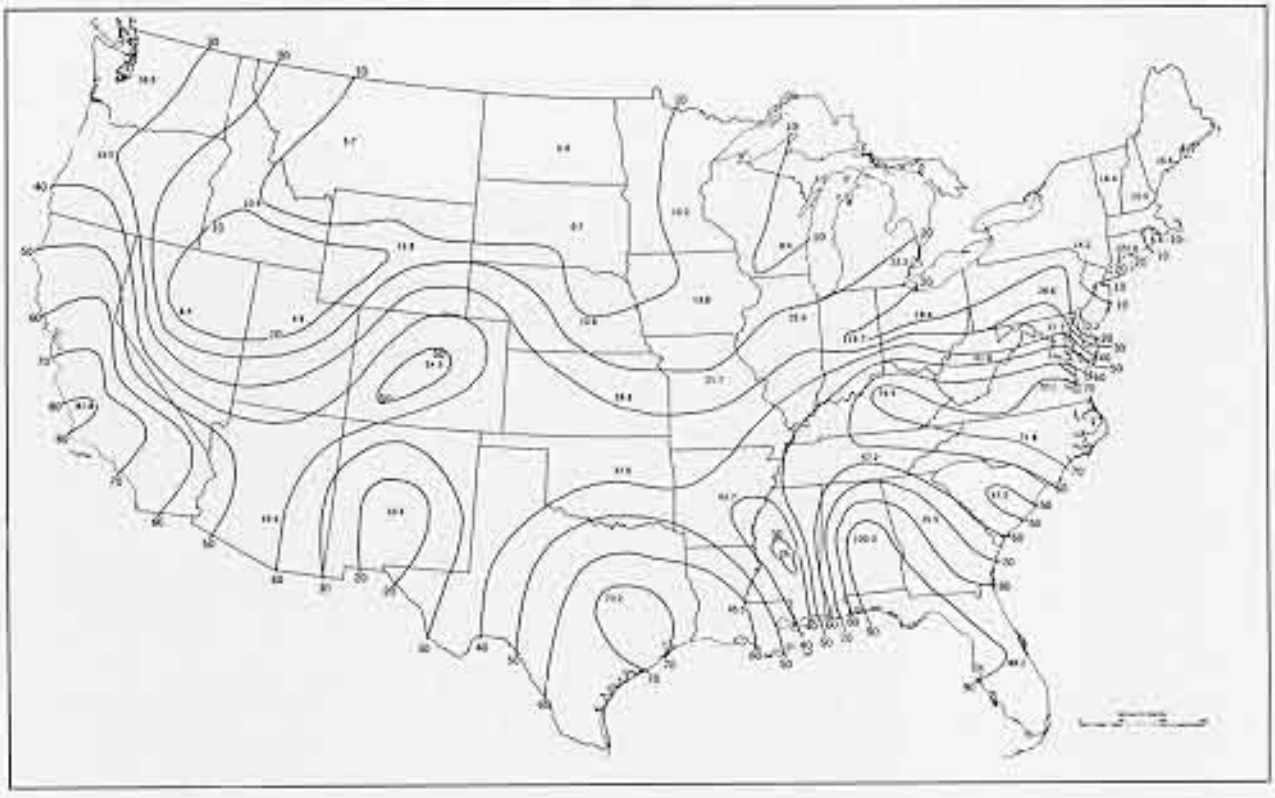

Figure 5: The View From Alabama: The First Dimension

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 I), 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

TABLE I

State	Percentage of Variance Extracted		
	I	II	III
Pennsylvania	46	16	6
Minnesota	41	15	7
California	36	15	9
Alabama	28	13	9

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] We shall meet such heterogeneity again when we examine the mental maps of French students.

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,[27] 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 of the states located in a random, and non-contiguous fashion. The successive

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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.

[27] J. Leith Holloway, "Smoothing and Filtering of Time Series and Space Fields", Advances in Geophysics, Vol. 4, 1958, pp. 386-387.

[28] Julian E. Hochberg, Perception (Englewood Cliffs: Prentice-Hall, Inc., 1964), p. 86.

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 assumptions of normality 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,[29] 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.

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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.

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 I) 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_s = .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.[30]

The second perception surface for Pennsylvania (Figure 7), bolsters 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

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[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 intriguing physical model in a geographical context in Robert E. Blackith, "Morphometrics", Chapter 9 in Talbot H. Waterman and Harold Morowitz (eds.), Theoretical and Mathematical Biology (New York: Blaisdell Publishing Company, 1965), p. 236.

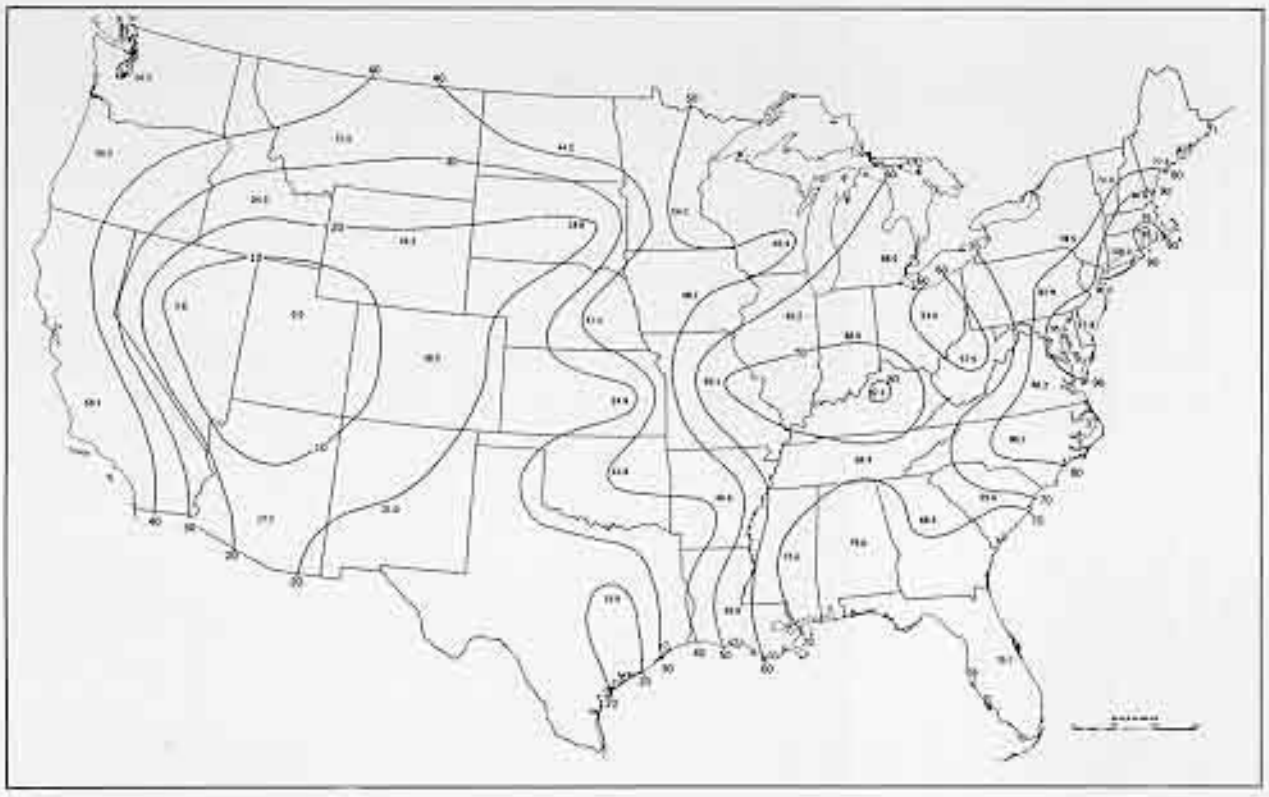

Figure 6: The View From California: The Second Dimension

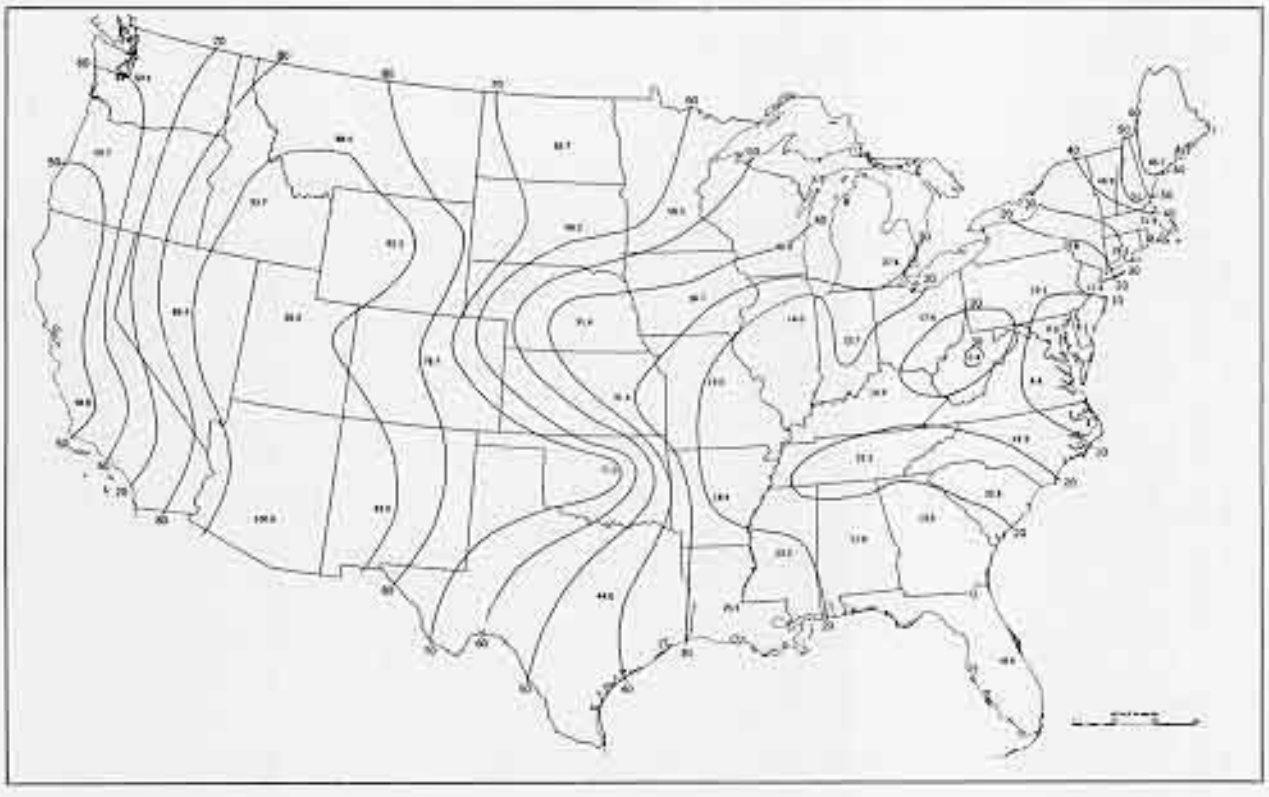

Figure 7: The View From Pennsylvania: The Second Dimension

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 virtually 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

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[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.

