Mobile Communications, Social Networks, and Urban Travel: Hypertext as a New Metaphor for Conceptualizing Spatial Interaction*

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The widespread use of mobile communications is leading to new practices in family life and social life, and these changes have significant implications for the study of urban travel. Because of the adoption of new modes of space-time coordination, changing time use and increasing mobility, changing use of existing urban nodes, the blurring of boundaries between home and work, the importance of social networks and social capital, and the shift to person-to-person connectivity, the spatial structure and processes of interaction among individuals have become much more complicated in this age of mobile communications. Static spatial frameworks based on fixed points (e.g., home or workplace) and distances among them are no longer adequate for understanding urban travel. The study of urban travel now needs new conceptualizations and new methodologies.
Key Words: activity patterns, mobile communications, social networks, spatial interaction, urban travel.

In a recent paper, Joe Weber and I question the suitability of conventional urban models and proximity-based methods for understanding urban travel and individual accessibility (Kwan and Weber 2003). We argue that most formal models of urban structure are based on a spatial logic that shapes individual mobility and urban form through the impedance of distance. In these models, distance between locations (e.g., home and workplace), expressed in terms of travel or transport cost and modeled with an impedance function, is the central mechanism of spatial choice of individuals and firms. For instance, proximity to shops, facilities, and services is a critical factor that determines individuals' residential and travel choices. We suggest that the effect of distance on the spatial structure of contemporary cities and human spatial behavior has become much more complicated than what has been conceived in conventional urban models and concepts of accessibility.

In that paper, we emphasize two recent changes that render proximity-based methods inadequate for understanding urban travel: one is in the processes underlying contemporary urban structure, the other is the increasing importance of information and communication technologies (ICT) in people's everyday lives. On one hand, recent research has observed new urban forms that cannot be explained adequately in terms of the organizing principles of traditional urban models and concepts of accessibility. Such models suggest that urban areas are organized in distinct land use zones with measurable economic or social characteristics; however recent studies have found otherwise (e.g., Giuliano and Small 1991). It has also been shown that both distance to employment centers and the geographical distribution of urban opportunities do not have a consistent relationship with individual accessibility (e.g., Weber 2003). The most significant observation from these recent studies is that distance as conventionally understood is of declining importance as an organizing principle of urban form. Land use patterns and individual accessibility seem to be determined by much more complicated processes in contemporary cities, and relationships between the spatial logic of traditional urban models and factors that shape urban travel are becoming increasingly unclear. For instance, distances to central business districts or suburban centers appear to provide little explanation for variations in housing value

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or the level of office employment within cities (Archer and Smith 1993; Hoch and Waddell 1993; Waddell, Berry, and Hoch 1993). It has also been shown that both distance to employment centers and the geographical distribution of urban opportunities do not have a consistent relationship with individual accessibility (Weber and Kwan 2002; Weber 2003).

Another important change that cannot be ignored is the impact of ICT on people's activity-travel behavior. We argue that with the help of ICT, many activities no longer need to be performed at certain places or times—for example, e-shopping and e-banking can be done on weekends or in the evening rather than within a limited time span on weekdays. ICT use may lead to the relaxation of some of the space-time constraints that limit people's spatial mobility and activity space. In other words, more time may be available for undertaking other activities and more flexible spatial and temporal arrangements of activities and travel may become possible. However, another process may be at work in the opposite direction as the time people spend using ICT may reduce their time available for undertaking other activities (Kwan 2002). For example, if people spend more time using the Internet, they may spend less time on social activities; and as Internet users purchase online, they may spend less time making shopping trips to stores in the physical world. It is apparent that the potential impacts of ICT on urban travel are highly complex (Mokhtarian and Meenakshisundaram 1999; Gillespie and Richardson 2000).

In light of these recent changes in the processes underlying contemporary urban structure and the increasing importance of ICT, we contend in Kwan and Weber (2003) that conventional urban models and analytical methods are becoming increasingly inadequate for grappling with the complex relationships among urban travel, urban form, and accessibility. We argue that a continued reliance on a simplistic understanding of the effect of distance and proximity for understanding people's experiences in the urban context is problematic.

In this article, I focus on some of these themes and consider the implications of mobile communications for the study of urban travel. As mobile communications can increase the spatial and temporal flexibility of some of our daily activities and trips, new patterns of socio-spatial interactions and use of urban spaces are emerging (e.g., Kopomaa 2000; Townsend 2000; Katz and Aakhus 2002; Katz 2003; Levinson 2004; Ling 2004; Zook et al. 2004; Ito, Okabe, and Matsuda 2005; Kwan 2006; Ohmori 2006; Ohmori, Hirano, and Harata 2006; Sheller and Urry 2006; Schwanen and Kwan, forthcoming). I argue that the analytical foundation of transportation geography is inadequate for understanding the complex social and behavioral changes brought about by mobile communications. I reflect on the potential impact of mobile communications on human activity-travel behavior and the implications of the new patterns of work and social life enabled by mobile communications for transportation geographers. I emphasize the importance of social networks for understanding urban travel in the age of mobile communications and suggest that we should take the new topologies of spatial interaction into account in our study of urban travel. I propose to use *hypertext* as a new metaphor for conceptualizing and modeling spatial interaction.

The arguments I put forward in this article are informed by the "new mobilities paradigm," which asserts the ontological significance of the movements of people, goods, and information, and challenges the conventional notion that places and regions are stable entities whereas movements are transient and analytically unimportant (Urry 2004; Sheller and Urry 2006). The paradigm emphasizes that all places are connected by networks of movements and flows, and that "the time spent traveling is not dead time that people always seek to minimize" since "activities occur while on the move" and "being on the move can involve sets of 'occasioned' activities" (Lyons and Urry 2005; Sheller and Urry 2006, 213).

