Results of the Utracs Internet-Based Prompted Recall GPS Travel Survey: Empirical Analysis of the Activity Planning Process

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ABSTRACT

This paper presents the results of an internet-based prompted recall activity-travel survey using GPS data collection combined with a short activity preplanning and scheduling survey. Besides collecting traditional activity-travel diary data, this survey also collects basic information about activity planning and the scheduling process. Since aging is a growing concern among transportation planners, this survey has a special focus on the elderly population with half of the survey sample consisting of elderly households. Respondents carried a portable GPS device for 14 consecutive days and at the end of each day uploaded the collected data to a website where the activity-travel survey questionnaires were answered. Results indicate that the quality of the data collected is good and that the response rates were satisfactory considering the commitment involved in participation. The results reinforce previous findings that GPS surveys have an improved ability to capture trips which are frequently under-reported and provide valuable data about the activity planning and scheduling process itself.

The survey, while collecting the standard household travel survey type questions, also collected data regarding the activity planning and scheduling process. Data regarding the planning process, including spatial, temporal and interpersonal flexibilities and planning horizons for the activity itself as well as plan horizons for various attributes of the activity, were all reported during the prompted recall portion of the survey. Altogether, the survey should provide important information regarding the nature of the activity-travel planning process.

Keywords: Activity-Travel Survey, GPS Data Collection, Prompted Recall, Activity Planning

INTRODUCTION

Activity-based microsimulation models of the activity-travel scheduling process, such as ALBATROSS (1), TASHA (2) and others, have been developed in order to generate a more policy-sensitive and theoretically satisfying depiction of travel demand, and have generated a growing interest in understanding the planning and scheduling process. The drive to more fully understand the activity scheduling process led to early empirical studies and new theories of the planning process (3, 4, 5) and to data collection efforts describing the process (6, 7, 8, 9, 10, 11).

However, the dynamics of the activity scheduling process have only begun to receive attention in both data collection and modeling effort. The CHASE© survey (7) was the first attempt to collect data regarding the "Plan Horizon", a concept discussed at length by Doherty (12). The plan horizon can be thought of as the "duration of time between the planning and execution of an activity." This survey collected planning time horizons for activities planned and scheduled throughout a one-week period. However, as Doherty (12) recognized, activity planning involves the planning and scheduling of multiple attributes and so any response to a query about a single plan horizon for an activity may be limited. This limitation motivated the development of the UTRACS survey (13), which was designed to collect data of this type for use in the ADAPTS (Agent-based Dynamic Activity Planning and Travel Scheduling) scheduling process model (14).

Motivations for Attribute Planning Order/Plan Horizon Models

Choice decisions for activity attributes in a typical travel demand model, whether it is the choice to add an activity, the choice of mode, location, etc., can generally be formulated with the probability for any choice as a function of the individual and household demographics, institutional, household and scheduling constraints, land-use patterns, network conditions, etc. However, in order to account for scheduling dynamics, a new formulation for choice probability is needed which has two important differences. First, the probability is time dependent, i.e. the probability of making the choice is calculated at a specific time in the simulation as opposed to within a fixed sequential order of schedule construction, so the probability of making a mode choice depends explicitly on when that decision is made, so decisions for the same activity can be different depending on when they are made due to changing constraints, new information, etc. Second, in a typical scheduling model, the activity schedule is built up in a sequential manner, typically scheduling around a core of skeletal or routine activities (2). This means that schedule constraints are determined based on the timing of the previously planned activity and any routine activities already in the schedule. The new formulation explicitly states that the choice probability is dependent on the schedule and existing constraints when the choice is made. The motivation for using a dynamic scheduling process is best exemplified with a planning/scheduling example:

- Situation 1. A person is planning to meet friends for lunch at 1PM. She realizes she has some shopping to do, and decides to go shopping at nearby store

beforehand. In this case, the previously planned activity of eating lunch dictates the planning of the shopping activity.

- Situation 2. A person is planning to do some shopping in a retail area. She decides to call some friends to meet for lunch nearby after her completion of the shopping trip at 1PM. Here the already planned shopping trip has constrained the choices about the eating out activity.

