Transportation (2006) 33:463–480
DOI 10.1007/s11116-006-8074-z

RESEARCH ARTICLE

Exploring the propensity to perform social activities: a social network approach

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Abstract Conceptual and empirical models of the propensity to perform social activity–travel behavior are described, which incorporate the influence of individuals' social context, namely their social networks. More explicitly, the conceptual model develops the concepts of egocentric social networks, social activities, and social episodes, and defines the three sets of aspects that influence the propensity to perform social activities: individuals' personal attributes, social network composition, and information and communication technology interaction with social network members. Using the structural equation modeling (SEM) technique and data recently collected in Toronto, the empirical model tests the effect of these three aspects on the propensity to perform social activities. Results suggest that the social networks framework provides useful insights into the role of physical space, social activity types, communication and information technology use, and the importance of ''with whom'' the activity was performed with. Overall, explicitly incorporating social networks into the activity–travel behavior modeling framework provides a promising framework to understand social activities and key aspects of the underlying behavioral process.

Keywords Social networks · Activity–travel behavior · Social activities · Information and communication technologies · Structural equation modeling

Introduction

Overview and motivation

Although metaphors from physics and other natural sciences have been useful in the past (Harvey 1969), they are now not enough to understand the rich complexity of travel behavior (Pas 1990). In this context, activity-based approaches incorporate

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more truly behavioral explanations which recognize travel as a *derived* demand, triggered by the desire to perform activities with others (Pas 1990). While this recognition has existed for some time, the need to complement the dominant econometric-based approach is still an important research challenge. More specifically, models that explain the *generation of trips* (''why'' travel is performed) still heavily rely on the individual socioeconomic characteristics of travelers, without considering the importance of the individual's social context in this process. A potential approach to better understand the generation of individual activities and travel in general, and *social* activities and travel specifically, is looking at the *propensity* to perform them, especially those elements less measurable in terms of costs and socioeconomics, as recognized long ago by Chapin (1974). In this context, a key hypothesis is that individuals' social network characteristics are relevant for their propensity to perform social activities and that these effects can be appropriately measured and used to understand the underlying decision making processes.

The study of social networks in activity–travel behavior responds to ''*the need to underpin our travel models with a better understanding of the social structures of daily life and, as we implicitly forecast/speculate about them when we predict travel behavior over long time horizons, anyway ...*'' as Axhausen (2002, p. 3), argues. This requirement is even more patent when a series of ''possible transport questions'' are considered, such as ''*physical spatial-temporal coherence/overlap (constraints), replacement of physical and telecommunication-based contact, interaction frequency and spatial reach, and interaction and information/knowledge transfer*'' (2002, p. 10).

In addition, the focus in social activities is particularly interesting since interactions intuitively play a ''motivator'' role in the behavioral processes that lead to the generation of those activities. The study of these activities has been a neglected area in travel behavior research, although some attempts have been undertaken recently (Mokhtarian et al. 2003; Schlich et al. 2004). In addition, social networks can potentially help capture the propensity to perform social activities in a new context, such as the role of information and communication technologies (ICT) in activity–travel generation. This link between social activity–travel and ICT has been discussed (Mokhtarian et al. 2003; Senbil and Kitamura 2003), but with no explicit inclusion of social networks characteristics.

Although the interest in social interactions in the activity–travel urban context has a long tradition (e.g., Stutz 1973; Kemper 1980), recent literature in this area is scarce. Some exceptions are theoretical discussions about long-term effects of social networks and travel (Axhausen 2006), and insights about social influence and travel (Dugundji and Walker 2005; Páez and Scott 2006). However, no dedicated data collection effort, and very few empirical analyses have been undertaken recently. In response to this need, the objective of this paper is to present a conceptual and an empirical statistical model to study the propensity to perform social activities, explicitly incorporating social networks concepts. The main underlying hypothesis is that studying social networks provides new insights to understand the social activity generation process. More explicitly, it is expected that this analysis incorporating the social network perspective will enrich the behavioral components of operational agent-based activity–travel demand models, such as TASHA (Miller and Roorda 2003) and integrated land-use models, such as ILUTE (Salvini and Miller 2005). The rest of this section further elaborates the social networks concept in activity–travel behavior; the second section presents the conceptual framework used in the

empirical models; the third section discusses the main results of these models; and the last section summarizes some conclusions and prospective future work.

Social networks and activity–travel behavior

''*Social network analysis is the study of social structure and its effects. It conceives social structure as a social network, that is, a set of actors (nodes) and a set of relationships connecting pairs of these actors*'' (Tindall and Wellman 2001, pp. 265–266). Two key components define this paradigm: *actors*, who represent different entities, such as groups, organizations, nations, as well as persons; and *relationships*, which represent flows of resources that can be related with aspects such as control, dependence, cooperation, information interchange, and competition.

The core concern of the social network paradigm is ''to understand how social structures facilitate and constrain opportunities, behaviors, and cognitions''. Social network analysis conceives overall behavior as more than the sum of individual behaviors, and contrasts with ''explanations that treat individuals as independent units of analysis'' (as traditionally used in travel behavior research). Thus, behavior is explained not only through personal attributes but also by using social structure attributes that incorporate the interaction among the different social network members. In this vision *the whole is more than the sum of its parts*; that is, social phenomena cannot be understood solely by individual characteristics (such as socioeconomic attributes), but also by the social structure attributes that emerge from the interaction between those individuals.