Mobile Communications and the Emergence of New Modes of Space-Time Coordination

In the early 1980s when AT&T was developing the infrastructure for providing nationwide mobile phone service, the company estimated that the U.S. cellular phone market would reach 1 million users by 2000. The actual number of U.S. subscribers, however, was about 100 mil-

lion in 2000 (35 percent of the population). By the end of 2004, mobile phone adoption rate had passed 60 percent in the United States (ITU 2005; Figure 1). At the same time, adoption rates had reached over 90 percent in fifteen European countries, with the top five being Luxemburg, Sweden, Italy, Czech Republic, and the United Kingdom. Outside of Europe, mobile phone subscription rates were highest in Israel, Taiwan, Singapore, Australia, New Zealand, South Korea, and Japan. The mobile phone has become the most widely adopted ICT throughout the developed regions of the world, and the ever-expanding functions of the mobile phone are driving the current ownership rates to even higher levels. In fact, in many countries the ownership rate of mobile communications has already surpassed that of the personal computer or conventional access to the Internet.

The dramatic increase in the adoption of mobile communications has been described as the next social revolution (Rheingold 2002). Mobile communications include a wide spectrum of technologies, including mobile phones, wireless portable computers, wireless personal digital assistants (PDAs), wireless messaging devices, and combination devices such as Internet-enabled PDA cell phones. The wireless communication capabilities of these devices are largely provided through mobile telephone service, wireless technologies such as Wi-Fi

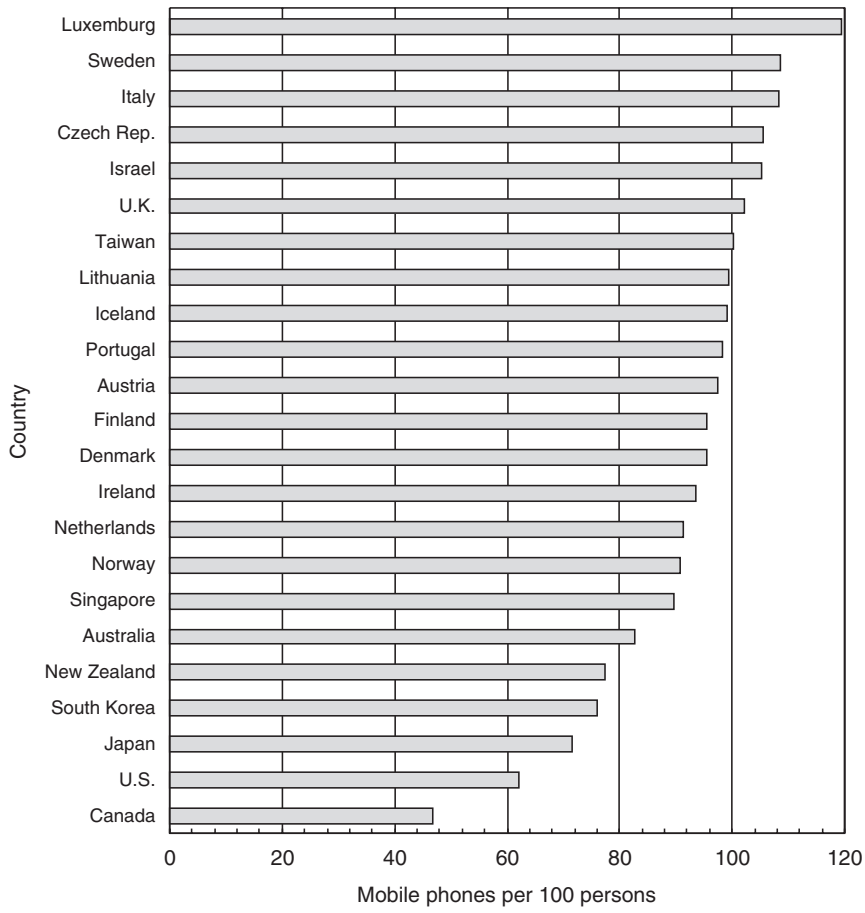

Figure 1 *Mobile phones per 100 persons, 2004. (Source: ITU 2005)*

(802.11a/b/g/n), wireless wide area network (WWAN), or Bluetooth using wireless access points (WAPs, or hotspots) in public locations such as hotels, airports, restaurants, cafés, and bookstores. Many of these devices can be used to perform Internet transactions and activities that include sending and receiving e-mails or short messages (SMS), taking digital photos, sending and receiving documents and multimedia files, e-shopping, and accessing information resources on the Internet. As many mobile devices can also function as music/video players or can be used to watch TV programs, mobile communication devices provide various forms of electronic entertainment. A recent additional function of the mobile phone is that of a credit card. Using New Field Communication (NFC) technology, now being tested in Atlanta (U.S.A.), mobile phone users can now make purchases by waving their mobile phones in front of a terminal.

From the limited literature on various countries and subpopulations, it is apparent that the use of mobile communications is affecting people's lives and social relationships in significant ways (e.g., Kopomaa 2000; Townsend 2000; Levinson 2004; Zook et al. 2004; Ito, Okabe, and Matsuda 2005). Recent studies have observed that new methods for coordinating daily activities and making trips are emerging with the use of mobile communications (e.g., Ling and Yttri 2002; Katz 2003; Ling 2004). For many users of these technologies, plans or schedules do not need to be fixed in precise terms as they can be adjusted later (Ohmori, Hirano, and Harata 2006). Continuous access also allows us to rearrange our schedules according to the needs of the present situation, rendering the need to follow predetermined schedules less necessary than before. This is leading to an ex tempore lifestyle in which details about the time and place of meetings can be progressively negotiated through a process of interactive coordination among those involved (Kopomaa 2000). The mobile phone, as Rich Ling (2004) argues, has brought about new modes of space-time coordination that differ markedly from the conventional time-based coordination system, in which meetings, appointments, and social activities are fixed at various time points. He calls this new mode "interaction-based coordination" and identifies three ways in which it is accomplished.

