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# Walking, Crossing Streets and Choosing Pedestrian Routes: A Survey of Recent Insights from the Social/Behavioral Sciences

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Hill, Michael R. 1984. *Walking, Crossing Streets and Choosing Pedestrian Routes: A Survey of Recent Insights from the Social/Behavioral Sciences*, by Michael R. Hill. (University of Nebraska Studies, No. 66). Lincoln, Nebraska: University of Nebraska.

Walking,  
Crossing Streets,  
and Choosing  
Pedestrian Routes



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# Walking, Crossing Streets, and Choosing Pedestrian Routes

A Survey of Recent Insights from the  
Social/Behavioral Sciences

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university of nebraska studies: new series no. 66

*published by the university*

*at Lincoln: 1984*

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Library of Congress Catalog Number 84-40229

US ISSN 0077-6386

Manufactured in the United States of America

To  
Mary Jo Deegan,  
partner, friend, and critic

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## *Acknowledgments*

I would like to express special thanks to Robert H. Stoddard, Douglas Amedeo, Werner Leinfellner, and Alan Booth who provided many helpful comments on earlier versions of portions of this monograph. The support and encouragement of the UNL Scholarly Publications Committee is also gratefully acknowledged. The anonymous reviewers of this work are especially thanked for their useful contributions and suggestions.

Financial support for portions of the work reported here was generously provided by the U.S. Department of Transportation and the U.S. Department of Housing and Urban Development.

## *Introduction*

Walking at first appears to be a relatively simple, mundane behavior that should pose no great puzzle for the diligent researcher in the social and behavioral sciences. The review presented here of recent studies, however, demonstrates that the behavior and experiences of ordinary pedestrians are filled with opportunities for empirical investigation and intricate theory building. But, why bring these studies together for synthesis in this volume? I suggest here that there are, in fact, several reasons that argue in favor of a timely focus on the apparently simple behavior of the pedestrian.

First, the deceptive simplicity of the pedestrian experience provides an excellent empirical focus for examination of a wide range of topics prominent in recent work in the emerging field of human-environment studies. Readers unfamiliar with the scope and intensity of research in this interdisciplinary enterprise would do well to consult the pages of *Environment and Behavior*; *Man-Environment Systems*; *Environment and Planning*; the annual proceedings of the Environmental Design Research Association (EDRA); and the topical volumes in the new review series entitled *Human Behavior and Environment: Advances in Theory and Research*, edited by Irwin Altman, Amos Rapoport, and Joachim Wohlwill. Even summary consideration of the many topics that have become the focus of considerable investigation in the last decade reveals that empirical and conceptual work regarding territoriality, crowding, privacy, personal space, sensory overload and deprivation, approach-avoidance, navigation and orientation, mental mapping, search processes, and environmental perception, evaluation, and decision making all bear on various facets of the pedestrian experience. Empirical verification of the viability of these conceptual ideas reveals a void which the study of the pedestrian helps to fill. The inner processes and complexity of pedestrian behavior are far greater, for example, than the outward simplicity suggested by the simple geometrical representation of a pedestrian trip as a line connecting an origin and a destination. The

complexity that lies behind this apparent simplicity provides a major challenge for the students of human-environment relations.

The applied user of human-environment research may be an urban planner, architect, interior designer, or landscape architect. But the applied worker may well question the utility of the growing list of behavioral concepts and constructs if they cannot be integrated in an empirically verifiable way to understand the essence of an everyday, ordinary behavior such as walking. For example, of what use is it to know that individual differences in "mental maps" can be recovered unless it can also be demonstrated that these hypothesized cognitive representations of the environment have behavioral significance for a fundamental and common activity, such as walking from one part of a city to another? Without an effort directed at conceptual integration, empirical verification, and practical interpretation at this basic level, the individual pedestrian remains an enigma before the eyes of the applied designer as well as the human-environment researcher. In short, the pedestrian serves as a handy foil for at least a few researchers who are attempting to demonstrate the relevance of concepts now evolving in human-environment relations research.

Two other factors combine with the possibility of conceptual integration to recommend the pedestrian experience for a high priority in the human-environment relations research agenda. First is a highly practical point that in some ways is so obvious that it may require emphasis. It is, simply, that pedestrians are readily available for observation and study in a wide variety of environments ranging from crowded urban streets to the solitude of wilderness hiking trails. The very ubiquity of pedestrians presents researchers with a wonderful opportunity to observe a cross section of *normal* individuals engaged in *normal* routines in everyday, *normally* experienced environments. Normality is emphasized here because focusing on the ordinary pedestrian frees the researcher from the limitations of studies like those based on college freshmen who have been coerced into participating in an experiment or on institutional settings that provide few generalizations, such as mental hospitals or remote military installations. The great variety of pedestrian environments and the potential heterogeneity of the pedestrians themselves are methodologically problematic, but this situation at the same time goes a long way toward improving the external validity of the researcher's empirical findings

(Bercher, 1981). While the control possible in an experimental laboratory is lost when observations are made in the undisturbed, natural environment, it is this everyday, ordinary environment to which the human-environment relations researcher ultimately wishes to be relevant. This argument is not offered to denigrate the insightful research suggestions that have sometimes issued from laboratory research, but merely to emphasize that to be useful in applied design work, the concepts of human-environment relations must be interpretable in everyday settings. What is truly fortunate is that a large array of concepts (many of them developed initially in experimental labs) is available now with which to work and further conceptualize. Study of the naturally occurring, ubiquitous pedestrian undoubtedly requires future refinement and further development of many of the ideas and techniques currently under discussion by human-environment relations researchers. But, investigators who pursue the behavior of the pedestrian as an object of study will find a large and growing number of studies on which to draw for inspiration (see, for example, bibliographies on pedestrians in Garbrecht, 1971a; Bartholomaeus, 1972; Akoi, 1977-78; Elkington, McGlynn, and Roberts, 1976; Hill, 1976a; Flynn, 1977; and Hill, 1982b). Additional reports and research summaries are found in the irregularly published newsletters of PEDNET, The Pedestrian Behavior Research/Design Network. The current address of PEDNET is 2701 Sewell Street, Lincoln, Nebraska, 68502. Papers sponsored by the Pedestrian Committee of the Transportation Research Board, Washington, D.C., form another source of pedestrian-oriented research. The newest addition to the published literature includes the proceedings of the annual pedestrian conferences sponsored by the Transportation Division of the City of Boulder, Colorado. A recent collection of representative research papers on pedestrians is found in Hill (1981c).

From an applied point of view, *pedestrianization*, the design of pedestrian-oriented environments, is now a basic and accepted concept in urban design (see, for example, Lewis, 1966; Fruin, 1971; Greater London Council, 1973; Brambilla and Longo, 1977; Pushkarev and Zupan, 1975; Breines and Dean, 1974; and Garbrecht, 1978, 1981). Any usable conceptual integration of human-environment relations concepts relating to the pedestrian experience has ready application in the fields of planning and urban design (Hill, 1979a; Hill and Crandell, 1981). So far, urban designers' efforts in formulating an imaginative spatial imagery with

which to create and plan pedestrian-oriented projects (e.g., Thiel, 1961, 1970; Noe and Abernathy, 1966; Halprin, 1965; Simonds, 1974; Foster, 1974; and Mitropoulos, 1973, 1975) have not been matched within the work of human-environment relations students. To date, researchers in human-environment relations have yet to develop an holistic, empirically grounded understanding of the pedestrian's relationship to the environment. Given the programmatic statements of the human-environment relations community, however, urban designers and planners expect such understanding to be forthcoming from the literature of human-environment relations. This review attempts to provide an outline report on just how far the discipline of human-environment relations has come in fulfilling its programmatic promises.

This introduction has discussed three reasons why human-environment researchers are well advised to continue to develop their studies of pedestrian behavior. First, the behavior of the pedestrian appears relatively "simple" and should be explainable if, in fact, human-environment relations research is capable of demonstrating empirical viability for its developing conceptual frameworks. Second, the study of pedestrians is the study of normal people in everyday environments, thereby increasing the possibility of generalizing about research results. Third, pedestrianization schemes are gaining applied acceptance among urban planners and designers. Virtually any insight relevant to the planning and design of such projects will find a ready and willing audience. It has been noted above, however, that the experience of the pedestrian is only superficially "simple." In the sections that follow, readers are introduced to a survey of insights into the character of the pedestrian's world as revealed in human-environment research of (for the most part) the last ten-to-twelve years.

It may be helpful at this point to say a few words about the organization of this review. The following material is presented in order of hierarchical spatial skills. The lowest order is *walking* per se, the ability to put one foot in front of another for the purpose of forward mobility, a skill that youngsters learn relatively early in life. More complicated, however, are the complex decisions that accompany risk assessment during street crossing, and this area forms the next level of the hierarchy. Once youngsters have mastered the art of street crossing, a considerably larger spatial environment opens for their exploration. The choosing of routes through this larger environment represents the highest level of

spatial skill. The competent adult pedestrian is expected to be knowledgeable concerning the “rules” of walking *per se*; to be able to cross streets safely and to select and follow routes to destinations without getting lost. This hierarchical framework already points toward the complexities of walking and, if nothing else, provides one of the first overall attempts to integrate the many recent human-environment relations insights concerning the intricacies and complexities of one of humanity’s most common, everyday, mundane activities.

# *Walking*

The act of walking is rarely considered a mode of transport per se. Rather, walking is usually studied as an adjunct of mechanized facilities, such as automobiles and rapid transit. There are, therefore, numerous studies of "acceptable walking distances," i.e., investigations of how far people are presumably willing to walk *in order to catch a bus or park a car*. The summary by Bandi and others (1974) provides a good example of this work. In legal statutes and case law, the pedestrian is almost always defined in the motor vehicles section of state codes or is adjudicated in contexts involving automobiles (Hill, 1980d). It is indeed rare to find attention given to walking as a mode in itself, and this review must draw upon research that has usually tied the pedestrian to motorized vehicles.

Walking requires many techniques and practices that are not generally brought under conscious reflection. Ryave and Schenkein (1974) note:

It is, after all, these methodic practices that make the phenomenon of doing walking so utterly unnoteworthy at first glance to both lay and professional social analysts alike; it is through these methodic practices that the commonplace presents itself to us as ordinary, and the exotic as the extraordinary. (P. 265)

Readers are now invited to explore several facets of this ordinary practice, to bring walking into reflective consciousness. First, consider the speeds at which pedestrians travel.

## *Velocity Studies*

It would fill many pages to recount the many findings concerning pedestrian velocity or walking speeds. Early studies include Hoel (1968), Navin and Wheeler (1969), and Older (1968). An especially comprehensive compendium is Fruin (1971). The most conscientious attempt to integrate information on velocity in an applied urban planning framework is Pushkarev and Zupan's landmark report on *Urban Space for Pedestrians* (1975). The behaviorally interesting aspects of the velocity studies can be briefly

summarized as follows: The general findings are (1) that men walk faster than women, (2) that youths generally walk faster than older people, and (3) that pedestrians in groups tend to walk more slowly than unaccompanied pedestrians. These findings, or some slight variation on them, find frequent and consistent revalidation. For example, Boles and Hayward (1978) recently reported that females "walked significantly more slowly than males under all environmental conditions" (p. 33).

One of the more interesting velocity studies in recent years looked at velocities *within* large, seemingly cohesive groups, such as crowds exiting *en masse* from large buildings. Henderson and Lyons (1972) observed two thousand people walking and found that males, even under conditions of extreme crowding, still walked faster than females in the same crowd. There may, however, be problems in taking these and other velocity studies at full face value.

Gifford and colleagues (1977) identified a major flaw in the majority of the reported velocity studies: "Unfortunately, these studies have not typically investigated more than one variable at a time, compared the influence of variables or assessed their interactions. Nor have the effects of walking in groups or under different weather conditions received much attention" (p. 66). They conclude by warning planners to be aware of the rather large variations in individual pacing and the relative effects of significant variables on overall rates. Thus, rather than closing the door on a long series of studies, Gifford and colleagues have opened the way for careful re-analysis of many engineering-oriented velocity studies. Recent work by Boles (1981a) demonstrates the importance of including psychological variables in velocity research.

### ***Walking and Climate***

It has been assumed by many designers that environmental variables under the control of engineers might well be adjusted to provide "optimum" walking conditions for pedestrians. This assumption runs into difficulties in outdoor settings where the engineer has little control over the environment. Arens and Ballanti (1975), who conducted a review of attempts to understand the effects of wind on pedestrians concluded that many wind models would probably give poor estimates of human comfort in outdoor pedestrian areas. Cohen and others (1977) concentrated on the effects of wind on pedestrians, and considerable mathematical



modeling and wind-tunnel testing was completed. In moving from abstract models to observations of actual pedestrians walking under various windy conditions, Cohen and his colleagues demonstrated that empirical study can often result in generating more questions than answers (Hill, 1978b). They point in the direction of correlating behavioral observations with models of new construction in wind tunnels (with the aim of eliminating extreme cases of wind shear before construction), but there are several technical and methodological problems to be worked out before this technique will become readily useful and available. To date, researchers have looked primarily at wind while doing much less with sunlight, temperature, precipitation, and other climatic elements.

### ***The Physiology of Walking***

Walking against the wind, through a snow storm, or up a steep hill consumes human energy. How much energy is a question posed by researchers in physiology and biomechanics. A good example of the field of questions available in this area can be found in Dean's (1965) research on energy expenditures in level and grade walking. The large body of literature on metabolic rates, energy consumption, heart rates, and so forth, quickly propels readers into the realms of sports medicine, physiology, and related medical research. Although this literature is interesting in its own right, it is beyond the scope of this presentation to cover it in detail.

