# Image & Environment

Roger M. Downs
David Stea
editors

## Cognitive Mapping and Spatial Behavior

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With a foreword by Kenneth E. Boulding

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# Foreword

I have read these papers with very great interest. They are interesting in their own right as an expression of an "invisible college" which represents almost a new discipline, cutting across the old disciplines of geography and psychology, with a considerable dash of other social sciences, and even a tantalizing flavor of history, as we move from space into space-time. They represent, furthermore, a significant contribution towards filling the biggest hole in the sciences, the missing science of human learning. In this connection the importance of any contribution can hardly be overestimated, for it may well be that in the present extraordinary period in the history of this planet a science of human learning is the only thing which can save us from disaster. All social problems, whether war, population control, the structure of authority, the distribution of income, or whatever we would like to mention, can only be solved by a dynamics which includes human learning as its most essential element.

The plain fact is, however, that up to now we know very little about human learning in an explicit model-building sense. Education is still a craft industry. Most of us teach the way we do because it is the way we were taught. The production of human beings in the family is also a craft industry. People raise children, on the whole, in the way that they themselves were raised. The few onslaughts from the scientific subculture in the way of learning theory, in the one case, and Drs. Gesell and Spock in the other, have made only marginal changes. Not, of course, that craft industries should be despised; they often produce very elegant and delightful articles. We must be doing something right both in childrearing in the family and in formal education; otherwise we would not have survived as long as we have. In what I have elsewhere called the "crisis of closure," however, in which our terrified spatial imagination perceives the all-too-near wall of the niche into which the human race has been expanding for so long, the craft production of human adults may not be enough, and any move towards a more systematic and specific knowledge of human learning is a big step towards survival.

My little book *The Image* propounded the then somewhat heretical notion that learning essentially consisted of a growth of knowledge, and that behavior was a function of knowledge; that is, the cognitive structure, which I called the "image," including the valuations which were placed over the structure. On this view most behavior could not be explained in terms of a response to any immediate stimulus. This is, of course, the sort of psychological doctrine one would expect from a simple-minded economist, who thinks mainly in terms of the theory of choice, for choice must be between alternative images of the future. There is nothing else to choose, and though immediate stimuli, like seeing something in a shop window, may affect our images of the future, the stimulus clearly is merely a trigger and the act depends on the whole cognitive-valuation structure, that is, on the image. We are not going to find any stimulus-response regularities, therefore, except in extremely simple cases, any more than we should expect to find regularities between a trigger and its consequences if we knew nothing about the system as a whole. The stimulus-response theory, therefore, seems to take us only a very little way into the system which we are really investigating, simply because between the stimulus and the response lies an image which simply cannot be dismissed by calling it an intervening variable. It is not a variable; it is a vast and complex set of parameters to which we also have some kind of access, even though an imperfect one.

It is one thing to postulate a cognitive-valuative structure as a necessity, almost indeed an evolutionary necessity, as Kaplan points out. It is quite another thing to be able to perceive it as a system and to understand its structure. It is indeed a very real question as to whether this is possible, that is, whether the knower can understand not only what he knows, but also what the systematic structure of that knowing is. Whether we can go all the way with this, however, does not concern us. The important thing is that we can go part way, and we should go as far as we can. In this connection, the study of spatial images is of peculiar importance, not only because they are of themselves perhaps the most significant part of the total structure, but also because they seem to be accessible in a way that other parts of the image are not. Indeed, if we think about other elements of the image, we have a strong tendency to structure this in spatial terms. Thus, an economist thinks of valuation in terms of the utility function, which is a kind of "mountain." We think of personal relationships in such terms as near and far, obscure and clear, devious and direct, exalted and commonplace, all of which have strong spatial connotations and are in fact spatial metaphors. It is a challenge indeed to try to think of a metaphor that is not in some sense spatial. We can perhaps rank the senses, in terms of the spatial quality of information which they give us; in the order of vision, hearing, touch, smell, and taste, with taste metaphors, such as bitter and sweet, salty and bland, having the least spatial connotations.

The spatial connotations of language indeed is a subject which does not seem to be included in this volume, perhaps because it does not yet exist, but it is clearly a fascinating field in which the geographer and the linguist might well get together. One thinks, for instance, of the spatial aspects of grammar. The comparative and the superlative are clearly spatial metaphors. Classificatory structures, like gender, have less direct spatial reference, but always involve spatial metaphors like pigeonholes and represent an extension of the spatial metaphor "here" and "there." Word order, which is of overwhelming importance in some languages, is very clearly spatial. Any ordinal ranking has a spatial referent and is indeed a spatial metaphor. It is hard to believe that this overwhelming importance of the spatial metaphor is not related to some as yet unknown spatial pattern of the human nervous system, which enables us to perceive the four-dimensional space-time world in which we live because of some kind of corresponding structure "inside," this structure coloring all our other perceptions. How startling it is, however, to find one's use of the word "color," which is a non-spatial metaphor, to describe the expansion of the internal spatial structure into a more complex image.

Perhaps the reason why the study of "inner space," or internal spatial structures, is so immediately rewarding is that we now have external "maps" which we believe are very accurate representations of the real world, derived from processes of surveying, the application of trigonometry and geometry, and so on, about which there is virtually no dispute, mainly because there is an extraordinarily powerful and effective feedback of mapping error from anyone who uses maps. It is significant that the error here is the failure of correspondence between an external map and an internal map, in which it is the failure of the external map which produces correction as a function of the social system. In the individual learning process, it is correction of error by the comparing of our internal maps with "maps of maps," internal maps of external maps. The map, therefore, in all its possible forms represents a unique contribution towards error detection and its use, not only in the form of geographical maps but in the form of chemical formulas, physical laws, and so on. The map concept is perhaps the real key to the development of science. This is an aspect of the theory of scientific epistemology which has not been sufficiently explored.

I cannot resist the temptation to conclude with a personal note on the curious nature of what might be called scientific space. The organization of science into disciplines sets up a series of ghettos with remarkable distances of artificial social space between them. I have been interested in establishing communications among the disciplines ever since I went to Iowa State College (as it was then called) at Ames, Iowa in 1943, to convert myself into a labor economist. Until that time I had been an extremely pure economist, believing indeed that the other social sciences either did not exist, or at least could make no contribution to economics. Getting into the study of the labor movement convinced me that without sizeable inputs, certainly of sociology and political science, and more doubtfully of psychology, the phenomenon of the labor movement could not possibly be understood. This got me interested in the problem of developing a general social science.

When I went to the University of Michigan in 1949 it was with the intention of developing a seminar in the integration of the social sciences, and this I carried on for a number of years. It attracted a very diverse group of people—engineers, architects, biologists, sociologists, anthropologists, and political scientists. I cannot recall that I was able at any time to find a psychologist interested in it, but I have to confess that my cognitive map of psychology looks remarkably like the interior of Greenland. The seminar, however, did have a curious indirect by-product. As a result of it, I got into correspondence with the late Ludwig von Bertalanffy, who was approaching general systems from the side of biology as I was approaching general systems from the side of economics. We spent a year together in 1954–55 at the Center for Advanced Study in the Behavioral Sciences at Stanford, and out of conversations begun there between Bertalanffy, Anatol Rapoport, Ralph Gerard and myself, we founded what eventually became the Society for General Systems Research. Even in this enterprise, psychologists played an extremely minor role. In that golden year at the Behavioral Sciences Center I recall very few fruitful contacts with psychologists with one exception, Elsa Frenkel-Brunswick. Her husband Egon's famous "lens model" is an important contribution to cognitive theory, and I am a little surprised that no use seems to have been made of it in this volume. The work of my colleague Kenneth Hammond, which follows very closely that of Frenkel-Brunswick, on computer graphic representations of conflictual positions, seems to me very close to the general problems of cognitive mapping, using spatial analogies rather than space itself.