A key link with travel behavior is that ties among people may be interpreted not only as mere interactions but also as *links that indirectly represent potential activity and travel where these actors are involved*. Analysis and modeling these ties not only requires understanding these interactions, but also what are the potential activities and trips involved in them. As a consequence, the structural characteristics—and the underlying individual or actor attributes—can be potentially *sources of explanation* of activity and travel, as the following conceptual framework presents.

Conceptual framework

The purpose of this section is to sketch the conceptual framework which serves as a background for the operational definition of the propensity to perform social activities, and the empirical analysis developed later.

Social networks

Egocentric approach

The general definitions about social networks outlined in the previous section need to be further operationalized in order to collect data and conduct empirical analyses into the phenomenon. Two kinds of studies can be done with social networks: whole or egocentric networks (Wellman 1988). Whole network studies assume that the entire set of actors and their relationships is known, forcing the analyst to know or at least make assumptions about all the individuals relevant to the phenomenon of

interest. On the other hand, egocentric network studies concentrate on one specific individual and those who are related with him/her. Concretely, since generally the interest in travel behavior research is about large populations in urban areas, the egocentric network approach constitutes the only feasible way to study explicit interactions. Egocentric networks thus become ''samples'' of the entire urban social network. The social network definition below uses this framework.

Social network definition

Each individual (called *ego*) has a *social network*, defined as a set of actors or *alters* who have relationships or *ties* with the ego, and who may or may not have ties with each other.

Network composition

A key characteristic of social networks is their *composition*, that is, *which alters* constitute the network and what are their characteristics. As previously discussed, this is an important aspect since it can be hypothesized that the network composition constitutes a potential source of explanation for the propensity to perform social activities. In this paper, the influence of the roles of the alters, their distance, and their gender homophily (having the same gender) with respect to the ego are analyzed.

Tie characteristics

Each tie may have several characteristics that define the relationship between the ego and each alter. In this paper, two tie attributes are explored. The first is *tie strength*, defined as the degree of closeness between the ego and alter. Ego-alter ties can be ''strong'' or ''weak'' depending on how emotionally close the ego feels to the alter. *Strong tie is* operationalized as ''people you discuss important matters with, or regularly keep in touch with, or there for you if you need help'', and *weak tie* is operationalized as ''more than just casual acquaintances, but not very close people''. These definitions also define the social network's boundary, explicitly excluding acquaintances. The second tie characteristic is the *frequency and media of interaction*, which measures the intensity and type of ego-alter interaction.

Social interaction and episodes

Social interactions

A social interaction can be generally defined as an activity or a set or activities performed by two or more individuals primarily for recreational or support purposes, that can be performed face-to-face or virtually (telephone or the Internet in the latter case). Social interactions are conceptualized as ''projects'', in the way Miller (2005) uses the concept; i.e., as a ''coherent, logically interconnected sets of actions'' (p. 22). Social interactions comprise a primary project because they represent a major generic activity type within the personal and household agenda (Miller 2005).

Social episodes

A social project generates a series of activity and travel *episodes*. Three types of episodes can be differentiated: *travel*, *provision*, and *social* episodes. Travel episodes are trips that start and end in a provision, social or another travel episode; provision episodes are shopping or another secondary activity necessary to perform the social activity; *social episodes* are the core of the social interaction project, and are the focus of this paper. Social episodes are undertaken using different kinds of *media*: *face-to-face*, *telephone* (cellular and regular), and *Internet* (email and instant message). At the same type, each *episode* has duration, start time, and location. Social episodes' locations can be *concurrent* (i.e. the same place for all the members interacting) or *non-concurrent* (i.e. different places). Furthermore, if the location is concurrent, for the purposes of this paper two kinds of places are differentiated: the ego's or alter's home (*hosting and visiting* social activities), or institutional or public places other than homes (e.g. social activities at *pubs or restaurants*).

The decision to perform a social project

The decision to perform a social project can be characterized by the individual's propensity and opportunity to engage in a social project, inspired by Chapin's general activity patterns model (Chapin 1974). For the specific purposes of this paper, personal and network attributes are explored to measure this propensity.

Propensity to engage in a social project

The propensity to engage in social projects, and more specifically, to engage in *social face-to-face episodes*, potentially depends on:

- Personal attributes, such as age, gender, income, lifecycle, personality, and household characteristics,
- Social network attributes, specifically the ego's network composition, and
- Social episodes performed by the ego with other media (telephone and Internet) by strength of the tie (strong/weak) and frequency of interaction.

Finally, the propensity to perform social projects is postulated as a ''latent'' attribute, not directly observable from individuals' activity patterns, that is measured in this paper as the intensity of face-to-face social episodes by tie strength (strong/weak), social activity type (hosting and visiting/bar and restaurants), and frequency of interaction.

Opportunities to engage in a social project

These mainly refer to the individual's time and space constraints and opportunities (Hägerstrand 1970; Chapin 1974). Although not explicitly considered in this paper, these latter aspects have a strong social network component, especially considering Hägerstrand's coupling constraints, and the fact that the locations of ego and alters are in general *fixed* in the short and medium-run (e.g. homes for visiting social activities).