### ***Pedestrians as Vehicular Units***

An especially important conceptualization of the pedestrian is presented by Erving Goffman in his book *Relations in Public: Microstudies of the Public Order* (1971). In this frequently cited work, Goffman observed that vehicular units are distinguished, in part, by the thickness of their outer shells or skins. He continued: "Viewed in this perspective, the individual himself, moving across roads and down streets—the individual as pedestrian—can be considered a pilot encased in a soft and exposing shell, namely his clothes and skin" (p. 7). In this conceptualization, the ordinary pedestrian is seen as a pilot who navigates a vehicle with some surprising characteristics.

The pedestrian vehicle is amazingly vulnerable to injury from the mechanized vehicles with which it is often forced to share the road. At the same time, it also possesses some attractive characteristics. Goffman continued:

Pedestrians can twist, duck, bend and turn sharply, and therefore, unlike motorists, can safely count on being able to extricate themselves in the last few milliseconds before impending impact. Should pedestrians collide, damage is not likely to be significant, whereas between motorists collision is unlikely (given current costs of repair) to be insignificant. (P. 8)

This flexibility is rarely reflected upon. Pedestrians, unlike motorists, can stop quickly to look at something that interests them (Rapoport, 1977). They can reverse themselves, walk through buildings, climb over barriers, and negotiate tight passages with a facility impossible for automobiles.

Goffman's (1971) work is particularly concerned with the *social* nature of pedestrian vehicle navigation, but he began by noting that the pedestrian must also take account of the *physical* environment, especially the sidewalk. This environment is observed through a process called "scanning," which Goffman described in the following way:

I have so far considered only those pedestrian traffic practices that are interpersonal (or rather intervehicular) in character. There are, of course, single unit practices. For example, as the individual proceeds along his course, he scans the flooring immediately in front of him so that he will have time to sidestep small obstructions and sources of contamination. Here, too, is a structured scanning that is performed without much awareness. Within the oval scanned for oncomers, then, is a smaller region that is also kept under eye. (P. 16)

The process of scanning the environment for oncoming traffic is examined below in more detail. What is important here is to note that the pedestrian, even when alone, is performing a sophisticated, but autonomic, scanning of the physical dimensions of the environment.

Golson and Dabbs (1974) reported on one aspect of the "downward scan" in a study of the effects of diagonal markings painted on a sidewalk. They observed that the markings were "designed for aesthetic purposes and not intended to have any particular effect on behavior." Yet, they found that the sidewalk pattern was associated with reversals in the usual tendency of many pedestrians to walk on the right-hand side of the sidewalk. This effect was especially marked in the case of women, suggesting that female pedestrians may devote more time looking downward as they walk. Three possible explanations were offered for this possibility: (1) Women walk more slowly on average and thus may have more time to perform a downward scan; (2) Women may want to avoid the gazes of male pedestrians and thus look downward more often than men; and/or (3) The characteristics of foot-

wear worn by many women (e.g., "heels") may require more attention to the walking surface.

Golson and Dabbs have thus opened the question of differential scanning by women and men. However, more research and observation are required before a full understanding of this process will be available. It is also unknown what other factors may affect environmental scanning, but clearly the quality of the environment itself must be considered. Korte and Grant (1980) found, for example, that: "the sight and sound of dense traffic can preclude pedestrians' noticing peripheral elements of the environments they are passing through, if not major elements as well" (p. 417). The work involved in scanning while navigating the pedestrian vehicle is generally unnoticed by the "pilot." This process is largely autonomic, but the tensions it creates, if too much attention to scanning is required, can be exposed through careful interviewing. Stiltz (1970) reported that pedestrians said they became "irritated" when they had "to pay attention" during crowded sidewalk conditions.

The pedestrian processes large amounts of sensory input. As this processing is often autonomic, the pedestrian rarely reflects upon it. Rapoport (1977) has provided a comprehensive survey of multisensory inputs to environmental perception. Noting that designers and planners tend to emphasize the visual aspects of the environment, he underscores the importance of sound, tactile sensations, kinesthetics, air movement, temperature, and smell. Information received through all these channels from physical as well as social sources must be woven into an image of a particular environment before one can effectively navigate in it.

Some environments appear much more coherent and understandable than others, and Rapoport calls these "complex" environments. Theoretically, they are neither too confusing nor too bland or boring. The elements that go into making an environment pleasingly and effectively complex lie beyond the scope of the present study, however. It is important to observe that at present there is no operational method for determining the complexity of an environment defined in these terms. It is also worth noting that the speed with which one travels through an environment has a definite effect on whether the environment is seen as complex or not, at least according to Rapoport's theory. This point would be especially crucial when a given environment is intended for use by a variety of vehicles that normally travel at much dif-

ferent speeds, e.g., automobiles and pedestrians. Rapoport observes:

An environment comfortably stimulating from a car becomes monotonously boring on foot while what is interesting on foot becomes chaotic in a car. . . . The two environments need to be quite different in terms of noticeable differences and perceptual organization: at high speeds one needs distant views, simplicity and large-scale while at slow speeds one needs small-scale, intricacy and complexity. (PP. 242–43)

Furthermore, he notes that the pedestrian can much more easily slow down, even stop, to take a careful look at a particular environment. The motorist, especially in large cities, can rarely do this:

Motorists' perception is affected by the length of time each element is in view and also the criticality of the task. The pedestrian has each element in view as long as he wishes and can satisfy his interest in it because of the low criticality of this task. When pedestrians are harassed by traffic their task becomes critical and they cannot perceive the environment in the way appropriate to their speed—this is a common problem. (P. 243)

It is not known whether the different velocities reported for various classes of pedestrians are sufficiently different so that they would have differential perceptions of complexity in the environment. It is also not known if some pedestrians might actually adjust their walking speeds in an attempt to influence the degree of complexity with which they must contend.

In sum, the pedestrian can be seen as the pilot of a very special vehicle, a vehicle that is flexible and always convenient, that readily survives “crashes” with vehicles of the same type, that does not in itself normally require sophisticated traffic control devices or high-cost freeways, and that engages in autonomic environmental scanning and information processing. The pedestrian is able to appreciate far more fine-grained detail in the environment than is the motorist. But beyond this, the pedestrian experience is almost always a *social* one.

### *The Social Context of Walking*

Whereas Goffman introduced the concept of the individual pedestrian as a “vehicular unit,” Wolff (1973) developed the notion of a “coordinate” to describe people who become part of “public orderings,” such as the pedestrian traffic system. He wrote:

First, as a noun, [“coordinate”] describes individuals in such systems as occupying related points within a patterned array. The mere physical copresence of individ-

uals establishes them as coordinates—as are trees, pillars, curbs, and walls. The relationship between (groupings or sets of) coordinates in a patterned array (in other words, opposing lanes, clusters, queues) guides the behavior of the individuals in that field. In addition, because they are mobile and flexible, individuals are potentially facilitators as well as obstructors of each other's progress. The term *coordinate* as a verb describes the normative baseline requirement for encounters in the public order on the facilitate-obstruct dimension: equal responsibility for equal effort for common progress. (P. 47)

“Cooperation” is a key element for understanding the social context of pedestrian behavior. Wolff noted that “a high degree of cooperation is an intrinsic part of pedestrian behavior—without it walking would be impossible” (p. 46). As members of a public order, or “coordinate,” whose members are traveling in opposite directions, one of the most basic social tasks that must be performed is the “simple” one of not bumping into each other. Most pedestrians expect each other to be cooperative rather than obstructive in the completion of this task.

A strategy that functions to reduce collisions is the process of “streaming,” as observed by Older (1968). He found that proportions of total flow in either direction on a sidewalk had little or no effect on pedestrian velocity. He suggested:

It is thought that this lack of effect is due to the considerable development of “streaming,” i.e. the tendency for pedestrians travelling in the same direction to follow one another in files which interweave with those from the opposite direction. This reduces the interaction between the two flows, so also does a natural tendency for pedestrians to keep to the right. Although it was seen to occur no measure of the extent of “streaming” was devised in this study. (P. 162)

Clustering, platooning, and streaming have been found to be complex phenomena. The “natural” tendency for keeping to the right that Older observed above is, in fact, a rule, or norm, that is early socialized in walkers. This social component of pedestrian behavior is revealed in the following analysis of Matson’s pedestrian skill-learning program.

Matson (1980) reports on efforts to teach mentally retarded children how to be “successful” pedestrians. The plan is based on the idea of breaking down the act of walking into minor behavioral units that can be taught one by one and then finally combined into sequential patterns. Despite the behavioristic framework of the proposal, the implicit social nature of walking becomes explicit when each of Matson’s behavioral objectives is given close examination. Matson defines proper sidewalk behavior as walking

on “the correct side of the walkway in a socially appropriate manner such that no disruptions in pedestrian traffic flow or social disruptions to other pedestrians were created” (p. 100). The specific tasks each youngster must first learn include:

- (a) The subject walks on the right side of the sidewalk.
- (b) The subject does not bump into other pedestrians.
- (c) The subject greets others when appropriate.
- (d) The subject does not stare at others.
- (e) The subject does not engage in inappropriate mannerisms. (P. 100)

Despite Matson’s behavioristic approach to learning theory, it is clear from inspection of the above tasks that the young pedestrian is required to learn a very subtle, flexible, and complex set of social rules in order to be judged a competent walker. There is obviously much more to learning to walk than just putting one foot in front of the other.

These social norms are learned and applied with increasing skill as the pedestrian becomes an accomplished walker. Ryave and Schenkein (1974) set the foundation for an analysis of the “work” of walking in mature humans. Three major components form the core of their analytical framework:

(1) *Navigation*. The basic ability to walk along a sidewalk without bumping into anyone or unintentionally walking between members of an oncoming group of pedestrians.

(2) *Recognition work*. The process of identifying whether oncoming pedestrians are walking alone or are members of a group.

(3) *Production work*. The process of emitting signs readable by others to indicate whether one is walking alone or as part of a group.

This scheme recognizes that the problem of “not bumping into anyone” is compounded by the additional tasks of not only *recognizing* “singles” and “groups” but also *producing* or sending out signals indicative of group membership status. All of this, however, is predicated on the process of *social scanning*.

Goffman (1971) explicated “scanning” in this lengthy, but insightful quote:

The term “scanning” does not have to be defined, but the way it is done in pedestrian traffic needs to be described. When a pedestrian in American society walks down the street, he seems to make an assumption that those to the front of a close circle around him are ones whose course he must check up on, and those who are a person or two away or moving behind his sight-line can be tuned out. In brief, the individual, as he moves along, tends to maintain a scanning or check-out area.

(By angling his own head so as not to be directly obstructed visually by the head of the pedestrian ahead of him, he can ensure his maintenance of this view.) As oncomers enter the individual's scanning range—something like three or four sidewalk squares away—they are commonly glanced at briefly and thereafter disattended because their distance from him and their indicated rate and direction of movement imply that collision is not likely and that no perception by them of him is necessary for his easily avoiding collision. (PP. 11–12)

He also noted the particular shape of the scanning area. “The scanning area is not a circle but an elongated oval, narrow to either side of the individual and longest in front of him, constantly changing in area depending on traffic density around him” (p. 12). When a pedestrian discovers an oncomer within the scanning oval, this information is acted upon in a patterned, but subtle, manner.

Goffman wrote that there are two “special moments” which occur during an encounter between two pedestrians. First, there is the emission of a “critical sign,” or act, that lets the other pedestrian know what you, as a pedestrian, intend to do next. These are frequently very subtle motions, the study of which is part of the evolving discipline of kinesics. It may be a straight-ahead glance or a small motion of the shoulder that tells the other pedestrian you are going to alter your course, and by how much, in order to avoid an impending collision.

Second, there is an “establishing point” or a recognition by both parties that they have exchanged “critical signs.” This exchange and verification procedure would also include the group-membership information discussed by Ryave and Shenkein. This exchange and acknowledgement process is very subtle and complex, but millions of pedestrians do it daily without ever giving it a thought. It is only after the completion of these two “special moments,” as Goffman named them, that actual changes in course are put into effect. Sometimes these messages become confused, with the result that two opposing pedestrians may find themselves in a sort of reciprocal “dance,” trying to figure out who is going to go which way. Tourists in foreign lands, for example, may experience increased levels of “bumping into” others. This may be because, in part, of differences in “critical signs” from one culture to another, which the tourist does not recognize or misinterprets, resulting in collisions and more frequent “near-misses.”

Wolff (1973) was among the first researchers to investigate

the "step and slide" movement that pedestrians use in adjusting their paths to avoid collision after the "establishing point" has been reached when sidewalks are crowded:

At higher densities a common behavior, especially between members of the same sex, was not total detour and avoidance of contact but a slight angling of the body, a turning of the shoulder and an almost imperceptible side step—a sort of *step-and-slide*. When a pedestrian executed a step-and-slide, he did not move enough out of the path of the oncoming pedestrian to totally avoid contact or bumping; for a clean "pass" to occur, the cooperation of the other pedestrian was required and given. However, even when the step-and-slide was properly executed, some body contact, such as brushing the shoulders, chest, arms, or hip area, almost always occurred, while the hands were pulled inward or away to avoid hand-to-hand contact. (P. 39)

Even when people cooperate, however, they may not like the fact that they have to do so.

Using half-hour semistructured interviews, Stiltz (1970) investigated the reported experiences of twenty-four people who walked to work everyday. He observed that the subjects seemed always in a "hurry" when walking and this condition may have influenced the following results. In any event, he found in general that

People disliked the forceful physical contact experienced under the most extreme conditions. Under less extreme conditions, they were irritated by delay. Under conditions where potential delay could be avoided, they were inconvenienced by the necessity of taking avoiding action. (P. 71)

Clearly, touching, brushing, and collision are not considered enjoyable situations, and the cooperation of all pedestrians in avoiding them is a general expectation, at least in American society.