The first is midcourse adjustment, which refers to the redirection of trips that have already started and the rearrangement of the details of meetings that have already been agreed upon. For example, one person might call another and ask her or him to stop by a grocery store on the way home. This might extend all the way into the store, where the person in the store calls the person at home while trying to recall whether it was whole milk or skim milk that was on the shopping list (that had been left on the kitchen table). As mobile communications allow us to receive information on the way to a planned activity, they enable us to redirect the course of a trip to a planned destination. This ability to redirect travel that has already begun may also lead to a reduction in some of the trips people planned to make (Ling 2004).

The second type of interaction-based coordination is interactive coordination, which refers to the progressively exact arrangement of a meeting. This type of coordination is an ongoing activity through which the details of a general agreement to meet are progressively worked out. The persons involved in a meeting may call or send messages that give increasingly specific information regarding where and when the meeting will take place. In addition, the place and the form of the meeting can be refined along the way (Ling 2004). For example, two persons might generally agree to meet somewhere at an approximate time. As they are in transit, they might call each other to confirm the timing and the location. If they cannot meet each other at the agreed place or at the agreed time, they can initiate another round of calls to decide on the final location or time of the meeting.

The third type of interaction-based coordination is the softening of schedule, which refers to the potential of mobile communications for increasing the flexibility of schedules when compared to the use of more precise time-based arrangements (Ling and Yttri 2002). For example, a person caught in a traffic jam can call ahead to her meeting partners and inform them of her situation. The agenda for the meeting might then be amended to postpone her presentation until later, and the rest of the meeting can proceed. Mobile communications can thus help relax the scheduling of events because calling ahead provides the opportunity to renegotiate arrangements (Ling 2004). As mobile

communications allow for direct interaction and a mode of coordination that softens the rigidity of a time-based system, they increase the flexibility of our schedules.

These new methods of nuanced arrangement of social interaction and space-time coordination are referred to as microcoordination by Rich Ling and Birgitte Yttri (2002). With the microcoordination enabled by mobile communications, there is no need to take an agreement to meet at a specific time and place as unchangeable, for details of meetings can be interactively adjusted as the need arises. As spontaneous, real-time, synchronized communication become more widespread and common, people are less restricted by temporal or spatial constraints. As colleagues and friends can be contacted with increasing frequency, it becomes possible for mobile phone users to act according to new and increasingly flexible schedules. The mobile phone therefore enables an increasingly flexible organization of work, social, and familial interactions. It increases flexibility not only in terms of the place where work can be performed, but also in terms of the time when work is done (Kopomaa 2000). Everyday life for certain users of mobile communications is now less structured by the rhythms of work and leisure, which have become inextricably intertwined with one another.

Mobile Communications and Their Impacts on Activity-Travel Behavior

In this section I discuss some of the effects of mobile communications on human activity-travel behavior that are particularly relevant to research on urban travel in the future.

Changing Time Use and Increasing Mobility

The use of mobile communications can affect people's use of time and mobility in significant ways. Many of us are already familiar with the idea of working with our portable computers in transit or in flight. As the mobile phone can be used for many more purposes and contexts, its popular use may lead to far-reaching changes in our work or social behavior. For example, mobile communications allow us to do many things at once. We can now use our spare time or previously unusable time (such as time spent waiting in a shopping queue) to plan and coordinate with others, get information or messages, or even shop remotely by phone while at the same time shopping in a mall or store somewhere (Katz and Aakhus 2002). When stuck in a traffic jam, we can spend that otherwise wasted time doing work or performing other activities (e.g., taking care of business and managing contacts with clients).[1] We can also spend less time at home because we can now make arrangements that before could only be done at home.

Mobile communications therefore not only allow for the redirection of trips to meet the real-time needs of people or groups, they also tend to increase people's spatial mobility and trips (Townsend 2000). Travel may increase because mobile communications allow people to change destinations on the spur of the moment, plus the time saved with the help of mobile communications may be used for traveling for recreational purposes. For some people, diminishing communication prices may help expand their social networks and increase their knowledge of the availability of services and commodities. This will likely increase their need and wish to travel (Kopomaa 2000).

Evidence in several countries suggests that the widespread use of mobile phones is leading to higher levels of personal mobility and less-pronounced rush-hour peaks. For instance, in France trips occur more evenly throughout the day due to the rapid spread of mobile phone use in recent years (de Gournay 2002).[2] There is little difference in traffic now between peak hours and the rest of the day, as people move about all the time, especially for recreational activities and shopping in the evening. In Norway, new forms of social interaction and coordination that largely transcend the confines of the geographies of traditional transportation infrastructure have emerged (as discussed in the preceding section based on the work of Ling and Yttri 2002).

In the United States there has been a rapid increase in both mobile phone subscription and personal travel in the past few years. Indeed, profound changes in personal travel have occurred over the past two or three decades in the United States. Among the most important are growth in nonwork travel and heavy increases in auto ownership and use (Deakin 2003). Between 1969 and 1995, work-related travel fell from 36 percent to 18 percent of all trips nationally, whereas nonwork travel now accounts for 82 percent of all trips nationally. It is apparent that

Americans are making a large number of trips for shopping, recreation, personal business, and social activities. According to the Nationwide Household Transportation Survey, the growth in total vehicle miles traveled in the United States has continued to increase for decades, growing two-and-a-half times as fast as the nation's population between 1936 and 2001 (Handy 2003).