Empirical models

Data: the connected lives study

A main challenge to effectively incorporate social networks in an activity–travel framework is the collection of adequate data that accounts for the interactions among individuals. The data used to calibrate the empirical models in this section corresponds to the *Connected Lives Study*, a broader study about people's communication patterns, conducted by the NetLab group at the Centre for Urban and Community Studies, at the University of Toronto. The study was occurred between May 2004 and April 2005, and consisted of 350 surveys of people randomly selected in the East York area of Toronto, with more detailed follow-up interviews and observations of a subsample of 87 from the original sample. The East York area is located east of downtown Toronto, and is fairly representative of the overall inner city characteristics regarding sociodemographics and general transportation level of service. For more details about the data collection process, the reader is referred to Carrasco et al. (2006) and Wellman et al. (2006).

The data used in this section corresponds to the initial survey part of the study. The method used to gather the characteristics of the respondent's social networks is known as the summation method (see McCarty et al. 2000 for details), and consists of eliciting the *number* of alters who have specific characteristics, such as role, gender, distance, and frequency and media of interaction. In addition, standard questions about personal and household characteristics were gathered.

Table 1 presents the list of variables considered in the analysis, conforming to the previous conceptual framework. The dependent variables—which serve as an indicator of the propensity to perform social activities—correspond to the number of people in the social network by *tie strength* (weak/strong) with whom the ego usually performs *social activities* (hosting or visiting/going to pub or restaurants) at a certain *frequency* (less than once a week/between a week and a month). These three dimensions (tie strength, social activity type, and frequency) imply eight dependent variables according to each tie strength/frequency combination for each social activity type. Regarding the independent variables, three sets are analyzed:

- *Personal and household characteristics*, including socioeconomic and lifecycle attributes.
- *Network composition attributes*, including roles of each alter, their distance, and their gender homophily (having the same gender) with respect to the ego. Role composition includes how many people of each relationship compose the network (close family, other relatives, friends, co-workers or classmates, and people from organizations). Distance of the networks' members with respect to the ego (number of people living in Canada at more than an hour's travel away, and number of people living outside Canada). Gender homophily is defined as the number of people from the network who have the same gender as the ego.
- *Interaction through information and communication technology use*, i.e., how many people the ego usually communicates with using each medium (cell phone/regular phone/email/instant message), by tie strength (strong/weak) and by frequency (at least once a week/between once a week and once a month). These three dimensions imply sixteen different independent variables according to each tie strength/frequency combination by media.

Table 1 Independent and dependent variables

Personal and household characteristics	
Income	Household income (categorical variable)
Age	Age (categorical variable)
Child in household	Presence of children at home
Female	Ego is female
Live with partner	Ego lives with partner
Employed	Ego is employed
Works at home	Ego works at home
Years in the household	Number of years the ego lives in the same household
Years in the city	Number of years the ego lives in Toronto
Network composition	
Immediate family	Number of social network members who are immediate family
Neighbors	Number of social network members who are neighbors
Work/student mates	Number of social network members who are work or student mates
From organizations	Number of social network members who are from other organizations (e.g. sport or social clubs)
Friends	Number of social network members who are friends not included above
With the same gender	Number of social network members who have the same ego's gender
In Canada >1 h of travel	Number of social network members who live in Canada at more than an hour's travel away with respect to the ego
Outside Canada	Number of social network members who live outside Canada
Network interaction through ICT use	
Call by cell phone	Number of social network members with whom the ego calls by cell phone: by tie strength (strong, weak), and frequency (typically at least once a week and between once a week and once a month)
Call by regular phone	Number of social network members with whom the ego calls by regular phone: by tie strength (strong, weak), and frequency (typically at least once a week and between once a week and once a month)
E-mail	Number of social network members with whom the ego emails: by tie strength (strong, weak), and frequency (typically at least once a week and between once a week and once a month)
Use instant message	Number of social network members with whom the ego communicates by instant message: by tie strength (strong, weak), and frequency (typically at least once a week and between once a week and once a month)
Dependent variables	
Host/visiting	Number of social network members with whom the ego visits or hosts: by tie strength (strong, weak), and frequency (typically at least once a week and between once a week and once a month)
Bar/restaurants	Number of social network members with whom the ego meets in places such as bar or restaurants: by tie strength (strong, weak), and frequency (typically at least once a week and between once a week and once a month)

Finally, since the number of members in a network can be very high for a few cases (a ''long-tailed'' distribution), the models in this paper have censored the network variables in the tenth higher percentile; this technical constraint is explicitly considered in the models and does not add bias to the results.