In both examples shown, the activity schedule looks identical: shopping, then a lunch with friends at a nearby restaurant. But in each case, how the schedule was determined was very different. Anything altering the planning process could result in an entirely different activity pattern. To relate this to potential travel demand management policies, imagine a road pricing regime was put in place which makes the cost of travel such that planning a trip to the store is undesirable, but travel for eating a meal with friends is still desirable. Under this new pricing policy Situation 1 would result in two activities since the shopping trip is in the vicinity of the restaurant, while Situation 2 would result in no activities as the impulsive decision to go to the restaurant would never be made as the initial shopping trip is no longer undertaken. It is critical to note that any model that does not explicitly take into account planning order cannot represent the distinction between Situation 1 and Situation 2, as the only difference lies in the order and degree of impulsiveness with which the activities are planned. In order to understand and model the dynamic planning process new sources of data regarding when activity and activity attribute planning decisions are made are required.

SURVEY METHODOLOGY

The survey documented in this paper consists of a prompted recall activity-travel survey which was completed on a daily basis by respondents after the completion of travel for the day over a period of two weeks. This section discusses implementation details of the survey Full details of the design and pilot-testing of the survey instrument can be found in Auld et al. (*13*). Details about the initial implementation of the survey, including a descriptive analysis of the respondents and a detailed assessment of the data quality regarding issues such as sample bias, fatigue, conditioning, etc. can be found in Frignani et al (*18*).

A new internet-based prompted recall study, the Urban Travel Route and Activity Choice Survey (UTRACS), was developed to specifically elicit information of planning horizon data from respondents. This survey utilizes GPS data loggers to collect activity-travel survey data from individuals, which is then uploaded to a website for analysis. The uploaded GPS trace data is then used to automatically generate a prompted recall survey which individuals complete, filling in the details such as the type of the activity, who was involved in the activity, reasons for location choice decisions, activity timing and flexibility decisions, as well as mode and route choice details and reasons for their selection. In addition, for all attributes individual planning horizon details were collected. For example, when a survey participant was asked about the location choice for the activity, an additional question such as “When did you make the decision to visit this location?” was asked. In this way, planning horizons

for all activity attribute decisions were obtained. An example of the UTRACS questions for an activity episode is shown in Figure 1.

The activity planning horizon questions asked in the UTRACS survey are as follows:

- When did you first think about PERFORMING this particular activity?
- When did you decide WHO was involved?
- When did you choose this LOCATION?
- When did you decide on the activity START TIME?
- When did you decide on the activity DURATION?
- When did you decide to use this MODE(S)? (For travel episodes)