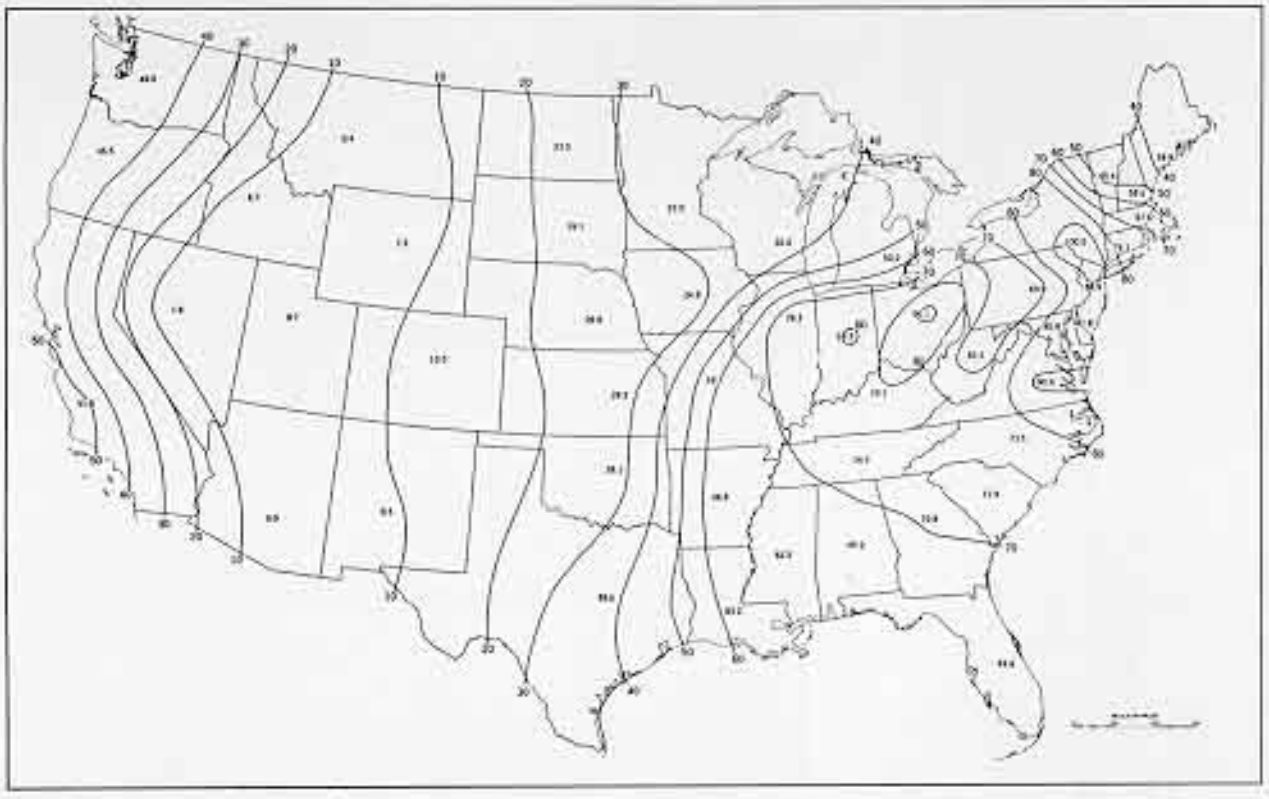

Figure 8: The View From Minnesota: The Second Dimension

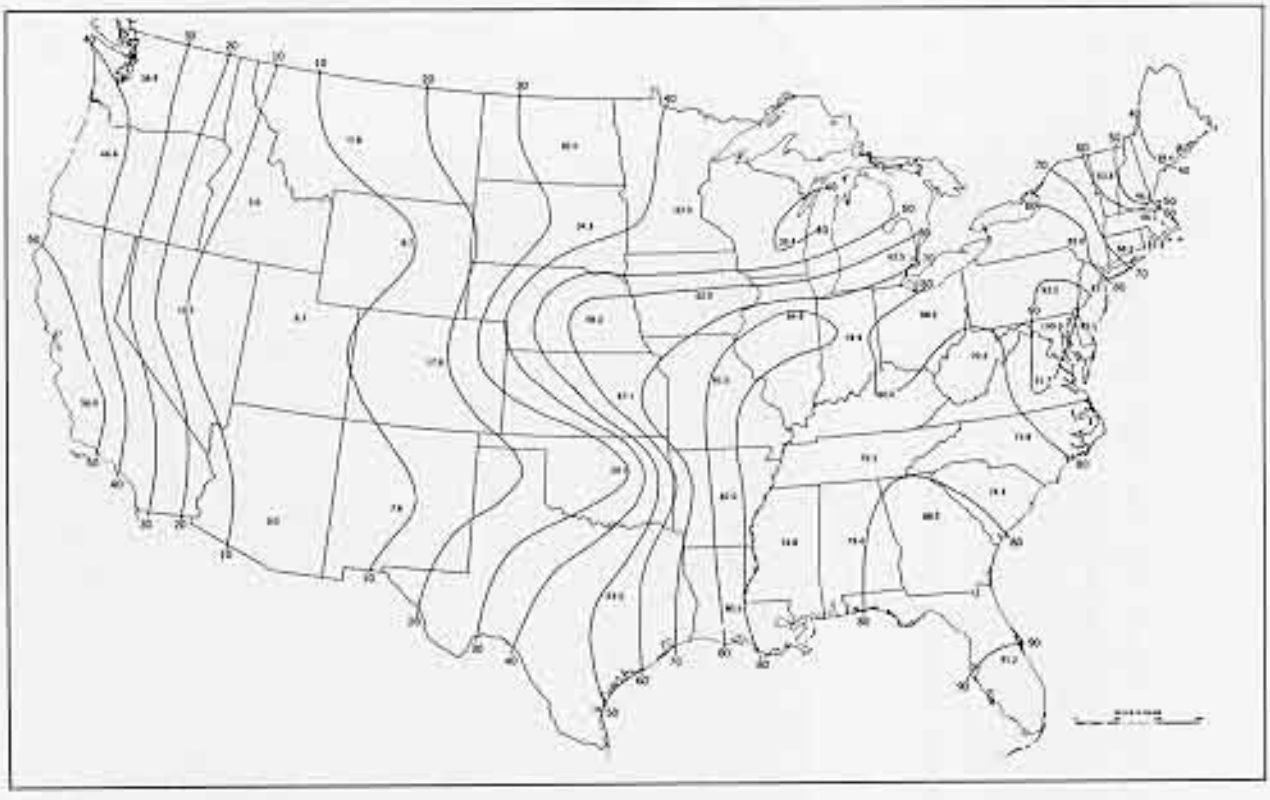

Figure 9: The View From Pennsylvania: The Inverted Surface on the Second Dimension

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.[32] 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 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 if is difficult to relate to any other insights we have. We do know that east-westness in travel produces distinct psychological and physiological

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[32] Comments upon this argument would be greatly appreciated since I have seen nothing in the literature referring to such a change that seems quite arbitrary until the geometrical structure is examined closely.

effects compared to north-south movement,[33] 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 its ability to support or deny the rather clear configurations of the other three examples.

EUROPE LOOKS AT EUROPE

In these days of newly emerging nations in Asia and Africa, we are apt to forget that it is really Europe that has experienced the most shattering political change of the twentieth century. Smashed by the First World War, and beset afterwards by violent revolution, catastrophic inflation and economic depression, the stable and ordered continent of the early years is now but an historical curiosity to three generations. Laid waste by yet another world war, in which civilian casualties alone were counted in the millions, and divided afterwards by ideologies that confront one another across a line drawn through her very heart, Europe is still in the process of settling down to a new, though hopefully a dynamic and moving equilibrium.

Faced for the first time with two powers larger than any that they have experienced before, the countries of Europe are seriously considering a degree of cooperation and unification that would have been unthinkable a few decades ago.

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[33] G. T. Hauty and T. Adams, Phase Shifts of the Human Circadian System and Performance Deficit During the Periods of Transition, Part I East-West Flight, Part II West-East Flight and Part III North-South Flight (Washington, D.C.: Federal Aviation Agency, Office of Aviation Medicine, 1965).