Sobel and Lillith (1975) instructed experimenters to walk straight at moving pedestrians on a New York sidewalk without stopping unless "a direct frontal collision was imminent." They found that collision situations never occurred because the observed subject always made a correction or side-step to prevent collision. Interestingly, however, they report a very high number of slight collisions or "brushes" even though the sidewalk density conditions were not high. They suggest that subjects "refused to give up unilaterally their right of way until the very last moment" and concluded that this indicates a strong "norm of bilateral accommodation in street behavior" (p. 44); that is, *unilateral* withdrawal from potential conflict is not expected. Rather, *cooperation*



is anticipated, and it could be hypothesized that the “brush” may sometimes serve to remind the offender of a failure to yield at least a little.

Availability of walking space on a sidewalk is a prerequisite if forward progress is to be achieved. Several factors enter into the amount of space made available under various sidewalk conditions. Dabbs and Stokes (1975) observed 470 pedestrians and found that pedestrians traveling in groups are given wider berth than are pedestrians walking alone. Furthermore, other pedestrians accord more space to approaching males than to females. Adding to their list of findings, they also reported that culturally defined “beautiful” women were given more space than “unattractive” women. The authors concluded that “sex, number, and attractiveness may be regarded as aspects of power” that enter into even the most “simple” human interaction of meeting and passing oncoming pedestrians on public streets.

But, do the above findings mean that “power plays” are frequent for pedestrians? Sobel and Lillith (1975) observed that women are generally given wider berth than men when passed by oncoming pedestrians. Observing 3,141 pedestrians, Willis and others (1977) suggested that “power” may not be so important as “galantry” in deciding who moves where during collision avoidance maneuvers. They found that “persons or groups moved for larger groups and younger groups tended to move for older groups, but women did not tend to move for men nor did blacks tend to move for whites” (p. 38). Furthermore, they go on to suggest that “maneuverability” may be the main issue. “It is easier for smaller groups to move for larger ones, as it is easier to move for those who are not carrying an infant, not handicapped, and not maneuvering a wheelchair or stroller” (p. 38). These authors remind the reader that in appearance, it may *look* the same when someone yields to someone with greater power as when someone in power is required by social convention to give deference to a culturally defined “weaker” person. The point to be drawn from these studies is that issues of convention, power, and deference appear to be at work on the sidewalk, but that the relative importance of each is still open for discussion and study.

The foregoing examples help to elucidate the assertion that “walking down the street” is not a simple, behavioristic exercise. It involves sophisticated signal exchanges and normative behavior when pedestrians meet each other from different directions and

must negotiate rights-of-way. The social aspects of walking, however, also include the experiences of people who walk together in groups.

### *Walking in a Social Group*

If little is actually known about the signal exchanges and social norms involved in walking, even less is known about how pedestrians proceed as members of social groups. Berkowitz (1971) made one of the only cross-cultural observations of pedestrians and, interestingly, he focused on the question of behavior in groups. Observing pedestrians in six countries, he reported that (1) the tendency for pedestrians to travel in groups was highest in the Moslem countries, England, and West Germany. It was lowest in Italy and the United States, and (2) pedestrians in the United States tend to be much less sociable with each other as measured on three sociability dimensions. Walking provides opportunities for socializing and friendly exchange, goals which may often have as much, if not more, value than actually getting to a particular destination. Yet, it appears that pedestrians in the United States are not utilizing the full potential of this aspect of pedestrian travel.

The walking habits of subhuman animals raise some interesting questions about group walking. Extrapolation from such studies is, of course, tricky at best and should generally be restricted to suggesting areas of inquiry that must be reformulated in human terms. One such study was recently completed by Rhine and others (1980) on the walking habits of troops of baboons. They observed that infants were protected by being placed at "the center of their troop" when baboons travel as a group. Thus, it is interesting to speculate about spatial placement rules, if any, for walking humans.

There are some norms that may provide clues for more detailed study. For example, males in Western cultures tend to take the street side of the sidewalk when walking with females (Goffman, 1971). Various cultures prescribe that females walk behind males. Contemporary changes, if any, in these norms as well as questions about the possibility of real but unrecognized additional rules for the spatial structuring of human walking groups remain open for study.

With regard to human infants, Wolff (1973) noted that adult pedestrians often treat children under seven years old as "baggage." He observed:

First, many of the people who were holding the hands of children appeared to be dragging them through traffic. The child trailed somewhat behind and was continually buffeted by oncoming pedestrians with no major objections, verbal or otherwise, issuing from the child or the accompanying adult. Second, it appeared that the oncoming pedestrians would "sight" the adult and negotiate the right-of-way with him; the child would be led, ignorant of where his next step would be and sometimes stumbling over himself and others. Third, it appeared that, for the most part, the child did not "attend to" the oncoming pedestrians. (P. 45)

He concluded that several questions remain open for future observation:

Several empirical questions can be generated from these observations. At what age or stage of development have children learned to negotiate right-of-way, territorial possession, and so forth, in public places? At what age or under what conditions is their attempted use of such knowledge "respected"? (P. 45)

The answers would clearly provide insight into the time of a literal "rite of passage." The child obviously looks to the parent for help in doing the work of walking but also learns a complex set of social norms that make walking possible, both in groups and alone.

### *The Macrosociology of Modal Choice*

Behavioral geography has long looked to psychological constructs to explain human spatial behavior. Such psychological processes have been noted above and will be discussed below in even more detail. It would be a mistake, however, not to at least devote brief consideration to the dynamics of macrosociological forces on pedestrian behavior. This is especially true since the studies cited above have generally tended to fall into the dangers of "psychologism, i.e., the examining of complex social and historical developments from the viewpoint of individual psychological processes" (Rieser, 1973: 205). A relevant example, chosen from more deserving candidates, is a statement by Hartgen (1974) that "the urban traveller's mode choice results from his evaluation of the perceived attributes of alternative modes, within situational constraints imposed on the individual and his household" (p. 378). While this hypothesis at least opens the door to consideration of "situational constraints," it is still psychologically oriented. Close examinations of the reasons why many people "choose" to travel in the walking mode need to be undertaken. It is important to realize that Hartgen (1974) found situational variables (e.g., income, automobile availability, and so forth) far more explanatory than "attitudes" toward modes in determining modal choice.

Despite the representativeness of the pedestrian population, it is not a mirror image of American society. The elderly, the handicapped, the very young, the impoverished, and women are consistently overrepresented in samples of pedestrians. Members of these "special groups" endure real problems of spatial/environmental inequality that have rarely been addressed in the literature. (The work of Paaswell, 1973; Paaswell and Recker, 1974; and Ballard, 1967, are important exceptions.) Insensitivity to these issues can result in seriously flawed planning for pedestrians.

I encountered a particularly forceful example of the failure to appreciate the macrosociological context within which many pedestrians must actually function when in 1981 I was invited to participate in a review of the pedestrian-research program proposed by the U.S. National Highway Traffic Safety Administration. NHTSA officials presented a color television spot that was to be used to educate children about the "correct" way to cross streets. The film used blue and red symbols to indicate "good" and "bad" choices. I inquired if children could distinguish between these symbols when the spot was received on a black-and-white (rather than color) television set. This inquiry was quickly dispatched with the summary observation: "Hell, everybody has color television sets these days, so no sweat." The safety education needs of pedestrians who cannot afford color television sets had not entered the consciousness of NHTSA officials.

The real needs and problems of pedestrians who have no other choice than walking as a transport mode (often for socioeconomic reasons) have received virtually no attention. Unfortunately, this is not surprising when one examines the social status of the groups in question: they are among the powerless and ignored who suffer from many additional forms of discrimination as well. Although not given central attention in the present research project, it is clear that macrosociological studies of the full-time pedestrian are long overdue.

## *Crossing Streets*

“Crossing the road,” which is explored briefly in this section, represents the next hierarchical component of spatial ability in the pedestrian. The youngster’s ability to cross the street means that he is no longer bound to his or her “home block.” Children who know how to cross streets are allowed to visit their friends on the “next” block and to walk to school on their own without supervision. In short, they have mastered an essential ingredient in their ever increasing spatial freedom.

Beyond the obvious safety issues and questions (cf., Flynn, 1977, for the major safety references), street crossings provide an environmental setting that interests social scientists in its own right. The following examples will be discussed below in greater detail but are introduced here to show the range of issues that may be studied in street intersections. Wagner (1981) finds street crossings to be filled with many unanticipated examples of *cooperation* and *trust* between perfect strangers. Ribey (1979) sees the act of crossing a street as a paradigm example of *micro-decision-making*. Several others have examined jaywalking as a function of *conformity*, *status*, and other *rules for normative behavior*. Hill (1979b) views the urban street intersection as a *complex system* that serves as an example for an holistic approach to *urban design and environmental theory construction*.

The diversity and complexity encountered in the urban street intersection can be seen as a challenging theoretical puzzle. Hill and Roemer (1977) expressed the following sentiment:

Whereas a focus on the urban intersection may seem, to some readers, superficial and not worthy of theoretical effort, one finds on examination that this system is complex enough to challenge the ablest theoretician when viewed from a theoretically explanatory perspective. The definition of the traffic intersection system and its component elements, together with an explication of element interactions, reveals nearly intractable problems when approached explicitly in a manner designed to provide a theoretical sense of understanding of behavior within the system as a whole. Even an examination of a subset of this behavior, pedestrian compliance, discloses a theoretical briar patch. It is obvious that the street intersection system is a “simple” system in comparison to the larger urban system of which it

is a part, but it is still complex enough to provide many tough and instructive theoretical puzzles. (P. 343)

Apart from a plethora of "safety" literature in which the problem of crossing streets is often reduced to educational and behavioristic banality, this aspect of the pedestrian experience has received strikingly little study as a subject in its own right.

### ***Related Street-Crossing Literature***

The express purpose of this section is to note several studies that relate to street-crossing behavior but have not examined this behavior as an experience-in-itself per se. Behavioristically framed approaches for teaching children how to cross streets are found in Matson (1980) and Page and colleagues (1976). Various programs to train students to cross streets safely have been implemented in a number of schools. Evaluation of these programs still remains problematical, however. The necessary evaluation research has generally been framed in behavioristic terms that are insensitive to the subtle factors involved in the decision to cross a street. The research designs themselves often raise more questions than they solve. For example, the results reported by Yeaton and Bailey (1978) are clouded because of small sample sizes (ten in one group, only four in another); special treatment of experimental groups ("children were released from school approximately 15 min. early each day"); and knowledge by the subjects that they were under observation (the children "were accompanied to the street corner. They received the simple instruction: 'Now I want to see how you cross the street when the crossing guard holds traffic'" [p. 322]). These threats to validity (cf., Campbell and Stanley, 1963) hurt the interpretation of an otherwise admirable attempt to document the effects of a presumably worthwhile safety education program. This is not an isolated example, unfortunately. The pedestrian safety community has been slow to undertake the difficult process of objectively evaluating the performance of its safety programs and proposals.

Several observers have noted considerable variations in the manner in which different categories of pedestrians cross streets. The degree to which these differences are innate, socialized, or adaptive is still a relatively open question. Repeated observers have found that women, pedestrians in groups, and the elderly tend to cross streets more slowly than men, pedestrians walking alone, and

the young. It has also been frequently observed that women and older pedestrians also tend to engage in less jaywalking than do men and younger pedestrians.

Interpretation of such findings is sometimes difficult and problematic, however. Although it is often assumed that females, for example, are socialized to be more compliant and law abiding, there are no studies that have investigated whether reduced jaywalking by women is simply a rational, adaptive response to drivers who may try to claim rights-of-way over female pedestrians. Such inquiry is clearly indicated by research conducted by Henderson and Lyons (1972) who found that the walking velocities of females are more frequently disturbed than those of males when crossing at a traffic intersection. They offered the hypothesis that "a motorist finds it much easier to perturb the motion of a female pedestrian on a zebra crossing than that of a male" (p. 355). Although based on observations made in England, this suggestion lends itself to an "intimidation" thesis. Under this conceptualization, motorists, especially men, may attempt to "force the issue" rather than yield when they identify what they perceive to be a less combative competitor for "right-of-way" in an intersection. This hypothesis would be consistent with the finding by Katz, Zaidel, and Elgrishi (1975) that females and older drivers slow down more than other drivers when they approach an intersection.

Sexist attitudes are not restricted to the street, however. They sometimes exist in the research literature itself. Collett and Marsh (1974), for example, observed the manner in which women moved when crossing streets and offered the astounding hypothesis that "we therefore require some explanation of why women *loathe* to orient toward oncoming pedestrians. Put in these terms, an explanation is not difficult to find: the *obvious* assumption to make is that women are concerned to protect their breasts" (p. 288, italics added). In their rush to prove this thesis, the authors failed to suggest that women may simply be trying to avoid the *uninvited* gazes and body brushes initiated by men. Nor do they discuss the possibility that males are overly "frontal" or "aggressive," hypotheses that are equally "obvious." This example demonstrates that future work on hypotheses concerning age and sex-specific socialization for explaining variations in street-crossing behavior requires researchers to divest themselves of sex and age biases.

Jaywalking or crossing the street against the light has been used by social scientists as an index of "conformity" to social norms.

While interesting, these studies are generally more concerned with theoretical issues surrounding the concept of "conformity" than they are with the behavior of pedestrians specifically. Pedestrian compliance has been studied by Lefkowitz and others (1955); Dan-nick (1973); Russell and others (1976); Hill and Roemer (1977); and Alexander and Federbar (1978). The research question generally put is: What factors will increase the likelihood that a pedestrian will fail to conform to prohibitions against jaywalking? Most findings support the idea that pedestrians will be more likely to jaywalk if they see other pedestrians jaywalk. This tendency increases if the jaywalking model is perceived to have high social status.