It was a real surprise to me, therefore, to learn from the papers in this volume that my little book *The Image*, which emerged from an intense nine days of solitary dictating at the end of my time at the Center for Advanced Study in the Behavioral Sciences, should have figured in the history of cognitive mapping in the way it seems to have done. In *The Image* I did make a somewhat half-hearted suggestion that perhaps a new science might emerge out of these concepts, which I dubbed "eiconics." However, after writing *The Image* I became interested in other things—in the theory of conflict, general systems, and so on—and my general impression was that *The Image* had fallen on fairly stony intellectual ground. It aroused interest in surprising quarters—among business executives, among the people who teach humanities in engineering schools, and in departments of communications—but as far as I knew it had never penetrated the boundary of the behavioral sciences, for whose benefit it was ostensibly written. These boundaries obstruct traffic both ways. I did not even run across the book by Miller, Galanter and Pribram until long after it was published. I have to confess to my deep embarrassment, especially as I have been a map lover since childhood and incapable of resting content at any new location until I have provided myself with topographical maps of the area, that the exciting development of cognitive mapping, as revealed in this volume, came to me as an almost complete surprise. Cognitive mapping must certainly be Part One of any textbook of "eiconics," so the surprise had a strong mixture of sheer delight along with the personal embarrassment. It is hard, therefore, for me to avoid looking on this volume, as delightful as it is in its own right, as a prelude to something larger, nothing less indeed than a general theory of the cognitive-valuative structure and the learning processes by which it is created.[1] One returns again, however, to the nagging question, how can the intellectual community be organized to reduce the social space between the disciplines? Walls, no doubt, there should be. Otherwise the interdisciplinary all too easily becomes the undisciplined. On the other hand, there surely doesn't have to be a Sahara desert between the economists and the psychologists. Volumes of this kind are an oasis, but one longs for a time when the oasis will expand and emerge in an uninterrupted fertile and traversable republic of the mind.

KENNETH E. BOULDING

1. In this connection the book *Culture and Cognition*, edited by James P. Spradley, should be noted as another step toward "eiconics." This is an expression of what might almost be called the "eiconics movement" in anthropology. But it is remarkable, and perhaps another symbol of the spatial isolation of the disciplines, that I am the only one out of forty-five authors contributing to both this volume and the Spradley volume.

# Preface

### *Aims of the Book*

The genesis of this book was an invitation to edit a special issue of the journal, *Environment and Behavior*, in which we brought together some of the emerging work on environmental cognition. After that task was completed, we embarked on the preparation of this book. It would be a fiction to claim that we had fixed aims—we can more easily postdict a set of aims. Primary among these is to introduce and give coherence to a recent approach to studying human environmental behavior. A concern with the link between human behavior and the environment has always been at least an implicit concern of the social sciences, but never before has this concern been manifested so vocally and forcibly as in the recent past—in fact, display of such concern is now demanded by the general public.

As a result, many disciplines have responded to the call, and in true academic fashion, have generated a series of "–ologies," "–istics," and "–isms." Foremost among these is the attempt to relate human behavior to the physical environment, the latter including both "natural" and man-made components. Hastily joining this effort have been a host of disciplines. Consequently, we are faced with a bewildering list of descriptive names for this sub-field: behavioral geography, environmental perception, environmental psychology, ecological psychology, and human ecology are among those proposed. Some clarification has been made in an edited collection of papers on environmental psychology by Proshansky, Ittelson, and Rivlin (1970), and in the reviews by Craik (1970a) and Wohlwill (1970). Even so, in an area where the geometric law of publication applies, we need overviews and critiques of the scattered and often conflicting work on environmental behavior.

In particular, this book represents a collection of papers on the topics of cognitive mapping and cognitive maps. Cognitive mapping is a construct which encompasses those cognitive processes which enable people to acquire, code, store, recall, and manipulate information about the nature of their spatial environment. This information refers to the attributes and relative locations of people and objects in the environment, and is an essential component in the adaptive process of spatial decision making. Thus, for example, cognitive mapping helps us to solve such diverse spatial problems as finding a supermarket, choosing a safe and quick route to and from our workplace, locating potential sites for a new house or a business, and deciding where to travel on a vacation trip. The cognitive processes are not constant but undergo change with age (or development) and use (or learning). Similarly, a cognitive map is an abstraction which refers to a cross-section, at one point in time, of the environment as people believe it to be.

In presenting this structured overview of cognitive mapping, we are *not* trying to force legitimacy on a field which has yet to earn it. The principal aim is the introduction of a new research area to a wider public, with the hope of encouraging further efforts in research and application. Linked with this aim is the presentation of some categories within cognitive mapping based upon what *has* been done rather than what *ought* to have been done. In achieving these goals, many compromises must be made. We had to temper the desire to include as much as possible with the economics of publishing; we balanced the desire to sample a bit of everything with the need to make the sections into meaningful, related collections of ideas and empirical data. Above all, we have allowed the weight and scope of published material to suggest the nature of the sections and define the boundaries. Nothing could be more inimical to the future of this interdisciplinary effort than premature fossilization.

Obviously, with so many pitfalls available, we could not attain perfection; but, given space limitations and our personal biases, we hope that the six sections—Theory, Cognitive Representations, Spatial Preference, the Development of Spatial Cognition, Geographical and Spatial Orientation, and Cognitive Distance represent a fruitful breakdown of cognitive mapping studies. Other breakdowns of the material are undoubtedly possible, given the overlap among the papers in the different categories we have chosen, though any other scheme would have generated as much or more overlap. We might have taken the suggestion of one reviewer and organized the book in accordance with a three-fold scheme consisting of (1) papers taking a theoretical position; (2) papers dealing with a general empirical overview of the field, and (3) papers dealing with specific experimental studies. We rejected this approach because our experience as teachers of this subject matter convinced us that students, at least at this stage, were more concerned with content areas than with the presence or absence of a theoretical statement. The breakdown of the material we have chosen is that which made most sense to us, our colleagues, and our students. No overall theoretical rationale is intended or, at this stage, probably even necessary. Application of the criterion of "aesthetic balance" would have led us to arrange things so that equal numbers of contributions appeared in each section, but would have accomplished little else.

We expect, however—and in fact hope—that readers will question both the number of sections and the overall coverage of material. We recognize the omission of work on environmental learning: the process of the acquisition of spatial information and its effects on existing cognitive structures. There is a lack of material dealing with pragmatics: the use of cognitive mapping concepts in improving the quality and process of environmental design. However, we were constrained by the paucity either of work in certain areas or of workers currently researching such areas. The omissions are a reflection of the current state of cognitive mapping studies.

We tried to depart from the normal format of a book of readings by providing some genuine integration among dispersed ideas from diverse philosophical backgrounds. This was realized in two ways: first, by our summary paper in the Theory section and by the section introductions; second, by the solicitation and editing of papers designed to fill existing gaps in cognitive mapping research. Thus, our objective is the coherent discussion of a research area and *not* merely the presentation of disparate views of academics bound and linked only by the covers of a book.

A book aims not only at meaningful content but also at a potential audience. In the choice of material and the mode of its presentation, we focused on three interest groups. The first was the individual social scientist attracted to the problems of relating behavior to the spatial environment. We have tried to present a comprehensive overview of cognitive mapping allowing him to grasp basic concepts, methods, and existing bodies of empirical data. Thus, the book is intended as an introduction to a field.

However, we wanted to produce a book satisfying a second reader—the would-be or current researcher in cognitive mapping. To this end, we solicited a wide range of new material, locationally and disciplinarily, indicating the current state of the art. Approximately 80 percent of the book consists of original contributions. In some instances, such as the paper by Kaplan (chap. 4), we sought contributions from outstanding researchers to cover the existing field. We also encouraged contributors to reference heavily and collated these references to form an extensive bibliography for research use.

Our third interest group consisted of students. We wanted to produce a book which could be used as a text or source book in courses dealing with man and his spatial environment. To this end, the sections are relatively autonomous, each having its own brief introduction; thus, the book can be read selectively and in an order suggested by a teacher.

Obviously, these three needs conflict and we have recognized this by not satisfying one exclusively, at the expense of the others. We felt that a state of the art book was required at this time to present the reader with the origins, achievements, and future of cognitive mapping research.

## *Scope of the Book*

In selecting contributions for the book, we aimed at a representative coverage of the content areas being studied by researchers in cognitive mapping. Consequently, the selection in no way indicates the relative volume of research either on an author or area basis. Within this guideline, we employed a set of criteria to select from the "classic" works and new contributions available. Obviously, in a new area, recency itself was an important consideration of our aim toward an up-to-date review of cognitive mapping.

One major criterion was the desire to make a sample of historical milestone papers available (such as chaps. 2 and 16), particularly if they were otherwise inaccessible (chaps. 5, 11, and 15). Second, we sought contributions with a theoretical component since we believe that pragmatic solutions depend upon the development of coherent and tested theory. The papers by Kaplan (chap. 4) and Stea and Blaut (chaps. 3 and 12) show how some of the disparate concepts and data can be meaningfully and productively related. Third, heavy empirical content was stressed because we are as much lacking in "hard" data as in developed theory. In this respect, we feel that the papers by Briggs, Lowrey, and Lundberg (chaps. 17–19) provide the foundations out of which speculations, then hypotheses, and eventually theories will emerge.