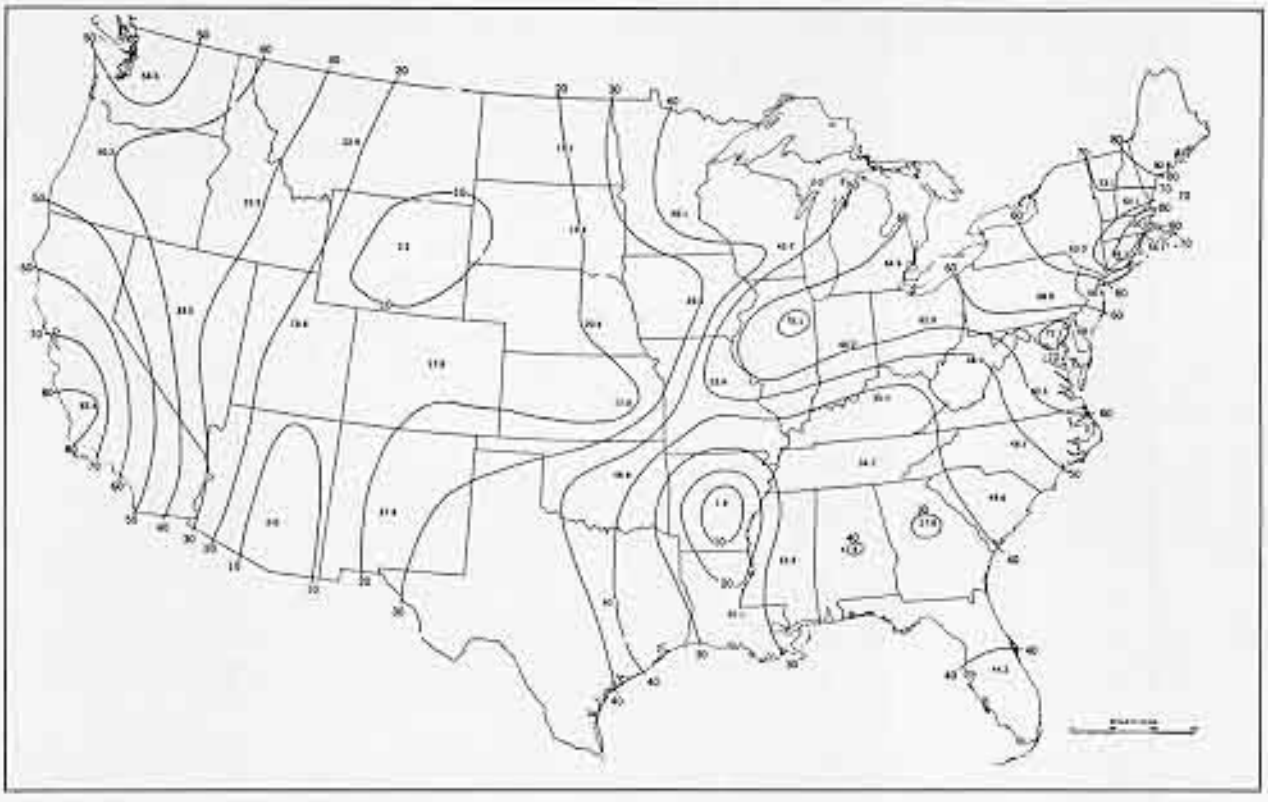

Figure 10: The View From Alabama: The Second Dimension

Military alliances, steel communities and joint atomic facilities, common aeronautical projects and Common Markets -- all are signs of an overall process of drawing together. True, the process is not altogether smooth, and there are backward steps as well as forward gains, but as economic cooperation leads towards some degree of political integration, it is pertinent to enquire about the mental images and preferences that these people have of other countries in the larger European community. For in the last analysis, the barriers to unification are mental, and where a government is ultimately responsible to an electorate the mental images that a people have are reflected to some degree in the policies towards other nations.

It would be foolish to pretend that the space preferences for residential desirability by university students are indicative of the overall mental images held by one nation for another. Nevertheless, by posing the question in terms of residential choice, we may record the mental maps of a small, but important group in the post-war generation -- a generation, let it not be forgotten, that has known only an uneasy peace broken by sporadic outbursts that could all to easily have triggered the Armageddon. Such a generation is likely to give thoughtful answers.[34]

Europe From Different Viewpoints

The sample from Sweden displays the highest degree of perceptual homogeneity with seventy-two percent of the variance collapsing upon the first component (Figure 11). On this general, overall scale, Sweden is by far the most preferred, followed by Switzerland, Norway, Denmark and the United Kingdom in a tight cluster. Other West European, democratic nations appear next, such as France, West Germany, Italy and the Benelux countries, followed by those with dictatorial regimes such as Spain and Portugal. The Eastern bloc is scored low, with East Germany and Albania per-

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[34] I would like to record my thanks to Professors Olsen, Garner, Manshard, Pecora and Juillard, geographers at the universities of Uppsala, Bristol, Giessen, Rome and Strasbourg respectively, for distributing questionnaries to their students for me.

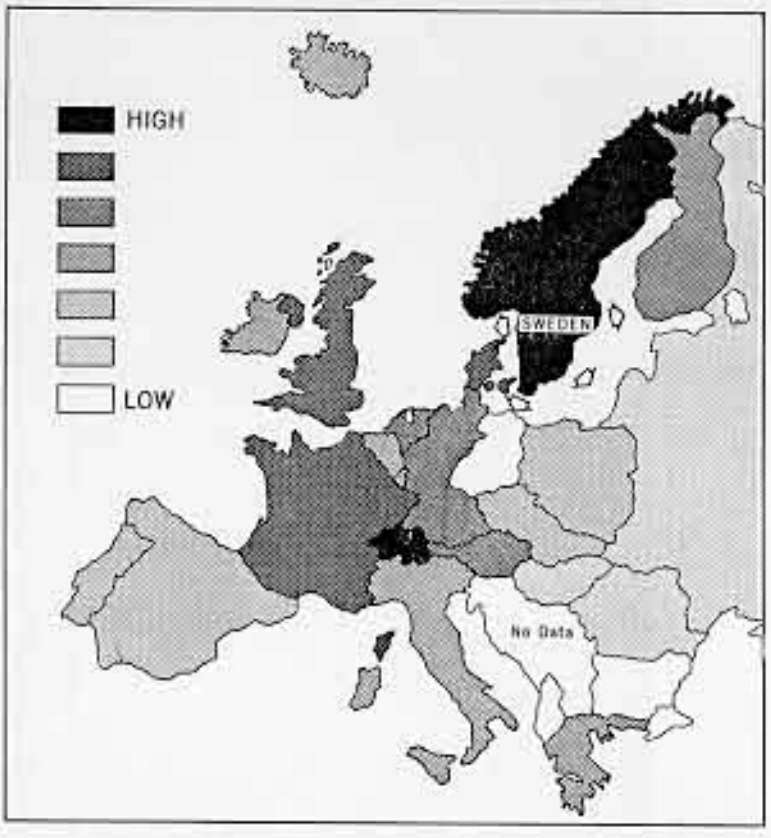

Figure 11: Europe Viewed From Sweden:
The First Dimension

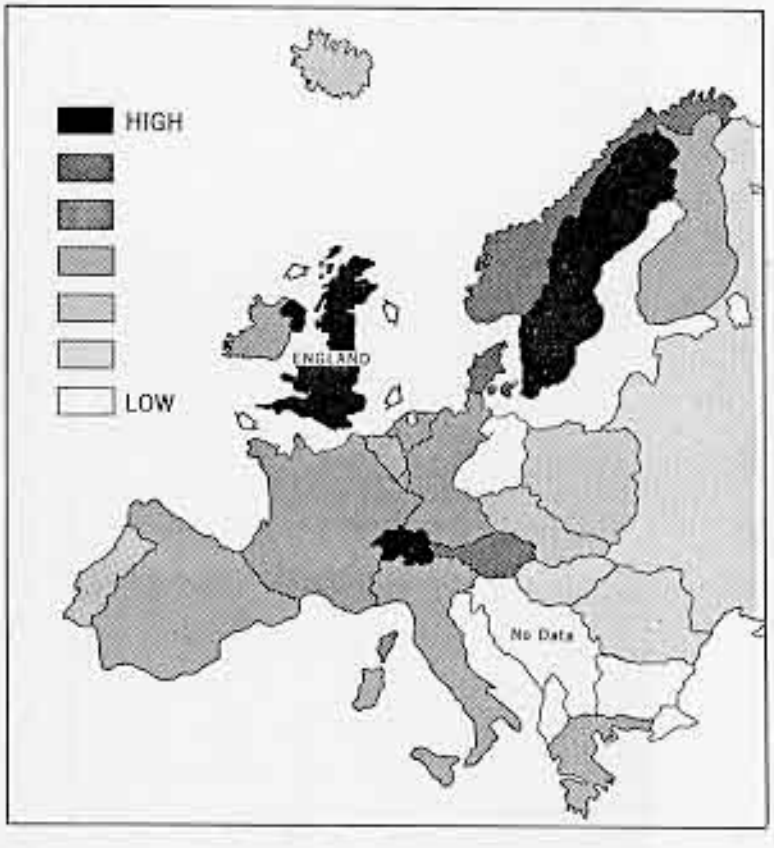

Figure 12: Europe Viewed From England:
The First Dimension

ceived as the least desirable of all.

While not quite as homogeneous in outlook as Sweden (Table II), the overall mental map of the English university students is remarkably similar to that of their contemporaries in Sweden (Figure 12). Indeed, with the exception of England's view of Finland, and Sweden's view of Eire, students in these countries seem to

TABLE II

Country	Percentage of Variance Extracted	
	I	II
Sweden	72	6
United Kingdom	66	8
Germany	56	10
Italy	55	8
France	45	15

view Europe through almost identical eyes. Both groups display a strong preference for western, democratic nations and tend to shun authoritarian governments able to exert a high degree of coercion upon their citizens. The contrast between east and west is virtually identical in every respect. Portugal scores slightly higher on the English map, indicative perhaps of the long historical ties between the two countries, while Iceland is placed somewhat lower than on the Swedish scale.

The view from Germany (Figure 13), reinforces a notion of cultural affinity that was displayed in a less severe form by Sweden's preference for the Scandanavian countries. After West Germany itself, the german-speaking countries of Switzerland and Austria are preferred over all others, with such linguistically similar nations as Sweden, Denmark and the Netherlands following closely. Significantly, Belgium, Luxembourg and France are preferred next, and the United Kingdom scores considerably lower on the German map than does Germany on that of the United Kingdom's! On the whole, however, Germany shares the viewpoint of England and Sweden for the West, and

