Inter-personal interactions and constraints in travel behavior within households and social networks

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Published online: 17 May 2013
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The need for modeling interactions between agents and the impact these interactions can have on activity–travel patterns has received much attention in recent years, with much of this attention focused on interactions between agents of a single household. Eric Miller has stated that, “much of the behavior of interest (in integrated urban modeling) involves the interaction among people” (Miller 2006). The first such effects to be studied and incorporated in travel demand models were interactions within households, for example serving dependents, modeling joint trips, task allocation and joint scheduling (Miller and Roorda 2003). Several of these features are now common aspects of activity-based models implemented by planning agencies, e.g. the CT-RAMP family of models (Vovsha et al. 2010). However, it is clear that many types of interaction behavior can occur outside of the household context and that even within the household many types of interaction behavior still remain to be studied and modeled. The effects of agent-interactions and the constraints on behavior that they can impose are still only partially understood. In addition, while much work has been done on understanding the basic characteristics and formation processes of social networks outside of the household and their impacts on aspects of activity–travel (e.g. Habib and Carrasco 2011), comparatively little has been done to integrate these findings into activity-based model frameworks as suggested by Arentze and Timmermans (2008). More theoretical understanding of the behaviors that govern agent interactions, both within and outside of the household, and especially on how information exchange and decision-making occurs within agent groups is needed. In other words, understanding more fully how agents cooperate, negotiate, learn from and plan with each other, and more importantly, understanding how these interactions can be modeled and simulated, is a pressing research

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need in integrated urban transportation modeling. The papers presented in this issue address aspects of agent-interactions both within and outside of the household context and present important findings for advancing the state of agent interaction modeling.

This Special Issue represents a mutually-beneficial collaboration between *Transportation* and the Transportation Research Board (particularly its Standing Committees on Travel Behavior and Values and Demand Forecasting), and publishes six outstanding papers originally presented at the 2013 Transportation Research Board Annual Meeting. These were further reviewed, based on the publication standards of *Transportation*, and selected due to both their high long-term research value and their focus on the same theme—Travel Behavior Interactions within Households and Social Networks. Collectively, they represent the state-of-the-art in behavior research on the theory of inter-personal constraints in travel decision-making, modeling the impact of such constraints on individual and system-wide travel demand patterns, and planning applications in the real world. The first two papers explore inter-personal interactions beyond just the household level, and explore the complex social contacts within personal networks and their influence on travel; an emerging and important area of travel behavior research. The remaining four papers focus on joint travel decision-making within multi-member households with rather original and significant contributions.

The opening paper, co-authored by Deutsch and Goulias and titled “Decision Makers and Socializers, Social Networks and the Role of Individuals as Participants”, studies the roles individuals fulfill in decision-making within a social network, focusing mainly on the location choice aspect of joint activities. This was done through internet-based data collection methods to determine not only the types of social networks an individual participates in, but also the roles that the individual fulfills in decision making within the various groups. In order to accomplish this, the authors develop a set of clustering models to first identify latent social network characteristics and participation clusters and then to identify latent decision-making type clusters. Such knowledge will be a critical factor as activity–travel demand micro-simulation models focus more on representing joint-travel decisions for both intra- and inter-household groups and the negotiations that take place in making multi-agent decisions.

Moore, Carrasco and Tudela, in a paper titled “Exploring the Links Between Personal Networks, Time Use, and the Spatial Distribution of Social Contacts”, investigate the relationship between joint social-activity–travel characteristics and the social context of the participants in the activity. Time use and social networking data were used to construct a series of structural equation models relating joint activity characteristics to the characteristics of the reporter of the activity and the other involved individuals. The work adds to the understanding of joint-social activities, and how the different characteristics of the involved individuals’ impact the observed activity characteristics. The authors find interesting relationships between the spatial–temporal characteristics of activity and the individuals involved in them, which possibly represent the outcomes of the negotiated decision-making process, such as the distance to the activity increasing with the number of other involved individual and the distance that those individuals have to travel to the activity. So, while the first paper looks at the decision-making process, this paper focuses on the outcomes. Both papers try to move the understanding of joint-activities out of a specific focus on agents in the same household to a wider social network context.