Although jaywalking studies concern a behavior that increases risk of injury from collision with an automobile, relatively few researchers have examined interactions between pedestrians and car drivers specifically. Because of the rarity of physical collision between pedestrians and automobiles during any given observation period of a few hours or so, behaviorist safety researchers simply conceptualize "risky behaviors" on the part of pedestrians rather than actually observing what happens in an actual pedestrian-automobile collision. I do not advocate real-life observation of tragic accidents that might otherwise be prevented, but the lack of empirical reference for behaviorist assertions about "pedestrian errors" is both methodologically and theoretically disconcerting (especially given the behaviorists' own stringent demands for solid empiricism). However, Katz, Zaidel, and Elgrishi (1975) conducted an innovative, controlled field experiment in which trained researchers assumed roles as pedestrians and initiated crossing negotiations as drivers approached a street intersection. These experimenters took somewhat of a risk to walk bravely in front of oncoming vehicles, but their results are exceptionally interesting. They found that drivers stopped or reduced their speed for crossing pedestrians more often when:

(1) The approach speed of the vehicle was low; (2) the crossing took place on a marked crosswalk; (3) there was a relatively long distance between the vehicle and the pedestrian's point of entry into the road; (4) a group of pedestrians, rather than an individual, attempted to cross; and (5) *the pedestrian did not look at the approaching vehicle*. Additionally, female drivers and older drivers slowed down more than other drivers. (P. 514, italics added)

These findings were especially interesting in light of the fact that "pedestrian safety propaganda urges people to look left and right



and again left before crossing, and then to keep looking at the approaching car" (p. 516). If the pedestrians *pretend* not to look at the driver (but do so only out of the corner of the eye), they may have a better chance of getting the driver to yield to their legal right-of-way. Such "games" indicate the sophistication and subtlety of pedestrian behavior that is often missed in behavioristic safety research. The experimenters cited above took risks to obtain their findings, but each pedestrian is required to take similar risks everytime a street crossing is effected. The process of risk estimation is both fascinating and subtle.

### ***Risk Estimation and Street Crossing***

It may be that pedestrians take a risk of getting "lost" whenever they start a trip, but they take a much higher risk in being struck down by an automobile. The assessment of this risk can be viewed from both macro- and microperspectives. Goodwin and Hutchinson (1977) examined the question of "risk" to pedestrians from a macroperspective.

These researchers defined "risk" in terms of an index of the following form: Number of Accidents/Exposure to Danger. Quantitatively, they employed an estimate of "time spent walking" as a proxy measure of "exposure." This definition is conceptually weak since walking per se is not particularly risky. Recall, for example, Goffman's (1971) observation that pedestrians can "bump" into each other with very little damage. The source of risk during walking derives from the potential of being struck by an automobile, specifically while crossing a street. Thus, a study by Routledge and others (1974) in which risk was estimated as a function of (1) the number of roads crossed and (2) the traffic density on those roads is much more satisfying conceptually. Additional characteristics, such as traffic velocity and the general environment (e.g., urban vs. rural), would also add to the utility of this line of thought. Unfortunately, Routledge and associates dealt only with children, whereas Goodwin and Hutchinson attempted a more universal estimate of risk for the general population.

The latter authors based their conclusions on data derived from the National Travel Survey 1972-73 conducted in the United Kingdom. They warn readers, however, that the walking data may well be underestimated. The same problem plagues the road-ac-

cident data that were obtained from the Transport and Road Research Laboratory. Problems of interpretation thus resulted: "While walking and accident data are therefore likely to be underestimated, possibly by a similar order of magnitude, it cannot be assumed that the composition of these biases either match or offset each other" (p. 219).

Thus, this macroview is built on a questionable data base. Nevertheless, the following is the best guess available. Comparing the overall risk of walking versus other modes, they found that pedestrians are estimated to experience 19 deaths for every 100 million miles walked. Car drivers on the other hand experience only 1.5 deaths for every 100 million miles driven. There is a flaw in logic, however, in conceptualizing the problem in this way. The risk in *both* cases stems from the same cause: *automobiles*. Left to its own devices, the pedestrian mode is obviously much safer than most other forms of transport. It should also be underscored that the death rate per mile computed above is based on other assumptions which may be inappropriate. The authors themselves noted: "If it is thought that 2.4 miles/h is an implausibly slow average pedestrian speed, and it is instead assumed that people walk for 20.2 minutes per day at an average of 3 miles/h, the pedestrian accident rates are reduced by 20%" (p. 228). This example illustrates the difficulty of estimating risk at the macrolevel and is a result in part of a real lack of reliable information on walking habits and walking environments. Furthermore, plausible conceptualizations like the one utilized by Routledge and colleagues should be pursued. Researchers should also distinguish between the risks incurred by walking per se (e.g., falling down, muscle strain, blisters, and so forth) and other risks, such as muggings and being struck down by automobile drivers. Finally, there is little information available that indicates the extent to which risk is judged so high by potential pedestrians that they fail to become actual pedestrians.

Risk may also be viewed from the microperspective, i.e., from the level of the individual pedestrian who crosses the street. It could be assumed that the riskiness of streets could influence an individual's decision to choose one route over another. Thus, this discussion is more relevant to the current project than may first be evident. However, there is virtually no empirical research available that is not tainted by behaviorist assumptions about what con-

stitutes "risk." A summary of research by Kastenbaum and Briscoe (1976) indicated that individuals who engage in more risky behaviors have somewhat different personalities than those who follow less risky courses of action. These researchers ranked 125 pedestrians by the risks they took in crossing streets and then interviewed them. They found risky crossers "neither wanted nor expected to live as long as did the cautious pedestrians" (p. 33). Additionally, they reported that the "safest" pedestrians "were more aware of their actions and considered themselves safer, more self-protecting people generally" (p. 33). These findings are certainly interesting, but readers should again be aware of the potential behaviorist bias in their study. The summary of the research states:

The researchers judged risk on the basis of such factors as whether or not the subject watched the traffic lights, kept an eye out for oncoming cars and stayed within the crosswalk or scurried from behind parked cars and other indications of recklessness or caution. (P. 33)

The problem here is that "recklessness" and "caution" are being judged on the basis of outward behavior that can be judged "risky" or "not risky" only if the researcher is willing to accept certain assumptions about the legitimacy of introducing lethal machines into the pedestrian environment. For example, one can conceptualize "darting out" across the street without looking for cars as a more "natural" action that was reasonably "safe" until the widespread introduction of automobiles. Hence, it is the automobile that makes the behavior "risky," not some innate quality of the behavior itself. Politically, the "safe" crosser can be seen as one who cowers in defeat in the face of the oncoming automobile and who thus contributes to the continued dominance of the technological age. Regardless of this "framework" issue, the real point is that there is very little information available concerning the risk-assessment skills of pedestrians.

Two relevant conceptualizations or theories of risk assessment, however, have been proposed but they remain without empirical validation in any complete sense. Ribey (1979) examines the problem of crossing streets at mid-block rather than at marked intersections. He conceptualizes the decision to cross the street as a "microdecision" in which the pedestrian is always calculating risks and benefits of multichanneled courses of action. His basic idea holds that the "legal trajectory" (i.e., the path prescribed by legal

codes, e.g., crossing only at marked intersections) of the pedestrian is frequently incongruent with the "free trajectory" (which Ribey illustrates as a direct, least-effort desire line). Each trajectory, or path, represents a different strategy for crossing the street. Each has different costs, or risks, and is built on very different value assumptions. In addition, the weights assigned to each decision change as each situation changes. For example, taking the "free trajectory" may save time for pedestrians who are late for a business meeting. It might allow them to catch a bus they would otherwise miss. It could permit catching up with a friend they wanted to speak to. The more such "advantages" occur at the same time, the higher the calculated benefit of choosing the "free trajectory." Thus, even law-abiding, "model" citizens may ignore the "legal" path when the advantages of the "free trajectory" reach a certain level of acceptability.

Ribey proposes, however, that few people use pure strategies. Instead, they employ "mixed" ones, which is held to result in the actual selection of what Ribey calls the "human trajectory." This path conforms to neither the "legal" nor the "free" paths. This "human" path across the street is said to be a compromise path that results in a "trajectory" that combines elements of both the legal and free options. It is an open question as to whether such a compromise path is viewed as a satisfactory one by the pedestrian, since the route chosen is neither particularly safe nor is it the shortest. Ribey's observation data confirm that people do appear to take the "human trajectory," but it is not yet demonstrated that they do so as a result of the "calculations" that Ribey proposes as an explanation.

Hill (1979b) proposes a generalized systems approach to the urban intersection in which risk assessment becomes an important process. Demonstrating how to articulate the full array of relevant elements required for a functional definition of an urban intersection, this paper ends with a brief scenario or theory sketch of how a lone pedestrian approaches the problem of risk assessment before crossing the street. The general character of the proposed systems conceptualization has also allowed its use to describe environmental art performances (Hill, 1980c). An independent, observational study by Wagner (1981) parallels several of Hill's ideas and provides empirical support for Hill's proposed environmental interrogation process. Wagner, however, extends his observations

to include the behavior of pedestrians in groups as well as the behavior of the lone pedestrian. For this reason, Wagner's findings are presented in some detail.

### ***Social Roles and Risk Assessment***

This section considers the overlap of socialization issues with those of risk assessment and is based on the recent and insightful report by Jon Wagner (1981). His research is based on photographic images collected in downtown Chicago. In all, some 1,500 photographic images of pedestrians crossing streets were produced. His analysis reveals that three sources of environmentally situated information are normally scanned by pedestrians before crossing the street. These sources or clues are: (1) traffic signals, (2) the street per se and traffic on the street, and (3) those people, if any, who may already be crossing the street or are about to.

Wagner's most interesting work concerns groups of pedestrians and the social roles they assume, but he also examines the case of the unaccompanied pedestrian. His photographic observations reveal the lone pedestrian scanning several sources of information:

With no one to help him out, he must read all three clues himself. Our observations indicate that he does just that, alternating his gaze between the "WALK" sign and the direction of oncoming traffic; and—if there are others waiting across the way—searching for other pedestrians to leave the curb and into the crosswalk. (P. 58)

Thus, Wagner's observational data are congruent with the theoretical systems analysis presented in Hill (1979b). Wagner, however, goes beyond the theory-sketch of the lone pedestrian to examine manifestations of "coordinate" behavior.

Whereas Wagner observes that lone pedestrians scan several sources of information, he finds changes in this pattern when groups of pedestrians wait for the traffic signal to change. Among pedestrians in the "front line" of a group waiting to cross, an unexpected "division of labor" takes place. Some become "specialists" who look only at the traffic signal while other "specialists" keep tabs on the traffic in the street:

It is noteworthy that the front-liners themselves are about equally divided between those who look up the street and those who look at the light. The mechanism by which these two "observation roles" are assigned remains unclear. In our limited research efforts, we have been unable to find enough pursuable cases to determine

if it is taken on anew at each street corner, or if it is an attribute of the individual pedestrian. (P. 58)

If this finding has wide application, then the process by which pedestrians divide observation tasks into distinct roles deserves considerably more study. The explanation of role assignment may lie in a socialization process, a hypothesis that suggests that the link between socialization and risk assessment processes may be deeper and less obvious than some psychologists would have us believe.

Pedestrians on the "front line" not only trust each other to perform their particular role (signal or traffic watching), the pedestrians in what Wagner calls the "backfield" trust the "front-liners" to make good decisions as to when to cross the street. The person in the backfield does not look at the signal or the traffic conditions, but just looks straight ahead at the back of a front-liner. The back-fielder often relies completely on the judgment of a front-liner. Furthermore, pedestrians who rush up to the crosswalk after the crossing process has already been initiated by others also put a good deal of trust in those who have gone before to have made the correct decision:

If someone approached an intersection and observed that its crosswalk had apparently-safe pedestrians already in it, the new arrival looked only at them. Rarely did this latecomer check his "safe" reading of the passage with either the traffic light or by glancing up the street to see if any traffic was moving into his path. The behavior of this pedestrian—who arrives on the scene when others are already preceding him across the street—is such that he seems to "trust" the anonymous others who appear before him in the crosswalk. He assumes that they are there for good reason, and he is willing to accept their actions within a context of "normal appearances." (P. 58)

Further research will surely spring from Wagner's astute discovery of social differentiation within the ranks of street-crossing pedestrians. Not only is the research interesting to the student of pedestrians, it sheds valuable light on the question of trust among strangers. Wagner concludes:

Participation by strangers in an *ad hoc* division of labor is notable in and of itself. Cooperation between individuals in times of crisis and catastrophe provide a wealth of human interest news. . . . While not nearly as newsworthy, the everyday practice of crossing streets shows a similar kind of differential social labor in the face of a common danger. In the roles of light-watcher, street-watcher and backfield, anonymous individuals have worked out a collective solution to one small part of their common fate. (P. 59)

The preceding review underscores the fact that there is much about pedestrian activity that is neither merely simple nor obvious. The questions generated by observing pedestrian behavior are far beyond the grasp of a single researcher, let alone a single research study. The separate issue of route selection by pedestrians, for example, is in itself a complex topic of which only minor aspects can be addressed in a survey of this size.

## *Choosing Routes*

This section concerns the most complex aspect of walking mode transportation: the selection of routes from one point to another. Choosing routes builds upon all the skills discussed in the preceding two sections: knowing how to walk and how to cross streets. Pedestrians engaged in moving through the environment may be searching for some particular place, enjoying a pleasant walk, or engaged in a more or less autonomic trip to or from work, school, or shopping. Whatever the case, each pedestrian is presumed in this study to be making decisions about which specific route to take from among all the possible routes that could be taken. This decision process does not reveal itself easily to the researcher.

