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Behavioral Geography and the Theoretical/ Quantitative Revolution

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Beginning with a position statement about the serendipitous nature of the emergence of both normative theory and quantitative methods in Geography, this chapter details the nature of the various contributions to both areas by Behavioral Geographers. Contributions to data collection and both qualitative and quantitative analysis are reviewed for the periods 1960 to the present. Particular emphasis is placed on contributions made by those interested in decision making and choice behavior, particularly in terms of the role of Spatial Cognition (theory and methods) in fostering and extending those dual "revolutions." Other themes emphasize the development of avenues of publication from the "gray literature" of Department Discussion Papers to the emergence of the journal Geographical Analysis and support by geographers for a variety of interdisciplinary journals. A final focus is on the great variety of themes pursued by the Behavioral Geographer of today, and some suggestions are made regarding possible avenues for future research.

Introduction

The late 1950s and early 1960s revealed the beginnings of a paradigm shift in Geography. This shift included a movement from descriptive to theoretical emphasis, and a consequent (and necessary) extension of geographic methods into the quantitative realm. Traditionally labeled the "Quantitative Revolution," I have always believed that it was equally a theoretical revolution as much as a quantitative revolution. My reasons are straightforward: (1) the late 1950s saw the introduction of agricultural, industrial, and urban location theory into Geography; (2) coincidentally, Walter Isard published an important book on *Location and Space-Economy* (1956) in which he examined the nature and potential applications of location

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theory in a spatial and regional context. Research into the theory and applications of urban systems and central place theory were prominent under the leadership of William Garrison and his outstanding group of graduate student researchers at the University of Washington, Seattle (see Garrison 1960). Research into the theory and applications (post hoc) of agricultural and industrial location decisions were prominent under the leadership of Harold H. McCarty at the University of Iowa (see McCarty, Hook, and Knos 1956). Transportation theory and modeling was prominent at Chicago (Harold Mayer: see Mayer and Kohn 1960) and Northwestern (Edward J. Taaffe: see Taaffe, Morill and Gould 1963). The various coworkers and disciples of these early leaders spread the revolution beyond the original centers to Michigan, Pittsburgh, Penn State, Illinois, Minnesota, Wisconsin, Indiana, Michigan State, and Ohio State—that is a concentration of effort in the Big 10 universities. William Bunge's book *Theoretical Geography* (1962) provided an outstanding stimulus for extending theoretical thinking deeper and deeper into traditional areas of geographical interest, including topics such as intraurban movement and migration (Pitts 1962; Boyce and Clark 1963; Morrill 1963; Clark 1965; Brown 1968; Moore 1970; and others), settlement patterns and consumer behavior (Berry 1961; King 1961; Tennant 1962; Pred 1964; Rushton 1964; Barnum, Kasperson, and Kiuchi 1965; Golledge 1966; Thomas 1968; Simmons 1974; and others), transportation (Gould 1959; Marble 1959; Kansky 1963; Smith, Taafe, and King 1968; Hanson 1970; etc.), regional scientists (such as Stevens [Stevens and Brackett 1967] and Boyce [Boyce and Clark 1963]), and urban structure (including regional scientists Alonso [1960] and others). The outcome of all this was the rapid spread of interest in spatial theory, spatial analysis, and computational methods and models.

But this explosion of new interest also stimulated many other new research directions in both Human and Physical Geography (see Chorley and Haggett 1967). Much of this spread was by person-to-person interactions and exchange (Hägerstrand 1957, 1970, 1973).

This was a time when it was difficult to obtain publication of theoretical or analytical work in the discipline. Much of the growth of interest in this area had to be focused on the ''gray literature,'' consisting largely of Discussion Papers from sources such as the University of Washington, the University of Iowa, Northwestern University, the University of Michigan, and, later Ohio State and Penn State Universities. Sources of publication apart from the traditional geography journals included *Papers and Proceedings of the Regional Science Association* and *The Journal of Regional Science*. The study of the early development of the Theoretical/Quantitative Revolution in Geography is incomplete and somewhat biased if it is based only on publications in the major journals at this time, and not on the generally acknowledged and oft-quoted ''gray literature.''

