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Transportation habits: Evidence from time diary data

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ABSTRACT

The interdisciplinary Time Use Observatory workshops learned that transportation research and social sciences strive for the same multi-day time-diary data in order to make interferences about human habitual (travel) behavior. It also is learned that when it comes to the mathematics and analytics involved both disciplines are miles apart, though both with founded reasons to do so. In brief, transportation research relies on modeling to make predictions whereas social sciences apply statistics to their data to draw conclusions. In line with the interdisciplinary philosophy of the Time Use Observatory workshops, this contribution aims to communicate 30 years of experience in analyzing time-diary data. To do so, it demonstrates the latter by calculation transportation habits and aims to illustrate that multi-day time-diary data might have some additional benefits for computing temporal regularities. It shows that including a flexible notion of both regular tempo (or recurrence) of activities (e.g. every day) and regular timing of activities (e.g. always at 6 am) produces different results for different kind of transportation purposes. It also shows that these calculations using multi-day time-diary data result in an indicator at the individual level that can be analyzed in terms of socio-demographic and socio-economic characteristics. This work concludes that partitioning temporal regularities in regular reoccurrence and regular timing is a crucial element of (transportation) habits.

1. Introduction

In transportation research there is a surmounting interest in individual travelers behavior along which travel demand forecasts can be simulated. Many studies try to complement earlier findings to eventually color the conceptual framework of Hägerstrand (1970) which departs from the fundamental notion that transference implies movement in time and space and which led to study the temporal and spatial dimension of transportation simultaneously in so-called 'time–space diagrams'. A fundamental task within this conceptual framework is surfacing the spatio-temporal constraints – capability, coupling, and authority constraints – that give direction to the decision individuals make (Axhausen and Gärling, 1992; Lenntorp, 1976; Neutens et al., 2014; Schlich and Axhausen, 2003).

Given these constraints the key element in understanding human behavior is to reveal activity patterns that are being repeated day by day, or put differently, to differentiate between randomness in human behavior and daily activities that are rather fixed and hence predictable (Neutens et al., 2012; Song et al., 2010). Estimating this so-called day-to-day variability in individual travel behavior received a large attention in many studies illustrating the temporal stability of activity-travel decisions and hence the existence of a repeating sequence of activities (Kang and Scott, 2010; Kitamoura and Van der

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Hoorn, 1987; Pas and Koppelman, 1987; Pas and Sundar, 1995; Roorda and Ruiz, 2008). This leads Arentze and Timmermans (2004) to speak of a *skeleton schedule* showing long-term commitments, whereas Gärling et al. (2001) speak of *script-based* decisions arguing that choices are less deliberate and behavior degenerates into an automatically triggered sequence of activities that is relatively fixed (see also Gärling et al., 2001; Ronis et al., 1989; Triandis, 1977; Verplanken and Aarts, 1999). As a result scholars conclude that past behavior has a much higher impact on current decision-making than preferences or attitudes (Kitamoura and Van der Hoorn, 1987; Oullette and Wood, 1998). Previous activities are to be seen as an important 'constraint' to what individuals potential can engage in (Pendyala et al., 1998). Hence predicting, modeling, or simulating (travel) behavior involves identifying activity-based habits or temporal regularities.

1.1. Temporal regularities

Many activities follow a pattern of recurrence within a certain time cycle, or *boundary walls* (Yamamoto et al., 2004): we sleep and eat every day, travel to and from work every workday, hit the gym once a week, receive a paycheck every month, have seasonal holidays, and celebrate our anniversary every year. This recurrence of activities provides our daily life with a degree of (temporal) order, but also leads to congestions in both time and space (Susilo and Kitamoura, 2005). Regular school hours make parents crowding at the school gates at the same time. Standard contractual working hours (e.g. nine to five) feed the morning and evening congestions on highways. And temporal norms on going out create crowded and cozy atmospheres in the city centers. As the examples show, often the spatial–temporal constraints are intertwined. Authority constraints, such as school hours, affect capability constraint, such as dropping of your kids at school in time, and in turn affect coupling constraint, such as the need to get up at a certain time in the morning in order prepare yourself and the children for departure. The embeddedness of daily activities (Lewis and Weigert, 1981) not only causes constraints to confine an activity directly, but also indirectly confines seemingly unrelated activities. A dinner party in the evening causes one to depart for work betimes in order to get the daily work done and be home in time.

Dealing with these direct and indirect impacts of these constraints means that daily life, as such, is composed of daily regularities that turn into habits in case these sequences of behavior are repeated frequently (Huff and Hanson, 1986; Pas, 1987). Habits, to us, are not to be understood in the non-reflexive consciousness, physical terms of the behaviorists (cf. Watson, 1913) but as a set of broad, durable dispositions (cf. Baldwin, 1988; Camic, 1986, 1988) that result in regular behavior (Gershuny, 2000). Temporal regularities, then, are rigid schemes of daily activities giving daily behavior its predictability and providing the fundamental assumption for modeling and forecasting.

It is the spatial–temporal structuring and congestion creating principle of our daily activities that both legitimize and enable the study of temporal regularities. The phenomenon of temporal structures leading to temporal and spatial congestions is subject to research of many academics as well as policymakers. Some communities in Italy started to impose shifting ending hours of primary schools to prevent congestion of roads. Many companies are juggling with flexible working hours and teleworking, to help their employees, for example, avoid traffic jams. And those responsible for spatial planning try to control the flow of people in city centers by creating pedestrian areas.

1.2. Multi-day time-diary data

This planning, controlling and forecasting of travel behavior based on the identification of daily travel patterns is one of the main goals of transportation research (often in function of social and economic trends and changes in transportation systems and accessibility of services) (Neutens et al., 2012). In other words, transportation research aims at identifying temporal regularities in travel behavior or, what we will call, transportation habits. Transportation habits are the conduct that results in behavior such as being on the roads every morning at 6 am to avoid traffic jams, or the fixed, daily trajectory of leaving work, picking up the kids at school, have a quick stop at the grocery store, and head back home. As we will discuss further on, transportation habits are based on three assumptions: (1) traveling has a purpose or *sequential activity* (e.g. grocery shopping), (2) traveling has regular reoccurrence or *tempo* (e.g. one travels every day), and (3) traveling has a regular *timing* (e.g. if one travels, one travels always at 6 am).

The first assumption of *sequential activity* is one of the reasons transportation research shifted toward time diary data (Pendyala et al., 2002). For decades there has been made a shift from a trip-based to an activity-based approach to travel looking at travel as goal-driven means rather than a goal in itself (Ettema and Timmermans, 1997; Jones et al., 1983, 1990; Kitamura, 1988; Pas, 1985; Van der Hoorn, 1979). This implied existing travel surveys to include more details on travel purposes as well as on individual and household characteristics. Still a sole focus on travel activity, despite all its details, did not suffice, since travel activities are the result of time-use decisions in a continuous time domain (Bhat and Koppelman, 1999: 119) or embedded in other activities (Lewis and Weigert, 1981). A continuous activity-diary, not exclusively focused on travel activities, is argued to be an ideal method for collecting travel information (Stopher, 1992).

Such a continuous activity-diary already exists for a long time in socio-economic research and many countries all over the world collect these so-called time-use data among a random population sample (mainly in function of construction social and economical indicators). Time-use data are gathered through a time-diary, which is an activity-based registration method, and although the main focus is not travel *in se*, they can be a useful source for modeling transportation and identifying travel patterns. At least it is proved that recording travel within the daily context of activities in time-diaries makes travel data less prone to memory flaws (Clarke et al., 1981).

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