Selection of routes through a maze of alternatives is one of the distinguishing characteristics of mobility in an urbanized society. Moles and his colleagues (1977) observed that the labyrinthic image permeates modern life:

The labyrinthic situation is one of the tourist who discovers the charm of the Small Village in Alsace, the one of the housewife fluttering through the multitudinous shelves of the supermarket, the one of the elegant woman scouring Saks Fifth Avenue or Sears from top to bottom, the one of the visitor awed by the science museum, of the motorist who discovers an unknown city. This is one of the *most common* occurrences of our life, precisely manifest in the ever increasing regulatory constraints of our society. Socialized life tends to be more and more like the vagrant existence in a maze of stone corridors described by Kafka and programmed by computers and bureaucracies. (P. 3)

Although this quotation has unfortunate sexist dimensions, its central point is well taken. Researchers have done little to explore the experiential aspects of life in urban mazes. A further introduction to the "maze" as a general framework for environmental design is found in Hill (1980a). The vast majority of research to-date, however, has focused abstractly on pedestrian "flow" through urban areas.



### ***Gravity Models and Pedestrian Flows***

Within the planning community, heavy emphasis on the prediction of pedestrian behavior with a view toward practical application in pressing and immediate planning situations has led to the construction of several mathematical models of aggregate pedestrian flow. For the most part, these models are variations of a general interaction model called a "gravity model." These models are "powered" with empirical data that are usually collected in a "pedestrian count."

Gravity model predictions are generally based on counts of pedestrians passing or "flowing" past designated observation points during specified periods of time. The resulting flow predictions provided by the models are thus extrapolations of these counts. Emmons (1965) provided a useful manual for conducting such counts. A more up-to-date survey of counting methodology is found in Mellor (1976). Yates (1960) outlined a "moving observer" technique that permits the researcher to estimate the number of pedestrians present on a given length of sidewalk. More technologically sophisticated (and expensive) methods employ aerial photography for the purpose of obtaining an estimate of the number of pedestrians on all streets under study at approximately the same moment. The limitations and advantages of these techniques are further discussed, with examples, in Lautso and Murole (1974) and, more exhaustively, in Pushkarev and Zupan (1975).

The majority of flow models are based on gravity formulations. Haggett and his colleagues (1977) provide a useful and basic introduction to the gravity concept. In essence, the model holds that interaction is more likely between two pedestrian generators if the generators employ or have more pedestrians individually. Furthermore, the concept suggests that interaction between two generators is decreased the further apart they are in space. In short, users of the gravity model attempt to predict how many pedestrians will "flow" between points A and B based on knowledge (or estimates) of how many pedestrians there are at points A and B and how much "distance" separates A and B. Such predictions may be conceptualized as either probabilistic or absolute. In practice, the level of predicted interactions using the basic or unmodified gravity model is rarely accurate. Initial attempts to improve the accuracy of the predictions usually involve the addition of an exponent to the distance term. Numerous other "re-

finements" are often proposed by the architects of gravity models, but the logic of these is most easily understood in reference to regression model versions of the basic gravity formulation. Regression techniques allow the planner to first state the basic ingredients: centrality and the pedestrian density at a given point. To this can then be added any number of additional factors such as time of day, day of week, retail floor space, number of restaurants within one hundred feet, and so forth. With this additional information, the model's "fit" with empirically collected data is often dramatically improved to the point that many planners feel comfortable in using the predictions as estimates in their work. Excellent examples of the gravity approach and its regression extension are found in Haas and Morrall (1967); Ness, Morrall, and Hutchinson (1969); Sandahl and Percival (1972); Lautso and Murole (1974); Scott (1974); and Pushkarev and Zupan (1975).

The flow models noted above (not all of which have been tested and calibrated) attempt to predict average flow of pedestrians on city sidewalks along the streets in central business districts. This allows planners to estimate potential changes in pedestrian flows resulting from planned locational changes in, or additions of, major points of origin and/or destination for pedestrians. While useful from this point of view, these models in fact do little to illuminate the nature of the individual pedestrian experience and are founded upon a static, status quo view of the world.

A major shortcoming of gravity and regression models employed in the planning community is that they reflect *current* situations because they are calibrated or "adjusted" using empirically collected data. Hence, *future* flows are predicted on the basis of present conditions. Innovative plans based on assumptions about behavior and/or experience *which have no current referents in present situations* cannot really be evaluated using this approach. Thus, gravity models tend to provide "more of the same" predictions which often become self-fulfilling prophecies. These and other problems and limitations of mathematical models used in traffic planning situations are reviewed in a monograph by Richardson and others (1979). In short, gravity model predictions are usually reified estimates bound up in past behavior patterns and structural constraints rather than insights that look forward to emancipatory challenges and possibilities.

Maps of pedestrian flow are usually abstracted from data collected at *points*, whereas the flow map purports to represent be-

havior along streets or *lines*. It is sometimes forgotten that this conceptual abstraction has taken place. In a very few studies, flow maps have been constructed using route data reported by pedestrians (e.g., Merchand, 1974; and Hartenstein and Iblher, 1967). The resulting maps unfortunately aggregate all of the individual routes in such a manner that the resulting diagrams are indistinguishable from ones constructed using point data. Although it is sometimes tempting to look at a flow map and observe that it illustrates the paths taken by pedestrians, one must quickly remind oneself that the map is an abstraction that is not at all informative about which routes are most favored or most utilized. It is the aggregate form of these maps that makes it very unlikely that they will ever shed much light on the reality of the pedestrian experience. This philosophical/methodological issue, called by some the "micro-macro debate," is discussed in depth by Cullen (1976) and Hudson (1976). It is a basic tenet of this study that far more attention should be given to the conceptualization and empirical investigation of route selection at the individual level. The time has passed for production of yet another model of undifferentiated aggregate level flows.

### ***Route Notation Schemes***

Although routes in this study are represented simply as lines and dots, other approaches should be noted. The problem of describing the environmental characteristics of a given route has been addressed in the fields of architecture and design. Several systems for graphically portraying what a pedestrian will see and experience along a particular route (often a route through a building) have been proposed (e.g., Halprin, 1965; Noe and Abernathy, 1966; Thiel, 1961; and Appleyard, Lynch, and Myer, 1964). These systems generally include a "travel line" that is augmented by other symbols indicating what is seen or experienced at various points along the route. In many ways, they are similar to "strip" maps. Other versions propose a series of sketches similar to frames in a movie. Thiel's work is probably the most comprehensive proposal and includes notations for variations in walking speeds, standing still, walking up or down, turns and the degree of angle, range of visual fields and the contents of these fields in terms of forms, enclosure, illumination, shadow, and color. Appleyard, Lynch, and Myer also suggest notations for dealing with high-speed travel in

an automobile and the apparent distortions that occur in visual fields at high speeds. Mitropoulos (1973, 1975) uses a series of sketches that focus on the form and enclosure of the spaces through which one might travel.

These notation proposals tend to be oriented toward future construction or designs. Their purpose is to give a client some feeling of what it might be like to “move through” an as yet unbuilt project. In addition, preparation of the “movement script” reminds the designer to think about a project in dynamic rather than static terms.

A more general conceptualization has been advanced by Perin (1970). She introduced the “behavior circuit” as a unit of analysis for environmental designers and architects:

By behavior circuit I mean to denote both the movement and the completion integral to tasks, errands, recreation, work, visiting, and so on. . . . What behavior circuits implies is an anthropological ergonomics, tracking people’s behavior through the fulfillment of their everyday purposes at the scale of the room, the house, the block, the neighborhood, the city in order to learn what resources—physical and human—are needed to support, facilitate, or enable them. (P. 78)

Perin’s idea was development of a research tool that could be applied to inform the architect before design work rather than to illuminate dynamic aspects of a completed (but unbuilt) design proposal. Perin suggested noting the kinds of things that people do as they move about from place to place and then using this information to design better environments. Perin was particularly concerned with the behavior of pedestrians and noted that “having given priority to the automobile, planners give little thought to the resident as pedestrian” (p. 82). The result of her concern was a call to designers to describe the *sequence* of events that unfolds as a pedestrian chooses and follows a route. Obviously, pedestrians may engage in a very wide range of activities and events while engaged in a “behavior circuit.” These may include shopping, visiting, helping, sightseeing, working, wandering, being lost, being surprised, marching in a parade, planning a revolution, grieving for a friend, exercising, dancing, escaping, and so on. Current work, however, has focused on a much more restricted range of events: the sequence of route-choice decisions a pedestrian makes when walking from one point to another.

In addition, it should be noted that it is also possible to focus on very minute aspects of pedestrian behavior. That is, how one swings one’s arms, turns the head, or rotates the hips while walk-

ing along a given route. Such microaspects of walking could be described using notational schemes devised to record the movements of dancers. The completed notation is a "movement score" that is directly analogous to a musical score. This score can be read by trained dancers who can then re-create the intended movements just as a musician re-creates a musical passage by reading the notes on a sheet of music. The method proposed by Laban (1975) is one of the better-known notation formats. To be useful to pedestrian behavior researchers, however, such a system would have to be adapted to allow the researcher to discriminate between subtle differences in walking behaviors that may not be part of "the language of dance." The dance metaphor is one worth exploring and has been employed on a macrolevel in Seamon's (1979) concepts of "place and body choreographies" and "place ballet."

In summary, the notation schemes now available provide a way to wed the activities of pedestrians on "behavior circuits" with the pedestrians' experiences of particular routes. These techniques have found little common acceptance in the design community, however, although their promise and utility continues to be championed by vocal proponents, particularly by many members of the Environmental Design Research Association. It may be that the proposed notation schemes are too complex and ambitious for practical use, but it is hoped that continued experimentation with these notational systems may someday provide a richer understanding of the world and activities of the urban pedestrian.

### ***Alternatives to Gravity Model Approaches in Route Selection***

Several attempts to explore the route-choosing behavior of pedestrians are briefly identified and reviewed in this section. All of these studies have adopted approaches that are alternatives to the gravity model. It should also be noted that there are several existing studies that relate to route choices by automobile drivers (eg., Michaels, 1965; Carr and Schissler, 1969; Benshoof, 1970; Colony, 1970; Gordon and Wood, 1970; and Jones, 1972) but which have little relevance to the decisions made by the pilots of Goffman's "pedestrian vehicle."

*Environmental Preference and Route Choice:* The first alternative approach to the gravity model is based on the idea of *preference*. For example, it can be assumed that when pedestrians have a choice between routes of equal length all going to the same destination,

they will choose the one they find more "attractive" in one way or another. By choosing a particular route, the pedestrian could be said to express a preference for a particular combination of environmental attributes, both physical and social. Rapoport (1977) provides an outstanding review of the environmental evaluation and preference literature (see especially pp. 48-107). Pendakur and Brown (1970), Bishop (1975), Lautso and Murole (1974), and Underwood (1975) have adopted this approach in looking specifically at preferences for urban streets.

Blivice (1974), however, took this tactic one step further and attempted to link the environmental preferences of adults with their reported route choices. He asked respondents in a questionnaire study to note on a map the walking segment of their last trip. Each designated path was described by three composite dimensions: (1) greenness, (2) scale, and (3) pleasure. This study of purposeful "walking-to-work trips" in Munich, West Germany, resulted in the following conclusion:

It has been shown that in general people tend to choose exposed places in the city which afford various kinds of views rather than enclosed areas such as arcades and narrow streets, seek out pleasurable environments such as plazas and green-islands and choose pathways lined with activities which are thronged with people, especially the pedestrian mall, rather than seek out the quieter parks and tree-lined streets. (N.p., from the abstract)

It should be kept in mind, however, that describing the paths people report taking does not mean that those people chose those paths *because* of the characteristics (e.g., greenness or scale) which the researcher feels are descriptive of the paths. The paths may have been chosen for completely different reasons. Thus, it is important that Blivice also asked his respondents *why* they chose their particular routes. The reasons most frequently cited were: (1) shortest path, (2) relative quiet, (3) greenery, (4) window displays in shops, and (5) safety. He also found that those who said they walked in order to experience the environment also reported taking paths that tended to be separated (as much as is possible in a city) from vehicular traffic corridors. Unfortunately, the aesthetic biases and sophistication of those who responded to the questionnaire are not known. Generalizations that can be made from Blivice's findings are clouded by the possibility that cultural variations may exist in what is given preference in the walking environment. In sum, Blivice took the first needed steps in linking environmental preference concepts to route choice. His findings, how-

ever, give rise to new questions rather than establishing preferences as an explanatory agency in route choice.

*Route Learning as Socialization.* It might also be assumed that there is a certain amount of training or socialization that goes into route-choosing behavior. Most young children, for example, are shown the way to school by adults or older children. During this process, a child would not only learn a particular route, but would also begin to learn something about what makes for a "good" route. Very little, however, is known about how people learn routes through the real world. There is a considerable body of laboratory research on spatial learning in both humans and rats (e.g., Morton, 1950; Simon, 1957; and Olton and Samuelson, 1976), but the reader is advised that little of this work is directly related to the problem of route selection in urban areas. For example, Beth Kerr (1975) completed a laboratory investigation of processing demands during movement. I asked her about the applicability of her findings to the larger environment beyond the laboratory. She replied, "In response to your question on processing demands for pedestrians: the jump from micro to macro for motor processes is not an appropriate one, as far as I'm concerned" (Kerr, 1977). Thus, what little can be abstracted from such studies must be heavily "interpreted" before it is applied to the pedestrian environment in urban areas.

One of the few studies that directly examined socialization patterns was a questionnaire study by Reiss (1977). He inquired about the routes selected by school children (ages 5–14 years old). He found that males more often said they chose the route taken to school because it is the "shortest" way. On the other hand, females more often said they "choose the route taken to school because they are taken by parents" and "would go a different way if told to do so by parents or if it was 'safer'" (p. 42). It was also noted that older students more often report taking the shortest route and would "take the route that avoids traffic" and "would take a different route to school if told by parents or school officials" (p. 43). Based on these and other results reported in the paper, including behavioral observation of street-crossing behavior, Reiss concluded that "the pattern of responses shows a progression in pedestrian capability from the kindergarteners to the eighth graders" (p. 43). These findings support the conclusion that

children are influenced by parents and peers in the selection of routes, a definite indication of socialization at work.