In a paper titled “Tour-based mode choice of joint household travel patterns on weekend and weekday”, Ho and Mulley employ a typology of joint household tours to consider the tour structure as well as various patterns of joint household activities and shared ride arrangements. Specifically, nine different types of joint tours are identified.

Using this typology, a nested logit model of tour type and mode choice is estimated to perform an empirical analysis of the determinants of tour structure and mode choice. Two different models are estimated—one for weekdays and the other for weekends—using empirical data from the Sydney Household Travel Survey. The empirical findings from the two models are used to compare and contrast the nature of intra-household interactions in joint travel between weekdays and weekends. The consideration of different patterns of intra-household interactions in the typology of joint tour patterns certainly helps in a better characterization of tours. Another important contribution of this paper is that it analyzes joint travel patterns for both weekdays and weekends while most previous publications on this topic were focused on weekday behavior. The discussions on differences between weekdays and weekends in terms of proportion of joint travel, shared activities, and Value of Time (VOT) are important and new findings along these dimensions of travel behavior are welcome.

In “Multi-state super-network framework for the two-person joint travel problem”, Liao, Arentze and Timmermans employ the concept of activity-based super-networks to address joint travel issues, and in this first exercise consider the interdependencies of mode and transit route choices between two interacting household members. This study assumes cooperative decision making, in which both decision-makers interact to define the activity/travel plans and minimize the resulting utility. The solutions to this joint utility maximizing problem, based on solution algorithms proposed by the authors, may also have applications beyond transportation modeling and can be useful for researchers of joint travel routing systems also. Modeling joint travel at the route and mode choice level, which is the focus of this paper, would become even more feasible in the near future as GPS-based and smartphone-based data sources allow for explicit tracking of travel trajectories for joint travel model calibration and validation. The super-network approach only considers feasible alternatives with a network representation, which avoids a number of inconsistencies that might otherwise arise in non-super-network type representations of alternatives. In addition, the first wait time at transit stops is treated by the authors as a random variable with a known distribution. In general, considering random travel times is an important direction in travel behavior research that relates to descriptive behavior representation, risk assessment, and travel time reliability. This treatment adds additional methodological value to this research.

The next paper, titled “A Model for Work Activity Schedules with Synchronization for Multiple-Worker Households”, coauthored by Gupta and Vovsha, builds on the understanding of intra-household interactions, specifically on synchronizing the scheduling of the work tours in households with multiple workers. The model differs from previous work in that it is not focused explicitly on joint-trip making but rather on how individuals jointly schedule their own work tours with other household members; a phenomenon usually modeled as independent to the individual. To explore synchronization effects, the authors estimate a hybrid choice-duration model which includes departure and return-home time choices for both workers. The authors find that worker schedules are indeed dependent and are often organized in such a way as to maximize the overlaps in non-working times and to synchronize the morning and evening commute when possible. These results may have significant implications as, similar to other social networking effects, individuals may have different responses to policy interventions due to the additional constraints, than would be expected based on purely independent models.

Finally, the paper by Seo, Ohmori, and Harata, titled “Effects of household structure and accessibility on travel”, analyzes the relationships among household structure, accessibility and travel patterns. This study contributes to a vast literature on the

relationships between accessibility and travel behavior by exploring how the effect is mediated by household structure. For each activity type, four models are estimated separately: elderly with vehicle, non-elderly with vehicle, elderly without vehicle and non-elderly without vehicle, which is justified statistically by comparison of log-likelihood at convergence with the pooled model. This paper also questions the common hypothesis that higher accessibility always leads to more travel, with some opposing evidence presented in descriptive and quantitative analyses. Findings suggest that household structure is an important factor influencing tour/trip frequency besides accessibility. It should also be noted that the accessibility indicator adopted is the logsum from a destination choice model that considers transit service coverage, frequency and service hours.

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