By the mid 1960s, both theory and analytical methods were being taught and used in research in a number of Geography departments, and the first books involving spatial statistics and geographic theory were underway (Haggett, *Locational*

Analysis in Human Geography, 1965; Chorley and Haggett, *Models in Geography*, 1967; Harvey, *Explanation in Geography*, 1969; King, *Statistical Analysis in Geography* 1969; Amedeo and Golledge, *An Introduction to Scientific Reasoning in Geography*, 1975). The need for more accessible (journal-type) publications resulted in the founding of *Geographical Analysis* (''An International Journal of Theoretical Geography'') first published in 1969, and the publication of the first of an expanding series, *Environment and Planning A*, also in 1969. The ''gray literature'' finally became mainstream!

The development of behavioral geography

One of the problems involved when incorporating theoretical research into Geography lay in the testing of theoretical concepts and structures in the real world. It soon became obvious that the theories that had already been introduced were normative and existed only within a basis of rigid, excluding constraints. For example, the geographic variability of landscape was usually assumed away (a uniform plain); transportation was assumed to be available equally in all directions at a similar cost; people were assumed to have the same utilities and preferences for goods, services, and products; populations were assumed to be constant, not exploding, and to consist of uniform ethnic or cultural memberships; and decision making and choice behavior was assumed to take place in such a way as to maximize utility. But this was a far cry from the world of empirical reality.

Although very constructive and theoretically relevant work relating to people's behavior in space had been (and continued to be) conducted by Brian Berry at the University of Washington (Berry and Garrison 1958a, b, c) and later by Berry and his students at the University of Chicago (e.g., Berry, Barnum, and Tennant 1962; Berry, Simmons, and Tennant 1963), their work provided hints that the behavior being observed was not necessarily optimal. This set the stage for detailed analysis of market areas and consumer behavior that was initiated at the University of Iowa.

Using data from the same source as was used in some of the Berry et al. work (i.e., a diary survey of farm and non-farm households in Iowa that recorded trips and expenditures over a 12 month period), Rushton and colleagues (Golledge, Rushton, and Clark 1966; Rushton, Golledge, and Clark 1967) began a series of detailed experiments with respect to observed and recorded patterns of consumers' behaviors. Their first joint product (Golledge, Rushton, and Clark 1966) showed a substantial difference between the distances that farm and non-farm household members traveled to make the nearest and maximum purchases of goods as opposed to where existing theories (e.g., by Christaller and Lösch) expected them to go. Except for a few functions and activities such as grocery purchases, attendance at church, and gasoline purchases (consumer activities that were classified as ''convenience'' goods and services), many other goods and services were typified by ''shopping around'' activities which could not be described by a least effort/least cost/least distance syndrome. These included shopping behaviors such as clothing, small and large appliances, produce, and automobiles; these were described by the term ''shopping'' behaviors and were more variable in space and time. Upon examining these different types of behaviors more intensely, a realization emerged that the mismatch between empirical reality and theory lay largely in the nature of the simplifying and constraining assumptions that had been imported into the fundamental theories (mainly assumptions of economically and spatially rational behavior).