Method: structural equation models

The statistical method used in this paper is structural equation modeling (SEM), which consists of a series of linear equations that relate observed exogenous and endogenous variables, and latent variables. This method has been extensively used in the social sciences for decades, and is increasingly a standard tool in travel behavior research (for a more in depth review of SEM and applications in the area see Golob 2003 and the references therein). The SEM used here consists of two equations:
Structural equation:

$$\eta = B\eta + \Gamma X + \varsigma \tag{1}$$

Measurement equation:

$$Y = \Lambda\eta + \varepsilon \tag{2}$$

where η is the vector of latent variables, X is the vector of observed independent variables, Y is the vector of observed dependent variables, ς is the vector of unobserved dependent variables affecting the latent variables, ε is the vector of measurement errors; and B, Γ and Λ are the coefficient matrices that reflect the causal relationships among the variables. The effect of the independent variables X on the latent variables η can be *direct* (measured by Γ) and also *indirect* (measured by B); thus, the *total* effect of X on η corresponds to the sum of both effects, measured in the *reduced form* equations. The measurement relationship between observed and unobserved independent variables is represented by Λ. It is assumed that there are no measurement relationships and errors at the level of the endogenous variables.

The SEM calibrated in this paper (see the path diagrams in Fig. 1) comply with the conceptual framework presented before: three sets of independent variables (personal and household attributes, ego's social network composition, and social network ICT use) influence the propensity to perform social activities by each type (hosting/visiting and going to pubs/restaurants) and strength of tie (weak/strong). These propensities are latent variables, measured by observed dependent variables, defined as the number of people with whom the ego socializes by tie strength, frequency, and activity type. In addition, the structure presented in the path diagrams allows models representing the influence of the propensity to perform social activities between both activity types, and both tie strengths for the given set of independent variables, capturing the indirect overall network effect. For example, although the number of strong tie friends directly affects the number of strong tie people hosting and visiting, the path structure allows models to explore the indirect effect of this variable on the number of *weak* tie people hosting/visiting. Three models were estimated (one for each independent variable set) rather than a single one due to small sample sizes, which did not allow statistically reliable results for combined models to be obtained.

Empirical models

The results from the three SEM are presented in this section. Tables 2–4 show the structural equations coefficients (representing the direct effects), and the reduced form equations (representing the total effects, direct and indirect); all models were

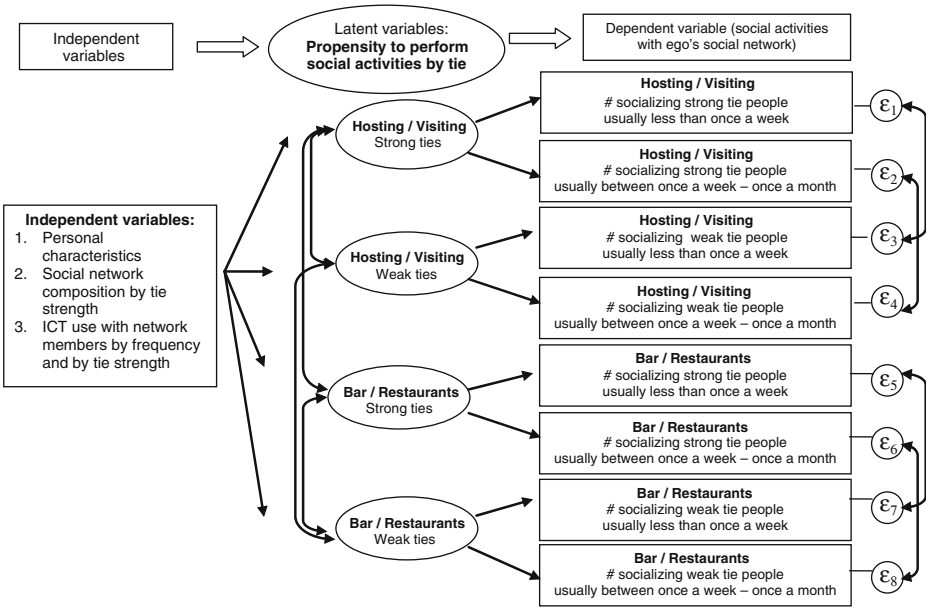

Fig. 1 Conceptual causal structure represented in the structural equation models

calibrated using the statistical package LISREL (Jöreskog and Sörbom 2001). Blank spaces in the tables indicate coefficients with a *t*-statistic lower than 1.20 (*p* value lower than 0.885), and the symbol"–"indicates coefficients not considered in the conceptual model sketched in Fig. 1. In general, the goodness of fit of the three models was adequate, according to standard criteria used in the literature, such as a ratio between χ^2 and degrees of freedom lower than 3, a Root Mean Square Approximation (RMSA) confidence interval which includes 0.05, and a comparative fit index (CFI) greater or equal than 0.95 (for more details, see Washington et al. 2003 and the references therein).

The first model tested whether personal and household characteristics are factors that influence the propensity to perform social activities (Table 2). In addition, these characteristics can be understood as "systematic effects" with respect to the social networks' influence in this propensity. A first interesting result is the significant positive coefficient of income for all four models, that is, a positive relationship between higher income and more people socializing. In the case of bar and restaurants, this positive relationship is consistent with other findings in the transportation literature (Lu and Pas 1999; Schlich et al. 2004). The case of hosting and visiting is less clear, since the dependent variable mixes in-home and out-of-home activities, and low income groups seem to have higher propensity to perform in-home social activities, and high income to engage in out-of-home activities (Lu and Pas 1999). A second intriguing effect is the *presence of children in the household* which is different between hosting/visiting (positive effect) and bar/restaurants (negative effect for strong ties). The negative effect in bar/restaurants is expected according to time-pressure hypotheses, which assume that the presence of children implies more maintenance activities and thus less time for social/recreational (Lu and Pas 1999). However, the positive effect opens some research questions: first,