In Europe, nonwork travel is also the fastest growing segment of travel in terms of the share of trips and the share of mileage traveled, and recent surveys show that this nonwork travel is mostly for social purposes—to meet friends, relatives, and acquaintances (Axhausen 2005). While the widespread use of mobile phones is leading to higher levels of personal mobility, it is also partly a consequence of these mobility trends: as people become more mobile and make more trips, they have greater need for coordinating their social activities while traveling. As the increase in mobile communications adoption and the increase in personal mobility are mutually reinforcing, contemporary cities will face tougher challenges in their attempts to address the environmental impact of the ever-increasing personal travel and use of the automobile.

Changing Use of Existing Urban Nodes and Spaces

Mobile communications may also lead to changes in the importance of existing urban nodes in cities. Before the era of mobile communications, coordination involved the direction and control of transport from geographically fixed functional nodes (Ling and Yttri 2002). Mobile communications may render this less necessary and lead to the coordination of interaction without the need for larger nodes or centralized bases of operation, as movements can be coordinated in real time anywhere with wireless connection. Further, as Stephen Graham and Simon Marvin (1996) suggest, the flexible use of mobile communications in transit is linked to the flexible use of public urban space, and mobile communications may alter the traditional spatial division of urban spaces into centers and peripheries. This means that the use of mobile communications may lead to important changes in the function and role of existing nodes in the urban and transportation systems.

The mobile phone encourages users to spend their free time outside of the home (Kopomaa 2000). It promotes and facilitates certain urban practices such as sitting in cafés or dining in restaurants, making it easier to spend leisure in a variety of places that were less feasible in the past. As the mobile phone has expanded people's capability from making calls at fixed phone booths to communicating from all public spaces in a city, it has enabled new ways of moving through public spaces. Mobile communications have reduced the need to be at a particular place at a particular time. All of this suggests that mobile communications have considerable potential for increasing our personal mobility and spatial freedom. This is especially true for leisure and social and recreational activities, where our newly gained space-time flexibility may lead to considerable change in our activity space, and the importance of existing urban nodes may also change as well (Black 2001).

In a recent study on the meeting and waiting behavior of young people in Tokyo, Nobuaki Ohmori, Takayuki Hirano, and Noboru Harata (2006) observed that, with mobile communications, those involved in a meeting do not need to wait at the predetermined location until the other person arrives. The study found that about half of those who arrived first for a meeting spent their time on other activities instead of waiting at the agreed-upon location—they relaxed at cafés, they window shopped at bookstores or fashion boutiques. The authors suggest that traditional meeting places may no longer be the actual places for waiting for people. Instead they may have become just common landmarks or temporary meeting spots. Further, the amount of activity opportunities around the meeting place has become more important than the environment of the meeting place itself.

Blurring of the Boundaries between Home, Workplace, and Urban Spaces

As mobile communications make it possible for us to be reached wherever we are (hence the notion of perpetual availability or contact), they blur the boundaries between in-home and out-of-home activities, and the boundaries between nonwork and work-related activities. They allow the user to combine out-of-home activities with connections that have been managed at home (Katz and Aakhus 2002). The widespread

use of mobile communications also facilitates the fragmentation (or disintegration) of activity, where activities that used to be performed at a single location (e.g., the workplace) are now broken down into many subactivities that are performed at scattered and geographically distant locations (Couclelis 2000, 2004). The workplace for mobile professionals, for instance, may be the office, the home, the hotel room, the car, or the airplane. Shopping can be done at home, at the workplace, or anywhere else with wireless communication. As a result, an activity may be distributed along a route or across a region (Couclelis 2004).

In the context of childcare, mobile communications enables parents to organize their time and manage contacts without having to leave their children (Dobashi 2005). They can maintain their accessibility regardless of the time and schedules required for playing outside with their children, feeding them, and taking care of other parental duties (Kopomaa 2000). Mobile communications also help parents manage the logistics of driving their children to locations of various extracurricular activities. For example, when one parent becomes available (due to the cancellation of a meeting) to pick up the children from after-school activities, he or she can call or send a text message releasing the other partner—who may already be en route—from the assignment (Ling 2004).

However, recent studies have highlighted the gendered use of mobile communications for work, social activities, and childcare responsibilities (e.g., Puro 2002; Dobashi 2005; Lemish and Cohen 2005). A study in Finland found that men and women have different mobile phone habits and treat everyday business and accessibility differently (Kopomaa 2000). It observed that women are less likely to own a mobile phone for work and generally see their mobile phones as serving a wider range of purposes than men do. Women use their mobiles for all types of social purposes, such as keeping in contact with children, relatives, and friends, in addition to nonhousehold, work-related activities. Further, women emphasize such issues as care and security more than men and see the mobile phone as a means to care for people. A study in Israel observed that women talked significantly more often with their children, whereas men talked more with their spouses and colleagues (Lemish and Cohen 2005). Men were more concerned about being able to reach others, women were more concerned about others being able to reach them and only the women in the study discussed use of the mobile phone in terms of managing their household and their traditional gender roles from a distance.

In a U.S. study, Lana Rakow and Vija Navarro (1993) also found that women tend to use the mobile phone to manage their responsibilities for home and children. Women use the mobile phone to keep track of children and to be available to them as well as to be available to ill or aged members of their families. They use it to carry out their geographically complicated responsibilities for home, family members, and paid labor. The study found that working mothers in particular are more likely to bring their private world of domestic responsibilities into their public world of work. For working mothers, the mobile phone provides a solution to the problem of safety and security in a violent and mobile society and to the problem of carrying out family responsibilities across barriers of time and space. Rakow and Navarro observed that men and women use the mobile phone differently. Men use the mobile phone to bring the public world into their personal lives, while women tend to use it to take their family lives with them whenever they go. Rakow and Navarro suggest that these differences both stem from and help preserve women's traditional gender roles within the household, and they identify the tendency for women to use the mobile phone for family responsibilities as "remote mothering."[3] If work and nonwork activities have become intermingled in people's daily lives, the distinctions between home and workplace and between private and public spaces will lose their analytical value in the age of mobile communications (Urry 2002).