The question that immediately faced many researchers was related to understanding how decision making potentially influenced choice behavior. In the early 1960s, regional scientists Walter Isard and geographer Michael Dacey (1962) had begun exploring the potential importance of game theory as a means for geographic researchers to examine decision making procedures. This interest was expanded by geographer Peter Gould (1963) as he examined various game theoretic scenarios for solving human-environment behavior problems. Both these streams of research indicated clearly that attitudes and preferences of decision making units significantly influenced choice and consequent spatial behaviors. Their work was complemented by Wolpert (1964), who introduced the different decision making strategies discussed in Herb Simon's *Models of Man* (1957), and showed how non-optimizing behaviors were (in Wolpert's case studies) more widespread than optimizing or utility maximizing behaviors. Rushton (1965) built on this by examining concepts of space preferences and discussed the empirical relevance of central place ideas of threshold, range, and town size-distance tradeoffs. In his work on market areas, Golledge (1966) simultaneously investigated the structure of decision making processes in the context of psychologically based theories of learning and knowledge acquisition. Further research by Clark, Rushton, and Golledge (1970) examined the relationship between empirical evidence and theory, including examinations of theoretical and real patterns of urban settlements in environments that conformed at least somewhat to the normative principles of a ''uniform plain.'' Their work in Iowa (not exactly a uniform plain, but a state with a fairly homogeneous agriculturally-based market economy) indicated that a Christallerian or Löschian central place system was not significantly different from the way that settlements had developed in Iowa up to that point in time. Obviously, if there was some conformance between theory and empirical reality, then any divergences when examining consumer behaviors could be inferred to be results of individual decision making in the context of incomplete information about the environment.

Thus, by the end of the 1960s, substantial progress had been made toward developing a behavioral approach in Geography (Golledge, Brown, and Williamson 1972). Several different ''approaches'' were developing, including: (i) an examination of place and landscape influences on behavior, (ii) an examination of attitudes toward environmental hazard occurrence and continuance of human behaviors and occupance patterns that were hard to justify using existing knowledge, and (iii) an examination of decision-making and choice behaviors that was at odds with the simplifying assumptions of economic and spatially rational behavior.

Behavioral approaches tended to:

- Emphasize process rather than form.
- Emphasize individual disaggregate behavior rather than the aggregate data required by most normative theory and models.
- Base their empirical studies on primary rather than secondary (aggregated) data banks such as the census.
- Introduce a variety of data collection techniques such as questionnaires and various types of surveys (mail, phone, personal interview).
- Require different analytical procedures not based on the normal curve and parametric data (such as scaling, non-metric analysis).
- Bring in, and spatialize, new theories from psychology, marketing, sociology, and anthropology (Golledge and Stimson 1997).

Theoretical contributions by behavioral researchers

Behavioral research was an outcome of the Theoretical/Quantitative Revolution. In the following sections, I will describe the major behavioral theoretical contributions, followed by an examination of contributions to the quantitative side of this equation.

The initial years of behavioral research were largely tied to two theories imported from Psychology and modified for relevance to the large area geographic scale environments that were the focus of much of the discipline's research. In the decade of the 1960s, two facets of learning theory provided theoretical insights for spatial behavioral research. The first of these emanated from Piaget and Inhelder's studies of *The Child's Conception of Space* (Piaget and Inhelder 1956) and *The Child's Conception of Geometry* (Piaget, Inhelder, and Szeminska 1963). In particular, researchers at Clark University interacted with developmental psychologists to explicitly explore the geospatial dimensions of Piaget's developmental theories. Piaget's levels of general interactual development (sensory motor, pre-operational, concrete operational, and formal operational) were related to levels of spatial organization (sensory motor space, projective space, concrete operational space, formal operational space), type of geometry (topological, projective, non-metric, and fully metric), and, particularly, the early phases of his stage theory were empirically investigated and supported (Blaut and Stea 1969; Hart and Moore 1973). Later, psychologists Siegel and White (1975) elaborated more fully this stage-type development in terms of the emergence of geospatial knowledge across the lifespan. In particular, they suggested that spatial knowledge acquisition began with landmark knowledge, progressed to route knowledge, and reached an ultimate of configurational knowledge. For nearly three decades this theoretical structure influenced behavioral geographic research on spatial knowledge acquisition. It was modified first in 1978 by Golledge who suggested a hierarchical organization of spatial knowledge (anchor point theory) which linked together the landmark, route, and configurational structures of the Piagetan and Siegal and White theories. Then

Liben (1981) challenged stage theory and substituted a ''lifespan'' theory. Later (1998), Montello modified this lifespan theory by arguing that, while children may go through the stages up to the end of their teen years, adults did not progress through these same stages of acquiring knowledge about a new environment, simply because they had already gained metric knowledge and could interpret geospatial concepts and relations such as location, connectivity, and region.