Fourth, we sought papers with good reviews of the literature relevant to cognitive mapping studies. Selection on this basis was difficult because so many reviews have touched peripherally on cognitive mapping. We avoided overlap with the works of Proshansky, Ittelson, and Rivlin (1970), and Craik (1970a) mentioned earlier. We felt that the present state of work on geographical and spatial orientation could be covered by the reviews in the papers by Griffin, and Lynch (chaps. 15 and 16).

Whenever we detected a gap which could not be filled in accordance with the above criteria, we solicited contributions from experts in the area. Hence, at a later stage in the compilation of the book, the papers by Francescato and Mebane, and Orleans were obtained (chaps. 7 and 8).

Editing is as much a task of exclusion as inclusion, and so we must indicate the decision rules for excluding papers. First, linguistic bias favored works authored in English and representing the U.S., British, and Swedish orbits. The only serious omissions appear to be the Russian studies of spatial orientation (Angyal, 1965 and Shemyakin, 1962), and some writings of the Piagetian School, which are represented in the paper by Hart and Moore (chap. 14).

Second, we gathered little material from outside the spectrum formed by geography, psychology, and planning. This is a reflection both of editorial competence and of the major interest in cognitive mapping within these disciplines. We were aware of studies in cultural anthropology and sociology which touched upon the topic of cognitive mapping, but whose prime objective, however, is different from that of this book; introductions to this other area are to be found in Brookfield (1969) and Campbell (1968). In addition, Lynch's bibliography (chap. 16) is an excellent primer for cultural and anthropological studies.

Three peripherally related types of work are excluded. First, studies of cartographic perception or psychophysics, though dealing with environment, perception, and behavior, have objectives different from our own. Studies such as Wood's (1968) attempt to relate the graphic map presentation mode to the amount and type of information perceived and abstracted by the map reader. They are oriented more to studying perception (for example, the discriminability of various color shading systems) than to a subject's cognitive grasp of his environment.

Second, we excluded studies of spatial mapping which are *not* cognitively oriented except by inference. Although the studies by Chapin and Brail (1969) or Moore and Brown (1970) show the mapped spatial pattern of human activities, the *cognitive* component is present *by inference only.* This comment should not be interpreted as a criticism of this valuable work, since it affords evidence of human spatial behavior regularities which can be investigated via cognitive methodologies.

Finally, we must stress that although we have not explicitly included the work of such cognitive psychologists as Bruner and Werner, we subscribe to the view expressed in chap. 4 by Kaplan. We believe that spatial cognitive mapping processes are part of a general cognitive process whereby an individual copes with information from his total environment. Although spatial cognitive mapping processes are a sub-set of this general process, studies have reached a stage where they are beginning to generate some higher level concepts and hypotheses: this is apparent in part II on cognitive representations. But again, space and our general theme limited our range of choice, and hence we were forced largely to exclude the non-spatial cognitive mapping processes.

The recently expanded interest in cognitive mapping is the result of many complementary factors. Among the more general ones are closer links among geography, planning, environmental design disciplines, and the social sciences. The more specific factors include the apparent bankruptcy of the regional descriptive approach and emergence of the so-called behavioral approach in the spatial sciences, as well as the rejection of economic formulations which relied heavily upon the concept of "rational" or "economic" man. As this book indicates, studies of cognitive mapping encompass a wide range of phenomena at a variety of spatial scales. Our present ability to explain and predict spatial behavior using the approach of cognitive mapping is limited, but the potential for future success is widely recognized. The six sections that follow should assist the reader in understanding what has transpired, and the probable nature of future directions.

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# Image and Environment

# I

# Theory

## *Introduction*

There is no generally accepted "party line" by which we can understand and explain cognitive maps or mapping. In this interdisciplinary area, writers bring disciplinary biases with them: thus, Orleans relies on insights from sociology, Briggs from geography, and Appleyard from planning. Each writer ultimately turns to psychology for "the answer," yet apart from Tolman's contributions (chap. 2) and the work of Piaget and Werner (summarized in chap. 14), little *theoretical* effort *per se* has been directed specifically to cognitive spatial representations.

The theorists cited in this introduction have contributed only peripherally to the question of cognitive mapping. Most of the research that they originally inspired was concerned with other problems. The recent empirical explorations of cognitive representation draw heavily upon the "classic" psychological theorists. However, even this apparently unified source has led to a divergence of emphasis—Kaplan and Lee both draw inspiration from physiological psychology; Lundberg and the Swedish investigators rely upon psychophysics, a reliance shared by Briggs and Lowrey; Appleyard has employed cognitive, learning, and perceptual psychology. Recent work into how environmental cognition develops has considered theoretical views in developmental psychology and ethnoscience (see chap. 14).

Thus, there is no unified theoretical framework upon which we can base our understanding of cognitive mapping. The initial paper attempts to develop such a framework. Kaplan (chap. 4) also offers the beginnings of a fruitful move in this direction but his argument, although attractive and intuitively plausible, remains an untested speculation.

The lack of a tested theoretical framework is a serious problem with many significant consequences. We find, for example, that there are terminological difficulties affecting not only our formulation of problems but also our methods of tackling them: are we concerned with perception or cognition, attitude or preference? There are obstacles in the context of research design: where are our *a priori* hypotheses, our standardized and validated measuring procedures? The result of these problems can be summarized as follows: work on the cognitive representation of man's spatial environment has identified interesting consistencies among phenomena, but has not developed any theoretical frameworks providing the necessary explanation or prediction.

However, we must temper this gloomy assessment by recognizing that such a stage is inevitable and normal. The difficulties faced in this interdisciplinary work are no greater than those portrayed by Watson in *The Double Helix*: Rome was not built in a day nor DNA explained overnight. Hence, it is neither the fact of nor the need for interdisciplinary work and cross-fertilization which is at issue, but rather the nature of the material under study, the method by which it is treated, and the basic theoretical underpinnings. This introduction cannot solve these problems, but it can discuss some of the significant issues. Accordingly, it touches upon three theoretical and methodological points:

1. *Models of Man.* Any behavioral theory makes assumptions about the nature of "human nature," and several of the major viewpoints are reviewed.
2. *Psychological Theory: Toward a Gestalt.* Because the works of Koffka and Lewin are not represented in the book, and because they provided an impetus for the theoretical and empirical work of others concerned with spatial behavior (Barker, 1963; 1968; Barker and Gump, 1964; Tolman, chap. 2), some of their relevant positions are summarized.
3. *Methodology.* The research methods used in the various studies reported here are as numerous as the contributors; as yet no single "acceptable" method or body of methods has emerged, and so a basic framework is established.

Theory and data are inseparable. Theoretical ideas are sprinkled throughout this book and, similarly, data is liberally sprinkled through the papers that follow. Stea and Blaut's (chap. 3) is a developmental paper, as is that of Hart and Moore. Either might have been appropriate to this section or to part IV, The Development of Spatial Cognition: similarly, the papers by Appleyard and Orleans have theoretical overtones. Thus, for a more complete outlook, the reader is urged to obtain a "theoretical gestalt" by combining the ideas that follow with those in succeeding sections of this book.

## *Models of Man*

Implicit or explicit in the writing of thinkers over the past several hundred years have been models of human behavior, incorporating assumed internal determinants as well as patterns of interpersonal influence, social interaction processes, motivation for group membership, and decision-making (Simon, 1957). Many writers of the seventeenth, eighteenth, and nineteenth Centuries, from Descartes through La Mettzie, Darwin, Spencer, and Huxley, were concerned with models based upon theological and biological determinants of behavior. The early twentieth Century saw the emergence of models for human decision-making incorporating or specifically neglecting the psychological component. Because our concern is with cognitive factors affecting one aspect of decision-making—vis-à-vis the spatial environment —we will review the crucial models, illustrating the conceptual extremes.

Psychoanalytic man, as delineated by Freud and Jung, was totally nonrational. His adult behavior was determined in large part by the (probably unconscious) resolution of psychological conflicts experienced earlier in life, and was influenced by biologically transmitted traces of earlier experiences in human evolution ("collective unconscious" or "racial memory"). External factors were assumed to play a small role in adult patterns of decision-making: social influence was secondary, and environmental influence negligible. The only exception to this latter statement is the work of Searles (1960) who incorporated influences from the physical (and spatial) environment into psychoanalytic thinking.