Yet, Reiss's work provides a good example for noting the variations that can occur when comparing "reported" behavior with "actual" behavior. It is quite possible that students also quickly learn to *say* the "correct" response while they in fact *behave* quite differently. Hence, the results reported by Reiss concerning route choice may represent socialized responses rather than socialized route-learning behavior.

A study by Routledge and colleagues (1974) found that the information provided by school children is often more reliable than that provided by parents when asked to estimate the extent to which the children are exposed to risk during the journey to and from school. This suggests that young children may gain the capacity for evaluating and judging routes rather quickly. How much of this skill is directly learned through socialization and how much might be a latent property of cognitive development is not known at this time. The truth, perhaps, may lie somewhere between these and other possibilities.

*Cognitive Aspects of Route Choice.* It can also be argued that the selection of a route depends on the development of certain cognitive structures and skills. Obviously, a certain degree of mental functioning is required for successful route selection. For example, Bowen and colleagues (1972) found that many patients afflicted with Parkinsonism "perform significantly below the level of normal controls on an established test of spatial orientation: namely, walking a route guided by a visual map" (p. 358).

An objection to this conclusion may be that a map-following test is not necessarily a test of route-finding ability. Garling (1975) observed that maps and other forms of "intellectual" knowledge are aids that may be useful but are not required by the route-finder:

Possibly, the information from maps as well as acquired spatial representations of route systems enable the individuals to determine their position during movement which in turn may have effects on confidence, the possibility of correcting wrong choices, and to effectively choose unknown paths. This orientation with the aid of intellectual knowledge . . . is seen as an aid to navigation and route-finding, though not always necessary for successful performance in a more restricted sense. (P. 175)

Furthermore, Piaget and Inhelder's (1956) research on the de-



velopment of spatial concepts in humans is consistent with the idea that the basic spatial abilities needed for route finding are well developed at an early age. Thus, with some exceptions, it seems reasonable to assume that most adults possess the basic cognitive equipment necessary to navigate successfully in the urban environment. Maps may be seen as important aids in route finding once the basic cognitive skills have been developed and sharpened.

From a cognitive perspective, one of the most important "maps" is the individual's "mental map" or "cognitive schema." The mental mapping perspective holds that individuals have some sort of "representation" of their spatial environment stored within the memory. This "cognitive schema" of the environment is "consulted" when the individuals want to go somewhere or find a particular place. There is debate concerning the precise manner in which spatial information is retained in memory, but most advocates agree that spatial information is stored in memory and that the nature of this information has an influence on subsequent behavior by the individual in space. Still useful, general statements on mental mapping and spatial orientation include a brief essay by Lee (1969) and a book-length review by Howard and Templeton (1966). Lee noted the relevance of the "spatial schema" approach to geographical orientation. This avenue is further explored in Downs and Stea (1973). More recent, comprehensive discussion is found in Rapoport (1977, especially pp. 108-77).

There is a large body of literature that discusses "distortions" and "gaps" occurring in the mental maps that individuals have of their environments. These issues presumably have ramifications for route choice. For example, if an individual does not know that a given route exists, then it is more likely that a more familiar, known route will be selected. Furthermore, if a given route is *perceived* as quite lengthy (even though it may be relatively short in comparison to other possible routes) it may not be looked upon with much favor if the pedestrian wants to take "the shortest" route to a destination. Many factors appear to be responsible for such perceptual distortions. These include: travel experience, psychological fears, social status, mode of travel, and so forth.

Rapoport (1977) made an important distinction between experientially perceived distance and remembered distance. Complexity (i.e., having more choice points and/or turns along a path) tends to increase the amount of information available along a given path. Since there is more information to process, such a route may

seem longer. This depends on a temporal factor, however. Rapoport noted that the experience of the pedestrian *at the time* of traveling a route is that the route is *shorter* when the route is complex rather than simple. This results from having his interest held by the increase in usable information available on a complex trip. Thus, a trip which is complex seems more exciting and quickly completed. But, *after the trip is over* the *remembered* trip seems *longer* than it did at the time he actually experienced it. He stated: "Experientially high information environments seem shorter to transverse than low information ones, but this is reversed in memory. Complex routes are experienced as short and remembered as long and vice versa" (p. 219).

The logic of the mental-mapping approach is attractive, yet few studies have been able to show much behavioral connection between mental maps and the observed behavior of individuals in urban space. There is basically only one major study that has, so far, attempted to link pedestrians' choices to the concept of mental maps. Because of the issues it raises, Marchand's (1974) investigation in Paris, France, is worthy of discussion.

Marchand obtained from each of 246 subjects "a detailed description of his itinerary when walking from home to the [subway] station" (p. 492). These itineraries represent a 12 percent questionnaire response, resulting in a sample that "is obviously biased" (p. 492). The individuality of each "itinerary" was lost, however, as a result of Marchand's cartographic approach. His mapped presentation of "routes" does not show individually identifiable paths. Rather, the data have been aggregated to produce what is essentially a flow diagram showing the frequency with which any given *link* in the street system was utilized by pedestrians. All information concerning the *sequences* of links that might have been combined into actual *routes* has been lost through aggregation into *flows*. Flow data are useful to engineers, but they provide little insight to students of route choice.

The aggregation of data into flows makes it difficult to fully evaluate several assertions offered by Marchand. For example, he stated: "Pedestrians show clearly a tendency to follow the *simplest* path even if it is not the shortest. They walk first to the main straight axis, then follow it all the way to the station" (p. 504). The definition of "simplest" is not clear. But, more crucially, the above cannot be determined from Marchand's map of aggregated routes or from any other data presented in the paper. If one assumes

that the flows are, in fact, routes or itineraries, the data actually appear to largely support a shortest-path hypothesis.

A further possibility for misinterpretation occurs in Marchand's observation that the graph theoretic interpretation of his aggregated map of itineraries does not allow it to be defined as a "tree" (cf., Deo, 1974, for a discussion of graph theory terms). He then argued that "this might appear as proof of some freedom of choice of itinerary" but then noted: "For instance at the crossroad between Avenue Carnot and Avenue Gambetta *each flow goes on straight ahead and crosses the other*" (p. 504, italics added). The conceptualization of aggregated flows as "crossing" each other is a major mistake. They could, for example, just as easily be seen as "mixing" or "joining." Marchand needs to present far more detailed analysis of actual routes if his otherwise interesting ideas are to be salvaged.

Marchand also asked his respondents to draw a map of the neighborhood in which they lived and in which the studied subway station was located. On the assumption that distortions in these hand-drawn maps were related to distortions existing in the mental map of the subject, Marchand made a detailed analysis of the subjects' mental geometry of the neighborhood. This study is, in itself, interesting and relevant to the growing literature on mental maps. A problem occurs when Marchand attempted to link the aggregated mental map data to the aggregated itinerary or route-choice data. The most that can be said is that the linkage is highly tenuous. The aggregations performed by Marchand leave the analysis open for artifactual interpretations and leave the reader somewhat skeptical of both the "theoretical laws of pedestrian behavior" (pp. 501-2) as well as the "observed laws of pedestrian behavior" (pp. 504-5) proffered by Marchand. This French study amply illustrates the problems encountered in attempting to relate the mental mapping literature to the actual route choices made by pedestrians. Hopefully, Marchand's innovative first attempts will be followed by additional work that recognizes and preserves the integrity of individual pedestrian itineraries.

A related cognitive approach focuses on the interpretation of incoming percepts. Here it is assumed that the individual's cognitive schema acts as a "filter" through which immediate percepts must pass. There is very little prior work that bears directly on the case of urban pedestrians, but there are a few clues here and there. Relying almost entirely on concepts of immediate infor-

mation processing, Best (1970) examined orientation in large buildings. He found that the character of signage was an important variable in explaining "lostness." Braaksma (1980) proposes a "sight line" approach for reducing orientation problems in large air terminals "based on the premise that human orientation is a function of the visibility of the destination that the person is moving towards" (p. 201). For the urban pedestrian, the "destination" is not always in view at the start of the trip. Clearly, however, one must be able to interpret incoming, visible messages if one is going to use them in the process of route finding. Studies on the interpretability of maps have also been completed (e.g., Bronzaft, Dobrow, and O'Hanlon, 1976; Garland, Haynes, and Grubb, 1979) for transit systems, but not for users of the pedestrian mode *per se*.

The whole question of visual cues is still fairly open, and the studies noted above only begin to scratch the surface of this important topic. Despite the lack of a solid base of data, it does appear, however, that a few, basic things could be done in the urban environment to make it more easily interpretable. For example, Woodson (1978) pointed out that "in most cities street signs are typically placed on only one corner. The signs are too high for the partially sighted to read, and obviously the blind have no way to identify the streets" (p. 542). The specific needs of the blind raise several additional questions that are still under investigation.

For the blind, visual cues available to sighted pedestrians are irrelevant. Thus, it can be assumed that the role of the blind person's cognitive map becomes more crucial as does the provision of environmental cues that use sensory channels other than sight. Little is known about the route-finding experiences of blind pedestrians, although Woodson (1978) provides an introduction. A behavioristic approach to this topic has been proposed by Schingledecker and Foulke (1978). Although they note that "because pedestrian performance is complicated, any methodology for assessing performance of blind pedestrians must be constructed with special care" (p. 275), they conclude that an "objective" approach is preferable. How unfortunate, because "objective" measures of observable "performance" tap such a small aspect of the pedestrian experience, especially for the blind.

Many pedestrians may find the pedestrian environment stressful, especially blind pedestrians. Wycherley and Nicklin (1970) found that the heart rate of blind pedestrians was significantly higher than that of sighted pedestrians who walked a 0.6 mile route

in a housing estate on the outskirts of Nottingham, United Kingdom. They concluded: "The data, therefore, indicate a substantial component of psychological stress, for blind pedestrians on a novel route, which declines with repetition. This appears to be specific to the route used" (p. 190). In other words, blind pedestrians face new threats of stress each time they elect to find their way along a route that is new to them. The origin of this stress is not known. It may be because of fear of becoming lost or fear of being struck by motor vehicles. The effort required to construct a new addition to one's inventory of mental maps may result in stress. These and other possible sources of stress remain uninvestigated at the present time. It is now known only that the sighted apparently experience less stress than the blind when exploring new routes as pedestrians.

*Introduction to Route-Finding Strategies.* Another alternative to the gravity model approach is based on the language of *strategies*. This section introduces the framework for this alternative and reviews those studies that have adopted this approach for the study of route choice by pedestrians. The strategy approach generally takes note of all of the other alternative approaches reviewed above. In general, the strategy approach assumes that most adults and many children possess adequate cognitive structures and social skills for navigation within an urban environment. Given these assumptions, the pedestrian is asked: What is your strategy for choosing routes?

Asking about route-finding strategies seems an especially relevant question for visitors to a new city. Kobayashi (1981) developed a computer simulation approach that may eventually help provide answers or, at the least, helpful clues. Kobayashi built a model that allows a stranger in a new city to choose a path. The model is based on the assumption that "in an unfamiliar city, a visitor will take a simple route to get to his destination lest he go astray" (p. 31). Hence, the visitor's assumed strategy is to keep the path "simple" in order to keep from getting lost or disoriented. During each run of the model, a simulated pedestrian is "sent" in search of destinations in a "city" in which street patterns, visual landmarks, and information points are manipulated by the programmer. This method provides an experimental system for suggesting where orientation points or "signboards" should be located to best help keep new visitors to a city from getting lost. Boles

(1981b) employs simulation techniques to explore far more micro aspects of pedestrian behavior. Simulation approaches allow programmers to make various assumptions about different types of search strategies and to explore the results in a simulated environment.

Schneider (1975), in a well-argued theoretical paper, discussed several problems related to the route-choosing behavior of urban residents. He was first interested in trips that were primarily *searches*, those in which the individual was looking for something. Schneider considered two basic types of searching. First, there is a "space-exhausting" search in which a person begins to "actively move through the city . . . looking directly for the target by examining locations sequentially until one with the required traits is encountered" (p. 173). Second, the pedestrian may engage in "route-finding search" wherein "he/she may first seek information about the target, including an address, and then locate the target through actively seeking that address by route-finding search" (p. 173). Further, in the route-finding search, it is assumed "that the searcher, through careful use of maps and other information sources, selects the shortest path between his/her point of origin and the nearest target, and that during the journey the person does not become lost or confused, thus increasing this distance" (p. 174).

Schneider suggested that space-exhausting search "works" only when the relative density of the desired targets is fairly high. He observed that "few targets have the densities required for location by simple space-exhausting search. Mailboxes, taverns, and small groceries may achieve these densities" (p. 183). On the other hand, many desired targets in urban areas are not randomly located, but have a patterned structure so that their presence is more likely or "expected" by the searcher to be found in some areas rather than others. For example, mailboxes are often found near major street intersections. Furthermore:

In all cases approximating space-exhausting search, exogenous information is utilized so that the actual search pattern, even when undertaken in a totally unfamiliar neighborhood, reflects spatial inhomogeneities familiar to urbanites. . . . In looking for a grocery store, for example, the searcher will probably concentrate on finding a busy street, where such activities will more frequently be located than on a quieter street. In this way the individual's perception of regularities within the environment is used to reduce search distances, even though neither the path nor end point is familiar. That is, random patterns contain no information, but

nonrandom patterns do (although, in an information-theoretic sense, essentially the opposite may be argued), and the information in nonrandom patterns is used by searchers to reduce their expected search distance. (P. 180)

The above reference to “patterned” structures echos an essay by J. B. Jackson (1957) in which he described the “path” taken by new arrivals in American cities. In most cases, Jackson found the morphology of this path, composed of bus stations, flop houses, pawn shops, rough taverns, and so forth, to be repeated in city after city. The stranger in a city, Jackson argued, knew where he could find a whole range of desired services and activities regardless of which city he might find himself in. Jackson’s “path” illustrates the kind of exogenous patterning to which Schneider points as central to more efficient searching strategies.