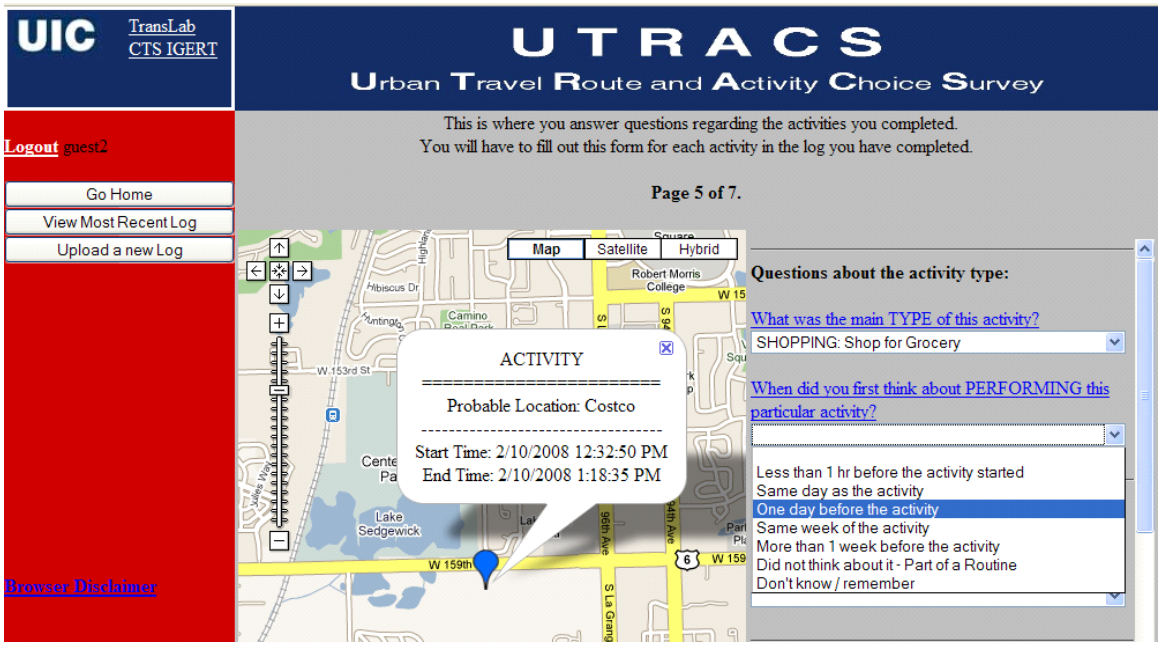


Figure 1. Example of UTRACS Activity Episode Questions

The following answers are offered as choices for each planning question:

- Less than 1 hr before the activity started
- Same day as the activity was performed
- One day before the activity
- Same week as the activity
- More than 1 week before the activity
- Did not think about it - Part of a Routine
- Don't know / remember

Individuals first correct and verify the log of activities extracted from the GPS data collected on a personal GPS data logger. The data is uploaded directly to the site when the data logger is connected to the user's computer and processed automatically into activity and trip episodes which are then verified. After the entire day's log is corrected the individuals answer questions about the attributes of the activity and trip episodes, which in addition to the planning horizon questions include the activity type, party composition, location name, travel mode, flexibility questions for many of the attributes (i.e. "Where these other(s) required to be involved in the activity", "How many locations did you consider", "How flexible was the start time", etc.), and many others. The survey respondents' answer these

questions for each episode until the activity-travel pattern is completed for each day of the survey, providing a wealth of both activity-diary-type data as well as the planning and process data required for advanced scheduling process modeling.

SURVEY SAMPLE DESCRIPTION

Data collection for the survey was begun in April 2009 and ran through February 2010. A total of 110 individuals in 102 households were surveyed. Forty-nine percent of respondents were seniors - 65 years-old or over - and the other 51% were between 18 and 65 years-old in order to assess potential differences in activity-travel planning strategies between the elderly and non-elderly. Data on 2,610 trips and 2,888 activities was collected from the seniors and on 3,020 trips and 3,290 activities from the younger respondents, totaling 5,630 trips and 6,178 activities. The trip rate was 4.3 trips per person per day, which indicates an above average number of trips when compared to the reference trip rate for personal travel suggested in (19), 3.4 trips per person per day. This result is consistent with the finding of previous studies which demonstrate that GPS surveys have improved ability to capture trips which are frequently under-reported in other types of survey. The overall non-mobility rate in the survey was 9.35%, which was within the acceptable range (20). This result is also similar to other long duration surveys such as the six-week Mobidrive survey which was considered to have accurate non-mobility levels (20). The data was validated against reference data from the 2007 ACS and a recent household travel survey conducted in Chicago, and the results shows that the data contain an acceptably low level of response bias in terms of both demographic and activity-travel characteristics. A full description of the current data collection effort, including sample validation, bias estimation, recruitment, etc., can be found in Frignani et al. (*18*).