Classical economic theory proposed an opposite model: man was, for the purposes of economic exchange, considered totally rational and influenced in his decision-making only by objective factors external to himself, of which he had total knowledge. All constraints were completely known and all were considered:

> There are two principal species of economic man: the consumer and the entrepreneur. Classical economics assumes the goals of both to be given: the former wishes to maximize his utility, which is a known function of the goods and services he consumes; the latter wishes to maximize his profit. The theory then assumes both of them to be rational. Confronted with a pair of alternatives, they will select that one which yields the larger utility or profit, respectively. (Simon, 1957, p. 197)

Like the psychoanalytic model, economic man failed to account for much of the variation in human behavior: for an empirical investigation of the degree of this failure in terms of human spatial behavior, see the paper on Swedish farming systems by Wolpert (1964).

Attempts to consider the finiteness of human rationality in a changing and complex world, the empirical limits upon cognition, and the "objective" weighing of alternative decision criteria led to the *principle of bounded rationality*:

> The capacity of the human mind for formulating and solving complex problems is very small compared with the size of the problems whose solution is required for objectively rational behavior in the real world—or even for a reasonable approximation to such objective rationality. (Simon, 1957, p. 198)

Behavior based on bounded rationality may seem "irrational" and may be characterized as such, but the resemblance is only apparent. Rather, the essential characteristics of the cognitive process are its limited ability to cope with and store information and its attempt to form impressions of and tentative decisions about the environment on the basis of limited, fragmentary information under severe time constraints. In the economic model, man maximizes his utility or profit. In Simon's boundedly rational model, he *satisfices*, finding a course of action which is "good enough" for the situation as he comprehends it. Psychological models based upon observation of human and animal learning (e.g. Estes, 1954) that postulate limitations in the complexity of the choice mechanisms and the capacity of organisms for obtaining and processing information account for observed behavior better than do models of rational choice:

> However adaptive the behavior of organisms in learning and choice situations, this adaptiveness falls far short of the ideal of "maximizing" postulated in economic theory. Evidently, organisms adapt well enough to "satisfice"; they do not, in general, "optimize." (Simon, 1957, p. 261)

Simon's interest in building computer models of man was not new as a philosophic ideal. La Mettzie's idea of *L'Homme Machine* had been promulgated two centuries earlier, and basic computer theory had existed for a century and a half. Newall, Shaw, and Simon (see Gruber, Terrell, and Wertheimer, 1962) extended these ideas to the construction of a program for a "thinking machine" called the "logic theorist," which was set the problem of deriving the axioms of mathematics from the axioms of logic à la Russell and Whitehead. The success of this modeling attempt is less well known than that of the many chess-playing programs which have been written. Simon and others have cautioned that the fact that a machine can play chess in much the same way that a man does (albeit more efficiently) does not imply that the internal hookup of the cerebral cortex must be like the innards of the computer—but the warning, in people's frantic search for the "lugram" of rational thought, has often gone unheeded. A parallel problem is discussed in chapter 1 in terms of representations of the spatial environment. Although the input source is identical, a city-dweller, a camera, a cartographer, and a tape-recorder all employ different signatures to arrive at a representation (or form) of a city; yet all of these forms have the same function. Parallel functions do *not* necessarily imply parallelism of form, but our understanding of cognitive representation has been hampered by overlooking this vital point.

### *Psychological Theory: Toward a Gestalt*

Among theorists in psychology, Koffka (1935) may have been the first to distinguish between the geographical environment (or absolute space) and the behavioral environment (or relative space), although he acknowledges borrowing some concepts from Tolman. Koffka held that the geographical environment is not a stimulus or set of stimuli in itself, but is "stimulus-providing," and that the mediation of the behavioral environment clarifies the relationship between the geographical environment and behavior:

> Behavior takes place in a behavioral environment, by which it is regulated. The behavioral environment depends upon two sets of conditions, one inherent in the geographical environment, one in the organism. But it is also meaningful to say that behavior takes place in a geographical environment . . . (1) Since the behavioral environment depends upon the geographical, our proposition connects behavior with a remote instead of an immediate cause . . . (2) the results of the animal's behavior depends not only upon his behavioral but also on his geographical environment. . . . The geographical environment, not only the behavioral, is changed through all behavior. (1935, p. 31)

Lewin, whose association with Tolman was closer, stressed the relationship of and distinctions among mathematical space, physical space, and psychological life space, concepts which resemble those of Koffka. Lewin developed a "topological" or "hodological" psychology, stressing the connection and paths between psychological regions: "There is a certain topological structuring of the environment in nearly all situations with which psychology deals, and no doubt there is always some structuring of the person" (1936, p. 62). For Lewin, the contrast between physical and psychological space stemmed from the laws appropriate to the two, with the determination of spatial relations in psychology dependent upon psychological processes and, hence, upon the nature and laws of psychological dynamics. While psychological life space was considered potentially "metricisable" in the same sense that physical space is metric, Lewin also clarified distinctions between physical and psychological worlds via differing notions of connectedness and closure. The *single* connected space in which all physical reality is included does not exist within topological psychology, each life space being viewed as dynamically unique and equivalent to the totality of the physical world. The notion of "dynamic closure" entered here as well, the physical world being considered as a "dynamically closed" unity and the psychological world a dynamically enclosed unity.

Tolman (1932, p. 158) acknowledges a greater debt to Lewin than to Koffka. But it was Koffka who foreshadowed the spatial nature of the controversy between the yet-to-emerge Hullian and Tolmanian camps in learning:

> We observe three rats in the same maze, each starting at one end and finally emerging at the other. Then in a way we could say the three rats have run through the maze, a geographical statement. But our observation has convinced us that there were obvious differences in their behavior . . . the behavior within the *behavioral* environment. A rat running for food does not do so only from the moment when it is near enough to see or smell it, but from the very beginning. Tolman's book gives ample evidence for this statement. But the first part of the geographical maze does not contain the food, nor any stimulation emanating from the food. . . . Behavior in the geographical environment is (thus) the activity as it really is, in the behavioral as the animal thinks it is. (1935, pp. 36–37)

## *Methodology*

There is no single correct path to understanding and explanation: hence it is impossible to specify an optimal research methodology. Consequently, we will not comment so much upon the specific methodologies (or *tactics*) used in studies of cognitive mapping as upon the overall research *strategies* utilized. Stea and Downs (1970) identified two basic strategies: system identification and system analysis. The former, a holistic approach concerned with the identification and description of the overall system, isolates relationships (and interactions) between segments of the spatial environment, types of people, and cognitive response typologies.

> On this level, a major concern is the establishment of purely functional relationships between, for example, socioeconomic status variables and the cognition of different segments of the environment. One main outcome is a classification or typology of cognitive responses, where such responses are the product of essentially unknown process interactions. (1970, p. 7)

The second strategy, employed once system interactions have been identified, described, and isolated, is a searching analysis of the system:

> The focus is on the interactions between sets of variables, together with a specification of the system parameters. Knowledge of relationships and of parameters can lead directly to casual models indicating, for example, the process by which information is coded to form part of cognitive representations. . . . An additional factor associated with the second strategy . . . is the use of quantitative methods of data analysis. The questions asked in the second strategy cannot be answered satisfactorily without mathematical and statistical analysis. Thus, for example . . . factor analytic, multiple regression, and analysis of variance models [have been used]. This is not to decry the first strategy as being weaker or less powerful that the second—rather their objectives differ and hence so do the means of attaining them. The relation-

> ship between the two strategies represents an overlap between two distinct stages of growth in studies of environmental cognition. The descriptive first strategy identifies general patterns of interaction between variables and serves to generate hypotheses which can be tested by the adoption of the second strategy. . . . [But] quantification and power are not synonymous. The advantages of a quantitative approach to environmental cognition should not obscure the need for care in its use nor the need for an adequate, preexisting conceptual structure. (Stea and Downs, 1970, pp. 7–8)

Within the literature, the distinction between these two strategies is *not* as clear cut as the preceding would suggest. Just as we lack an overall theoretical framework, so too we lack a consensus as to what constitutes a "good" or "bad" research design. The dangers inherent in this lack are obvious. The current *ad hoc* posture towards methodological questions is acceptable and even necessary in the exploratory stage of any research effort. However, it also runs the risk of producing incompatible results and delaying the development of cumulative scientific knowledge. There are disciplinary orientations in our approaches to research design, with geographers tending to favor the search for relationship via variance compounding (i.e. correlational methods), while psychologists favor variance splitting via analysis of variance methods. Linked with the previous observation is the problem of control and inference. We are faced with four sets of variables—the spatial environment itself, the information or stimulus set, the intervening cognitive processes, and the group and individual differences in the operation of these processes—yet we lack the research design capability to cope with this type of complexity. Thus, although we have overlooked methodological questions until now in our efforts to understand cognitive maps, we cannot afford to continue to do so because theory and data (and therefore methodology) are inextricably linked.