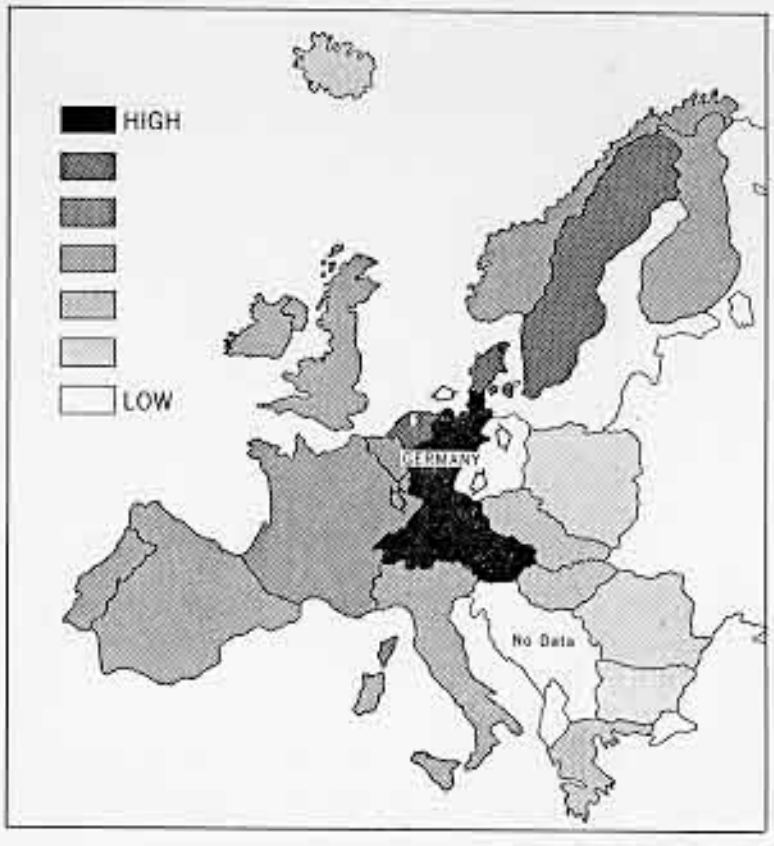

Figure 13: Europe Viewed From Germany:
The First Dimension

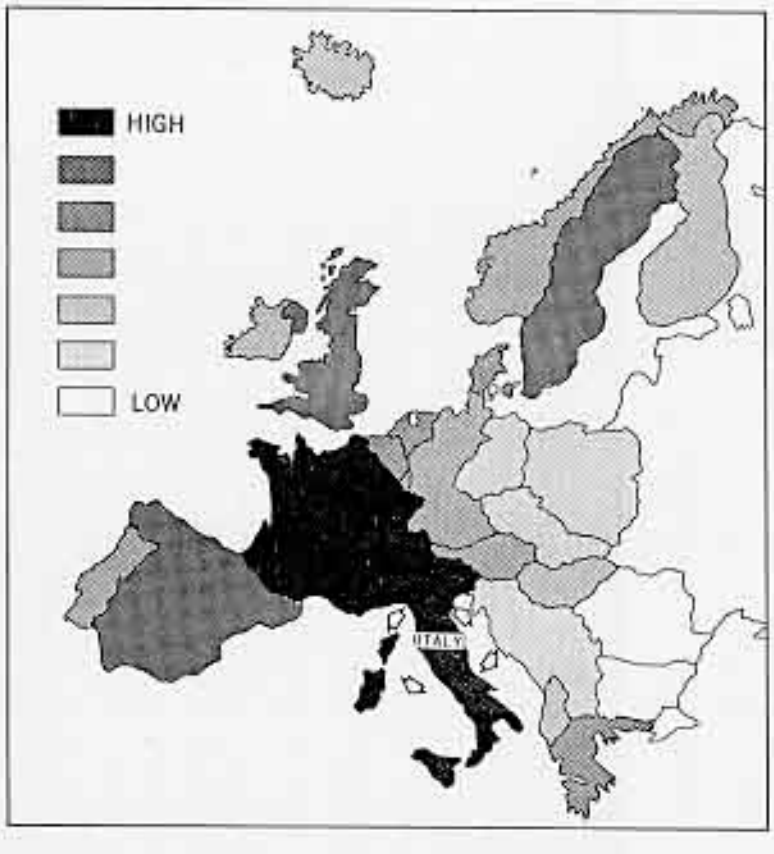

Figure 14: Europe Viewed From Italy:
The First Dimension

the Iron Curtain is again a most vivid divide.

Similar to Germany in the degree of perceptual homogeneity (Table II), but displaying a mental map that is just as distinctively individualistic (Figure 14), Italian students have a view of Europe that places the Catholic and Latin countries of France and Spain much higher than any other. Greece, too, with its sunshine and blue waters, is perceived much more favorably, while Western Germany is given a lower rank in the Italian sample than by any other group. Nearby Albania, normally the last country in Europe where students would like to live, receives a higher rank than usual, close behind Finland and Iceland and well ahead of most of the Eastern bloc.

France possesses the least homogeneous of viewpoints, although the dominant one is very close to those of Sweden and the United Kingdom (Figure 15). However, there is a second view from France (Figure 16), producing a larger second dimension (15%) than any other, which places the U.S.S.R. and Yugoslavia on par with the homeland and eschews Scandanavia, the Low Countries and perfidious Albion!

Overall Views of Europe

We can consider the scores of countries upon the main dimensions extracted by the principal components analyses as values on new variables that are a result of linear combinations of the original rank order lists. These variables display some interesting summary interrelationships. For example, while the dominant views of all five samples are closely related (Table III), Italy meshes less strongly than the other four, agreeing least of all with Germany.

TABLE III

Correlations Of Component I Scores

Country pair	Similarity of Viewpoint
Sweden-U.K.	.94
U.K.-Germany	.90
Germany-Sweden	.90
Sweden-France	.89
France-U.K.	.88
Italy-France	.81
Germany-France	.79
Italy-U.K.	.73
Italy-Sweden	.69
Italy-Germany	.62

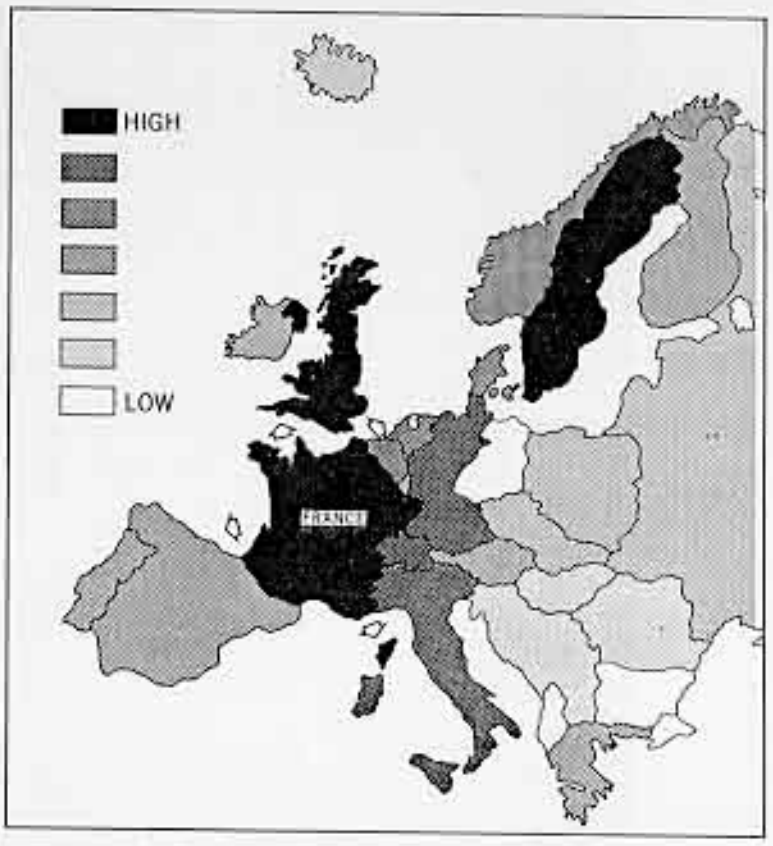

Figure 15: Europe Viewed From France:
The First Dimension

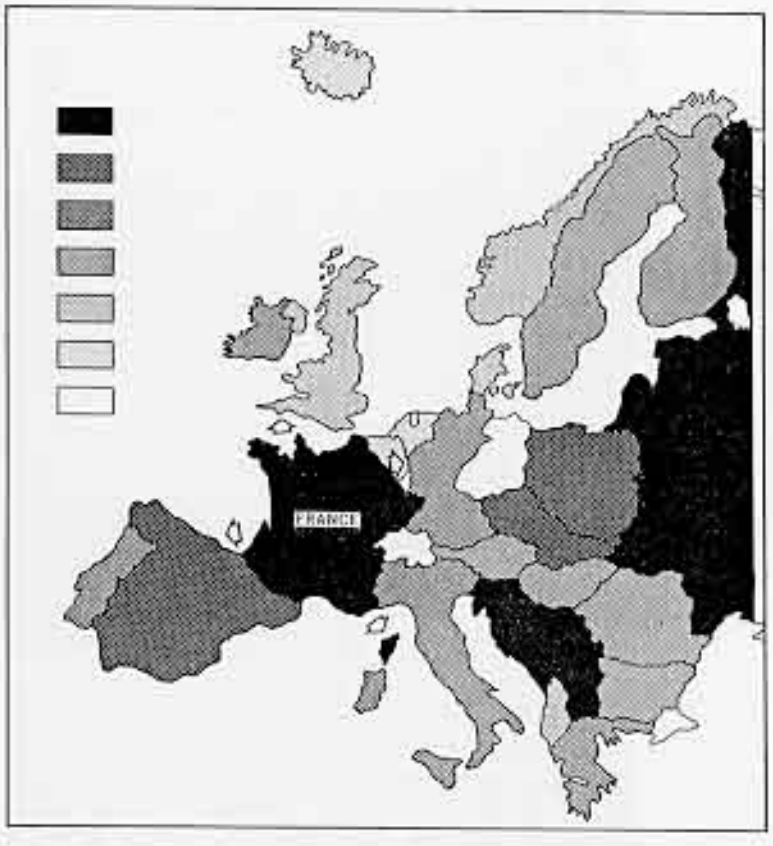

Figure 16: Europe Viewed From France:
The Second Dimension

Given the problem of indifference in ranking, the second components, which do not produce uniform maps, must be used with caution. Relationships between the scores on this second group of artificial variables (Table IV), are not always strong, but the directions of the signs are intriguing: all are positive with the exception of Germany. Whatever the second viewpoint from Germany represents, it relates slightly to the second from Italy, and inversely with all the others. Favorably

TABLE IV

Correlations Of Component II Scores

Country pair	Similarity of Viewpoints
Sweden-U.K.	.60
U.K.-France	.46
Italy-Sweden	.32
France-Sweden	.22
Italy-France	.14
Italy-U.K.	.09
Germany-U.K.	-.06
Germany-Sweden	-.14
Germany-France	-.17
Germany-Italy	.16

evaluating the surrounding neighbors (Figure 17), including Fascist Spain, this dimension is inversely related to the first components of Sweden and the United Kingdom, components that displayed such strong preferences for democratic institutions (Table V). Similarly, Italy's second dimension relates inversely to Sweden I and the United Kingdom I, although all these should be interpreted with caution since

TABLE V

Correlations Across Components

Country pair	Similarity of Viewpoints
Sweden I-Germany II	-.23
U.K. I-Germany II	-.13
Sweden I-Italy II	-.52
U.K. I-Italy II	-.43

both Germany II and Italy II have high variation remaining on the diagonal of the

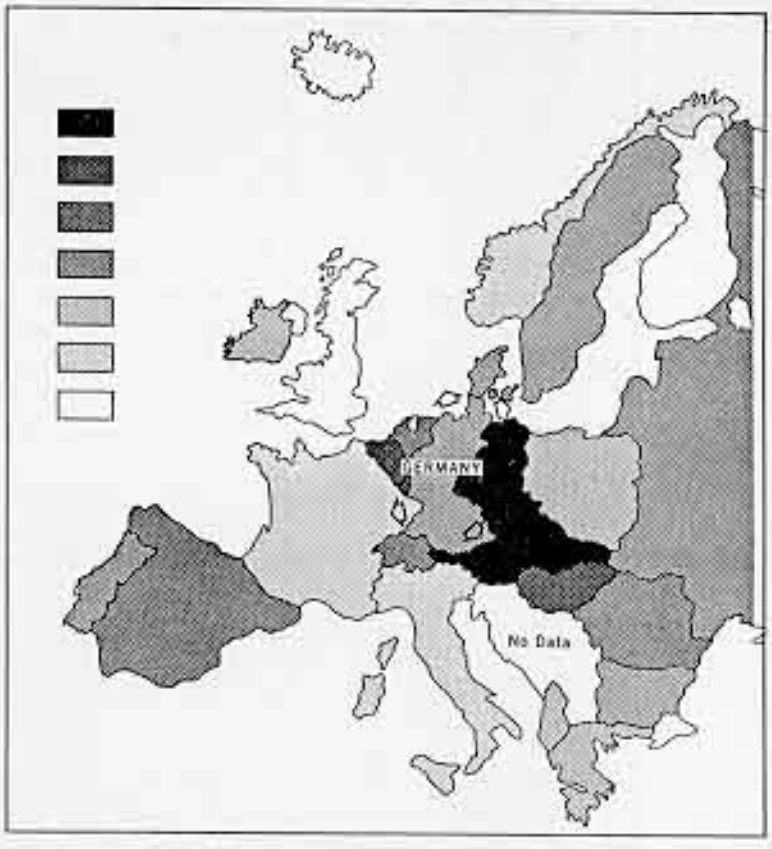

Figure 17: Europe Viewed From Germany:
The Second Dimension

residual matrix, indicating that low communalities would be appropriate and that the specificity of their variation is high.