Table 2 Model 1 (personal characteristics)

From/to	Effect	Host/visiting				Bar/restaurants			
		Strong ties		Weak ties		Strong ties		Weak ties	
Host/visiting, Strong ties[a]	Total	–	–	0.22	(1.66)			–	–
	Direct	–	–	0.22	(1.66)			–	–
Host/visiting, Weak ties[a]	Total	0.22	(1.66)	–	–	–	–		
	Direct	0.22	(1.66)	–	–	–	–		
Income	Total	0.23	(3.72)	0.29	(5.60)	0.12	(2.70)	0.30	(6.75)
	Direct	0.17	(2.49)	0.23	(3.37)	0.15	(3.24)	0.29	(4.18)
Age	Total	−0.38	(−5.75)	−0.34	(−6.64)	−0.11	(−2.33)	−0.28	(−6.85)
	Direct	−0.32	(−4.43)	−0.25	(−3.78)	−0.15	(−3.31)	−0.28	(−4.05)
Child in household	Total	0.04	(1.68)	0.13	(2.95)	−0.09	(−2.66)		
	Direct			0.12	(2.85)	−0.09	(−2.44)		
Female	Total	−0.06	(−1.62)	−0.27	(−6.33)			−0.29	(−7.89)
	Direct			−0.25	(−4.42)			−0.28	(−5.81)
Live with partner	Total	0.04	(1.29)	0.09	(1.93)	−0.17	(−4.51)		
	Direct			0.08	(1.86)	−0.16	(−4.48)		
Employed	Total	−0.66	(−5.45)	−1.14	(−9.8)			−1.03	(−9.95)
	Direct	−0.40	(−2.57)	−0.97	(−4.99)			−1.00	(−4.93)
Works at home	Total	0.62	(5.57)	1.02	(9.54)			0.93	(9.88)
	Direct	0.39	(2.79)	0.86	(4.86)			0.91	(4.98)
Years in the household	Total	0.11	(1.86)						
	Direct	0.11	(1.85)						
Years in the city	Total	0.10	(1.68)						
	Direct	0.09	(1.67)						

Minimum fit function $\chi^2 = 110.86$; Degrees of freedom = 55; RMSEA 90% confidence = [0.037, 0.067]; CFI = 0.98

Note: ''−'' are coefficients omitted in conceptual model, blank spaces = $t < 1.20$; a, b, c, d = coefficients set equal in the SEM

whether the mix between in-home and out-of-home activities in hosting/visiting influences the final positive result; second, whether measuring the *number* of individuals with whom social activities are performed induces a positive effect in this case (e.g. families with children will tend to have more relationship with other people with children and, in general, bigger groups); and third, whether the effect is mainly due to the activity type (e.g. with children, bar/restaurants are less ''convenient'' or comfortable places to perform social activities than homes).

A similar difference in signs can be found for the case of whether the ego *lives with partner*: positive for hosting/visiting and negative for bar/restaurants, an intuitive result in that people living with a partner would have more propensity to perform more activities at homes compared with single people. In the case of *gender*, the negative effect of being female is consistent with other results (Lu and Pas 1999). Regarding the negative effect of being *employed* and the positive effect of *working at home*, time pressure explanations intuitively support this result; being employed generates a much more fixed schedule than working at home, potentially making people have lower propensities to perform social activities. Finally, the results show an interesting statistically significant and positive effect of *years in the household* and *years in the city* for strong tie people in hosting/visiting. A low residential and urban mobility can be a proxy for a more stable and settled social network, and thus more intimate people with whom to socialize. Further, there could be a neighborhood and urban effect that could trigger a positive social effect: the more time people have

spent in their neighborhood and city, the more close people they know, and the more potential for social events.

Regarding network composition (Table 3), a first interesting result is the *positive* relationship between the *number of people living in Canada at more than an hour's travel away* and the propensity to socialize with both strong and weak ties and both hosting/visiting and bar/restaurants. This is an interesting result which apparently contradicts the intuition that distance is a barrier to performing social activities. However, from a network perspective, a potential explanation is that, if respondents report many people living at further distances in their network, it is very likely that these egos actively work more to ''maintain'' their relationships. In other words, these egos may have more ''propensity'' for performing social activities compared

Table 3 Model 2 (network composition)