New Topologies of Spatial Interaction

It is apparent from the preceding discussion that the widespread use of mobile communications is leading to new practices in our family and social life, and these changes have significant implications for the study of urban travel. The most important implication is that it is now much more difficult to pinpoint when and where an activity or a trip begins, and how to include all relevant influences on people's

activities and travel in the analytical framework (Couclelis 2004; Carrasco and Miller 2006).

In this age of mobile communications, many of the daily activities once performed at fixed locations such as home or workplace can now be performed while we are in transit, in flight, walking, and so forth. This means that not only the origins but also the destinations for certain kinds of spatial interaction are no longer fixed. Urban travel can no longer be understood in terms of the spatial interaction between two fixed points in space, as the interactive coordination enabled by mobile communications that leads to a particular meeting or social activity may be transacted continuously over a span of time and space. The attributes of locations, whether expressed with respect to point locations or areal units in geographic space, are now far from sufficient for providing a satisfactory explanation of human activity-travel patterns in the urban context—since trips can be redirected and planned destinations changed according to the location of the persons involved and the route they are taking at the moment. As person-based, real-time interaction now plays an important role in determining individual movements, the conventional notion of spatial interaction based on place-based attraction is no longer adequate for understanding urban travel in the era of mobile communications.

As a characteristic of contemporary social life, we are now embedded in complex and multilayered social networks that may intersect or overlap (Wellman 2001; Wittel 2001; Urry 2003). We have our own networks of friends, family, relatives, and colleagues. In many senses, we are no longer individuals separable from the social relations or networks that we maintained over space and time. Indeed much of urban travel is undertaken to sustain important social connections and relations of trust through "face-to-face co-present conversations" (Urry 2002, 265). Travel is the means by which social networks are "glued" together. In light of the importance of social networks in people's daily life (e.g., job search and access to information), Susan Hanson (1998, 244) urges us to "move beyond an individual-focused analysis to include the social networks that people are part of." She argues that our understanding of geographical context should be extended to include people's personal relations and social networks that make up social and cultural capital. She also emphasizes the mutually constitutive relations between social networks and social and cultural capital in place-based communities. Societies with high social capital, as John Urry (2002, 263) suggests, are characterized by "dense networks of reciprocal social relations, well-developed sets of mutual obligations, generalized reciprocity, high levels of trust in one's neighbors, overlapping conversational groupings, and bonds that bridge across conventional social divides."

But with mobile communications, our social networks in a certain sense now travel with us because we can now link in real time what we are doing at the moment to our spatially distributed social networks (Wellman 2001). Further, rather than being limited to interacting with one social network, as in the case of social interactions in the physical world, we can now choose or switch between networks at the push of a few buttons. The use of mobile communications is therefore leading to fundamental changes in the spatial structure of connectivity and social networks. A landline phone "rings at the *place*, no matter which *person* is being called," whereas a mobile phone rings to the person carrying the phone, no matter where he or she is (Wellman 2001, 238). Mobile communications shift social ties from "linking people-in-places to linking people wherever they are" (Wellman 2001, 238). As the connection is to the person and not to the place, it shifts the dynamics of connectivity from places—typically home or workplace—to individuals.[4] This shift to a personalized, wireless world is leading to the emergence of what Barry Wellman calls "networked individualism" and "personal communities" that "supply support, sociability, information and a sense of belonging separately to each individual" (Wellman 2001, 238). With this shift from place-to-place to person-to-person connectivity and from inter-household to interpersonal networks, the individual instead of the household becomes the primary unit of connectivity.

The Need for New Metaphors and Methods for the Study of Urban Travel

As this discussion suggests, the widespread use of mobile communications has profound implications for the study of urban travel. Because of

the adoption of new modes of space-time coordination, changing time use and increasing mobility, changing use of existing urban nodes, the blurring of the boundaries between home and work, the importance of social networks and social capital, and the shift to person-to-person connectivity, the spatial structure and processes of interaction among individuals have become much more complicated. A spatial framework based on fixed points and distances among them are no longer adequate for understanding urban travel. Although people still move on transportation networks, the decisions and processes that lead to these movements are now much more complex (Carrasco and Miller 2006). As a result, the study of urban travel needs new conceptualizations and new methodologies.

We need new conceptualizations in light of the new topologies of urban travel, which are driven by the possibility for fine adjustments to activities and trips through means of microcoordination. As activity and travel decisions are now more spatially and temporally contingent than before, and people to a certain extent travel together with their social networks, we need new metaphors that can take the influence of real-time interactive coordination and personalized individualism into account. One helpful metaphor is hypertext, which is text with links to other text (Figure 2). Documents written as hypertext contain text that, when "clicked on" by the user with a mouse, links to other documents. In a hypertext document, any word can be a link to another document (e.g., a Web page, an image, a Web site). As hypertext is a nonlinear, nonsequential method of organizing text that enables the text to be linked in multiple ways, it provides a powerful means for capturing the complex web of interactivity among groups of individuals pertinent to activity scheduling and travel decision-making.[5]

In a hypertext model, each individual has several nodes (as hypertext in a document) that connect to different social networks (e.g., to different groups of friends, colleagues, or relatives). Each link in these networks represents the possibility of interactive coordination between two individuals, who are also connected to many other individuals through various sets of real-time communication links. A communicative action between two individuals through a phone call or text message is analogous to the triggering of a hyperlink between them—like activating a hyperlink that connects the reader to another document. It conveys information that may lead to further communicative action or a decision regarding the details of a meeting for them or the group they belong to.