Schneider also noted the importance of *signs* in locating points and proposed that signs with differing configurations and degrees of visibility would result in variations in average search distances. Two factors were assumed to influence the distance at which a subject could detect a sign:

- (1) the lettering on the sign decreases in interpretability with distance and,
- (2) more important in urban areas, is the blocking or masking effort of other signs along the pathway. In a heavily commercial area, the extent to which signs interfere with each other at any appreciable distance is quite great. (P. 179)

Observations such as these demonstrate that questions concerning search strategy overlap with issues central to environmental perception specifically and the cognitive approach generally.

In any event, given that a point in space must be located, does a pedestrian select route-finding search or space-exhausting search? Schneider discovered that all models of space-exhausting search “require from two to fifty times as much travel as successful route-finding for targets whose expected distances are up to one mile. Moreover, as expected distances to the nearest target increase, this ratio becomes still more unfavorable” (p. 183). Thus, it could be assumed that adult pedestrians have learned how “expensive” it is to conduct a space-exhausting search. As an alternative, they would likely pursue a route-finding search with all that it implies about careful use of maps, addresses, and other locational aids. Even if this careful preparation is not possible, it can be assumed that astute pedestrians utilize their knowledge of the nonrandom nature of urban form to at least delimit a small area in which to concentrate a space-exhausting search. Several studies noted above re-

vealed that pedestrians often report taking the "shortest route." If so, they probably know where they want to go and how to get there before starting out. If they do not, it can be assumed that they do their best to delimit a small area of likely search, head toward it while inspecting signs, look up and down streets at intersections, and use other cues in order to come close to a shortest route solution. This latter hypothesis assumes considerable search sophistication on the part of the average pedestrian. The frequency of this type of search is unknown. Schneider's paper presents only a theoretical discussion of search strategies rather than an empirically grounded investigation.

Regardless of search strategy employed, it can be assumed that most pedestrians either take shortest route paths or attempt to approximate shortest route paths through the careful use of environmental cues. Prior research by Hill (1975, 1978a) indicates a high occurrence of shortest distance path taking by observed pedestrians. A finding that pedestrians take shortest routes is interesting but hardly exhausts the questions that can be posed in an urban environment characterized by a grid-like street pattern, a situation that occurs in most American cities. In a grid system, there are *several* "shortest" routes to many points. This observation, considerably detailed below, raises the interesting question: What strategy does a pedestrian utilize in order to select from among several, equally attractive, equally short, alternative routes to a destination?

### ***A Strategy Framework for Route Choice***

Thinking about pedestrian behavior as a *game* played on a *graph* builds on earlier efforts by Dietrich Garbrecht (1969, 1970, 1971b). It extends, from a strategy-oriented perspective, his innovative theoretical work on pedestrian path selection within an environmentally uniform rectangular grid. It is important to note that Garbrecht's theoretical models remain untested empirically except for a small pilot study completed by Hill (1975, 1978a). Thus, an aim of this review is to provide a more full-fledged exploration of this line of thought. The emphasis given to Garbrecht's work is largely because his efforts represent one of the few alternatives to a gravity model perspective on pedestrian path selection, a point underscored by Pushkarev and Zupan (1975). More recent work by Hill (1982a) extends the empirical investigation of the strategy-



oriented approach to route selection, the foundations of which are presented below.

Investigation of strategy choice requires correspondence between the proposed conceptual framework on the one hand and a concrete, empirical situation on the other. It can be argued that a graphic representation of the strategy employed in an observed trip through an urban area is congruent with the pedestrian's decision strategy for completing a given trip. This assumption is central to the logic of Hill's (1982a) study. The basic problem is that a decision-making strategy is internal to the individual. Thus, some way must be found to externalize it before it is possible to evaluate it.

Cooper and Elithorn (1973) maintained that (in many instances) observable, external behavior is an intrinsic part of a problem-solving process so that the pattern of this behavior provides clues about the internal problem-solving activity and also provides "a physical set of markers which form a track through the problem space" (pp. 199–200). This rationale led them to select board games like chess and checkers for the study of internal processes. Thus:

In choosing a boardgame to study thinking, we have been influenced considerably by the opportunity that this offers to record operations by the subject on a mechanical system which is part of the problem structure. Since the problem requires the subject to make a series of sequential choices from subsets of possible moves we can use an analysis of the subsets and the choices he makes from them to test hypotheses about his thinking processes. Moreover as these externalized responses are an integral part of the problem it cannot be argued that recording them objectively will interfere with the internal aspects of the problem solving activity. (P. 200)

Based on the logic of the argument by Cooper and Elithorn, it is argued here that pedestrian route selection is, in fact, a big-as-life game played on a city-wide game board and that this situation can be exploited successfully for the study of decision strategies used in human way finding, at least in an introductory way.

The conceptual viewpoint adopted for this type of analysis characterizes the pedestrian trip as a *game*. In the most general game, "winning" consists in successfully reaching a destination from a stated origin. More complex and sophisticated games (e.g., journey-to-work, going shopping, visiting a friend, finding an address, getting some exercise, and so on) can be contemplated and distinguished on the basis of rules of play and criteria for winning. Re-

search on pedestrian walking speeds and acceptable walking distances suggests that the criteria for winning many of the most general pedestrian games are a function of spatial and/or temporal minimization, i.e., that trips should be short in both distance and time. Other possibilities will be suggested below.

It should be pointed out that game theory per se has come under criticism within geography by Richard Prentice (1975), who maintained that *formal* game theory requires unjustified assumptions and fails to completely model decision-making processes. Even if Prentice's argument is accepted as valid, his critique does not exhaust the concept of "game" per se. The ordinary language concept of game is associated with a rich family of related notions (e.g., winning, losing, goal, strategy, playing field, game board, penalty, rules, sportsmanship, referee, spectators, players, and so on) useful in the conceptualization of pedestrian behavior. The concept "game" has no unitary definition in ordinary language. This was specifically observed by Wittgenstein (1953) in relation to language games:

The result of this examination is: we see a complicated network of similarities overlapping and criss-crossing: sometimes overall similarities, sometimes similarities of detail.

I can think of no better expression to characterize these similarities than "family resemblances"; for the various resemblances between members of a family: build, features, colour of eyes, gait, temperament, etc., etc., overlap and criss-cross in the same way. And I shall say: "games" form a family. (P. 32)

This helps to underscore the point that formal concepts of game theory do not exhaust the concept of "game" itself. There are other members of the "family" that can be invited for discussion when the more formal branch of the family proves stubborn and uncooperative. For example, there is Suits's (1967) conclusion that

to play a game is to engage in activity directed toward bringing about a specific state of affairs, using only means permitted by specific rules, where the means permitted by the rules are more limited in scope than they would be in the absence of the rules, and where the sole reason for accepting such limitation is to make possible such activity. (P. 156)

With this conceptualization of a game, one needs only to posit that the specific state of affairs to be brought about is that of successfully reaching a destination and to observe that pedestrian behavior in urban areas appears to be governed by at least a minimal set of social norms to conclude that much pedestrian behavior may be legitimately characterized as a game.

The urban environment in which pedestrian games are played is conceptualized as a *graph*. Streets are identified as edges, intersections become vertices, and the route-selection process is conceived as the linking of an origin and a destination via selection of edges in a network to form a walk that may be either open or closed. Such a graph incorporates several salient structural elements of an urban path system and can be viewed as the *game board* for the play of various pedestrian games.

The play of pedestrian games on highly structured spatial game boards is especially characteristic in *urban* environments. The spatial structure of the city is a limiting environmental constraint that does not characterize open-field situations such as those studied by Menzel (1973) who observed the search behavior of chimpanzees in a spatially open environment. Under the conceptualization of the pedestrian environment as a graph, the problem of route selection from a set of pre-existing edges is a human-made problem. It is imposed upon pedestrians by the structural form of the human-built environment through which they travel. Thus, the structural aspects of the urban environment are not presented as influences on the behavior of pedestrians, but as spatial problems that require solution and negotiation in everyday life. By focusing on the decision problem of choosing between alternate routes of equal length, pedestrians do not focus on space or distance as a causal variable. Instead, it is the physical structure of urban space as a medium for behavior that is given primary emphasis.

In summary, completing a walk requires the sequential selection of edges from those available in a graph. It is in this regard that pedestrian route selection resembles a game, since in game theory a game may be defined as a *sequence of decisions*. The decision-making aspect of a pedestrian game can be seen as a *tree* where each vertice represents a decision point. Thus, any sequence of moves is a series of choices, one after the other, which continues until the game is over. A planned sequence of such moves is called a *strategy*. The comparison of observed strategies with those consistent with various theoretically postulated strategies provides the empirical-theoretical linkage and focus for strategy-oriented investigations.

### ***Hypothesized Spatial Strategies***

The term *complexity* is a fundamental concept in several of the discussions that follow below and refers to the extent to which a pe-

pedestrian structures a route so that more *turns* (i.e., left or right) are effected than would be necessary if a less complex or "simple" path were chosen. Thus, a "simple" route is one with the bare minimum of turns, and a complex path is one with as many turns as possible. Empirically, there is the possibility of selecting a route with a number of turns which would place it somewhere between the minimum and the maximum possible.

*Distance-Minimization Strategy.* It is reasonable to assume that the primary decision strategy used by pedestrians is selection of a route that minimizes distance. In a pilot study of forty-five walking trips, Hill (1975, 1978a) found that in every case the observed pedestrian took a least-distance path from the point of origin to the destination. Thus, if the pedestrian is faced with only one least-distance path, it is assumed that this is the one which will be selected. It is in this sense that the distance minimization strategy is called a *primary* strategy. Zipf (1949) provides the classic theoretical rationale for distance minimizing behavior.

Distance minimization does not exhaust the possibilities for explaining human spatial behavior, however (Hill, 1976b). One can consider the nature of the pedestrian's choice when faced with choosing between two or more routes of equal length which all lead to the desired destination. This is a common situation in urban areas with a rectangular street pattern. For example, a pedestrian who makes a trip to a diagonally opposite destination from an origin in a two-by-three-block street grid (making the trip itself five blocks long) can take any one of ten possible routes of equal length to reach the desired destination. Thus, several *secondary* strategies for choosing between routes of equal length can be advanced. The following proposals emphasize the spatial structure of a range of choices in the urban environment.

*Complexity-Reducing Strategies.* Marchand (1974) offered the conjecture that the pedestrian walks directly to the main perceptual axis and then follows it straight ahead, even if it is not the shortest path. Although deviations from shortest path routes have not been corroborated by North American data, Marchand's work is still interesting in that his hypothesis may apply in other cultures and is consistent with the idea that the pedestrian is trying to reduce the number of critical decisions that must be made while walking. Thus, one strategy for choosing a route could be to choose one with few turns, one which is easy to remember and follow.

*Complexity-Maximizing Strategies.* Other pedestrians may intentionally choose more complex routes, ones with many turns in them. Rapoport and Hawkes (1970) noted that the greater the number of turns in a route, the greater the amount of significant information available to the pedestrian. Thus, someone who is searching the grid network *en route* to a destination could be expected to take a turning, twisting route in order to gain the maximum amount of environmental information available. The pedestrian would take a complex route with many turns in it.

Bussard (1977) suggested that considerable route complexity might result in urban districts where traffic flow is controlled by automatic traffic signals. Here, a pedestrian who wanted to minimize travel time might always cross the street at the first available "green light." Bussard proposed that the result would be a zig-zag route with several turns in it. In this case, the resulting complexity would not be intentional (as in information search, above) but an artifactual result of the timing of traffic signals.

*Random Strategies.* While there may be some pedestrians who always take "simple" routes as well as others who always take "complex" ones, it may also be proposed that many pedestrians take routes with intermediate levels of complexity. Two such strategies, first introduced by Dietrich Garbrecht, are outlined below:

(1) *Random Walk Strategy.* Pedestrians who adopt this strategy make a random choice at each intersection about which street to follow next. If these decisions are randomly distributed, the pedestrians would sometimes take a "simple" route along the outer edge of the grid. At other times, the route would be a more "complex" interior route through the heart of the grid.

(2) *Random Path Selection.* Randomness also plays a role in this strategy, but the temporal location of the pedestrians' decision-making is different than in the random walk strategy identified above. It is assumed here that pedestrians preplan the complete trip *at the start, not as they walk along.* At the start of the trip, pedestrians choose one of the several complete paths available and then follow it without deviation. On a subsequent trip, another route would be chosen randomly and it, too, once chosen, would be followed without deviation until the destination was reached.

Since randomness plays such a central role in the presentation of both strategies of intermediate complexity, it might be thought that they are essentially identical. However, rectangular grids of-

**Table 1:** Expected Frequency of Trips with X Number of Turns

Number of Turns in Path (X)	<i>Random Path:</i> Expected Times Path with X Turns is Chosen	<i>Random Walk:</i> Expected Times Path with X Turns is Chosen
1	4.4	8.250
2	6.6	5.500
3	8.8	6.875
4	<u>2.2</u>	<u>1.372</u>
	22.0	22.000

Example expected frequencies under two strategy assumptions for a hypothetical group of twenty-two pedestrians traveling from a lower left-hand origin to an upper right-hand destination in a  $2 \times 3$  grid (cf., Hill, 1978a).

fer an artificial situation in which the two strategies sketched above have observable differences. Garbrecht demonstrated that, in a rectangular grid, the random walk strategy and the random path-selection strategy result in different expected frequencies of pedestrian flow over the same links in the grid network. Hill (1975,1978a) extended this argument by showing that the two strategies of path selection could also be distinguished on the basis of the frequency of paths taken with specified numbers of turns. For example, Table 1, above, shows these expected frequencies calculated for a group of twenty-two hypothetical pedestrians.