From/to	Effect	Host/visiting				Bar/restaurants			
		Strong ties		Weak ties		Strong ties		Weak ties	
Host/visiting, Strong ties[b, c]	Total	–	–	0.13	(1.71)	0.18	(4.73)	–	–
	Direct	–	–	0.13	(1.71)	0.18	(4.73)	–	–
Bar/restaurants, Strong ties[c]	Total	0.18	(4.73)	–	–	–	–		
	Direct	0.18	(4.73)	–	–	–	–		
Immediate family, Strong ties	Total	0.23	(4.83)	0.03	(1.89)	0.08	(1.89)		
	Direct	0.21	(4.97)	–	–			–	–
Neighbors, Strong ties	Total	0.15	(3.35)	0.02	(1.52)	0.02	(2.77)		
	Direct	0.11	(3.42)	–	–			–	–
Work/student mates, Strong ties	Total	0.07	(1.57)			0.01	(1.50)		
	Direct	0.08	(2.00)	–	–			–	–
From organizations, Strong ties	Total	0.02	(2.08)	0.01	(1.37)	0.10	(2.27)		
	Direct					0.09	(2.26)	–	–
Friends, Strong ties	Total	0.29	(6.30)	0.04	(1.66)	0.26	(5.87)		
	Direct	0.28	(6.64)	–	–	0.20	(4.66)	–	–
In Canada >1 h of travel, Strong ties	Total	0.06	(1.29)			0.12	(2.52)		
	Direct	0.06	(1.43)	–	–	0.10	(2.35)	–	–
Outside Canada, Strong ties	Total	−0.16	(−3.53)	−0.02	(−1.5)	−0.03	(−2.85)		
	Direct	−0.16	(−3.79)	–	–			–	–
Host/visiting, Weak ties[b, d]	Total	0.13	(1.71)	–	–	–	–	0.11	(1.64)
	Direct	0.13	(1.71)	–	–	–	–	0.11	(1.64)
Bar/restaurants, Weak ties[d]	Total	–	–	0.11	(1.64)			–	–
	Direct	–	–	0.11	(1.64)			–	–
Immediate family, Weak ties	Total	0.02	(1.47)	0.14	(3.27)			0.12	(2.82)
	Direct	–	–	0.13	(3.06)			0.10	(2.47)
Neighbors, Weak ties	Total	0.01	(1.34)	0.09	(1.89)	0.01	(1.31)	0.01	(1.24)
	Direct	–	–	0.08	(1.88)	–	–		
From organizations, Weak ties	Total			0.01	(1.44)			0.12	(2.89)
	Direct	–	–			–	–	0.12	(2.89)
Friends, Weak ties	Total	0.03	(1.65)	0.11	(2.41)			0.20	(4.47)
	Direct	–	–	0.09	(1.90)	–	–	0.19	(4.28)
In Canada >1 h of travel, Weak ties	Total	0.03	(1.65)	0.20	(4.27)			0.25	(5.56)
	Direct	–	–	0.17	(3.58)	–	–	0.23	(4.99)
With the same gender, Weak ties	Total	−0.02	(−1.36)	−0.13	(−2.71)			−0.20	(−4.47)
	Direct	–	–	−0.10	(−2.24)	–	–	−0.19	(−4.28)

Minimum fit function $\chi^2 = 193.02$; Degrees of freedom = 86; RMSEA 90% confidence = [0.044, 0.067]; CFI = 0.95

Note: ''–'' are coefficients omitted in conceptual model, blank spaces = $t < 1.20$; a, b, c, d = coefficients set equal in the SEM

with those that have less people living further away. A second complementary potential explanation is that individuals with more network members living further from them compensate their socializing needs with network members living closer. This network effect in distance has however some limit; in fact, the more strong tie *people living outside Canada*, the less likely the individual hosts or visits strong tie people. This last result also shows that having more people in the social network does not directly translate into necessary having more propensity to perform social activities. Regarding the number of *people of the same gender as the ego*, results show a significant negative effect in the case of weak ties for both hosting/visiting and bar/restaurant propensities to perform social activities. These results intuitively seem appropriate since social activities with weak ties tend to be in large groups of friends, and generally in couples or in family (in the case of family, this is reaffirmed by the significant effect of weak ties *immediate family*).

Also, the role composition within the network has different effects comparing hosting/visiting and bars/restaurant social activities, and strong and weak ties. First, the positive and significant direct effect of *neighbors* in both strong and weak ties in hosting/visiting suggests that they are still an important part of urban social life. Interestingly, this result also reaffirms the continuing importance of local space and short distances for socializing activities, mainly related with home, also with an indirect positive effect in bar/restaurants. Second, *work and student mates* have a positive significant effect only for strong ties, direct for hosting and visiting social activities, and indirect for bar and restaurant social activities. Thus, the relationship between *work and student mates* and the propensity to perform social activities is a positive relationship mainly when the intimacy is higher. The propensity effects in activity types are different in the case of *people from organizations*, which are only direct for bar/restaurants for both strong and weak ties, and indirect for hosting/visiting. Third, the results also suggest the importance of the number of *immediate family* in performing social activities, especially hosting and visiting, but also bar and restaurants for weak ties. As intuitively expected, the other role as important as *immediate family* is that of *friends*, whose directs effects are positively significant for both tie strengths and social activity types.

The previous results suggest an interesting intertwined effect between *with whom* individuals socialize and the *distance* for these social activities. First, *local space* remains important, judging for the effect of *neighbors*, and also by the results in the personal and household characteristics model, regarding the *number of years in the household* and the *number of years in the city*. At the same time, *further distances* also remain important, as the effect of the *people living at more than one hour's travel* suggests. Although the previous results are not conclusive, they seem to confirm a ''*glocalization*'' effect in the context of social activities (Wellman 2001), that is, heavy interaction intensity at both far and close distances. Second, the differences found between hosting/visiting and restaurants/pubs, suggest a *specialization* of both spaces, which reinforces the argument that social activities conform to a broad set of activities and episodes, which needs to be analyzed in their specific context. In other words, *with whom* social activities are performed, is a relevant aspect to understand the specific characteristics of each activity type and their propensity to perform them.