A second significant theoretical contribution was evidenced in the work of Roger Downs (1970) and David Stea (1969). Stea introduced the idea of cognitive maps from Tolman's (1948) place-learning theory at a geography conference in sessions organized by Cox and Golledge (1968) who then published all the session contributions in the first book focused strictly on behavioral approaches (Cox and Golledge 1969). Stea's work emphasized spatial cognition theory and stimulated decades of work in cognitive mapping and wayfinding behavior (Golledge 1999).

A third theoretical influence came from perceptual theory (e.g., J. J. Gibson 1966; Barker 1968; and E. J. Gibson 1969) and was evidenced in the rapidly growing work in the environmental perception of natural hazards (White 1945; Saarinen 1966; Lowenthal 1967). This research focused on the contributions of J. J. Gibson (1966) and Roger Barker (1968) and eventually led to today's emphasis on risk taking propensity (Krantz et al. 1971; Kasperson and Dow 1993), attitudes toward environments and environmental settings, and sustainable and vulnerable environments (Kates 1970, 1980).

As with the influence of various location theories in developing quantitative methods (now generally entitled ''spatial analysis''), the various theories incorporated into geographic behavioral research were modified for use in the large-scale geographic domain and, because of their specific requirements, involved the introduction and development of a substantial range of quantitative methods and experimental designs. They also emphasized that geospatial research could be undertaken in laboratory conditions under controlled settings for simulating real world spaces typical of everyday behavior. We turn now to a discussion of some of the specific quantitative contributions that have directly or indirectly resulted from the introduction of these theories to meet the needs of behavioral researchers.

Methodological needs of behavioral geography: boundedly rational behavior

The outcome of some of these theoretical and empirical investigations in the 1960s was the realization of the mismatch between theory and reality. Two of the main theoretical streams, locational analysis and regional analysis, were largely imported from Economics and, while explicitly concentrating on spatial concepts, assumed away much of the spatial variability that typified objective reality. In most cases, also, the theories and their models proved to be static. Realizing that decision making was a dynamic process and that choices resulting from those processes may change over time (e.g., types of crops grown, places in which to purchase goods and services, sources of raw materials or labor), the first generation of behavioral geographers began investigating what happened when the constraining assumptions of existing theories and their associated methodologies were changed to meet empirical reality. For example, decision making was examined both in a context of how decisions were made in institutions and firms (i.e., locational and regional development decisions; Hamilton 1967), and, simultaneously, how decisions were made by individuals, families, or small groups (e.g., Huff's articles on consumer behavior [1960, 1961, 1962, 1963], Hägerstrand's [1957] and the Brown and Moore (1970) studies of migration, and Clark's (1970) study of residential change). These researchers adopted two principles: first, that they would look at processes and behavioral dynamics rather than create static pictures of the outcome of decision making; second, that in order to understand decision making, it appeared to be more fruitful to work at a highly disaggregate level (primary data) rather than use the much more aggregated (secondary data) Census data that was currently in vogue.

New interdisciplinary ties

These decisions had far-reaching implications. First, in order to satisfy the demand for increased knowledge of decision making and choice behavior, paradigms had to be imported from additional disciplines such as Psychology, Sociology, and Marketing. Basing research on such disaggregate population and individual sources of information at first seemed quite hazardous. This was because disclosure and privacy rules precluded communal primary type data sets from being compiled publicly (i.e., data at the individual or family level). In the early 1960s, Census tracts were more or less the standard units in which population data was published. In succeeding decades, Census data began to be published (or at least available on request) at the block level. But, still, the Census information consisted only of the functional, demographic or structural, spatial, political, and socioeconomic characteristics of people. Analysis was often undertaken by matching characteristics taken from this data source with behaviors or occurrences that resulted from choice acts and was described by the term ''areal association.'' To do this, methods of association, including correlation and regression analysis, proved to be necessary, and this need paved the way for their introduction into the discipline generally (e.g., Berry and Garrison 1958a, b, c; Salisbury and Rushton 1964).