A second, or higher principal components analysis provides us with an overall scale for all the samples (Figure 18).[35] Summarizing forty-five percent of the variation, it may be interpreted as a complex scale that seems to reflect both the level of the standard of living and the degree of political authoritarianism. Highest are Switzerland and Sweden, both havens of neutrality with high standards of living and liberal democratic governments. This cluster is followed by most of the democratic socialist countries of Western Europe with high living standards and predominantly protestant church affiliation. The remainder of Western Europe scatters down the scale, with dictatorial regimes such as Spain and Portugal coming last. A fairly wide gap separates the Eastern bloc, led by Poland which is perceived as the most liberal of this group. East Germany, Bulgaria and Albania are the least desired countries for residential purposes.

GOVERNMENT ASSIGNMENT: THE VIEW OF AN AFRICAN ELITE

In most of the countries of Africa the number of university students and graduates is still extremely small. With the exception of a few in business and private law practice, most of them enter government service in a variety of diplomatic, administrative and teaching positions where the pace of advancement can be very rapid indeed. The result is that positions of considerable responsibility are often held by men and women only a few years away from their graduation. When such decision-making power is in the hands of a fairly small elite group, the view they hold of their own nation becomes of more than passing interest. For example,

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[35] Once again, comments on this analysis would be welcomed. Usually higher order analyses are performed upon components which have been rotated according to some criterion that results in obliqueness. Thus the dimensions are no longer orthogonal, and a more parsimonious space and expression can be obtained. Here we are closer to a components analysis of canonical variates resulting from five, separate analyses.

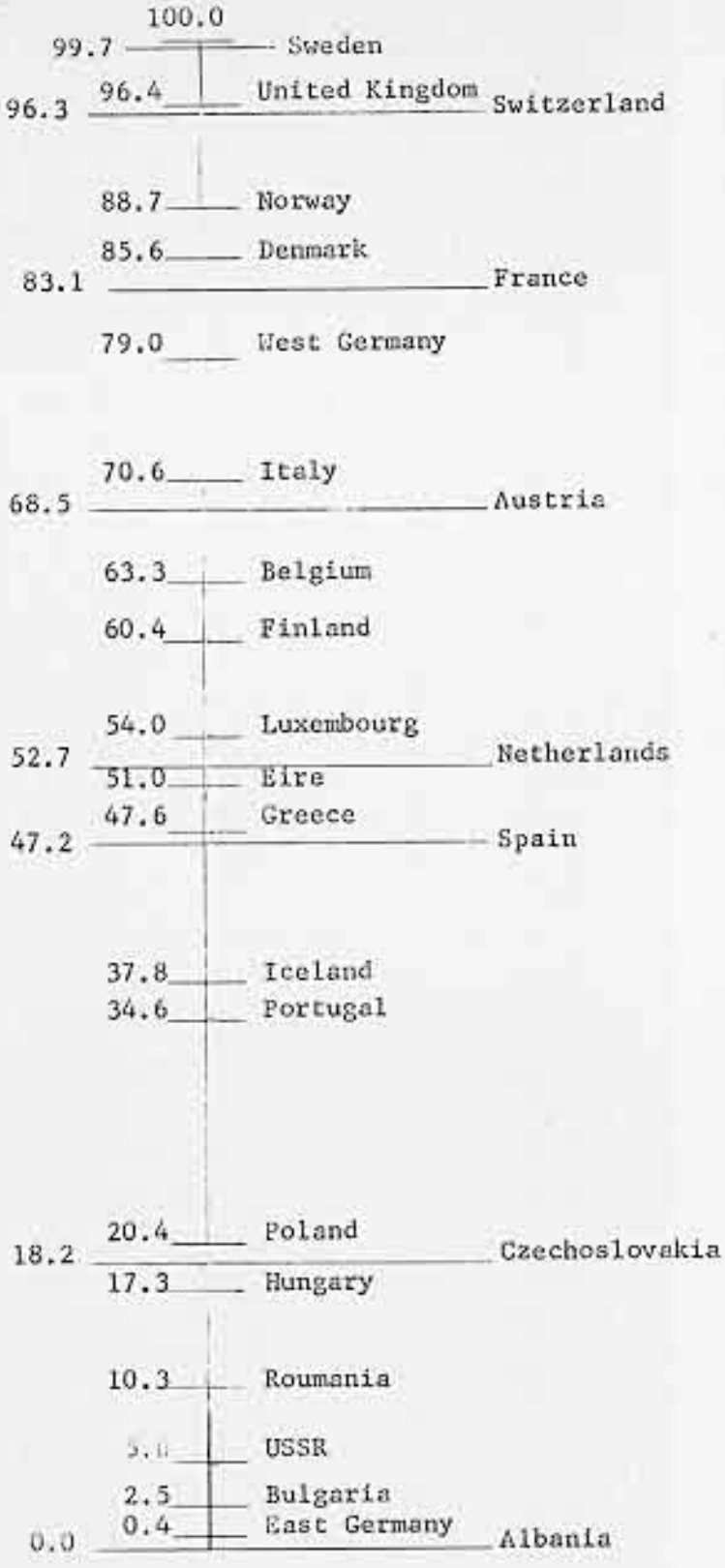

Figure 18: Space Preferences in Europe: The Overall View

investment must be assigned spatially, as well as sectorally, and the overall differential images held by such a group may influence the allocation of the meagre development funds that are under such intense competition.

Ghana

In sampling the mental maps of Ghanaian and Nigerian students,[36] the question was posed in terms of the residential desirability of districts given complete freedom of choice of assignment in some type of government service. In Ghana (Figure 19), there is a very high degree of agreement of spatial perception, with 67.4% of the total variation collapsing upon the first component. Generally the coastal districts containing the major urban centers all have high scores, and the preferences decline fairly regularly away from the southern "core" of the country towards the north. On successive components the drop in the explained variation is marked. After the variation in the overall mental map is extracted, the remaining components appear to be small regional effects that contrast one traditional area against another. For example, component II, extracting 7.5% of the variation (Figure 20), contrasts vividly the eastern Ewe area with the core area of Ashanti, and such an interpretation is bolstered by the close matching of contrasting signs in the factor loadings with places of birth and residence of the students. The third dimension highlights in a similar fashion a core area centered on the town of Koforidua north of Accra.

The degree of spatial regularity in the scores of the overall mental map (Figure 19), suggests that fairly simple perception surfaces could describe the national pattern with some accuracy and so allow us to separate broad trends from local anomalies. If the perception scores are related to their geographical

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[36] I would like to thank Professors Amano Boateng and George Benneh of the University of Ghana, and Professor Akin Mabogunje of the University of Nigeria at Ibadan, for distributing the questionnaires and maps to their students. Samples from Uganda and Tanzania are still in the process of completion.