In summary, rationales have been provided for a range of route-choosing behaviors. Complexity minimization would result in frequent choice of paths with very few turns in them. Information gathering, on the other hand, is expected to result in turn maximization. Two intermediate strategies were also introduced. Random walk tends to emphasize less complex paths and is characterized by pedestrians making changes in their route as they walk along. Random path selection is characterized by pedestrians who choose the structure of their entire route before they start their trip.

*Cognitive Strategies vs. Observed Strategies.* It can be hypothesized that cognitive route structures revealed by asking pedestrians to "give directions" to a known destination will be less complex than the structure of routes pedestrians are actually observed to take when walking to a destination. Giving directions to a stranger who asks how to find a given location is probably not fully equivalent to the cognitive processes which precede (and unfold during) an indi-

vidual's own route-choosing activity. Nevertheless, both processes (giving directions and choosing routes) require familiarity with the spatial organization of the local environment as well as the ability to fruitfully employ such information. Providing "simple" directions to a stranger reduces interaction time between the person asking for directions and the person giving the directions. This is consistent with Milgram's (1970) hypothesis that urbanites generally attempt to reduce the frequency and duration of interpersonal contacts with strangers. Furthermore, giving "simple" directions probably increases the likelihood that the instructions are understood and remembered.

Thus, pedestrians are here conceptualized as cognitively able to reduce the spatial "complexity" of their environment (evidenced by giving "simple" directions). Yet, it is hypothesized that pedestrians take somewhat more "complex" routes when actually going for a walk themselves. This finding would be in accord with that of Rapoport and Hawkes (1970) who proposed that pedestrians probably enjoy having more than a minimal level of "complexity" in their trips.

*Variations in Trip Strategy by Age.* It is hypothesized that children walking home from school will generally tend to have more complex path structures than adults. This proposal is based on Robert White's thesis of *effectance* in which it is maintained that "exploration, manipulation, locomotion, language and the practice of motor skills, the growth of cognition, the development of plans and intentional actions, and the emergence of higher thought patterns" (cited in Perin, 1970, p. 46) form the "growth processes" which, when put together, result in "man's complex repertory of adaptive behavior." Piaget and Inhelder (1956), together with Merleau-Ponty (1963), also presented arguments that support a general effectance model of environmental manipulation. In capsule form, such a model asserts that environmental manipulation is required during the development of the individual in order for the person to develop a sense of personal competence (cf., White), a sense of space (cf., Piaget and Inhelder), and a stable orientation in the world (cf., Merleau-Ponty). Thus, it is reasoned that school children will tend to be more exploratory in their route selection since they are still learning how to manipulate or navigate within the urban environment than will adults, generally. Using Rapoport and Hawkes as a guide, it is assumed that "exploratory" be-

havior will tend toward route choices with the maximum number of turns.

*Variations in Trip Strategy by Gender.* It is hypothesized that adult women may have slightly less complex trip strategies than adult men. This thesis is based on the observation by Beck and Wood (1976) that women are less able cognitive mappers than men. They suggest that this situation may have arisen from the fact that women in American culture are often passive passengers when traveling and thus do not have a direct motivation to learn the routes over which they travel. If Beck and Wood are correct in their conjecture, then there should be no very great difference between women and men who walk *as a usual mode of travel* since there is no sense in which an individual female who is walking can be considered a "passive passenger." Yet, since it is possible that there might be some carry-over from previous deprivation in practice in learning environments, it is hypothesized that women may show a slight tendency to take less complex routes than men. The rationale for taking a less complex route is that such a route is more easily conceptualized and remembered, thus reducing the risk of becoming lost while en route on the part of those who are somewhat less experienced with the environment or who are unsure of their route-following ability.

The sections above outlined several major hypotheses that can be investigated from the strategy-oriented perspective. Below, readers are invited to review the findings of Hill's (1982a) most recent investigation of route selection. Hill assumes that pedestrians have mastered the basic pedestrian skills, but that they do differ in their strategies for choosing among alternative routes when they are faced with more than one shortest path possibility.

### *An Empirical Study of Route Selection*

In order to explore the route-selection strategies employed by pedestrians, Hill (1982a) unobtrusively tracked two hundred adult pedestrians and fifty school-age pedestrians. The results of the study on young children are summarized separately in Hill (forthcoming). The adults were also handed questionnaires when they reached their destinations. In addition, one hundred adult pedestrians were asked for directions to nearby elementary schools and the responses recorded on a hidden tape recorder. All sub-



jects were randomly sampled with the aid of a spatially stratified sampling frame. A standardized index of route complexity (Spatial Structure Index or SSI-score) was devised to enable comparison of the complexity of trips of various lengths.

A major purpose of Hill's work was the "uncovering" of pedestrians' rules for choosing and describing routes. The search for these rules was set within a game strategic framework in which each trip was conceptualized as a "game." As such, Hill was interested in the strategies employed by pedestrians for "winning" their games, that is, for successfully getting from one place to another on an urban "game board" composed of a maze of passageways connecting origins and destinations. Hill does not believe that pedestrians are particularly aware of the strategies they employ. Culturally, such an awareness would usually be found astonishing by most of us. For instance, let's look at a frame of the comic strip "Star Trek" that appeared in the *Des Moines Register* on February 15, 1981. After managing to find their way through the confusing maze of Lozite-M, a crew member of the Starship Enterprise says, "Spock, I don't understand how you led us through this maze." Spock's reply is a straightforward recounting of a binary strategy: "When we were here before, I observed 128 turns, some left, some right . . . a simple binary code." The comic strip makes the reader smile because Spock makes a seemingly difficult route-finding strategy appear matter-of-fact and inherently simple. But, most pedestrians are not as attentive as Spock. This state of "unreflectiveness" applies not only to route-selection strategies but also to such processes as "scanning"; the exchange of cues when pedestrians approach each other; the assignment of "watching roles" at urban intersections, and so on.

If pedestrians do use various strategies in route selection, Hill concludes that they are applied largely without conscious reflection. When subjects were asked to provide reasons for their route choices, many responded with some variation on "directness" as a factor in route choice. This primary strategy, distance minimization, was observed over and over again. It is essentially a universal strategy. Although in reduced number, many subjects still cited "directness" as a reason for route choice even when they were choosing between two or more alternate routes of the same length. The concept of "directness" itself may well be associated in the subject's mind with some function of simplicity vs. complexity rather than with physical distance per se. Hence, even when subjects re-

port "directness" as a reason for route choice, it is not at all clear they they are necessarily aware that they are minimizing distance as a primary strategy in route choice. Whatever the case, the pedestrian's self-understanding of route-selection patterns does not appear to be particularly deep.

When subjects responded with "other" reasons for route choice it was almost always in terms of physical, environmental attributes, such as, "It's a nice way to walk," "The 7-11 is on the way," or "The park is so pretty." Issues of imageability, simplicity, complexity, choice, freedom, and so forth, were never raised by the pedestrians themselves. Thus, one may question whether the "strategic" framework advanced by Hill is *experientially* relevant to the pedestrian in the street.

*Theoretically*, on the other hand, the strategic orientation is reasonably fruitful. The strategy framework adopted by Hill was derived from existing literature. The pioneering work of Dietrich Garbrecht deserves very special mention. The more general, but centrally important man-environment theories of Amos Rapoport must also be cited. Based on the content of published research, a series of hypotheses were presented:

*First*, that pedestrians would choose shortest paths whatever else they might do. This was demonstrated to be nearly universally true for the subjects in this study.

*Second*, that pedestrians giving directions to someone else would choose to describe relatively simple routes. This was clearly shown to be the case. The simple spatial structure of these routes was confirmed through analysis of the Spatial Structure Index scores for the proffered directions.

*Third*, that young pedestrians would select relatively more complex routes in an effort to explore, comprehend, and gain mastery over their environments. Analysis of SSI scores revealed that elementary school children as a group took much more complex routes than their adult counterparts.

*Fourth*, that adult pedestrians would seek more complexity in their own routes than was manifested in the routes that subjects proffer when asked for directions to a target landmark. Again, analysis of SSI scores demonstrated this to be the case.

*Fifth*, it was hypothesized that women would select less complex routes than men. Analysis of SSI scores revealed just the opposite. The original hypothesis was based on the notion that women had less spatial experience, that they were more often passive pas-

sengers. The data show this is clearly not an accurate description of women in the pedestrian mode. Women were found "in the streets" in larger numbers than their proportion in the general population would warrant. Further, women frequently make very lengthy pedestrian trips. Women are experienced, knowledgeable pedestrians. Given these findings, it is not now surprising to find the reverse of that which had been hypothesized.

Thus, the theoretical fruitfulness of the strategy framework is clear. But, again, the relevance of this approach for understanding the experiences of pedestrians remains open. It is suggested here that exploration of this question will best be accomplished through a qualitative approach, such as that adopted by David Seamon (1979) in his phenomenological study of the spatial life-world. Additional departures from the positivist approach are outlined in Hill (1981a;1982c). A culturally-based framework for pedestrian-oriented design is presented in Crandell and Hill (1981). Specific attention to user input from pedestrians is the central element in the urban trail design demonstration packet by Hill and Andersen (1981). It is only through qualitative (rather than quantitative) listening to the comments of real pedestrians that the world of abstract theory can be linked to the subjective experiences of pedestrians.

Methodologically, Hill (1982a) demonstrated for the first time that relatively reliable route descriptions can be obtained by the use of questionnaires. This is a definite boon for further studies of routes and route selection. The high cost (especially in time) of ethological tracking results in small sample sizes, as was the case in this study. The small sample size hampered the depth and definitiveness of the analysis. It was not possible, for example, to further investigate the two route selection strategies proposed by Dietrich Garbrecht (i.e., random path and random walk) because the data provided only thirteen cases that could have been analyzed using the technique developed by the present author in a previous study. For reasons such as this, it is a definite advantage to know that questionnaires can be used with relative confidence in future studies. This may, in fact, turn out to be the most useful empirical finding to come out of Hill's work so far. The error rate between observed and reported route descriptions amounted to a relatively small 13 percent. Unfortunately, the sample size was not sufficient to investigate the nature of potential bias in this error. Whether failure to accurately describe a route is associated with

age, gender, length of residence in a neighborhood, frequency of walking, and so forth, remains an open question at this time.

In summary, the pedestrian's selection of a route from one place to another is hardly a simple process. It involves far more than just "placing one foot in front of the other." The overall dimensions of pedestrian movement in urban centers have been well-described by the architects of gravity models, but the internal mechanisms and experiences that give meaning to these abstract descriptions are only vaguely understood at this time. A number of avenues for future work are provided by preference studies, mental mapping approaches, and the analysis of various strategy and information processing models. Much empirical work needs to be done, but the continued fruitfulness of theoretical work (exemplified by Garbrecht, Rapoport, and Schneider) should remind us to give at least equal emphasis to the abstract world of the theoretician, for it is theory that ultimately guides the design of empirical studies.

## *Postscript*

This survey provides a hierarchical account of recent insights from the behavioral and social sciences into the nature of walking, crossing streets, and choosing routes. As the reader can well judge, what is known is indeed fragmentary; at the same time, that much of this research has been done recently must also be taken into account. I feel confident that further insight will be forthcoming in the not-too-distant future. Developing new insight is important, for suggestive insight is ultimately the most useful to the environmental designer who must balance and cut through literally thousands of potential variables and "causes" to give expression to a specific design for execution in a unique spatial location. If present trends continue, the production of more insightful design guidelines is a reasonable expectation. The last decade has witnessed a virtual explosion of interest in and research on pedestrians and their world. Where there were barely any published researches on pedestrians fifteen years ago, there are now several bibliographies listing hundreds of entries on pedestrian-related topics.

Three areas of inquiry are ripe for further exploration. First, researchers need to concentrate on people who *actually walk as a usual or frequent mode of travel*. As a class, this group is not well understood nor well characterized. Second, it is time for a study of the *macrosociology* of walking. Little has been written on the technological and political status of the person who chooses to walk, although the perspective adopted by sociologists in the critical theory school may prove to be a useful place to start (Hill, 1980b). An outline of the socioeconomic macrostructures in which pedestrians are located has been attempted by Hill (1983), but this sketch only scratches the surface. The status of women who walk in a patriarchal world has been addressed recently from a feminist perspective by Hill and Deegan (1982). These studies represent alternative theoretical perspectives for assessing the political and social standing of pedestrians, but even within the "standard,"

mainstream research tradition there is little factual material with which to work. We know very little, for example, about the socio-economic characteristics of those who are forced to travel by foot in the U.S. Finally, it is time to explore the subjective aspects of walking from a phenomenological, experiential point of view. The dominance of the positivist perspective (outlined in Hill, 1981b) has too long kept us from a serious look at the subjective dimensions of the pedestrian experience. Although several architectural theorists have examined the symbolic aspects of movement through the environment, human-environment researchers have not taken up the challenge to investigate these issues in a full-fledged manner.

The present review demonstrates that the conceptual apparatus of human-environment relations research finds ready application in the study of pedestrians. It is hoped that engineers, planners, and applied designers come to appreciate the suggestion that walking is not a monodimensional human activity that can be easily captured in a gravity model equation. This is the major conclusion that I hope readers will draw from the preceding review. There is still much to learn and much to think about, but given the work of the past decade, future researchers will not be starting empty-handed. I hope that investigators who are contemplating new projects focused on pedestrians will have found some useful leads, ideas, problems, and unanswered questions in the pages of this review. If this hope becomes a realization, this review will have served its purpose well.

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