The conceptual framework presented in Section 2 explicitly incorporates the potential role of information and communication technologies (ICT) in social episodes, defining them as different media, which can supplement, complement or be

neutral to social face-to-face interactions. As it was discussed before, this media use variable is measured as the usual number of people with whom the ego communicates by tie strength and frequency in each media (cell phone, regular phone, email, and instant messaging) (see Table 4). First, a key general observation is that all significant estimated direct and total effects are positive for communicating by *cellular phone*, *regular phone*, and *email*; that is, from this perspective, communicating with more people in each of these three media shows a *complementary* (if significant) or *neutral* effect (if not significant) in the number of people with whom individuals socialize, but *never* a substitution effect. This complementary effect is consistent with previous discussions in the travel behavior literature (Mokhtarian et al. 2003; Senbil and Kitamura 2003). Exceptions of this result are the effects of *frequent instant messaging*, where very frequent communication has a negative direct and indirect effect; further investigation needs to be done considering that less frequent instant message communication has a positive or neutral effect, that individuals who use instant message correspond to only a 15% of the entire sample and are mainly restricted to the young cohort (less than 29 years old), and that instant message seems to be less important in the social activity planning process than other media (Hogan 2005).

Second, different ICT media seem to have different stimulation effects based on the nature of the tie, the frequency of communication, and social activity type. In the case of *regular phone*, there is a consistent positive direct effect in most of the strong/weak tie combinations for both hosting/visiting and bar/restaurants. The effects seem to be more specific for the other media communication patterns, depending on tie strength and the frequency. For example, the major direct effects in *cell phone* seems to be for strong tie/very frequent and weak tie/less frequent combinations, and the importance of *email* communication varies according to tie strength and activity type. This apparent specialization of frequency, tie strength, and media raises interesting research questions about the influence of ICT and the propensity to perform social activities. For example, this specialization effect may illustrate the influence of ICT in the social activity planning process (as described using the same data set in Hogan 2005); however, more disaggregated data accounting at the level of each ego-alter is needed to obtain more solid conclusions about this issue.

Conclusions and future work

This paper presents a model that incorporates the concept of *propensity* to perform social activities, using a social networks approach. In general, propensity helps to link a set of different potential causes of the generation of social activities, such as social networks, socioeconomic, and individual attributes, as well as the ego's communication patterns with his/her network by other means, such as telephone and Internet-based media. The explicit incorporation of social network concepts provides a useful way to describe the complexity of social activities, which not only depend on the individuals' scheduling and time use decision process, but also on their social context, that is, ''with whom'' individuals perform those activities. Social network theory provides a natural way of incorporating the intrinsic interactions that occur in social activities, and also provides a potentially useful way of understanding aspects such as the influence of information and communication technologies.

Table 4 Model 3 (ICT contact in social network)

From/to	Effect	Host/visiting				Bar/restaurants			
		Strong ties		Weak ties		Strong ties		Weak ties	
Host/visiting, Strong ties	Total	–	–					–	–
	Direct	–	–					–	–
Bar/restaurants, Strong ties[a]	Total			–	–	–	–	0.13	(1.89)
	Direct			–	–	–	–	0.13	(1.89)
Call by cell phone <1 week, Strong tie	Total	0.22	(5.90)			0.15	(3.24)	0.02	(1.76)
	Direct	0.21	(4.86)	–	–	0.12	(2.34)	–	–
Call by cell phone 1 week–1 month, Strong tie	Total								
	Direct			–	–			–	–
Call by regular phone <1 week, Strong tie	Total	0.34	(8.36)			0.15	(3.24)	0.01	(1.39)
	Direct	0.32	(7.73)	–	–	0.06	(1.24)	–	–
Call by regular phone 1 week–1 month, Strong tie	Total	0.25	(5.83)			0.08	(1.43)		
	Direct	0.24	(5.66)	–	–	0.05	(1.26)	–	–
E-mail <1 week, Strong tie	Total					0.09	(1.58)		
	Direct			–	–	0.09	(1.57)	–	–
E-mail 1 week–1 month, Strong tie	Total	0.06	(1.53)			0.14	(2.38)	0.01	(1.49)
	Direct	0.05	(1.21)	–	–	0.13	(2.26)	–	–
Use instant message <1 week, Strong tie	Total	−0.05	(−1.35)			−0.09	(−1.97)	−0.01	(−1.41)
	Direct			–	–	−0.08	(−1.85)	–	–
Use instant message 1 week–1 month, Strong tie	Total								
	Direct			–	–			–	–
Host/visiting, Weak ties	Total			–	–	–	–		
	Direct			–	–	–	–		
Bar/restaurants, Weak ties[a]	Total	–	–			0.13	(1.89)	–	–
	Direct	–	–			0.13	(1.89)	–	–
Call by cell phone <1 week, Weak tie	Total								
	Direct	–	–			–	–		
Call by cell phone 1 week–1 month, Weak tie	Total			0.09	(2.00)	0.02	(1.64)	0.13	(1.76)
	Direct	–	–	0.09	(1.81)	–	–	0.13	(2.81)
Call by regular phone <1 week, Weak tie	Total			0.06	(5.13)	0.01	(1.35)	0.10	(1.81)
	Direct	–	–	0.25	(4.94)	–	–	0.09	(1.47)