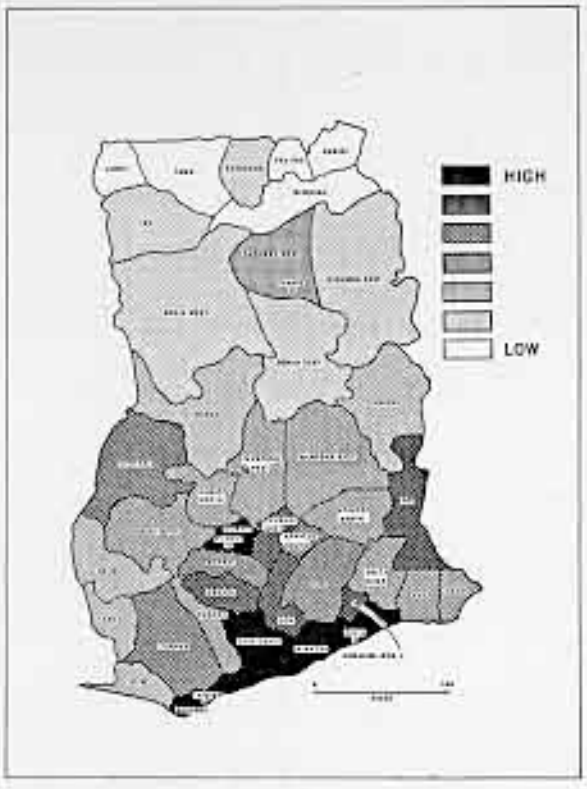

Figure 19: The View From Ghana:
The Most General Viewpoint

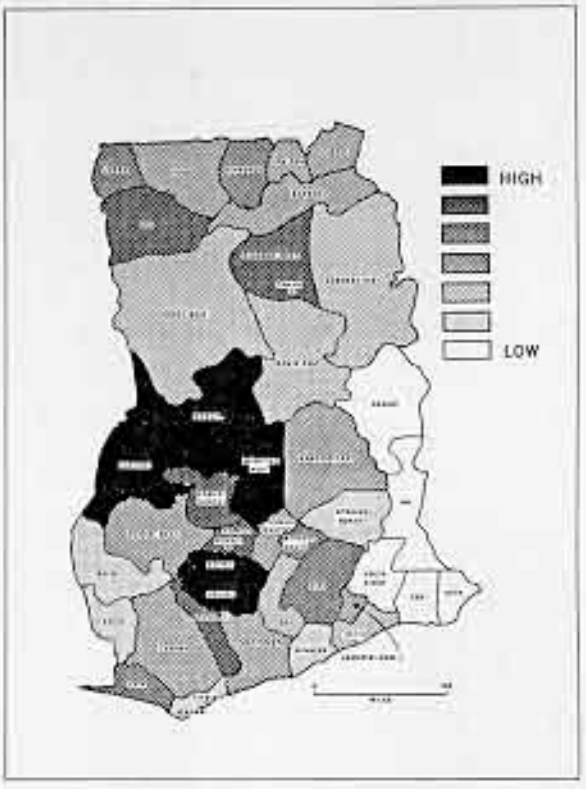

Figure 20: The View From Ghana:
Regional Contrasts

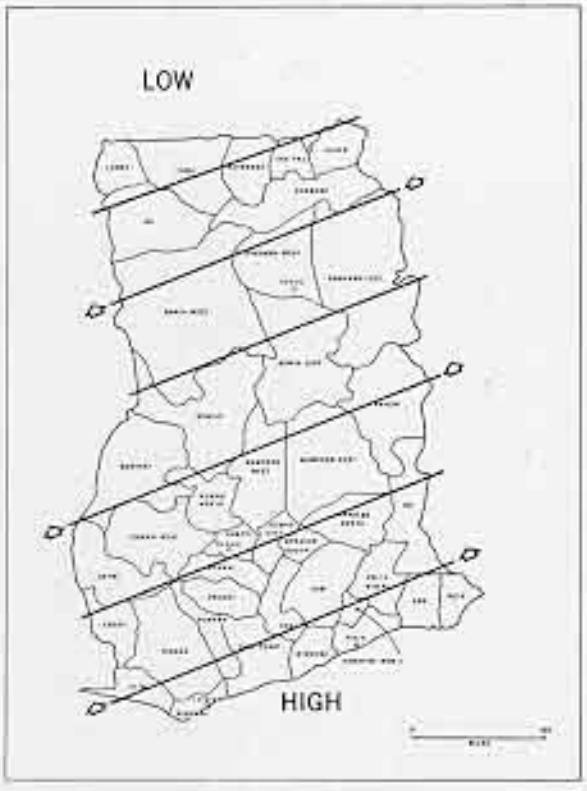

Figure 21: Ghana: The Linear
Perception Surface

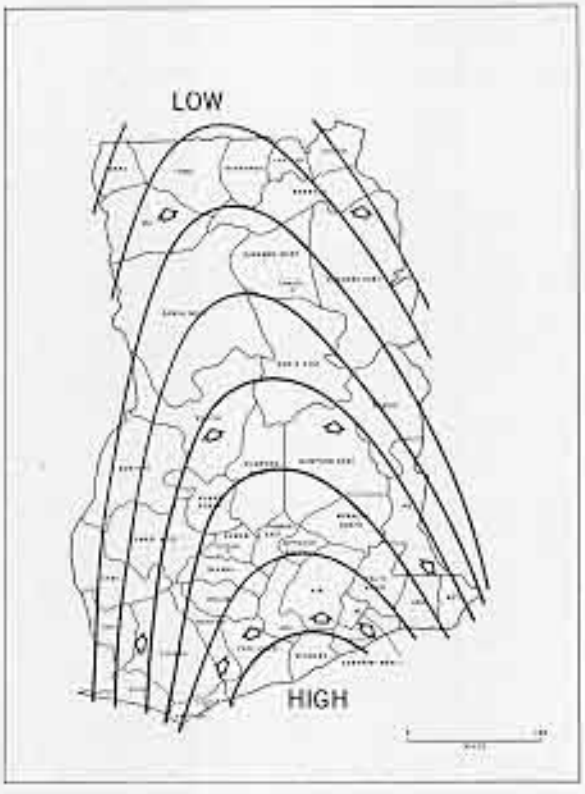

Figure 22: Ghana: The Quadratic
Perception Surface

coordinates, the simplest surface (Figure 21), which in terms of sums of squares accounts for 64% of the variation, is a plane tilted in a northwesterly direction whose southern edge almost parallels the coastline. However, at the expense of only slightly greater complexity, the quadratic surface is a much better description, accounting for an additional 15% of the variation (Figure 22). It appears to be the "best" in the sense that it combines parsimony of equational terms with an ability to account for perception scores by their geographical locations. For example, adding the cubic terms only raises the sums of squares by 3%, from 79% to 82%.

Having estimated the overall trend surface in an objective fashion, the anomalies may now be interpreted (Figure 23).[37] Here the power of the urban centers to cast bright images in the minds of men is shown all too clearly. Accra the capital of Ghana, Kumasi the center of Ashanti and the principal inland town, Ho the administrative center of the Volta Region, and Tamale the center of the north all have images far brighter than the overall trend would predict. Even Kusasi, Navrongo and Wa in the far north are above the surface, for they contain the main towns and administrative centers. Of particular interest is the image that the Sunyani district holds, due not only to the presence of a main town, but because this is an area that is exploding economically. Here traditional authority and modern higher education blend to sparkplug an area whose dynamism is clearly perceived so that it appears much more attractive than its peripheral position away from the core would suggest. Similarly Enchi in the southwest is higher than one would predict due to recent economic developments in the area. It, too, partakes of the pioneer glow, perhaps because of the increased information people have about these areas from newspapers and news reports.

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[37]The notion that spatial relationships may be illuminated by contrasting opposite anomalies finds an intriguing expression in a rather different context, see F. C. Happold, Religious Faith and Twentieth Century Man (Harmondsworth: Penguin Books, Ltd., 1966), p. 46.

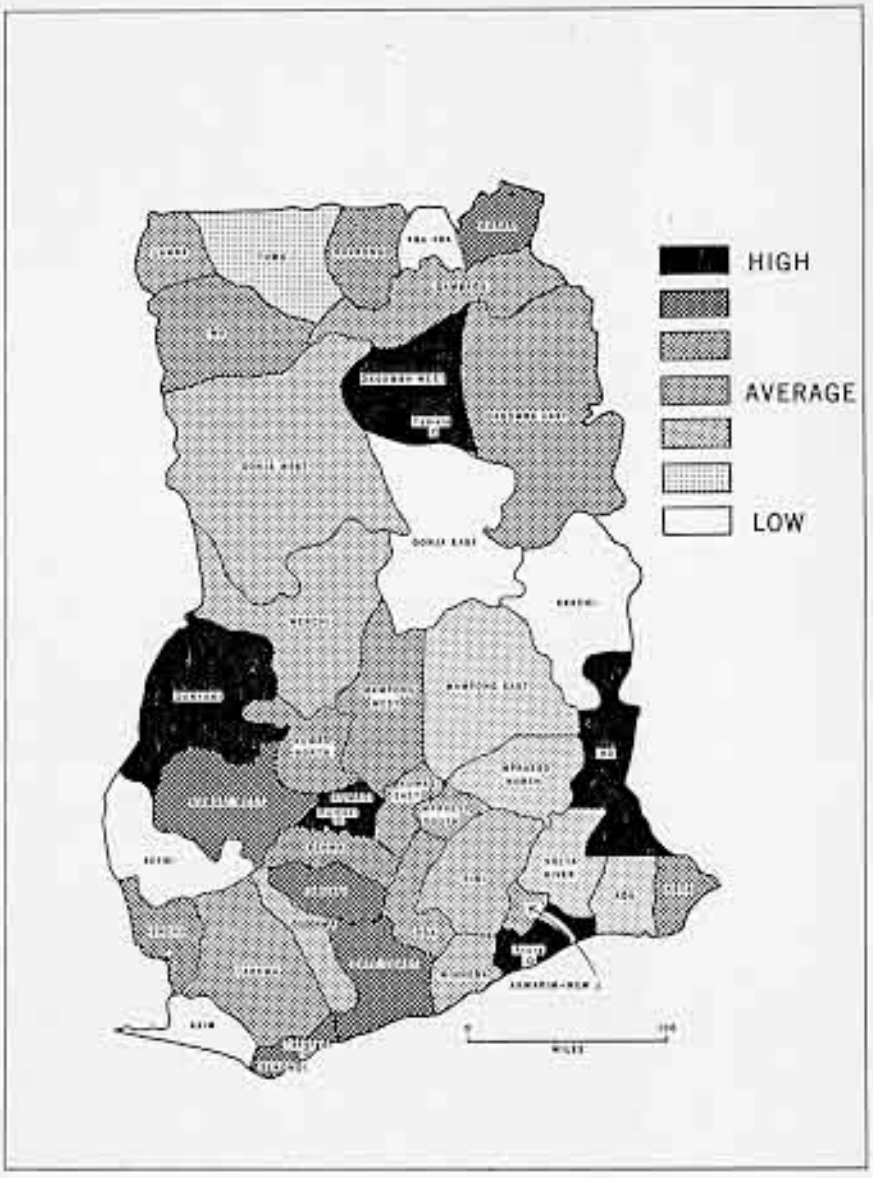

Figure 23: Ghana: Residuals from the Quadratic Perception Surface

The negative residuals, those areas perceived as even less desirable than the overall trend would suggest, lie mainly in a zone trending from the southeast to the northwest. Many lie in the Barren Middle Zone, an area that for environmental (tsetse fly and low, irregular rainfall), and historical reasons (devastated by slave raiding from the north and south), appear especially unattractive. Indeed, it is only now that population is trickling back to the area,[38] settling along the major north-south roads whose original purpose was to provide administrative and economic links between the poorer north and the bountiful south.

Nigeria

The overall viewpoint of university students in Nigeria is only slightly less homogeneous (62.5%) than that of Ghanaian students. For those who are aware of some of the less optimistic political prognostications that have been made in recent years, such agreement will come as a pleasant surprise. While Nigeria is assumed to face divisive forces along traditional regional lines between the North, Southeast and Southwest, the strong agreement in the space preferences of university students has considerable implications for forging national unity. Despite different backgrounds and home residences, nearly all the sample loaded highly on this first, general dimension indicating that each agreed to a marked degree about this overall mental map (Figure 24). The perception surface, however, is not so simply described as in the case of Ghana. Two distinct cores appear; one a band stretching over most of the southern portion of the country from the Yoruba east to the Ibo west, the other a perceptual peak in the north centered on the Jos, Zaria and Kano districts. While the overall linear trend is clearly from the southwest to the northeast, the variation accounted for by even the quadratic

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[38] David Grove, Population Patterns: Their Impact on Regional Planning (Kumasi: The Kwame Nkrumah University of Science and Technology, 1963), pp. 13-14 and map p. 47.