New types of data

But the Behavioral Geographer needed a different type of information. The data they needed included perceptions, preferences, attitudes, beliefs, values, risk-taking propensity, and other information that can be obtained only by directly communicating with individuals. While geographers had intermittently experimented with survey research in field method contexts, many of the personal influences integrated into decision making and choice processes had not been well investigated (e.g., preferences, perceptions, cognitive maps). Consequently, there developed a need for new types of data. These were data representing the attitudes, feelings, emotions, habits, state of learning, preferences, and strategies that were employed in decision making and choice processes.

New experimental designs

Because no generally collected data sources existed (except for isolated studies) that provided these types of information, the Behavioral Geographer was faced with another major need. This consisted of exploring methods for collecting the type of data they thought was relevant for their research. Given the difficulties of communicating with or interviewing individual people (e.g., lack of cooperation, time required for interviews, etc.), the first step was to move away from the massive Census or other spatial area-type (secondary) data sets that were constantly being used in geographic research. This move away resulted in the drastic reduction of sample sizes and a move toward non-probability sampling (Stimson 1978). It was, in fact, a move from the secondary data sources typified by the Census to primary data sources typified by individual responses to carefully designed questions and experimentally controlled tasks. There followed a surge of interest in different types of non-probability sampling, including survey research by questionnaire, diary, and telephone, and detailed personal investigator observation of behaviors and activities of individuals and households. Data were collected in the form of binary (yes/no) answers to interviewer questions, unidimensional scaling (e.g., Likert Scaling, Preference Scaling, and Semantic Differential Scaling), and paper and pencil tasks completed in laboratories under specific experimental design conditions (e.g., sketch mapping, paired comparison of interpoint distances, estimation of the intensity of feelings or emotions, and so on). While mail, interview, or telephone surveys often were still carried out within the structure of probability sampling designs, many personal interview, experimenter observation, and task-related laboratory activities had to be conducted with small n-sizes, voluntary participation, and non-probability sampling frames.

Adding qualitative methodologies

This demand for a different type of data in turn produced a demand for controlled experimental designs and initiated a demand for quantitative and qualitative methodologies that proved to be somewhat different from the dominant form of quantitative analysis—that is confirmatory statistical analysis based on standard probability distributions. At first, Behavioral Geographer's needs appeared to be partly satisfied by non-parametric statistics such as Chi Square, *t*-tests, and tests of randomness. But, as the nature of Behavioral Geography research expanded, a multitude of different needs emerged in the analytical domain. Some of these could be satisfied using more conventional geographic methods (e.g., cartographic map matching procedures for sketch mapping or cognitive mapping experiments). In the latter case, problems quickly arose because of the lack of uniform metricity in sketches or cognitive maps generally. Other data collections required analytical procedures that were suitable to nominal or ordinal data rather than the typical interval and ratio data used in more aggregate analyses. Thus, techniques for analysis of rankings and ratings were imported into the discipline, and they expanded the general composition of methodologies and quantitative analyses used in Geography.

Initially, although some work on decision making and choice procedures was undertaken by Behavioral Geographers using learning theory formats (Gould 1965; Golledge 1967, 1969; Golledge and Brown 1967), there was soon a shift to the cognitive theories of place learning and field theory (Tolman 1948; Lewin 1951). Place learning in geographic research was largely exploratory rather than confirmatory. The analytical methodologies required to examine these experiments encouraged Behavioral Geographers to examine the relevance of uni- and multidimensional metric and non-metric scaling methods (Golledge and Rushton 1972). In some cases, the more conventional methodology of aggregate analysis was creatively used in a cognitive behavioral context. For example, Downs (1970) examined the cognitive structure of shopping centers by collecting detailed personal construct information along with physical characteristics of shopping centers, and using a principal components factor analysis to help organize, interpret, and analyze his collected data. Concurrently, Golledge and coworkers at Ohio State University (Golledge, Briggs, and Demko 1969; Golledge, Brown, and Williamson 1972; Golledge, Rivizzigno, and Spector 1974) used metric and non-metric multidimensional scaling and metric and non-metric hierarchical clustering techniques to examine consumer preferences for shopping centers, travel behaviors, and landmark-based layout knowledge (cognitive mappings) in large scale urban environments.