A summary of the trip and activity attributes collected is available in Table 1. The attributes are compared against those observed at the Chicago Metropolitan Agency for Planning (CMAP) 2008 Travel Tracker Survey (21). The Travel Tracker is a multimode household travel and activity survey which was collected from 10,552 households in a 1 or 2-day survey on the Chicago metropolitan area. Telephone interviews were the primary data collection mode. Over 23,000 individuals participated in Travel Tracker, out of which 4,315 were ages 65 and over. Table 1 displays the average number of activities by type per person per day and the percentages of accompanying persons, travel mode, trip duration, daily travel time, trip distance and automobile and bus speeds for the elderly and non-elderly subsets. The trip distance available on the Travel Tracker Survey is the straight line distance from one activity to the next. The reference values for trip distance displayed in Table 2 were increased by 20% to estimate the real distance traveled. Average speeds were calculated as trip distance (estimated real trip for CMAP survey) divided by travel time.

TABLE 1. UTRACS Activity Survey Results and Comparison to Travel Tracker

Attribute	Value	CMAP Survey: Elderly	UTRACS: Elderly	CMAP Survey: Non-Elderly	UTRACS: Non-Elderly
Average Number of Activities by Type per Person-Day	Change transportation	0.02	0.11	0.06	0.07
	Healthcare	0.12	0.16	0.07	0.14
	Social/leisure/recreation	0.34	0.65	0.35	0.45
	Meal	0.22	0.33	0.26	0.23
	Other	0.41	0.60	0.54	0.47
	Personal Business	0.15	0.24	0.13	0.15
	Work	0.19	0.05	0.77	0.66
	Religious/Civic	0.10	0.22	0.06	0.06
	School	0.00	0.02	0.03	0.04
	Shopping	0.55	1.08	0.48	0.73
Accompanying Persons	Alone	68.10%	55.71%	70.20%	65.14%
	With Others	31.90%	44.29%	29.80%	34.86%
Share of Travel Mode	Auto drive	71.38%	72.35%	72.21%	78.28%
	Auto passenger	16.91%	13.70%	10.32%	11.85%
	Bicycle	0.41%	0.36%	1.03%	0.41%
	Bus	1.89%	5.35%	1.93%	1.01%
	Commuter rail	0.38%	0.76%	1.80%	1.15%
	Light rail	0.29%	0.81%	1.57%	0.92%
	Walk	7.29%	6.31%	9.47%	5.42%
	Other	1.46%	0.36%	1.66%	0.97%
Share of Trip Distance	0 to 5 kilometers	55.40%	51.30%	49.70%	55.17%
	5 to 10 kilometers	21.00%	22.38%	18.10%	14.58%
	10 to 20 kilometers	13.50%	14.97%	15.20%	12.92%
	20 to 30 kilometers	4.90%	5.34%	7.10%	7.01%
	30 to 50 kilometers	3.40%	4.20%	6.10%	5.90%
	More than 50 kilometers	1.60%	1.81%	3.30%	2.40%

Table 1 reveals that respondents reported a higher activity rate per person-day for almost all types of activities. Noticeably, at least 50% more shopping activities were reported in this survey than in the reference. The automated recording and detection of activities made possible that minor shopping activities such as stopping on the way and buying a drink be reported at a higher frequency. The same effect occurred to changes in transportation. Because these are usually short activities and people tend to think they are unimportant, the automated survey mode yielded a lot higher rate of this type of activity than that observed in the reference, both for elderly and non-elderly population. Social/leisure/recreation and, specifically for the elderly, civic and religious activities were also observed in a higher rate here. For the accompanying persons, trip distance and travel mode responses this survey had comparable shares to the Travel Tracker.

ACTIVITY PLANNING AND SCHEDULING OBSERVATIONS

In addition to the basic activity-travel survey data collected, activity attribute plan horizon data was also obtained from the survey. The plan horizon data obtained from the UTRACS survey respondents is shown in Table 2 below. The table shows the total plan horizon observances for both the overall activities, and the five main activity attributes as well as the percentage of each plan horizon value within each activity/attribute. Note that there are fewer observations for the "Who With" and "Mode" attributes, as the "Who With" plan horizon was not asked for activities conducted alone, and the "Mode" plan horizon was only asked when a preceding trip was present (no mode planning is given, for example, when the individual starts the day at home). In general, the aggregate results show that overall just under half of all activities are planned on the day of execution, with the rest divided almost equally between preplanned (previous day – weeks before) and routine activities. The party composition plan horizon distribution follows almost a similar distribution, while location and mode are generally more routine and the start time and duration are more impulsive than the overall activity plan horizon.