Instead of modeling urban travel with a sequential, hierarchical structure (like reading a document in sequence from the beginning to the end) the hypertext model allows us to take the interactive decision-making process and the complex structure of communication networks into account. It provides a conceptual framework for considering the simultaneous interaction among many individuals and the effects of sudden shifts or jumps from one personal network to another—as the reader of a hypertext document can jump to another document by

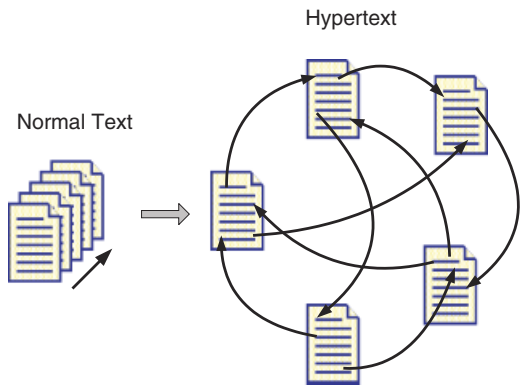

Figure 2 *The hypertext model.*

activating a particular hyperlink embedded within the current document. The hypertext model overcomes some of the limitations of conventional modeling approaches, which consider activity scheduling and travel decision-making as sequential and hierarchical processes. In the age of mobile communications, the hypertext model may be a useful framework for conceptualizing the effect of real-time interactivity and social networks on urban travel.

Specialized network-based analytical methods are needed to apply the hypertext model to empirical studies of the dynamic interaction between mobile communication and urban travel. Recent studies that use social network analysis have made considerable progress in representing the topological structure and composition of social networks and examining their relationships with the propensity to perform social activities and travel (e.g., Larsen, Urry, and Axhausen 2005; Carrasco and Miller 2006; Carrasco et al. 2006; Timo 2006). The Connected Lives Study, for instance, adopts an egocentric approach that focuses on specific actors (*egos*) and those who have relations with them (*alters*) (Carrasco et al., forthcoming). Results of the study indicate that a person's social network plays an important role in shaping his or her social activities and travel.

The social network analysis in these studies, however, treats social networks as largely stable and lasting structures. Since the real-time communication flows among members of a personalized social network conceived with the hypertext model are dynamic and transient, a dynamic approach that takes the timing of information flow among actors and the change in network structure over time is needed for the study of the interaction among personal networks, mobile communications, and urban travel behavior. In a dynamic network, a time-ordered path traces the routes in a personal network through which information flows, and the timing of a communication flow is crucial in deciding whether the flow is relevant to a particular behavioral outcome (e.g., Suitor, Wellman, and Morgan 1997; Moody 2000). For instance, a person cannot act on a particular piece of information before the communicative action through which it is conveyed has occurred. A dynamic network approach can therefore be used to operationalize the hypertext model proposed above.

As much of the interactive coordination that affects people's activities is performed while they are traveling or walking, we also need to develop methods for collecting data about the real-time interactions among individuals. These methods should also allow us to isolate the effects of mobile communications on people's activity-travel patterns from other factors. Recent studies using GPS-enabled mobile phones or PDAs to collect activity-travel data as subjects are moving about (e.g., Ohmori, Makazato, et al. 2006) reveal several advantages to these methods over paper-based activity-travel diary surveys. These include: (a) people can easily carry a mobile phone in their daily lives and can enter data into the device wherever they are; (b) data are collected electronically via a custom interface and can be automatically transmitted to a server via a wireless network; (c) positional data are automatically generated and transmitted at a regular time interval for identifying the activity location (Ohmori, Makazato, et al. 2006). These methods seem promising for collecting information about people's activities and trips while they are traveling.

Conclusion

The widespread use of mobile communications has important implications for the study of urban travel and mobility. As research on the impact of mobile communications on human activity-travel behavior has been very limited to date, the arguments I put forward in this article are largely based on research in countries with high mobile phone adoption rates (especially Finland, Norway, France, Japan, and the United States). Due to the particular social groups and the types of activities on which recent studies have focused, the new activity-travel behavior I discuss is more representative of the experiences of certain groups of people (especially young people and women with children) than others, and more relevant to social activities/trips than other types of travel such as the journey to work. But as many more people become users of mobile communications, and as current teenagers become older adults, the new patterns of social life and work suggested in the article will likely be more common.

In light of the limited empirical evidence available to date, my arguments are put forward as helpful points of departure for contemplating

the implications of mobile communications for the study of urban travel and for formulating meaningful research questions. They are not intended to be conclusive or definitive, as much research is still needed before a nuanced understanding of the complex interactions between mobile communications and human activity-travel behavior can be achieved. Further, while land use still seems to be a useful predictor of aggregate trip patterns under the conventional zone-based framework, there is some evidence to suggest that the configuration and composition of people's social networks also play an important role in their propensity to undertake social activities and travel (e.g., Carrasco and Miller 2006). My primary intention is to argue for the need to broaden the analytical framework of conventional transportation geography to include people's social context and networks (see also Gilbert 1998; Hanson 1998; Axhausen 2005).

Although I suggest that the role of distance has become much more complicated, and that we need to reconsider our analytical framework to address the dramatic changes bought about by mobile communications, I by no means suggest that distance or place-based constraints do not matter in the age of mobile communications. However, as destinations, origins, and routes can be renegotiated through real-time interactive coordination, the conventional notion of distance may have much less explanatory power than before. Deciphering the ways in which distance may affect urban travel remains a major challenge for transportation geographers. In addition, despite the flexibility afforded by mobile communications, people have material bodies that are physically located at particular places and move through transport networks. There are also place-based restrictions on the use of mobile communications (e.g., for maintaining a quiet environment or for personal safety), as mobile interactions necessarily take place at particular times and in particular places in the physical world. Place therefore continues to be relevant to the study of urban transport in the age of mobile communications. Lastly, as business and institutions still largely rely on a time-based coordination system, there are limitations to the extent to which mobile communications may change business and institutional practice in the near future. ■

Notes

[1] Using handheld mobile phones while driving, however, is prohibited by law in some countries because of safety issues (e.g., the United Kingdom). The use of hands-free mobile phones is allowed in some of these countries, but in others the use of any types of mobile phone while driving is banned. The extent to which we can spend the time otherwise wasted in a traffic jam for work or for performing other activities therefore depends on the extent to which such use is allowed or restricted by law in the country or region in question.