Table 4 continued

From/to	Effect	Host/visiting				Bar/restaurants			
		Strong ties		Weak ties		Strong ties		Weak ties	
Call by regular phone 1 week–1 month, Weak tie	Total			0.29	(5.64)	0.02	(1.56)	0.13	(2.39)
	Direct	–	–	0.29	(5.33)	–	–	0.12	(1.91)
E-mail <1 week, Weak tie	Total					0.02	(1.55)	0.15	(2.76)
	Direct	–	–			–	–	0.15	(2.77)
E-mail 1 week–1 month, Weak tie	Total			0.06	(1.24)	0.02	(1.55)		
	Direct	–	–	0.06	(1.20)	–	–		
Use instant message <1 week, Weak tie	Total					−0.02	(−1.69)	−0.17	(−3.54)
	Direct	–	–			–	–	−0.16	(−3.54)
Use instant message 1 week–1 month, Weak tie	Total					0.01	(1.39)	0.10	(2.01)
	Direct	–	–			–	–	0.09	(2.01)
Minimum fit function $\chi^2 = 218.31$; Degrees of freedom = 89; RMSEA 90% confidence = [0.048, 0.072]; CFI = 0.96									

Note: "–" are coefficients omitted in conceptual model, blank spaces = $t < 1.20$; a, b, c, d = coefficients set equal in the SEM

A first step towards testing and further understanding these ideas was made through an empirical model that studied the propensity to perform social activities, measured as the number of people with whom individuals socialize. Overall, results suggest that the effect of personal and other characteristics on social activities cannot be generalized, and depends on the tie strength (''with whom'' the social activity is made), and specific social activity type (hosting/visiting versus bar/restaurant). Further analysis needs to be done to disentangle the effect of income and gender that suggest different—or at least complementary—explanations from those traditionally found in the existing literature. Another interesting result is the positive effect of the number of years in the household that seem to uncover a set of interesting processes, such as the neighborhood effect in social activities, complemented with the importance of neighbors network members on the propensity to perform hosting/visiting social activities. Also in the case of role composition, the results of this paper suggest that family is an important segment to consider as well as friends, but their effect varies according to tie strength and social activity type. Regarding network composition, another interesting result is the positive relationship between the number of people with whom individuals socialize and variables such as the number of people living more than one hour's travel away, and the number of neighbors in the social network. This relationship suggests that the propensity to socialize cannot be explained only by physical distance but needs to consider aspects of the individuals' social behavior, more explicitly who composes their social networks.

This distance effect, combined with the importance of neighbors suggests a potential ''glocalization'' effect in face-to-face social activities (Wellman 2001); that is, intense social activities both at near and far spaces, although the linkage with other ways of social interaction remains to be seen. Precisely the effect of most ICT media on the overall propensity to perform social activities suggests a complementary effect at most, but not a supplementary effect for the overall sample. The exception is instant messaging, which needs further cohort study. Finally, results indicate differences in the effects of different media, tie strength, and frequency combinations, which suggest interesting venues to further analyze the effect of ICT in social activity–travel behavior. Overall, the exercise of exploring these several attributes and their effect in social activities show that studying the social context can help to better understand behavior in physical space and the individuals' propensity to perform social activities.

Although the empirical model has not rejected the ideas elicited from the conceptual model, a number of aspects need further research. First, the effects discussed here need to be further controlled by personal and socioeconomic characteristics, and possibly time use and scheduling context, in order to assess whether they can be generalized or depend on specific personal contexts. Second, personality needs to be explicitly incorporated; in fact, the Connected Lives Study includes indicators of extroversion that can be incorporated in further analysis. Third, the opportunities to engage in the social project need to be explicitly studied, exploring the differences in the behavioral processes between hosting/visiting and bar/restaurant activities; this exercise would require a more explicit and detailed consideration of space. Finally, since the empirical model discussed here uses aggregated measures of the social network's composition and ICT communication patterns, a more disaggregated data analysis needs to be developed, which could include in more detail the specific characteristics of each ego-alter interaction. This kind of data were collected in the

interview stage of the Connected Lives Study, and can serve to illuminate and further test the questions raised here.

Overall, explicitly incorporating social networks into activity–travel modeling provides a rich set of insights into social activities and their embedded behavioral processes, potentially helping to better understand the propensity to perform social activities in particular, and the general activity–travel behavioral process in general.

Acknowledgements The authors would like to thank Barry Wellman, Bernie Hogan, Jeffrey Boase, Kristen Berg, Jennifer Kayahara, and Tracy Kennedy, members of the NetLab group at the Centre for Urban and Community Studies, University of Toronto, with whom the data used in this paper were collected. Thanks also to Ilan Elgar, K. Nurul Habib, Antonio Páez, Matthew Roorda, and three anonymous referees for their comments on previous versions of this work. Finally, the authors would like to acknowledge the financial support received from the Social Sciences and Humanities Research Council of Canada (SSHRC), Major Collaborative Research Initiative (MCRI), and Regular Research Grant.

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