TABLE 2. Activity and Attribute Planning Horizon Responses

	Activity	**Mode***	**Who With****	**Location**	**Start Time**	**Duration**
< 1 hr before	22%	14%	21%	17%	30%	47%
Same Day	22%	14%	20%	13%	21%	9%
Same Week	13%	12%	13%	10%	8%	4%
Preplan	7%	6%	9%	6%	5%	3%
Routine	29%	31%	28%	46%	28%	28%
Missing/DK	7%	23%	7%	7%	9%	10%
Total	**6178**	**5236**	**3309**	**6178**	**6178**	**6178**

* Only asked when a trip to an activity occurred.

** Only asked for activities conducted with other individuals.

A potentially more informative way to view the planning time information is to see how the attribute plan horizons vary by the stated overall activity plan horizon, in order to evaluate any differences between when the respondents feel that an activity was planned and when the different attributes of the activity were actually decided on. These comparisons are shown in Figure 3, where the percentages of each plan horizon for each attribute are shown for three different aggregated activity plan horizons – Same day (combination of "< 1 hr" and "Same Day"), Preplanned (combination of "Same Week" and "Preplan") and Routine.

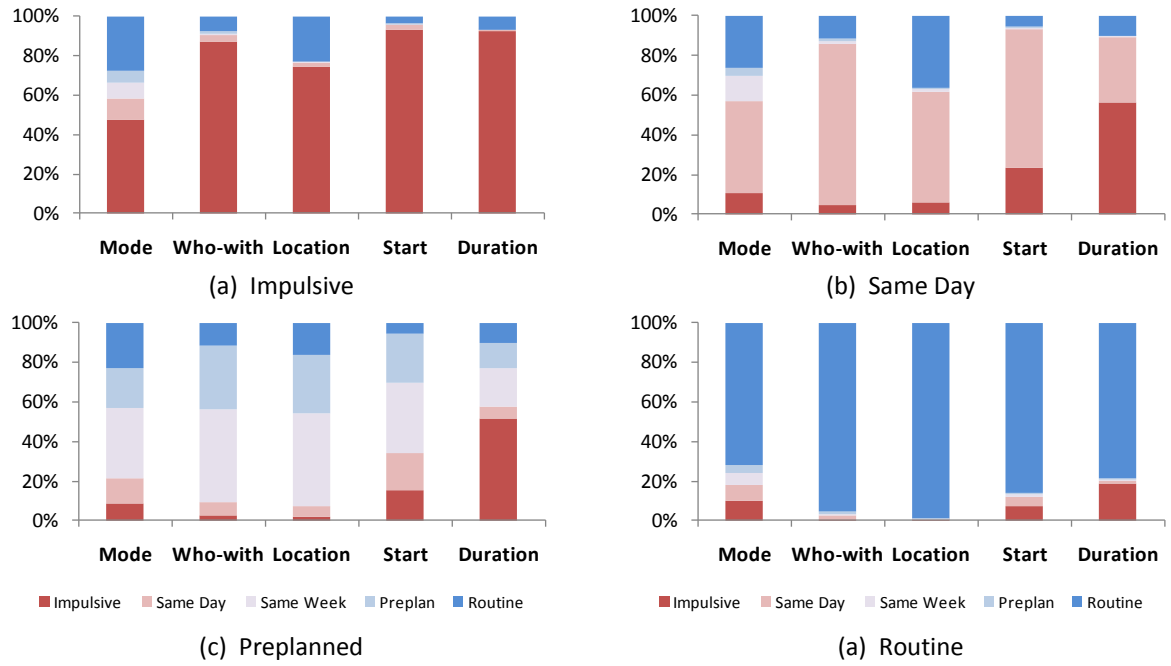


Figure 3. Activity Attribute Planning By Overall Activity Plan Horizon

The figure shows that the individual activity attribute planning horizons are distributed about as expected. For "impulsive" and "same day" planned activities, most of the activity attributes are also planned on the same day, with a significant percentage of the attributes also being considered routine, especially for location and mode decisions. This makes sense, as there should most likely not be many "preplanned" attribute choices made before the activity was decided on, i.e. a person would not be likely to say "I think I'll go somewhere at 9a.m. in two days" without having any idea of what they would be engaging in. An exception to this is for the mode choice, where due to trip-chaining the person may have already known they would be in an auto-tour, for example, and impulsively decided to stop for an activity. In this case the auto-mode could have been preplanned. The high level of routinely planned location and mode choices shows that even a lot of supposedly "impulsive" activities are still occurring at least in some aspects in a routine pattern, for example, an impulsive stop at a favored coffee shop on the drive to work.

For the "preplanned" activities, the results show that indeed, most of the attributes are also "preplanned" (either same week or longer), with a smaller percentage of routine activities. These activities therefore are more likely to be planned as stand-alone trips requiring separate attribute planning rather than impulsive stops at routine locations along routine trips. The party composition, location, and travel mode are all almost entirely preplanned. The timing decisions, however, remain somewhat impulsive, with over 35% of the start time decisions and almost 60% of the duration decisions occurring on the same day as execution, showing the flexibility that remains in planning these decisions. In fact the duration of a preplanned activity tends to be quite flexible, with many decisions made during the execution of the activity.