[2] Less-pronounced rush-hour peaks may be due to other factors such as greater use of flexitime, staggered work hours, and a smaller proportion of the population in the workforce, but de Gournay (2002) is referring to a trend related to the increasing mobility and adoption of mobile phones by young people and women. In light of the data on the actual mobility of mobile phone users in France, which show that the daily distance traveled has barely increased but the trips occur more evenly throughout the day, the reasons for less-pronounced rush-hour peaks in France seems to be more a consequence of a significant increase in nonwork trips that are more evenly spread throughout the day than of a temporal redistribution of the commute trips of full-time or part-time workers.

[3] This observation is corroborated by my recent study, which shows that women's Internet use tends to reinforce their traditional gender roles and perpetuate existing gender division of household labor (Kwan 2003; Schwanen and Kwan, forthcoming).

[4] In his argument regarding the shift from place-to-place to person-to-person connectivity and from interhousehold to interpersonal networks in the age of mobile communications, Barry Wellman (2001, 238) uses the word "place" to refer to sites typically occupied by many persons: households with many members or worksites with many coworkers. He therefore obfuscates the analytical distinction between places and households. His argument should be more accurately recast as a shift from interhousehold or homework connectivity to interpersonal connectivity.

[5] The metaphor of hypertext proposed here is based more on notions in social network analysis than on other conceptualizations of networks (e.g., that of actor-network theory developed by Bruno Latour and others; see Latour 1987; Latour and Woolgar 1986). It focuses mainly on personal networks (and therefore ignores nonhuman actors) and on analysis of the topological structure of social networks. Although important differences exist between social network analysis and actor-network theory, the hypertext model can be elaborated and situated in the more comprehensive framework of actor-network theory.

Literature Cited

Archer, W. R., and M. T. Smith. 1993. Why do suburban offices cluster? *Geographical Analysis* 25:53–64.

Axhausen, K. W. 2005. Social networks and travel: Some hypotheses. In *Social dimension of sustainable transport: Transatlantic perspectives*, ed. K. P. Donaghy, S. Poppelreuter, and G. Rudinger, 90–108. Aldershot, U.K.: Ashgate.

Black, W. R. 2001. An unpopular essay on transportation. *Journal of Transport Geography* 9:1–11.

Carrasco, J. A., B. Hogan, B. Wellman, and E. J. Miller. 2006. Agency in social activity interactions: The role of social networks in time and space. Paper presented at the Second International Specialist Meeting on ICT, Everyday Life and Urban Change, Bergen, the Netherlands, 9–12 November.

———. Forthcoming. Collecting social network data to study social activity-travel behavior: An egocentric approach. *Environment and Planning B*.

Carrasco, J. A., and E. J. Miller. 2006. Exploring the propensity to perform social activities: A social network approach. *Transportation* 33:463–80.

Couclelis, H. 2000. From sustainable transportation to sustainable accessibility: Can we avoid a new tragedy of the commons? In *Information, place, and cyberspace: Issues in accessibility*, ed. D. G. Janelle and D. C. Hodge, 342–56. Berlin: Springer Verlag.

———. 2004. Pizza over the Internet: E-commerce, the fragmentation of activity and the tyranny of the region. *Entrepreneurship and Regional Development* 16 (1): 41–54.

Deakin, E. 2003. Trends and policy choices. *Access* 23:26–31.

de Gournay, C. 2002. Pretense of intimacy in France. In *Perpetual contact: Mobile communication, private talk, public performance*, ed. J. Katz and M. Aakhus, 193–205. Cambridge, U.K.: Cambridge University Press.

Dobashi, S. 2005. The gendered use of *keitai* in domestic contexts. In *Personal, portable, pedestrian: Mobile phones in Japanese life*, ed. M. Ito, D. Okabe, and M. Matsuda, 219–36. Cambridge, MA: MIT Press.

Gilbert, M. 1998. "Race," space, and power: The survival strategies of working poor women. *Annals of the Association of American Geographers* 88 (4): 591–621.

Gillespie, A., and R. Richardson. 2000. Teleworking and the city: Myths of workplace transcendence and travel reduction. In *Cities in the telecommunications age: The fracturing of geographies*, ed. J. O. Wheeler, Y. Aoyama, and B. Warf, 228–45. New York: Routledge.

Giuliano, G., and K. A. Small. 1991. Subcenters in the Los Angeles region. *Regional Science and Urban Economics* 21:163–82.

Graham, S., and S. Marvin. 1996. *Telecommunications and the city: Electronic spaces, urban places*. London: Routledge.

Handy, S. 2003. Driving less. *Access* 23:20–25.

Hanson, S. 1998. Off the road?: Reflections on transportation geography in the information age. *Journal of Transport Geography* 6:241–49.

Hoch, I., and P. Waddell. 1993. Apartment rents: Another challenge to the monocentric model. *Geographical Analysis* 25:20–31.

Ito, M., D. Okabe, and M. Matsuda, eds. 2005. *Personal, portable, pedestrian: Mobile phones in Japanese life*. Cambridge, MA: MIT Press.

ITU. 2005. *Cellular mobile subscribers per 100 inhabitants 2004*. Geneva: International Communications Union.

Katz, J. 2003. *Connections: Social and cultural studies of the telephone in American life*. New Brunswick, NJ: Transaction.