The demand for new analytical methods therefore expanded the Quantitative Revolution into a two-fold quantitative and qualitative revolution. Spatial reasoning, disaggregate levels of investigation, primary data sources, different experimental designs, and new non-probability based methods of analysis were developed.

Publishing research

Like other exploding areas of theoretical and quantitative development in the discipline, the Behavioral Researchers came across the same difficulty in getting research published within the framework of the existing publication structure of the discipline. While journals such as *Environment and Planning A* and *B* and *Geographical Analysis* were developed to host the rapid outpouring of theoretical and quantitative research in the discipline, behavioral researchers were forced to turn more and more to non-disciplinary publications such as *Environment and Behavior*, the *Proceedings of the Environmental Design and Research Association*, and the *Journal of Environmental Psychology* as primary places of publication. Much of their contributions in theory and methodology continued in the gray literature of NSF technical reports and were thus not well distributed throughout the discipline. This, in turn, led to various misunderstandings of the changing nature and content of behavioral geographical research (e.g., Thrift 1980). But, decades later, with the advent of Geographic Information Science and recognition of the cognitive base of visualization, spatialization, and data representation and analysis generally, behavioral research seemed to pull itself out of this imposed obscurity and establish anew the principles that first initiated this research. Today, behavioral geographic research emphases can be found in areas as diverse as Cognitive Cartography, Geographic Information Science, Gazeteering, Consumer Behavior, Migration and Mobility Analysis, Market Area Analysis, Locational Decision Making, and Travel Behavior Modeling, to name but a few. Organizations such as the International Association of Travel Behavior Researchers and specialty journals such as Cognition and Computation, have evolved to satisfy interdisciplinary needs generally but are particularly suited to satisfying the publication and diffusion needs of geographically based behavioral research.

By the early 1970s, Behavioral Geography had emerged as a distinct and productive approach in Geography. But, as the discipline continued to explore new areas of research, Behavioral Geography began accumulating criticisms. The most prominent of these derived from social theory and political economy and was epitomized by those adopting Marxist principles. The highly disaggregate approach adopted by behavioral researchers stumbled over various problems of aggregation. The emerging emphasis on societal solutions, and alternative economic principles in particular, caused some to reject behavioral work along with more conventional location theory and other approaches using normative assumptions and positivist (experimental) principles. Other criticisms came from poorly read writers who constantly confused fundamental terms like ''perception'' and ''cognition,'' while also not understanding the difference between ''behavioral'' and ''behaviorist.'' The latter brought forth accusations of trying to ''condition'' people—a silly error that a little careful reading would have obviated.

Further criticisms were focused on the emphasis on methodology. Again, this showed a fundamental misunderstanding and consequent misrepresentation of behavioral research, and the need to go beyond existing procedures to invent new ones (e.g., in cognitive mapping research). For example, some researchers tried to empirically investigate the relevance of ''mental maps'' for explaining movement behavior. Unfortunately, they used only Gould's ''mental map'' idea (Gould 1966), not realizing that these were revealed preference surfaces created by researchers but were not the ''cognitive maps'' they mistook them for (Golledge 1981).

The result of these various critiques has been that, about every decade, writers of learned books on the history of geographic thought pronounce the ''death'' of Behavioral Geography. This is far from the truth and reflects a very myopic view of Geography; as I shall explore in following sections.