Finally, the analysis of the "routine" activities is very much as expected. Almost all attributes of a routine activity are also reported as routinely planned, with some flexibility in the timing, duration and mode choice for these activities. Most activities classified as routine

tend to be of the "mandatory" activity type, such as work, school, etc. which usually occur alone and at a fixed time and place. These tend to be long established parts of the activity travel pattern where the attribute decisions have already been made, although again, some of the timing decisions are still made impulsively, especially for the duration choice.

Another way to analyze the planning horizon data is to compare the plan horizons for activity attributes with each other for the same activity; in other words, to look at the order in which the attributes are planned. Since the number of potential activity planning orders is fairly large for five attributes (3,125 possibilities including simultaneous planning), the current analysis is limited to evaluating the first activity in the planning sequence. The initial analysis is shown in Table 3 below.

The table shows all of the activities split into routine versus none routine first planned activities, then categorizes the activities by the number of attributes which were planned first, ranging from 1 to 5 (where all of the attributes where planned simultaneously). Then, each row of the table shows the percentage of time that each of the five activity attributes was planned first for the given routine and number of first planned activities. For example, the first row of the table shows that of all the activities, 1,227 were planned with only one attribute decided first where that attribute was routine. In 6% of these cases, the first attribute planned was the party composition, in 52% of the cases the location was selected first, etc.

One encouraging result of this analysis is that there appears to be a fairly small amount of activities where all of the activity attributes were selected at the same time; in fact, less than 7.5% of total activities were planned in this manner. This shows that at least the survey respondents potentially thought about the planning of each attribute separate from the rest, rather than assigning the same plan horizon to all attributes in most cases (it is recognized, however, that planning all attributes at the same time is not necessarily erroneous).