# 1

# Cognitive Maps and Spatial Behavior: Process and Products

ROGER M. DOWNS AND DAVID STEA

## *Introduction*

A surprising fact is associated with studies of cognitive mapping: although the emergence of this vigorously developing research area has been recent, we are not discussing something newly discovered such as a subatomic particle or a cell protein structure. Instead we are concerned with phenomena so much part of our everyday lives and normal behavior that we naturally overlook them and take them for granted.

A series of examples indicate the pervasive influence of cognitive maps and mapping processes. *Newsweek* (June 15, 1970) quoted a London cab driver: "It's crazy, . . . How do they expect anyone to find their way around here?" This plea resulted from an ingenious planning experiment in which sidewalks were widened and streets narrowed and turned into a system of mazes, dead-ends, and one-way routes. The objective was to create a confusing obstacle to drivers, forcing them to abandon habitual short cuts in favor of main streets, or, better still, to give up driving and use public transportation. That the drivers have well-developed cognitive maps is implied in one planner's claim: "You can't make it just difficult. You have to make it nearly impossible or you won't win."

As a graphic example of the value of cognitive maps consider the 1970 Apollo 14 moon walk. Astronauts Shepard and Mitchell were within 75 feet of their objective, the rim of Cone Crater, but returned to "Antares" without completing their mission. The reason? They had become confused and disoriented by the lack of distinctive lunar landscape features and the endless sequence of gullies. It was only later that they realized just how close they had been to their objective.

We are all aware of the image evoked when the news media use a locational term such as "the South" in the U.S.A. or "the Midlands" in England. We share common reactions when told that "it" happened in the South:

images of the climate, the prevailing social system, the attitudes of the people, the food they eat, readily "spring to mind." We rely on these images for understanding and explaining the event (it) because "you would expect that sort of thing to happen there." Cognitive maps are convenient sets of shorthand symbols that we all subscribe to, recognize, and employ: these symbols vary from group to group, and individual to individual, resulting from our biases, prejudices, and personal experiences. In the same way, we respond to an advertisement's exhortation to "come to sunny Florida" or, on the other side of the Atlantic, to "come to sunny Brighton." We associate images of beaches, sun-bathing, amusement parks, golf courses with such simple locational terms; our cognitive mapping processes fill in the necessary details. Thus an advertisement offering ice cream store franchises in the *New York Times* made the following appeal:

> Tired of snow? Tired of crowded city life?
> BE A CONTENTED SOUTHWESTERNER!
> Enjoy life the way it should be; among neighborly congenial folks on the balmy Gulf Coast, or the dry Texas "Hill Country;" or the scenic "Piney Woods" of East Texas. (February 21, 1971, Section 5, p. 2)

So we find that planners try to alter cognitive maps, astronauts need them, the news media use them, and advertisers tempt us with them: they *are* part of our everyday lives. But for research designed to understand and explain them, definitions by example are necessary but *not* sufficient. Consequently, we offer a formal definition: *Cognitive mapping is a process composed of a series of psychological transformations by which an individual acquires, codes, stores, recalls, and decodes information about the relative locations and attributes of phenomena in his everyday spatial environment.*

In this paper, we will expand this definition and examine the conceptual frameworks which are subsumed within it.

## *An Analysis of Cognitive Mapping Processes*

### COGNITIVE MAPS AND ADAPTIVE BEHAVIOR

Underlying our definition is a view of behavior which, although variously expressed, can be reduced to the statement that *human spatial behavior is dependent on the individual's cognitive map of the spatial environment.* That this formulation is necessary is indicated by a comparison of the characteristics of the individual with those of the spatial environment.

The environment is a large-scale surface, complex in both the categories of information present and in the number of instances of each category. Things are neither uniformly distributed over this surface, nor ubiquitous: they have a "whereness" quality. In contrast, the individual is a relatively small organism with limited mobility, stimulus-sensing capabilities, information processing ability, storage capacity, and available time. The individual receives information from a complex, uncertain, changing, and unpredictable source via a series of imperfect sensory modalities operating over varying time spans and intervals between time spans. From such diversity the individual must aggregate information to form a comprehensive representation of the environment. This process of acquisition, amalgamation, and storage is *cognitive mapping*, and the product of this process at any point in time can be considered as a *cognitive map*.

Given a cognitive map, the individual can formulate the basis for a strategy of environmental behavior. We view cognitive mapping as a basic component in human adaptation, and the cognitive map as a requisite both for human survival and for everyday environmental behavior. It is a coping mechanism through which the individual answers two basic questions quickly and efficiently: (1) Where certain valued things are; (2) How to get to where they are from where he is.

## COGNITIVE MAPS AND SPATIAL BEHAVIOR

Although the cognitive map represents a set of processes of unknown physiological and controversial psychological nature, its effect and function are clear. We believe that a cognitive map exists if an individual behaves as if a cognitive map exists (Stea and Downs, 1970). Above we cited anecdotal examples of the relationship between behavior and the cognitive mapping process. Normal everyday behavior such as a journey to work, a trip to a recreation area, or giving directions to a lost stranger would *all* be impossible without some form of cognitive map. These ubiquitous examples are overlooked and relegated to "second nature" status. Admittedly, much spatial behavior is repetitious and habitual—in travelling, you get the feeling that "you could do the trip blindfolded" or "do it with your eyes shut." But even this apparent "stimulus-response" sequence is not so simple: you must be *ready* for the cue that tells you to "turn here" or *prepare* for the traffic light that tells you to "stop now" or *evaluate* the rush hour traffic that tells you to "take the other way home tonight." Even in these situations you are *thinking ahead* (in both a literal and metaphorical sense) and using your cognitive map. In human spatial behavior, we consider even a series of stimulus-response connections as a "simple" (or "impoverished") form of cognitive map, in which the general aspects of spatial relationship implicit in cognitive mapping play a minimal role. In terms of the two basic questions raised earlier, the person *knows* that an object is valued and one way of getting to it, but knowledge of the "whereness" in relation to the *location* of other objects is absent. The goal is always a part of the cognitive map, however primitive the map might be, even when the degrees of closeness of approach to the goal cannot be articulated. Thus, someone "who knows only one route" knows more about that route than just the appropriate responses at certain choice points, and because he "thinks ahead," is also engaging in cognitive mapping. We are postulating the cognitive map as the basis for deciding upon and implementing *any* strategy of spatial behavior.

However, we must make it perfectly clear that a cognitive map is not necessarily a "map." This apparently paradoxical statement focuses on a misconception which has emerged in research in this area over the past ten years and which our definition might exacerbate. We are using the term *map* to designate a functional analogue. The focus of attention is on a cognitive representation which has the *functions* of the familiar *cartographic* map but not necessarily the physical properties of such a pictorial graphic model (Blaut, McCleary, and Blaut, 1970). Consequently, it is an analogy to be used, not believed. The problem of the map analogy is particularly acute for geographers, a group with a distinctive viewpoint or "spatial style" (Beck, 1967). In fact, if we are to believe Beck, geographers are strangely ambivalent as to whether they prefer features to be "up" versus "down" or "horizontal" versus "vertical". This ambivalence may result from their way of approaching the world, based on concepts of relative location, proximity, and distance, and especially geared to the use of cartographic maps. Boulding (1956) argued that "the map itself . . . has a profound effect on our spatial images (p. 65)." More particularly, drawing upon Lynch's (1960) attractive and appealing series of cognitive maps of U.S. cities portrayed as cartographic maps, we might paraphrase Boulding's statement to read: "The cartographic map has had a profound effect on our concept of a cognitive map."

Spatial information can be represented in a variety of ways. Consider, for example, a street directory in which streets are ordered alphabetically and people ordered spatially (by residences *and* apartments) and contrast it with a telephone directory listing exchange areas spatially and people alphabetically. Further representations include tape-recorded walking tours for museums or European cities, rail and bus route schedules, and electronic media such as radar and laser holograms. All of these media share the same function, not structure; and thus cognitive maps are derived from analogies of process, not product.

