Representation of Geographic Space in Natural Language, Minds, Culture and Computers

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INTRODUCTION

The following is more an essay than it is a paper. In the essay, I raise some issues that I believe are important and that I hope will form a basis for discussion. The essay will be organized around the following bipolar contrasts:

1) Cognition and Behavior
2) Language and Cognition
3) Objectivism and Reality
4) Objectivism and Culture
5) GIS and Latin America

COGNITION AND BEHAVIOR

It seems obvious that people's spatial behavior and their spatial decision-making will depend upon their individual cognitive models (ICMs) of situations they find themselves in and will not depend directly upon any objective description of those situations. Note that this does not rule out positivist explanations. However, a positivist model of human spatial behavior can account for observations only if one or both of the following conditions holds. Either: 1) the individual cognitive models of those aspects of the world that are relevant to the model are very similar to the objective descriptions of the world that are used in the model; or 2) aggregation damps out individual differences and allows solutions to converge toward descriptions of space sufficiently similar to the objective view. Much of statistical, positivist geographic modelling is based on the often-implicit assumption that both of these conditions are true. However, a variety of evidence suggests that condition number one is not sufficiently close to the truth. If this is so, then attempts to characterize the relationships between objective or measurable properties of the world and the ICMs of that world are of high priority if we are to continue to apply mathematical or statistical models to predict of explain human spatial behavior.

LANGUAGE AND COGNITION

At least three distinct approaches are available for learning about human spatial cognition. One approach common in psychology is to observe the performance of human subjects in carefully-controlled experimental conditions. A second approach, not very often used, is to directly observe human spatial behavior under natural conditions. A third approach, and the one most

commonly used in geography, is to observe artifacts and patterns on the earth's surface that are the result of human activities and to use properties of these to infer cognitive process. And lastly one can observe how human natural languages represent geographic space (see Talmy 1983; Mark, Svorou and Zubin 1987) and how people talk about space and spatial relations. Studies of natural language represent a very important source for building and testing models of human spatial cognition.

Perhaps the most important work in this area is Leonard Talmy's paper, "How language structures space" (Talmy 1983). Talmy based his thesis on detailed cross-linguistic comparisons including both Indo-european and Native American languages. Each language organizes its locative expressions around particular concepts of space, spatial relations and abstracted spatial objects. For example, as presented in great detail by Herskovits (1985, 1986), the locative expressions in English commonly include prepositions, of which the most fundamental are "in", "on" and "at." These in turn express spatial relations between abstracted or idealized spatial objects such as points, lines, strips, regions and surfaces. As Talmy (1983) has pointed out, most of these relations are invariant under changes in material, scale (size) and orientation. However, in one sense of the English preposition "on," which **[end p. 331]** expresses the relation of lateral adjacency only between some geographic feature and some larger reference region (as in "Cleveland is **on** Lake Erie"), the reference object must be a water body, a pathway or a public open space (Herskovits 1986: 148), and the feature being located must be a building or some small space where human activities take place. An English-speaker cannot say "Philadelphia is on New Jersey," meaning adjacent to New Jersey.

Few English speakers know these restriction at a conscious level but most will recognize that something is seriously wrong with this example. Similarly, a Spanish speaker knows that they can use this form for pathways and open spaces but not for adjacency to water bodies. Thus in Spanish one can say "Mi casa está en la plaza" to mean "My house is on [the edge of] the plaza." Yet for a water body the same spatial relation must be expressed as "Mi casa está en **la orilla de** la laguna," or "My house is on the edge of the lake," with an explicit mention of *orilla*, edge or bank. The two situations, the plaza and the lake, seem similar and equally unambiguous. Typically, houses are not within the spatial polygons called either lakes or plazas but would be next to them. Typicality or conventionality would account for the plaza example, because the typical relation of a house to a plaza, assuming that the plaza is the salient reference object, is adjacency. One might expect language to "mark" the atypical situation of a house out on the plaza linguistically, as would be observed in the expression "Mi casa está en la mitad de la plaza." But if we apply that reasoning to the lake the same "should" hold. A house within the boundaries of a lake certainly would be unusual and so we might expect a house "on" the lake to be adjacent to it.

Some non-Indo-European languages have much more complicated systems for indicating locations. For example Cora, a language spoken in an area in western Mexico, has approximately 150 words that would translate to the English deictic "there" (Casad 1982, after Lakoff 1987, and Lakoff, personal communication 1990). A speaker of Cora cannot talk about a location without specifying such characteristics as whether the location is in sight or not, whether it is at the top, flank, or base of a hill, and so on. There is no "just plain there" in Cora.

Similarly, in Atsugewe, a language from northern California studied by Talmy, there are over a dozen verbs roughly equivalent to the English "to go into" but depending on what the reference object is. There is a verb for "to go into a cave," another for "to go into a hole larger than a person," another for "to go into water," another for "to go into a human body," and so on.