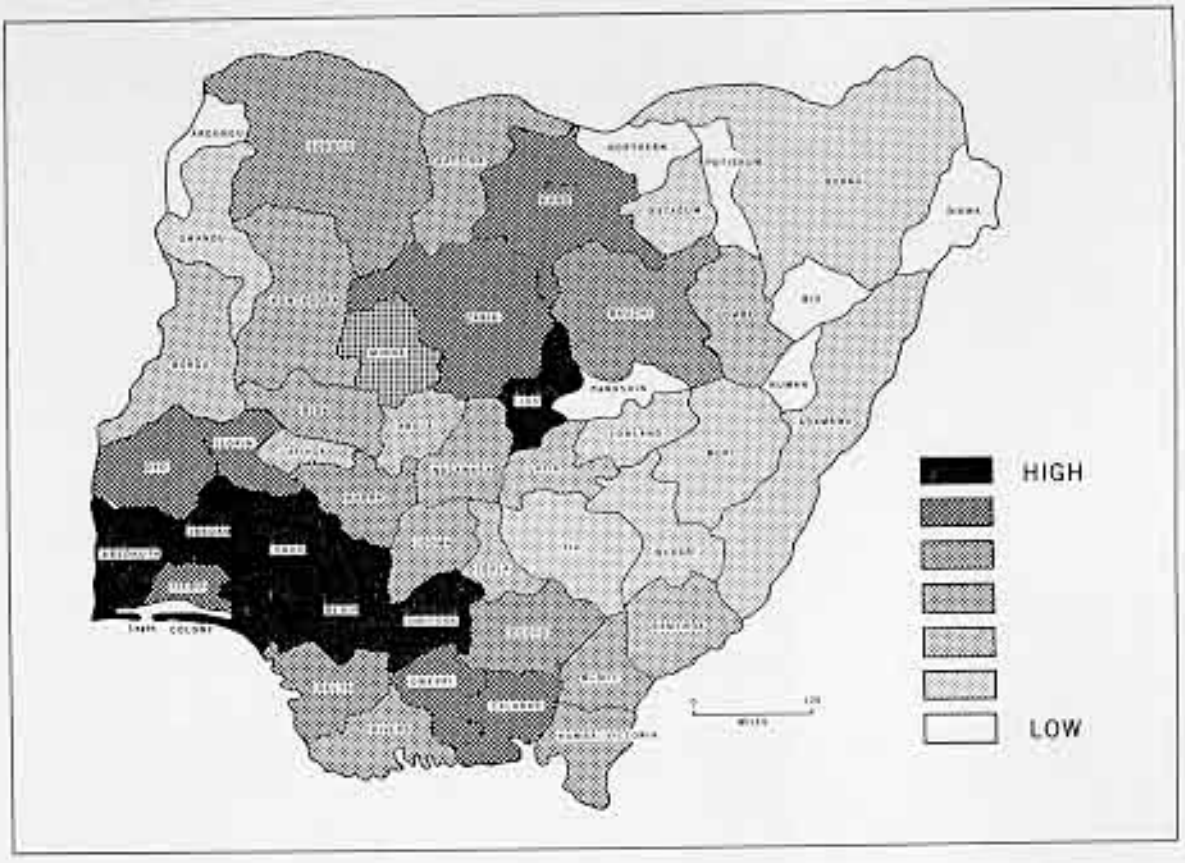

Figure 24: The View From Nigeria: The Most General Viewpoint

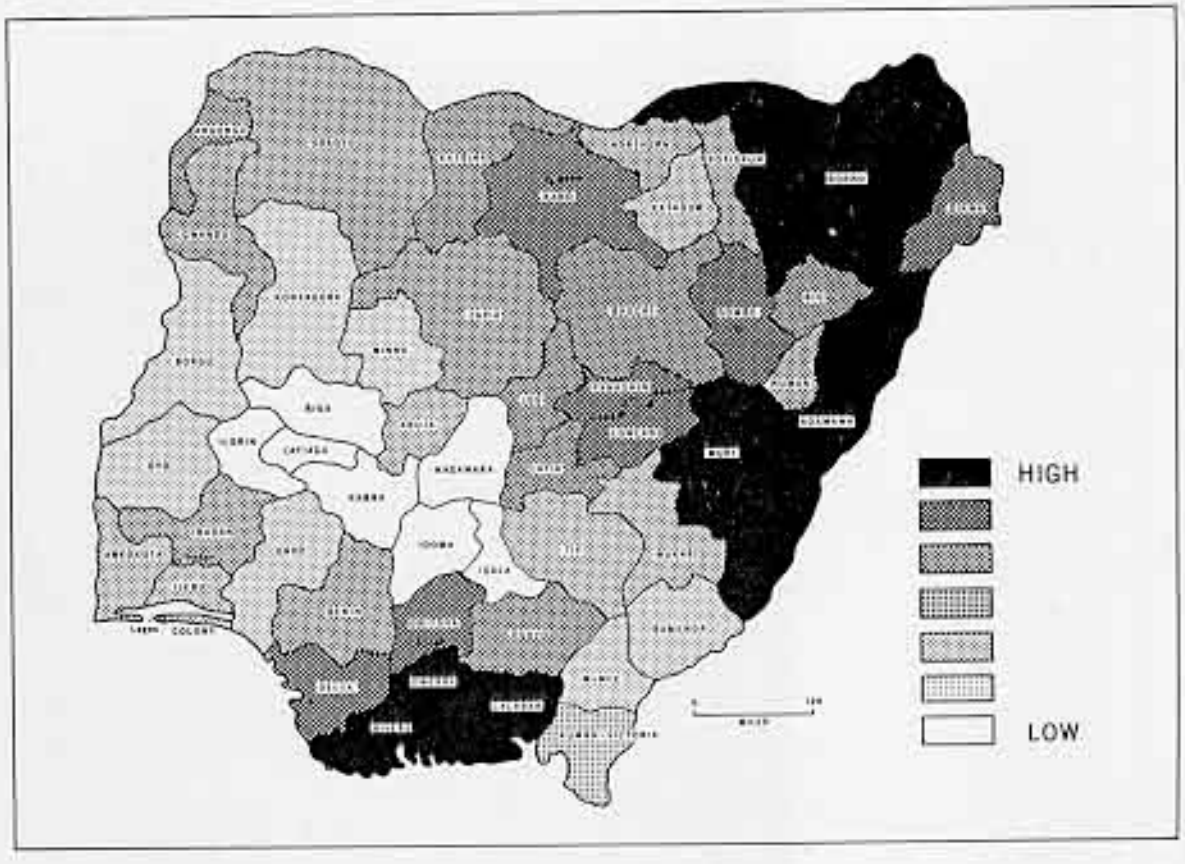

Figure 25: The View From Nigeria: Regional Contrasts

surface (52%) is considerably lower than in the case of Ghana. One is reminded vividly of Whitten's examination of the multiple intrusion hypothesis in the Lacorne granitic massif,[39] where two cubic surfaces were required to raise the sums of squares significantly. Here there is little doubt that a similar division of the area along the Barren Middle Zone, an area that is quite marked on the mental map, would provide a much more accurate description of the overall surface. Nigeria, at least in the minds of this small elite group, seems to be divided into two, quite desirable parts -- the Northern core and the Southern band composed of a blend of the Eastern, Western and Benin regions.

Away from the Northern core perceptual scores drop sharply, and much of the northeastern part of the country is not regarded at all favorably. Generally there is some element of "peripheralism" as in the Ghanaian map, and it is striking the way in which both of the perception surfaces closely reflect the pattern of road density.[40] Thus, we may have some confirmation that road density is a useful surrogate measure not only of accessibility, but those aspects of the modernization and development process that seem to be closely related to this slippery, but useful concept.

The second component (Figure 25), like the subsidiary dimensions of Ghana, accounts for only 5% of the variation and is a scale upon which small

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[39]E. H. T. Whitten, A Surface-Fitting Program Suitable for Testing Geological Models which Involve Areally-distributed Data, ONR, Geography Branch, Technical Report No. 2, Contract Nonr 1228(26), discussed in R. J. Chorley and Peter Haggett, "Trend Surface Mapping in Geographical Research", Transactions and Papers of the Institute of British Geographers, Publication No. 37, 1965, pp. 56-57.

[40]See, for example, Peter Gould, The Development of the Transportation Pattern in Ghana (Evanston: Northwestern University Department of Geography Research Series, No. 5, 1960), p. 109; and Edward Taaffe, Richard Morrill and Peter Gould, "Transport Expansion in Underdeveloped Countries", The Geographical Review, Vol. 53, No. 4, October 1963, pp. 512 and 515, in which reference is also made to the peripheral border areas away from the main cores.

regional effects are contrasted. Compared to the strength of the first dimension, these do not appear to be strong or important, and they support the idea that for Nigerian university students petty regionalism has long been put aside.

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,[41] 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).[42]

We might consider the even march of the isochrones defining the simplest, or linear surface (Figure 26), 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

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[41] 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 study "Western New York: A Culture Hearth?", June, 1966, to which reference should be made for a much fuller [sic] discussion than is possible here.

[42] The idea comes from: Peter Haggett and Richard Chorley, "Trend Surface Mapping . . .", op. cit., p. 64.