### COGNITIVE MAPPING SIGNATURES AND COGNITIVE REPRESENTATIONS

As Blaut, McCleary, and Blaut (1970) indicate, the basic functional identity among the media exemplified above can be subsumed under a general "black box" model. All of the media rely upon the same sort of spatial information, and all are employed in the same sorts of spatial behavior: thus, the inputs and outputs are specified while the intervening storage system (the black box) is not. The way in which spatial information is *encoded* (map making) and *decoded* (map reading or interpreting) gives rise to a set of operations called the *signature* of a given mapping code. Thus, a cartographic map signature is dependent upon three operations: rotation of point of view to a vertical perspective, change in scale, and abstraction to a set of symbols (for example, red dots for towns, blue lines for rivers). These operations are more general than the specific signatures, however. Thus, many other signatures are feasible; we have no reason to anticipate that cognitive maps should necessarily have the same form of signature as cartographic maps. Above all, we should avoid getting "locked" into a form of thinking through which we, as investigators, force a subject to "produce" a *cartographic* cognitive map and which we then "verify" against an objective cartographic map. It is significant, therefore, that Lynch (1960) used several input signatures (verbal and graphic) in his original study and a single, graphic output signature to produce his now famous maps of Boston, Jersey City, and Los Angeles.

The issue of mapping signatures involves some fundamental theoretical and methodological issues in the study of cognitive mapping processes. Underlying the whole approach is the basic question: How is information, derived from the absolute space of the environment in which we live, transformed into the relative spaces that determine our behavior? The transformation can be viewed as a general mapping process involving any or all three fundamental operations: change in scale, rotation of perspective, and a two stage operation of abstraction and symbolization, all of which result in a representation in relative space.

We are interested in the class of cognitive representations which result from the transformation of information about spatial phenomena from one set of absolute space relationships into a set which is adaptive or useful in terms of human spatial behavior.

Thus, we should be interested in developing theoretical statements about the *cognitive signatures* that are employed in dealing with information from the spatial environment. We have given these signatures a seemingly bewildering series of labels (cognitive maps, mental maps, images, and schemata) without applying the necessary critical scrutiny. For example, the only differences between Lynch's "images" (1960) and the city maps of cartographers lie in the degree of abstraction employed and in the type of symbols chosen to depict information. The research procedure is the result of a series of transformations: each individual constructs his own relative space based upon approximately the same absolute space. Lynch aggregates and summarizes these relative spaces reconverting the information by using another signature—conventional cartography with associated scale change and rotation to a vertical perspective. Such representations may be heavily *content-loaded*—that is, they may stress *what* is being represented and not the *way* in which it is being represented. Instead, we should be concerned with the nature or signature of relative space as it is construed and constructed by the individual. Only if we do this can we ask how relative and absolute spaces compare and differ. Speculatively, it seems likely that cognitive representations may employ a variety of signatures simultaneously; some aspects of our composite cognitive maps may resemble a cartographic map; others will depend upon linguistic signatures (in which scale and rotation operations are irrelevant), and still others upon visual imagery signatures derived from eye-level viewpoints (in which the scale transformations may be disjointed or convoluted). These remain speculations because we have not yet fully understood *what* we should be looking for—in our view we must regard cognitive maps as the result of these mapping signatures and try to understand the nature of such signatures.

We have defined cognitive mapping as the process of acquiring, amalgamating, and storing spatial information. We have tried to specify more clearly the meaning of a cognitive map. However, before considering the nature and functions of cognitive maps in more detail, we must discuss some basic definitions and attempt to clarify a few misconceptions which currently prevail.

## *The Concepts of Perception, Cognition, Attitude, and Preference*

### PERCEPTION AND COGNITION: DISTINCTIONS

Unfortunately, perception and cognition have been employed in a confusing variety of contexts by psychologists and other social scientists. Frequently, the context itself is ambiguous, since the word falls into the "process-product" category (Rudner, 1966, p. 7). When such a word is used it is difficult to determine whether the *process* of perceiving is being discussed or whether the concern is with the *product* of the perception process. Both aspects are of importance in our studies of cognitive mapping, but if we are to develop cumulative scientific knowledge, an explicit statement of the focus of interest must be included. Such a statement is notably lacking in geographic studies. In addition, perception has been used in a variety of ways: to experimental psychologists, it involves the awareness of stimuli through the physiological excitation of sensory receptors; to some social psychologists, it implies both the recognition of social objects present in one's immediate sensory field *and* the impressions formed of persons or groups experienced at an earlier time. To many geographers, perception is an all-encompassing term for the sum total of perceptions, memories, attitudes, preferences, and other psychological factors which contribute to the formation of what might better be called environmental *cognition.*

The complex interrelationship between perception and cognition is illustrated by the definition of a perceptual-conceptual repertory as:

> The stable, recognized patterns of perceptions into which sensory complexes are organized. Species differ radically in their capacity to organize sensory complexes into such patterns. The confirmed city dweller does not see the browning wheatfield as ready for harvest; the country dweller may find the directions in the subway confusing rather than patterned. (English and English, 1958, p. 379)

Given the varied uses of the terms, it is difficult to distinguish between perception and cognition, but we will make a "distinction of convenience," the necessity for which is indicated not so much by the responses of individuals to "stimuli," but by their responses to "labels." Environmental designers and geographers have identified some of the issues in human response to natural and designed environments as "perceptual problems," but, to their dismay, often found that studies of single-neuron preparations and autokinetic effects have little to say about human "perception" of the landscape.

Thus we reserve the term *perception* for the process that occurs because of the presence of an object, and that results in the immediate apprehension of that object by one or more of the senses. Temporally, it is closely connected with events in the immediate surroundings and is (in general) linked with immediate behavior. This accords with the view of perception delineated by experimental psychology. *Environmental cognition* is thus the subject matter of interest to geographers, physical planners, and environmental designers working on behavior issues. Cognition need not be linked with immediate behavior and therefore need not be directly related to anything occurring in the proximate environment. Consequently, it may be connected with what has passed (or is past) or what is going to happen in the future.

However, this distinction falls short of establishing a clear dichotomy. We agree with Levy that the difference between perception and cognition is one of degree and focus (1970, p. 251). Both refer to inferred processes responsible for the organization and interpretation of information, but perception has a more direct sensory referent than cognition. Cognition is the more general term and includes perception as well as thinking, problem solving, and the organization of information and ideas. A more useful distinction from a spatial point of view is offered by Stea (1969). He suggests that cognition occurs in a spatial context when the spaces of interest are so extensive that they cannot be perceived or apprehended either at once or in a series of brief glances. These large-scale spaces must be cognitively organized and committed to memory, and contain objects and events which are outside of the immediate sensory field of the individual. This scale-dependent distinction, intuitively acceptable to a geographer, also suggests that we are concerned with the nature and formation of environmental cognitions rather than with briefer spatial perceptions.

### ATTITUDES, PREDICTIONS, PREFERENCES, AND COGNITIVE MAPS

The processes of perception and cognition that lead to predispositions to behave in certain ways toward object classes *as they are conceived to be* are termed *attitudes*. The parallels between the concepts of cognitive map and attitude are marked. For example, we assume that knowledge of an individual's cognitive map is necessary to predict his spatial behavior: a similar claim has been made in psychology with respect to attitudes. Yet as Fishbein says:

> After more than seventy-five years of attitude research, there is still little, if any, consistent evidence supporting the hypothesis that knowledge of an

individual's attitude towards some object will allow one to predict the way he will behave with respect to the object. (1967b, p. 477)

He rejects the argument that the lack of confirmation of the hypothesis is due to an incorrect operational definition of the terms involved, since continual revisions of measuring instruments have brought no success. Instead, he suggests that the conceptualization of an attitude and its hypothesized links with behavior are faulty, and replaces the holistic concept of an attitude with a formulation containing three components: *cognitions* or beliefs, *affect* or attitude, and *conations* or behavioral intentions.

Fishbein claims that the fact that affect, cognition, and action are not always highly correlated necessitates this more complex typology (1967a, p. 257). The belief component of Fishbein's model is relevant to our definition of a cognitive map. He distinguishes between beliefs concerning the *existence* of an object and about the *nature* of an object, both of which are expressed in probability-improbability dimensions. Significantly, Boulding refers to the *image* (or cognitive map) as being subjective knowledge which "largely governs my behavior (1956, pp. 5–6)."