TABLE 3. Analysis of First Planned Activity Attribute

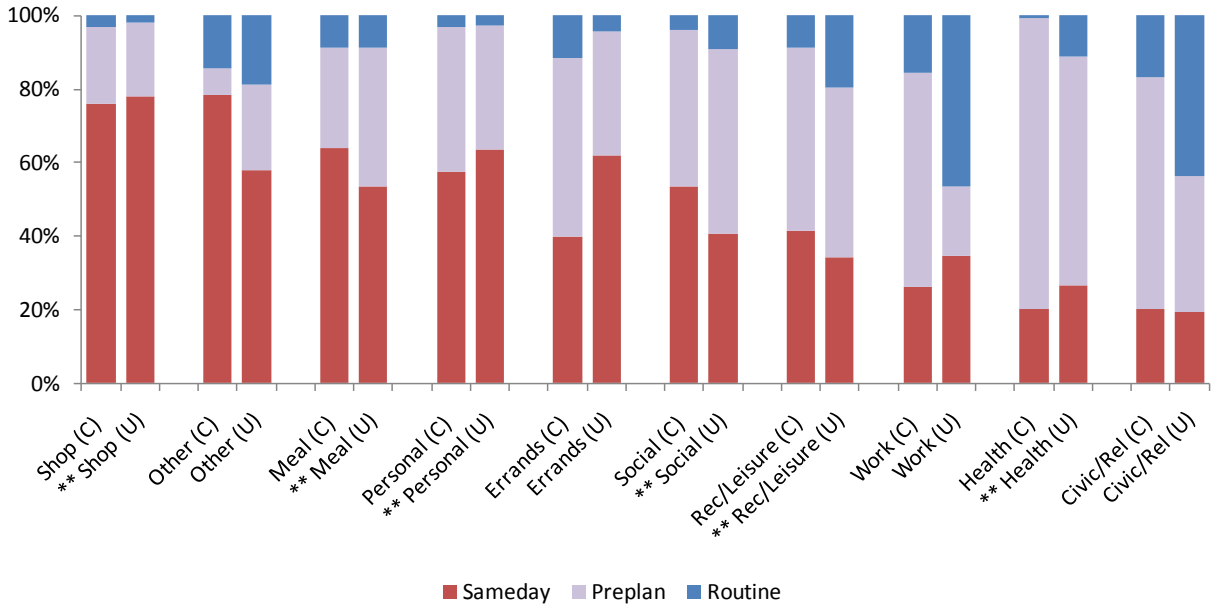
1st Planned Attribute Routine?	Number of attributes planned 1st	Count*	% of Activities With Attribute Planned First				
			Mode	Who*	Location	Time	Duration
Yes	1	1227	33%	6%	52%	2%	7%
	2	530	46%	22%	75%	31%	26%
	3	736	28%	23%	96%	77%	77%
	4	750	70%	44%	99%	95%	91%
	5	245	100%	100%	100%	100%	100%
	Total	**3488**	**47%**	**27%**	**78%**	**49%**	**49%**
No	1	508	55%	14%	23%	6%	2%
	2	341	34%	38%	80%	38%	9%
	3	604	40%	49%	96%	85%	30%
	4	636	64%	86%	100%	99%	52%
	5	183	100%	100%	100%	100%	100%
	Total	**2272**	**54%**	**54%**	**79%**	**65%**	**32%**

* Excludes activities where the overall activity plan horizon was missing or unknown.

The results show that the location attribute is most frequently planned first, especially when the location is a routine location, followed by the mode, timing and duration and finally the party composition. It should be noted, however, that the party composition plan horizon appears low in this table due to the fact that this attribute is not recorded when the activity is performed alone. This compromise in the data collection was made due to initial respondent annoyance on answering "when did you decide who to perform this activity with?" when they did not in fact engage in the activity with anyone. Pilot test results showed that this question was answered either with "routine" or "don't know/missing" in almost all cases, and so was removed from the survey and recorded as "performed alone" when a solo activity was entered. An interesting result shown in Table 3 is that activities where the attributes are non-routine exhibit a higher degree of simultaneity in planning, with more activities having two, three and four attributes planned at the same time, when compared to activities with a routine first attribute.

COMPARISON OF PLANNING OBSERVATIONS TO OTHER DATA SOURCES

In addition to comparing the prompted recall activity/attribute planning horizon results to the prospective estimates from the preplanning survey, it is also informative to show how the current results compare to previous activity planning horizon results. Because there are no other sources of data on individual activity attribute planning horizons available, this comparison is necessarily limited to involve only the overall activity planning horizon. For this analysis, the prompted recall activity plan horizon results are compared to the activity plan horizons found in the CHASE© survey (*7*) results. This survey was conducted for a one-week time period and involved collecting activity planning and scheduling results from 373 individuals (*7*), with the individuals asked about the activity planning horizon whenever an activity was added to the schedule. The comparison is shown in Figure 4, with the activity planning horizon distributions for 10 classes of activities from both the UTRACS and CHASE surveys. The plan horizons are classified into three responses "Same Day", "Preplan" and "Routine" for clarity. The activities are sorted roughly in order of increasing plan time.