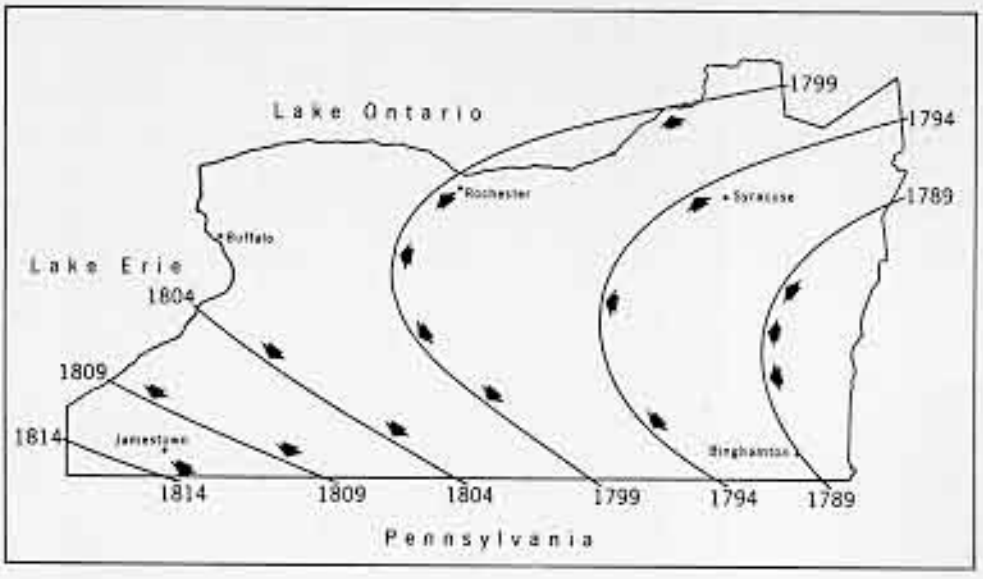

Figure 28: Western New York State: The Quadratic Surface

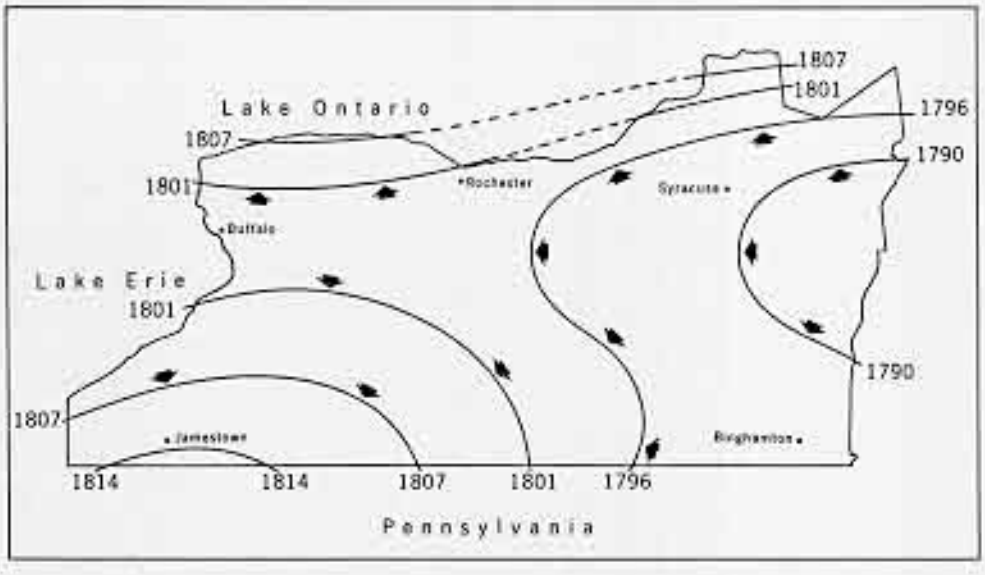

Figure 29: Western New York State: The Cubic Surface

varied and was strengthened by differential feedback processes. While analogies may be 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".[43] Thus, in the same way a submarine valley can distort an evenly spaced wave train (Figure 27)[44] so we might think of the underlying surface of perception distorting the even waves of settlement over the land. Fitting the quadratic surface (Figure 28), which represents the next level of accurate description gained at the least expense of complexity,[45] 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 29), indicates even more strongly the way in which the Lake Ontario plain was perceived 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.[46] 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

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[43]Quoted by Bruce Mazlish, The Railway and the Space Program: An Exploration in Historical Analogy (Cambridge: MIT Press, 1965), p. xiii.

[44]Blair Kinsman, Wind Waves: Their Generation and Propogation on the Ocean Surface (Englewood Cliffs: Prentice Hall Inc., 1965), p. 19.

[45]Sums of squares increased from 36% to 49%.

[46]Fuller, op. cit., p. 11.

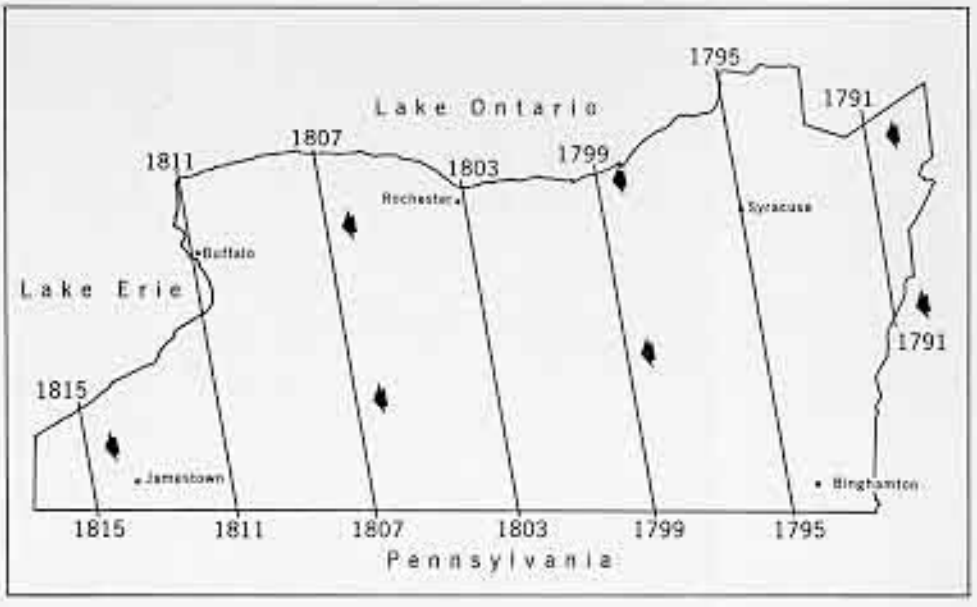

Figure 26: Pioneer Settlement Waves in Western New York State

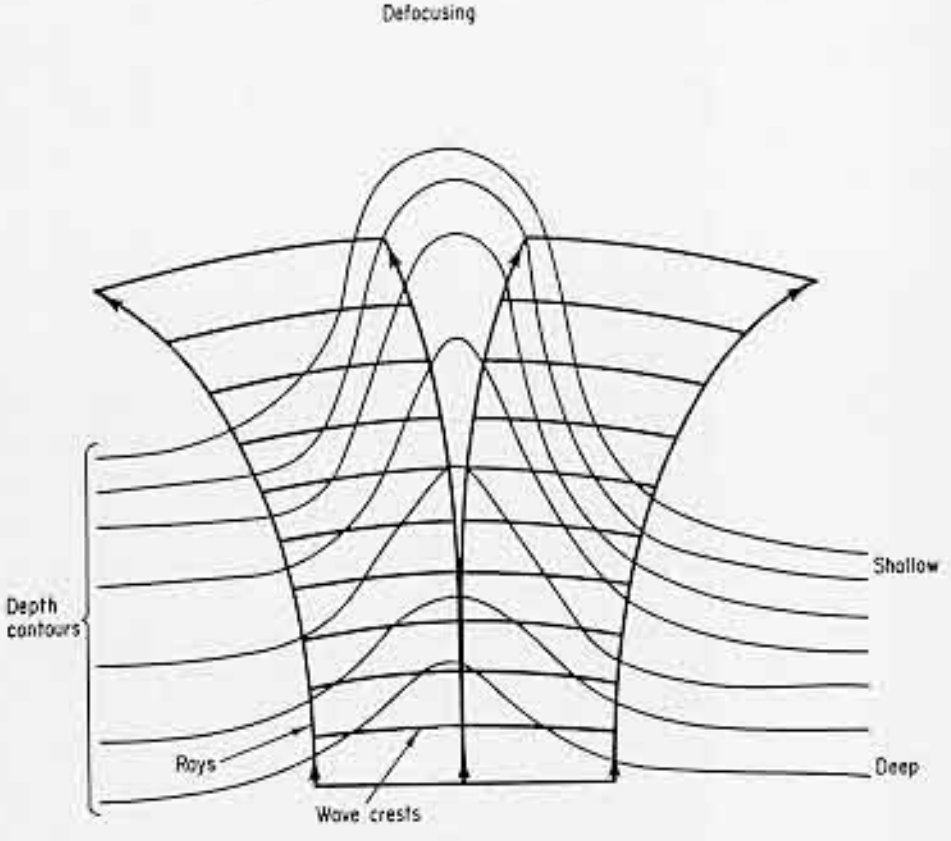

Figure 27: The Refraction of a Wave Train over a Submarine Valley. From Blair Kinsman, WIND WAVES: THEIR GENERATION AND PROPAGATION ON THE OCEAN SURFACE, (C) 1965. Reprinted by permission of Prentice-Hall Inc., Englewood Cliffs, New Jersey, and the author.

the new lands of the west.[47]

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 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.[48]

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 enquiry 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

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[47] Maps of residuals highlight the areas that were perceived as particularly attractive or repellent, see Fuller, op. cit., p. 14.

[48] Useful references include: Richard Budd and Robert Thorp, An Introduction to Content Analysis (Iowa City: State University of Iowa Press, 1963); Robert North, Ole Holsti, M. George Zaninovich and Dina Zinnes, Content Analysis (Evanston: Northwestern University Press, 1963); while imaginative applications include David McClelland, The Achieving Society (New York: VanNostrand and Co. Inc., 1961) and Richard Merritt, "Systems and the Disintegration of Empires", General Systems Yearbook, Vol. VII, 1962, pp. 91-103.

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.[49]

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 the African countries particularly, the mental maps closely corresponded 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

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[49]Anon., "Under and Over", Manchester Guardian Weekly, July 7, 1966, p. 8.

very high incentive pay to lure her people into the new and dynamic lands of Siberia.[50]

In the area of migration, too, mental maps may shed some light on the gross and long-term movements of people. Thomlinson, for example,[51] 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.[52] In England, work is currently proceeding on the mental maps of pupils about to leave school in the hope that they will shed some light on the migrational streams of young people that are causing such concern to regional planners.[53]

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

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[50]Some investigations are proceeding in New Guinea on the mental maps of district officers for administrative assignments.

[51]Ralph Thomlinson, "A Model for Migrational Analysis", Journal of the American Statistical Association, Vol. 56, No. 295, September 1961, pp. 675-689.

[52]Two thousand questionnaries were recently obtained from high school students by Mr. Robert Ziegenfus, Department of Geography, The Pennsylvania State University, on this topic.

[53]In cooperation with Mr. Peter Haggett, 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.

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?[54]

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 inter-urban 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!

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,[55] and the way the "big city" newspapers raised the information level of the rural population and altered their consciousness of time and space.[56]

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

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[54]Herbert Simon, Administrative Behavior (New York: The Free Press, 1965), p. xv.

[55]Thomas C. Cochran, "The Social Impact of the Railway", in Bruce Mazlish (ed.), The Railroad and the Space Program: An Exploration in Historical Analogy (Cambridge: MIT Press, 1965), p. 177.

[56]Ibid., p. 178.

inherit our mental maps? It would be interesting to sample the geographic images in successive generations to see what significant changes existed between them. To what extent, for example, is the bright image of the Jos district in Nigeria due to it being the traditional "local leave" resort for the European population in colonial times? How closely would the mental maps of district officers in the 1920's and 1930's match those of the present? 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.[57]

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,[58] the changes in mental images from one generation to the next. As Mencius noted more than two millenia 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.[59]

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[57] Happold, op. cit., p. 40.

[58] Louis Guttman, "The Nonmetric Breakthrough for the Behavioral Sciences", invited address to the Automatic Data Processing Conference of the Information Processing Association of Israel, January 5-6, 1966.

[59] Mencius, circa 335 B.C., quoted in Truman Kelley, Essential Traits of Mental Life (Cambridge: Harvard University Press, 1935).