However, this governing relationship may be both indirect and highly complex. In such a light, work on the perception of environmental hazard and individual locational behavior must be reevaluated. For example, the questions that Kates (1967, pp. 72–73) developed in his study of storm hazard on the Eastern seaboard of the U.S.A. measure the structure and content of belief systems. Through the verbal content of people's responses, Kates attempts to infer the reasons for people choosing to locate in potentially hazardous areas. However, Fishbein points out that attitudes, beliefs, and expressed behavioral intentions are frequently brought into line with actual behavior. Consequently, Kates' approach contains problems of causal relations and inference, since the perception of the hazard may have been adjusted, or *rationalized*, so that it conforms with past behavior (i.e., the decision to locate). In other words, if a behavior can be specified, an attitude can usually be postdicted.

Finally, we must distinguish among attitudes, preferences, and traits. In comparison with attitudes, preferences are usually considered to be: (1) less global—often directed to a specific object rather than a class of objects; and (2) less enduring over time—more subject to change than relatively stable, permanent attitudes. When a given attitude pervades a wide variety of objects over a considerable period of time, it becomes a *personality trait*. Craik has suggested the existence of environmental traits:

Individuals not only exhibit characteristic styles of relating to other persons, such as "dominant," "assertive," "deferent," and so on, they also display enduring orientation toward the physical environment. Designed to identify the individual's conception of himself in reference to the natural and man-made physical environment, an inventory of environmental traits would permit the declaration: "I am the sort of person who reacts in these ways to the molar (large scale) physical environment." (1970a, p. 86)

Hypothetically, one could construct a scale from preference through attitude to trait, increasing in both inclusiveness and duration of the cognitive, conative, and affective components.

These discussions indicate the depth of confusion that exists concerning the key concepts of perception, cognition, and attitude. Part of the confusion is due to obvious interrelationships; for example, cognition is assumed by many to be the major component of perception (Langer, 1969) although affective and conative characteristics are present as well. Similarly, there is interplay between an attitude and the way an object is perceived. Boulding argues that "for any individual organism . . ., there are no such things as 'facts.' There are only messages filtered through a changeable value system (1956, p. 14)." This lack of conceptual clarity is a major problem in an area already overburdened with tentative and unrelated conceptual infrastructures.

## *The Nature and Functions of Cognitive Maps*

To understand more fully what cognitive maps are, how they are formed, and how they work, we need answers to three basic questions: (1) What do people *need* to know? (2) What do people *know?* (3) How do people *get* their knowledge?

### WHAT DO PEOPLE NEED TO KNOW?

Given an individual with the limitations specified earlier and a spatial environment with complex characteristics, there are two basic and complementary types of information that he must have for survival and everyday spatial behavior: the *locations* and the *attributes* of phenomena. Cognitive maps consist of a mixture of both. Since location and attribution are properties of objects as well as of phenomena, we must also know what an "object" is.

*Locational information* is designed to answer the question, Where are these phenomena? and leads to a subjective geometry of space. There are two major components to this geometry, *distance* and *direction*. Distance can be measured in a variety of ways, and we are surprisingly sensitive to distance in our everyday behavior. The claim that "it takes you only half an hour to go and get it" will perhaps receive the reply that "it's too far to go." We think of distance in terms of time cost, money cost, and the more traditional measures, kilometers and miles. Knowledge of distance—the amount of separation between pairs of places and pairs of phenomena—is essential for planning any strategy of spatial behavior. Geography, for example, has developed a series of models of human spatial behavior which depend upon the individual's sensitivity to distance variations and upon his assumed goal of minimizing the distance traveled either by himself or by his products.

Direction is no less important in the geometry of space, although we are less conscious of directional information. We take direction more for granted than we perhaps should. It is only when we cannot find a map in the glove compartment of the car and become lost that the need for directional information becomes acute. The person who "gives" directions by pointing vaguely and saying "it's over there" is no more helpful than one who says "it's on the left"—we need to know *whose* left.

By combining distance and direction we can arrive at locational information about phenomena, but not necessarily the same as that provided by the Cartesian coordinates of cartographic maps. For example, suppose that we wish to visit a drive-in movie theater—what do we need to know? First, we need to know where we are—this means "keying" our cognitive map to our current location. We need to know where the movie theater is, which, at this spatial scale can be accomplished in two ways. Either we know where the theater is *in relation to* where we are now and consequently can select the easiest route to get there, or we know its location *relative* to some other place whose location is known—thus it may be "about five minutes' drive past the Suburbsville Shopping Center." Second, we need to know how far away it is, how to get there, and how long it will take to get there.

Thus, locational information is not as simple as it might appear. We must store many bits of distance and direction data to operate efficiently in a spatial environment, a process involving relatively accurate encoding, storage, and decoding. Use of locational information in formulating a strategy of spatial behavior, however, requires a second type of information: that concerning the *attributes* of phenomena.

*Attributive information* tells us what *kinds* of phenomena are "out there," and is complementary to locational information, indicating *what* is at a particular location and *why* anybody would want to go there.

An attribute is derived from a characteristic pattern of stimulation regularly associated with a particular phenomenon which, in combination with other attributes, signals the presence of the phenomenon. A concrete example will clarify this definition. Imagine that at the end of the search process specified in the drive-in theater example you are confronted with something that you "recognize" consisting of a large open space surrounded by a wall with an enormous screen at its far end, a small building at a break in the wall, and lots of teenagers driving in and out in cars. Obviously, it is the drive-in movie theater that you were searching for, and the screen and teenagers can be considered attributes of the phenomenon "movie theater." You can interpret the pattern of stimulation (visual in this instance) as indicating a series of attributes that, in this combination, signal the presence of a drive-in theater.

We can divide attributes of phenomena into two major classes: (1) descriptive, quasi-objective, or denotative; and (2) evaluative or connotative. The attributes listed as signaling the presence of the drive-in all belong to the first type, while attributes such as "reasonable prices," "good shows," or "easy to get to" are evaluative or connotative. Here, we are separating attributes which are affectively neutral (descriptive) from those which are affectively charged (evaluative). This process of evaluation involves a relationship between a phenomenon and its potential role in the behavior of the experiencing individual.

*What is the relationship between an attribute and an object?* An object is identified and defined by a set of attributes and bits of locational information. However, what is an object at one spatial scale can become an attribute at another. Consider the following sequence: at an interurban scale we might view cities as objects with population density, built-up area, and level of industrial growth as examples of attributes; at an intraurban scale, we could consider shopping centers as objects with number of stores and number of different types of retail functions as attributes; at an intracenter scale, the stores become the objects; and finally, at the intrastore scale, the offerings of the store become attributes. The scale of analysis of the problem at hand defines what is an object and what is attributive and locational information.

### WHAT DO PEOPLE KNOW?

If we compare a cognitive map with a base map of the real world (whether it be an aerial photograph, a cartographic map, or a scale model), we find that *cognitive* mapping does not lead to a duplicative photographic process with three-dimensional color pictures somehow "tucked away in the mind's eye," nor does it give us an elaborately filed series of conventional cartographic maps at varying spatial scales. Instead, cognitive maps are complex, highly selective, abstract, generalized representations in various forms. As Kates and Wohlwill (1966) argue, we must realize that "the individual does not passively react or adapt to the environmental forces impinging on him, but brings a variety of cognitive activities to bear—expectancies, attitudes, even symbolic elaboration and transformation of the world of reality—which come to mediate and modulate the impact of the environment on him (pp. 17–18)." We can characterize cognitive maps as *incomplete, distorted, schematized,* and *augmented,* and we find that both *group similarities* and *idiosyncratic individual differences* exist.

*The Incompleteness of Cognitive Maps.* The physical space of the real world is a continuous surface which we have come to understand through a classic geometrical framework, that of Euclid. Even though the amount of the earth's surface within our immediate visual range is limited, we are told that the surface is one of approximately continuous curvature. There are no gaps or bottomless voids, and the Flat Earth Society to the contrary, we cannot fall off the edge. There is always something at the "back of the beyond." Yet all cognitive maps depict discontinuous surfaces. Seemingly, some areas of the earth's surface do not "exist" when existence is defined by the presence of phenomena in the subject's cognitive representation. Carr and Schissler (1969) show how the knowledge of approach routes to a city extends only as far as the visual range attainable from the highway in the journey to work, a finding also apparent in the work of Appleyard, Lynch, and Myer (1964). On a smaller scale, Ladd (1970, pp. 90–94) indicates that black children do not represent certain sections of the neighborhood environment in their cognitive maps.