Consequent (post 1970s) contributions

The last two and a half decades have seen selected gains in the contribution that Behavioral Geographers have made to the continuation and consolidation of the Theoretical/Quantitative Revolution. Rather than elaborate on these, below I offer a listing of some of the more accepted and integrated contributions:

- Popularization of Tobler's Bi-dimensional Regression software (1978, 1994). This was used by cognitive mapping researchers in many countries to analyze the fit between subjective and objective layouts of landmarks (usually produced from non-metric multidimensional scaling analyses). Successful interpretations and applications were later summarized in the C-MAP software developed by Kitchin (1994; awarded an AAG Specialty Group Prize for innovative software). Tobler's (1976, 1978) various representational procedures that produced distorted grids (GRID) proved to be a very useful way of visualizing distorted surfaces. In addition, Tobler's (1978) suggestions for developing error-ellipses [variations of the Tissot Indicatrix] proved to be important in displaying and analyzing variability in subjective location errors.
- Probabilistic Multidimensional Scaling. This was developed by Zinnes and MacKay (1983) (Geography, Marketing, and Psychology) and was a Probabilistic Scaling Model (PROSCAL) of perceptions and/or cognitions of people's preferences for places.
- Spatial Autocorrelation (Hubert and Golledge 1981a, b, 1982; Hubert, Golledge, and Costanzo 1981, 1982): Emphasis was placed on metric and nonmetric measures of spatial association (i.e., spatial autocorrelation) and methods for analyzing square and rectangular data matrices derived from different explanatory models. Made necessary by the need to evaluate alternative predictive models—such as variations of the Spatial Interaction Model—predictions of shopping center choices, and by comparing objective and subjective models of behavior—models such as CONGRU (Olivier 1970), PROFIT (Carroll and Chang (1970), and Quadratic Assignment Procedures (QAP: Hubert and Golledge 1981a, b) were developed and tested.
- Interaction Models: Different versions of the Social Gravity/Spatial Interactance Model were developed to include subjective distance, travel time, and attitudinal and preference factors (Huff 1963; Cadwallader 1973, 1976; Fotheringham 1981, 1983, 1984a, b, 1986).
- Cognitive Cartography: This included visualizations, spatializations, eye-tracking, and layout representation (e.g., Olson and Brewer 1997; Montello and Battersby 2004; Battersby 2006).
- Disability Studies: This research reintroduced the use of multiple analysis of variance (MANOVA), use of combined GPS and GIS technologies, and varying cartographic representations such as auditory mapping (e.g., Klatzky et al. 1990; Golledge et al. 1991, 1998; Golledge, Loomis, and Klatzky 1994).

- G. I. Science: Behavioral Geography has contributed to examining spatial-cognitive functions (Albrecht 1995), examining subjective distance representation (Montello 1991), and examining time-space behavior (Hägerstrand 1970; Miller 1991; Kwan 1995) among other research activities.
- Computational Process Modeling: Used by Smith, Pellegrino, and Golledge (1984), and later by Gopal (1988), Gärling, Kwan, and Golledge (1994), and others to examine individual activity behaviors and wayfinding behaviors.
- Transportation Modeling: Developed by Marble (1967) to examine representative trip behaviors, and built on by Hanson and Hanson (1980), Huff and Hanson (1989), and others to examine disaggregate travel behavior.

I am not able to list all the contributions by Behavioral Geographers—there are just too many. For example, I have not listed the role played in developing qualitative analysis in the geoeducation domain or the area of Hazards Research, and have neglected the timely and useful contributions of many non-U.S. Behavioral Researchers, including those from the United Kingdom, the Netherlands, Sweden, Switzerland, and Japan in particular. A much longer article would have been required to do this.

Much of this history is not well known and has led to many misinterpretations of the nature and content of Behavioral Geography (usually by non-practitioners). But it is significant that behavioral researchers in Geography complemented and expanded the initial Theoretical and Quantitative Revolution of the late 1950s and 1960s and, by the early 1970s had established that they had played (and would continue to play) an important role in the growth and development of Spatial Analysis in Geography and related disciplines. While this article has addressed primarily the initial decade of the Theoretical and Quantitative Revolution, behavioral geographers have continued to contribute to many different areas of today's discipline, including the quantitative side (e.g., concept maps, self organizing maps, content analysis). There appears to be little doubt that this practice should and will continue.

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