** Difference not statistically significant at the 0.05 level for chi-square test.

FIGURE 4. Activity Plan Horizon by Activity Type for UTRACS(U) and CHASE(C) Surveys

The results show that, first, there is an approximately similar trend in how activities of different types are planned between the UTRACS and CHASE survey results. Mandatory-type scheduled activities, i.e. work, healthcare, etc, tend to have the highest percentage of preplanned and routine episodes as would be expected by definition. In contrast, maintenance-type activities: shopping, meals, personal, errands, tend to have the lowest degree of preplanning, with the obvious exception of healthcare activities, while discretionary activities fall somewhere in the middle. One obvious difference between the UTRACS and CHASE results is evident from the figure, however. For the activities which are traditionally referred to as mandatory – primary work, school, and to a lesser extent religious/civic and healthcare – the UTRACS results exhibit a higher level of routinely planned activities as compared to the CHASE data. The higher level of routine healthcare and religious activities is expected for the UTRACS survey as it is composed of a much higher proportion of elderly individuals than are found in the CHASE survey and elderly people tend to have more routine doctor visits and routinely attend more religious services than do non-elderly individuals. However, the differences in planning for work activities between the UTRACS and CHASE databases are not readily explainable beyond stating that it is likely that there were differences in interpretation of what accounts for a routine activity when it comes to working between the respondents to the two surveys.

The plan horizon distributions from UTRACS for the remaining activity types are remarkably similar to the results of the CHASE survey considering the socio-demographic and regional differences in the samples. Six of the 10 activity categories, including most of the maintenance and discretionary type activities, have statistically insignificant differences based on the results of a chi-square test at the 0.05 level. In fact most of the differences appear to come from different interpretations of “routine” activities for certain mandatory activities such as work or activities involving others such as “errand” and “religious” – with all of these activities showing about the same degree of impulsivity in both surveys. This

potentially shows that the differences in the plan horizon distributions between the surveys are mostly in the understanding of what is meant by "routine" activity. Perhaps because participants were asked to give plan horizons for both the activity and its attributes in completing the survey they were more willing to mark an activity as "routine" while not considering the individual attributes as such rather than being forced to give one overall plan horizon which could potentially cause confusion about what the plan horizon refers to as observed by Doherty (*12*). For example, if a respondent was going to work on an average day but ended up going in late and driving instead of taking the train as usual, due to a doctor's appointment or some other change in the schedule, if forced to decide whether the activity is routine or not, many might respond that it was not as the start time and mode choice are different than usual. However, the activity could still be considered routine as it is just a modified portion of an average workday, so ultimately UTRACS allows the respondent to make this distinction, potentially accounting for these differences observed in the highly routine activities.

DISCUSSION AND CONCLUSIONS

This paper has discussed the implementation of a new GPS-based internet prompted recall survey and has presented the results of a preliminary analysis of activity travel characteristics and activity attribute planning horizons. This survey has collected data on activity-travel patterns, attribute plan horizons and spatial, temporal and interpersonal fixities over a period of two weeks. The initial results of the survey show that the planning data obtained from the survey respondents appear to be reliable, with the data exhibiting expected patterns in regards to how attributes are planned in relation to how the overall activities are planned. A preliminary analysis of the activity planning order was also undertaken to determine which attributes are planned first for both routine and non-routine activities. This analysis showed that there is a wide diversity in how the activities are planned with respondents rarely determining that all activity attributes were selected at once. Finally, overall activity plan horizons for different activity types where shown to be fairly similar to results obtained in a different activity scheduling survey, where the differences were mainly due to differing interpretations of what constitutes a "routine" activity. As a whole, the results of the survey with regards to activity and activity attribute planning horizons are encouraging and future planned analysis and modeling efforts should help to elucidate more about the activity planning process.

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