However, before we accept the discontinuous nature of cognitive maps, we must question the nature of our evidence, particularly negative evidence. As Crane (1961) observes in a provocative review, Lynch's (1960) maps of Boston omitted the city's then most prominent feature, the John Hancock Building. Yet it is difficult to accept that residents did not know of its existence; they chose not to represent it externally on their *drawn* cognitive maps. The reason for this omission may be related to the distinction between denotative and connotative meaning. Although the phenomenon may *denote* something to the individual, it may have no *connotative* meaning; that is, it may play no significant or valued role in the person's behavior. In addition, we frequently find that cognitive maps are distorted so that the size (scale) of represented phenomena, especially in the drawings of young children, indicates relative connotative significance. Therefore, we must be careful in interpreting the absence of phenomena from cognitive maps as reflecting cognitive discontinuity of space.

*Distortion and Schematization.* By the *distortion* of cognitive maps, we mean the cognitive transformations of both distance and direction, such that an individual's subjective geometry deviates from the Euclidean view of the real world. Such deviations can have major effects upon the patterns of spatial use of the environment. In terms of distance distortions, Lee (1962; 1970) has indicated that, given two urban facilities equidistant from an urban resident, one located on the downtown side is considered closer than the one which is away from the city center. If people are sensitive to distance, consequent spatial behavior patterns will be dependent upon such distance distortions.

Far more significant, and as yet little understood, are the results of *schematization.* By schematization we mean the use of cognitive categories into which we code environmental information and by which we interpret such information. We are, as Carr (1970, p. 518) suggests, victims of conventionality. This conventionality may be expressed in two ways. The first involves the use of those spatial symbols to which we all subscribe and which we use both as denotative and connotative shorthand ways of coping with the spatial environment. Thus, we all understand (or *think* we understand) the intended, value-loaded meanings of "Africa the Dark Continent," "Europe the Center of Culture," "Behind the Iron Curtain," and "The Midwest as the Heartland." Symbols (often mythological), such as the Western route to India and the search for the Northwest Passage, have had major effects upon the course of history. In general, such symbols deal with large spatial areas and are subscribed to by a large part of the population.

However, there are other symbols dealing with geographic entities at many scales; geographic entities which owe their cogency and importance to their mere existence—even to rumored existence. In the aggregate, such entities have been termed the "invisible landscape" (Stea, 1967). As images, these elements are perhaps the most purely symbolic. Included are certain National Parks and Wilderness Areas (of importance to many people who never have and perhaps never will see them); national landmarks such as the Statue of Liberty, once (and perhaps still) *the* symbol of the United States; New York's theater district, for those inhabitants of "The City" who never have gone there and never will go; and even, for some, New York City itself. It could be argued that even though many people do not want to go into New York, it is still important for New York to maintain its image because the same people want to locate around it. "Suburb of *what?*" is perhaps not an insignificant question.

A second aspect of schematization or conventionality involves the very limited set of cognitive categories or concepts that we have developed in order to cope with information derived from the spatial environment. As we were recently told, "Once you've seen one slum, you've seen them all." Are all older center-city areas "slums" to middle-class whites or do they have more sophisticated cognitive categories? Our understanding of the semantics (or the vocabulary) of cognitive maps is remarkably limited.

The controversy over linguistic relativity suggests that there are cross-cultural differences in the ways in which spatial information is coded. Such barriers are not only cross-cultural. Burrill (1968), a geographer studying an Atlantic coast swamp area, found that "swamp" meant a complex, multi-attribute feature to local residents; to Burrill it was a simple, single attribute feature. Communication using the term "swamp" was impossible because of this difference in meaning. Similarly, Downs (1970) assumed that a neighborhood shopping center would be a clearly defined and commonly agreed upon spatial unit, with the edge of the commercial area defining the shopping center boundary. However, residents of the area recognized four distinct subcenters.

A modern counterpart of Dick Whittington's belief that the streets of London were paved with gold may have been the belief of Blacks, Puerto Ricans, Appalachian Whites, and other disadvantaged people that they could find "a piece of the action" in the cities of the Northeastern United States, their desire to share in "the good things of modern society," and their trust in the willingness of those who had "made it" to help them. The gap between such beliefs and reality is almost painful (Brody, 1970). Yet another example of the ways in which people cope with spatial information comes from studies of environmental hazard evaluation: Burton and Kates (1964) indicate the unrealistic nature of people's estimates of the probabilities of hazards. Thus, the Los Angeles earthquake of 1971 has not served as a warning to Californians. Building continues, house sales continue—apparently the "lightning will not strike twice" mechanism is operating in spite of warnings that even more severe earthquakes can be expected in the near future.

*Augmentation.* Another characteristic of cognitive maps is *augmentation.* There is some indication that cognitive maps have nonexistent phenomena added as embroidery. Ancient cartographers abhorred voids and filled blank spaces with fictitious rivers, mountain ranges, sea monsters, and possible locations of Atlantis. A respondent in Appleyard's (1970) study of Ciudad Guayana drew in a railway line on his map of the city because he felt that one must exist between a particular pair of points. Such distortions may be highly significant, but we know little about their causes, and nothing about their eradication.

*Intergroup and Individual Differences in Cognitive Maps and Mapping.* Superimposed upon the overall relationship between cognitive maps and the real world are significant intergroup differences in the specific ways in which identical or similar spatial environments are construed. The underlying group perspectives are the result of a combination of three factors. First, the spatial environment contains many regular and recurrent features. Second, people share common information-processing capabilities and strategies. The capabilities are associated with the innate, physiological parameters of human information processing while the common strategies are learned methods of coping with the environment. Third, spatial behavior patterns display similar origins, destinations, and frequencies. These factors in combination yield intergroup differences in cognitive maps. Lucas (1963) indicated that the perceived spatial extent of a wilderness recreation area in the Northeastern United States was defined differently by various subgroups of users and by those who were responsible for its administration. Tindal (1971) studied the spatial extents of home ranges among black children in urban and suburban contexts, and found the spatial extent to be correlated with age and sex.

The individual differences among cognitive maps emerge primarily from subtle variations in spatial activity patterns, variations which can have striking effects on such maps. Ladd (1970) cites the case of two brothers who produced surprisingly different cognitive maps of their neighborhood. Such idiosyncracies are particularly notable in verbal descriptions of cognitive maps—the choice of visual details shows tremendous variation from subject to subject.

In answer, therefore, to the question "What do we know?" we can conclude that we see the world in the way that we do because it pays us to see it in that way. Our view accords with our plans for use of the environment. In other words, differences between the "real world" and cognitive maps based on it serve a useful purpose in spatial behavior. Koffka (1935, pp. 28; 33) expressed this idea well:

> Let us therefore distinguish between a *geographical* and a *behavioral* environment. Do we all live in the same town? Yes, when we mean the geographical, no, when we mean the behavioral "in". . . . Our difference between the geographical and the behavioral environments coincides with the difference between things as they "really" are and things as they look to us, between reality and appearance. And we see also that appearances may deceive, that behavior well adapted to the behavioral environment may be united to the geographical.

People behave in a world "as they see it"—whatever the flaws and imperfections of cognitive maps, they are the basis for spatial behavior.

### HOW DO PEOPLE GET THEIR KNOWLEDGE?

We have postulated a set of basic characteristics that our knowledge of the spatial environment should possess, and we have indicated the characteristics that our knowledge (or cognitive map) actually possesses. Some of the differences between these two sets of characteristics can be attributed to the ways in which we *acquire* spatial information. What are the various information processing (or sensory) modalities? What are the basic sources and types of spatial information? How does our knowledge (or stored information) change through time? How do we know that cognitive maps exist?

*Sensory Modalities.* In our studies of cognitive maps, we have overlooked the *range* and *number* of sensory modalities through which spatial information is acquired, and have ignored the integrative nature of cognitive processes related to spatial information. The visual, tactile, olfactory, and kinaesthetic sense modalities combine to give an *integrated* representation of any spatial environment. The modalities are complementary despite our intuitive belief (and linguistic bias) that visual information is predominant. For example, Manhattan tower-dwellers often know the local Horn and Hardart or Chock-Full-O'Nuts restaurants through the smell of their famous coffee being brewed. Dock areas of cities are memorable because of the distinctive sounds they emit; the sea has a distinctive smell; certain streets, because of cobblestones or frequent railway line crossings, have a certain texture. Thus, the quality of distinctiveness or memorableness is not solely the result of the way the environment looks. Some blind people (Shemyakin, 1962) remember the various paths they traverse through the city by the different feel of each path. Held and Rekosh (1963) have demonstrated that