The Sapir-Whorf hypothesis, which states that people who have different native languages **think** differently in at least some circumstances, is controversial. The idea is that people "think in language." This is controversial in part because like environmental determinism it can be used to support racist principles. Indeed, strong experimental evidence to support the hypothesis is rare. People whose language requires them to specify some property are apparently no better at remembering that property than are others whose language ignores it. But it seems that if, as Talmy suggests, a person's language provides a structure to space, then the way that an individual's language structures that space will have at least some influence on the way the think about space and spatial relations. At the very least it will influence the structure or organization as well as the content of user interfaces for computer systems for dealing with space, including geographic information systems (GISs).

OBJECTIVISM AND REALITY

In a positivist's world there is an objective reality. The post-Modern view would, among many other things, suggest that cultural and linguistic relativism must not be ignored. Instead, human cognitive models are more "real" or at least more relevant than are any measurable "objective" properties of the environment. But cognitive science provides new approaches to formal representations of concepts, formalisms that do not carry with them all of the weak points of positivism. They undoubtedly have other weaknesses. In this view cognition and even direct perception have both bottom-up, sense-driven and top-down, concept-driven components. Whereas the sense-driven portion of the process may be objective, the concept-driven portion is not.

In his book *Women, fire, and dangerous things* (1987) George Lakoff presents a relatively new model of human cognition that he terms experiential realism. In the book Lakoff first presents a somewhat exaggerated version of objectivism closely related to positivism. Categories or kinds are represented in the positivist view as sets; in principle, there is a set of necessary and sufficient conditions for something to be a member of the set and all members of the set are equally good examples of it. Lakoff presented a number of published critiques of objectivism, including Hilary Putnam's "The meaning of 'meaning,'" in which he showed that positivism is internally flawed by the fact that one cannot define the "true" meaning of language by reference to the real world. **[end p. 332]** Lakoff takes the reader to the edge of a solipsist view in which the existence of any external world is questioned because the mind could not have access to such a world but can know only what the senses report. And that is where the deconstructionists apparently want to leave us.

But in his book, Lakoff continues on and provides "experiential realism," which he developed in collaboration with the philosopher Mark Johnson, author of *The body in the mind* (Johnson

1987) and based, in part, on the work of Eleanor Rosch (1973, 1978; see also Lakoff and Johnson 1980). Let us begin by assuming, without the possibility of absolute "proof," that the "real world" exists in some objective sense. Next, since human bodies and senses and brains have a great deal of similarity across individuals, there will be a great deal of concordance in the way we individually sense and perceive and conceptualize that "real" world. Furthermore, because most people are not raised in isolation but in societies and cultures this raises the concordance of individual cognitive models even more.

This "experiential realism" seems to provide an answer to the apparent conflict between naïve realism and objectivism on the one hand and post-Modern existentialism or solipsism on the other. Experiential realism admits the technical disconnection between the mind and any "objective" or "real" world, a touchstone of positivism. But at the same time, it appears to have considerable potential to account for the fact that many of our formal models in science (such as Newtonian physics) are very good approximations to the naïve realism that grows from our experience and that allows us to deal with the physical world on a day-to-day basis.

OBJECTIVISM AND CULTURE

Within a cultural/linguistic group such as North American, English-speaking environmentalists or foresters or geographers there probably is enough of a common conceptual basis that the non-objective or individualistic aspects of perception and cognition can be pretty much ignored. Scientists can "do science." Differing concepts of geographic space itself probably contribute very little to the conflicts over the old-growth forests of the Pacific Northwest; rather, these conflicts stem from differences in the relative values of nature, of endangered species and of jobs and economic development. But differences in culture and especially language can lead to more substantial mismatches among ideas of what is "the" objective reality or what is the "truth."

It would be interesting to compare the "world models" of the Aztecs to those of the "*conquistadors*" around 1500. Many of the "*conquistadors*" were of the warrior-noble class that for the previous 500 years had been attempting to re-Christianize the Iberian peninsula by defeating and driving out the Moorish "infidels." The mis-match in the idea of what is real and what is not may have had as much to do with the Aztecs' problems as did the Spaniards' "hi-tech" weapons and their diseases. Attitudes toward land among the aboriginal peoples of the Americas and Australia were often very different from those of Europeans. Just read Bruce Chatwin's *The songlines* (Chatwin 1988), or Mario Vargas Llosa's *The storyteller* (Vargas Llosa 1989). In areas where indigenous cultures have survived to the present cultural differences in concepts of geographic space and of the relations of people to that space lead to challenging problems of defining aboriginal land claims in ways that can stand up to European-style courts and can be entered into computerized legal land tenure systems (cf. Brody 1981).

GIS AND LATIN AMERICA

At a recent NCGIA (National Center for Geographic Information and Analysis)-sponsored workshop, Spanish was identified as a high priority language for cross-linguistic studies of

geographic information (Mark 1989b; Mark, Frank and others 1989). This was in part because Romance languages structure space in different ways than do Germanic languages spoken by the designers of most current commercial GISs. But perhaps more importantly Latin America was recognized as an important area for GIS technology transfer in the immediate future because of the urgent nature of environmental and social problems in the region combined with rapidly developing educational and technical infrastructures that make GIS adoption in Latin America more realistic than it might be in other parts of the world.