Katz, J., and M. Aakhus. 2002. Introduction: Framing the issues. In *Perpetual contact: Mobile communication, private talk, public performance*, ed. J. Katz and M. Aakhus, 1–13. Cambridge, U.K.: Cambridge University Press.

Kopomaa, T. 2000. *The city in your pocket: Birth of the mobile information society*, trans. Tomi Snellman. Gaudeamus, Helsinki: Oy Yliopistokustannus University Press Finland.

Kwan, M.-P. 2002. Time, information technologies and the geographies of everyday life. *Urban Geography* 23:471–82.

———. 2003. Gender troubles in the Internet era. *Feminist Media Studies* 3 (3): 371–74.

———. 2006. Transport geography in the age of mobile communications. *Journal of Transport Geography* 14:384–85.

Kwan, M.-P., and J. Weber. 2003. Individual accessibility revisited: Implications for geographical analysis in the twenty-first century. *Geographical Analysis* 35:341–53.

Larsen, J., J. Urry, and K. W. Axhausen. 2005. *Social networks and future mobilities*. Report to the Horizons Programme of the Department for Transport, Department of Sociology, University of Lancaster and IVT, ETH Zürich, Lancaster, and Zürich.

Latour, B. 1987. *Science in action: How to follow scientists and engineers through society*. Cambridge, MA: Harvard University Press.

Latour, B., and S. Woolgar. 1986. *Laboratory life: The construction of scientific facts*. Princeton, NJ: Princeton University Press.

Lemish, D., and A. A. Cohen. 2005. On the gendered nature of mobile phone culture in Israel. *Sex Roles* 52 (7/8): 511–21.

Levinson, P. 2004. *Cellphone*. New York: Palgrave Macmillan.

Ling, R. 2004. *The mobile connection: The cell phone's impact on society*. Amsterdam: Morgan Kaufmann.

Ling, R., and B. Yttri. 2002. Hyper-coordination via mobile phones in Norway. In *Perpetual contact: Mobile communication, private talk, public performance*, ed. J. Katz and M. Aakhus, 139–69. Cambridge, U.K.: Cambridge University Press.

Lyons, G., and J. Urry. 2005. Travel time use in the information age. *Transportation Research A* 39:257–76.

Mokhtarian, P. L., and R. Meenakshisundaram. 1999. Beyond tele-substitution: Disaggregate longitudinal structural equations modeling of communication impacts. *Transportation Research C* 7:33–52.

Moody, J. 2000. The importance of relationship timing for STD diffusion. *Social Forces* 81:25–56.

Ohmori, N. 2006. Connected anytime: telecommunications and activity-travel behavior from Asian perspectives. Paper presented at the 11th International Conference on Travel Behaviour Research, Kyoto, August 2006.

Ohmori, N., T. Hirano, and N. Harata. 2006. Meeting appointment and waiting behavior with mobile communications. Paper presented at the 85th Annual Meeting of the Transportation Research Board, Washington, DC, 22–26 January.

Ohmori, N., M. Makazato, N. Harata, K. Sasaki, and K. Nishii. 2006. Activity diary surveys using GPS mobile phones and PDA. Paper presented at the 85th Annual Meeting of the Transportation Research Board, Washington, DC, 22–26 January.

Puro, F.-P. 2002. Finland: A mobile culture. In *Perpetual contact: Mobile communication, private talk, public performance*, ed. J. Katz and M. Aakhus, 12–29. Cambridge, U.K.: Cambridge University Press.

Rakow, L., and V. Navarro. 1993. Remote mothering and the parallel shift: Women meet the cellular telephone. *Critical Studies in Mass Communications* 10 (2): 144–57.

Rheingold, H. 2002. *Smart mobs: The next social revolution*. Cambridge, MA: Basic Books.

Schwanen, T., and M.-P. Kwan. Forthcoming. The Internet, mobile phone and space-time constraints. *Geoforum*.

Sheller, M., and J. Urry. 2006. The new mobilities paradigm. *Environment and Planning A* 38:207–26.

Suitor, J. J., B. Wellman, and D. L. Morgan. 1997. It's about time: How, why and when networks change. *Social Networks* 19 (1): 1–7.

Timo, O. 2006. Mapping social networks in time and space. Working paper, Institute for Transport Planning and System, and Swiss Federal Institute of Technology Zurich.

Townsend, A. 2000. Life in the real-time city: Mobile telephones and urban metabolism. *Journal of Urban Technology* 7:85–104.

Urry, J. 2002. Mobility and proximity. *Sociology* 36 (2): 255–74.

———. 2003. Social networks, travel and talk. *British Journal of Sociology* 54 (2): 155–75.

———. 2004. Connections. *Environment and Planning D* 22 (1): 27–37.

Waddell, P., B. J. L. Berry, and I. Hoch. 1993. Housing price gradients: The intersection of space and built form. *Geographical Analysis* 25:5–19.

Weber, J. 2003. Individual accessibility and distance from major employment centers: An examination using space-time measures. *Journal of Geographical Systems* 5:51–70.

Weber, J., and M.-P. Kwan. 2002. Bringing time back in: A study on the influence of travel time variations and facility opening hours on individual accessibility. *The Professional Geographer* 54:226–40.

Wellman, B. 2001. Physical place and cyberplace: The rise of personalized networking. *International Journal of Urban and Regional Research* 25 (2): 227–52.

Wittel, A. 2001. Toward a network sociality. *Theory, Culture & Society* 18 (6): 51–76.

Zook, M., M. Dodge, Y. Aoyama, and A. Townsend. 2004. New digital geographies: Information, communication, and place. In *Geography and technology*, ed. S. Brunn, S. Cutter, and J. W. Harrington, 155–76. Boston: Kluwer.

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