This need for GIS and related technology has already been recognized by researchers and educators in the region as well as by the International Geographical Union (IGU). Thus, the "Primera Conferencia Latinoamericana sobre Informática en Geografía" ("First Latinamerican Conference on Computers in Geography") was held in San Jose, Costa Rica, in October, 1987, under the leadership of Dr. Merrill Lyew and under the co-sponsorship of the IGU Commission on Geographical Data Sensing and Processing (Lyew 1987). This meeting was attended by people **[end p. 333]** from 11 Latin American countries as well as from the United States, Canada and six European countries. Most of the European and North American participants gave papers and almost all of those were presented in English. The conference proceedings included the full text of 25 papers (14 in English, 11 in Spanish) and summaries of 10 others (mostly in Spanish). Thus "northern" presenters made up about half of the program. The meeting was highly interdisciplinary and the program included papers on geographic information systems, cartography, remote sensing, archaeology, climatology, energy planning, ecology, urban planning and conservation. The main conference was preceded by a two-week workshop on GIS with two instructors from the United States, one from Costa Rica and one from Spain. The workshop attracted many young scientists and engineers, people actually involved in practical GIS applications in Latin America. Their enthusiasm and camaraderie at the end of the workshop were obvious and the impact of the workshop on GIS use in Latin America may be felt long after the paper sessions are forgotten.

In September, 1989, a second meeting was held in Mérida, Venezuela, under a modified name, "II Conferencia Latinoamericana sobre la Tecnología de los Sistemas de Información Geográfica" ("Second Latinamerican Conference on the Technology of Geographic Information Systems"). At that meeting a much greater proportion of the papers were presented in Spanish and by Latinamerican scientists and researchers. A third meeting in the series will be held in Santiago, Chile, in November, 1991.

GIS query languages, human-computer interfaces and even GIS data models may contain artifacts of the language spoken by their designers. For GIS, design has most commonly happened "in" English or German. Systems that mimic human cognitive structure and behavior are more likely to be useful and effective than systems which are designed based primarily upon current hardware and software trends. This may be especially true for systems that are to be used by novices or by non-geographic personnel.

Cross-linguistic and cross-cultural concerns are a fairly recent yet important aspect of human-computer interaction research (see papers in Nielson 1990, especially in Sukaviriya and Moran 1990) and have very recently been discussed in the GIS literature (Mark, Gould and Nunes

1989; also Gould, this volume).

Mark, Gould and Nunes (1989) began their paper for the second (Mérida) meeting with the following claim:

> Because major language groups differ in the ways they structure and express geographic space, the fact that most current geographic information systems have been designed by native speakers of English or German is a potential impediment to the widespread adoption and effective use of GIS in countries where people speak Romance languages (such as Spanish and French) and especially non-Indo-European languages.

They went on to state:

> From principles of cognitive science and human factors, we can predict that the ideal Geographic Information System (GIS) for an individual to use would define spatial objects and spatial relationships in a way that is consistent with that person's language, culture, and background. But this implies that such an "ideal" GIS would not be ideal for speakers of other languages, or even for speakers of the same language who belong to different cultures, dialects, or disciplines. Thus a cross-linguistic perspective on cognitive categories for geographic space raises serious issues for GIS technology transfer across cultural and especially linguistic boundaries.

Present GIS design allows for the use of technology only by a minority consisting of highly-trained personnel. This is true even in English-speaking countries, but is amplified many-fold in countries where other languages are spoken. Based on some anecdotal evidence, it seems that people who use "English" software; that is, the current users, accept this situation as ***status quo***. Also, for some users, there probably exists an element of elitism associated with being able to understand English well enough to operate computer software. Software written **[end p. 334]** and supported in Spanish would allow "anyone" to be a computer user. If knowledge is power, control of information technology also is power. Furthermore, many people find documentation and software to be their best, perhaps only, chance to learn or practice their English.

Mark, Gould and Nunes (1989) concluded as follows:

> We contend that the application of creative and innovative science, engineering, art, and application in the geographical sciences is hampered by the present need for users to devote a considerable majority of their time to building, learning, optimizing, and maintaining systems and databases. Again, this effect is exaggerated when translation of manuals, documents, and commands is also needed.

It is not too soon to begin designing systems to take advantage of real-time spoken natural-language understanding. Systems already are able to understand such speech within limited

knowledge domains and for limited vocabularies. The technology probably will be available before we can implement and test language-understanding procedures for GIS and spatial data handling.

SUMMARY AND PROSPECTS

Recent research in cognitive science suggests that language and thought are deeply intertwined and that cognitive models influence perception of the external world, including geographic space. People with different natural languages probably conceptualize at least some aspects of their worlds differently. And the more different the languages the more likely these differences will be. "Culture" may be an even greater source of differences in individual cognitive models of environment, but cultural differences are often correlated with linguistic ones. Recent developments in cognitive science and in GIS provide Latinamericanists with many new concepts and tools that should be useful to them in both theoretical and applied research.

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