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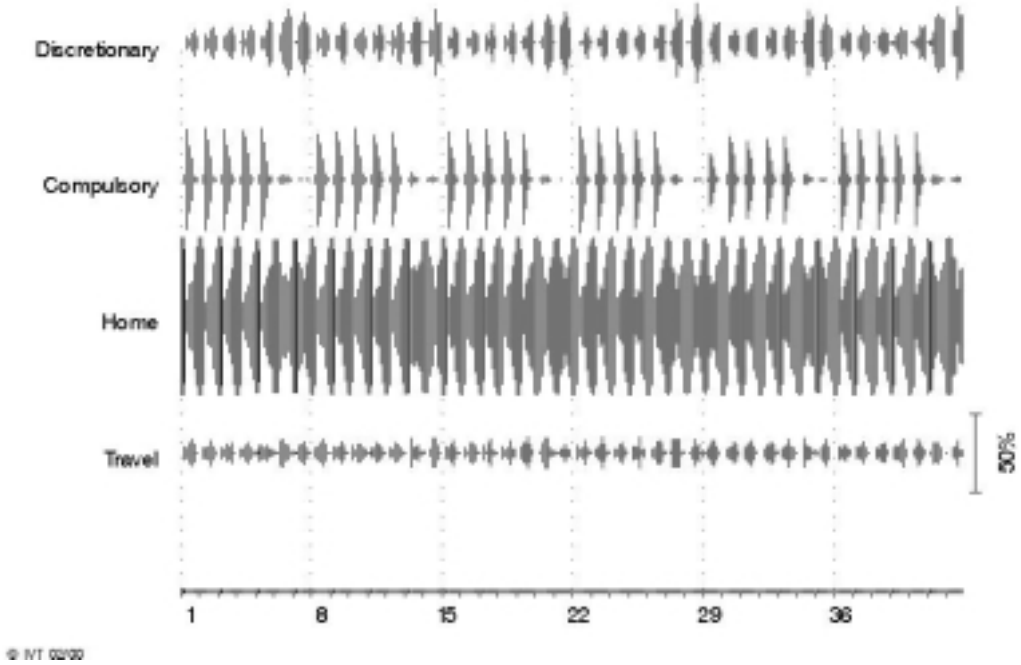

Observing the rhythms of daily life: A six-week travel diary

Paper submitted to *Transportation*

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ETH Zürich

Paper

OBSERVING THE RHYTHMS OF DAILY LIFE: A SIX-WEEK TRAVEL DIARY

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ABSTRACT

The recent shift in transport policy to emphasise travel demand management has directed the attention of transport planning research towards the dynamic processes in travel behaviour: learning and change on the one side and rhythms and routines on the other. Progress in the understanding of these processes requires data over long durations, from observation or self-reports. The survey reported here provides for the first time in 30 years a data source suitable to address these issues.

The project Mobi*drive*, funded by the German ministry of Research and Education, conducted a six-week continuous travel diary, with the aim to analyse the rhythms in the behaviour of the respondents. The paper describes the implementation and conduct of this travel diary survey, which was performed in Karlsruhe and Halle, two German cities of about 300'000 inhabitants, in the fall of 1999. A total of 317 persons over 6 years of age in 139 households participated in the main study.

The description covers the development of the forms, the design of the survey protocol, the screening experiences (including participation rates) and an assessment of the data quality in terms of item/unit non-response and reporting fatigue. The paper closes with an outlook for the analyses planned by the project team.

KEYWORDS

Continuous six-week travel diary, Germany, rhythm, travel behaviour, survey design, survey protocol, Mobi*drive*

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1 INTRODUCTION

Transport planning has traditionally focussed on the representative day with the representative peak hour (Ortuzar and Willumsen, 1994). Data collection and modelling was geared to capture this day in the best possible way. Recent policy changes are now trying to change behaviour in ways, which have impacts beyond a single day: peak pricing, which might lead to the consolidation of planned activities into a block later in a week, information provision, which accelerates learning and therefore changes temporal patterns and paths. This widening of the temporal horizon of planning and planning models immediately raises the issue of how such changes interact with underlying rhythms of daily life. These rhythms have long been known and analysed at an aggregate level, in particular as traffic or passenger counts. The analysis of the rhythms of individuals was only possible, if one was willing to aggregate many single days from different persons into a composite person (Schmiedel, 1978; Herz, 1983), a generally unsatisfactory procedure from a statistical point of view. While multi-day surveys of travel behaviour have become more frequent recently, they are normally only two to three days long and are motivated by an attempt to capture most of the variance of the behaviour, but not its temporal structure. Seven day surveys have a long history, with the UK National Travel Survey being the oldest and best known one (e.g. Department of Transport, 1994), but they only enable the study of shorter rhythms.

The only known prior example of a survey with a substantially longer reporting period is the Uppsala Travel Survey of 1971, which is by now in many respects out of date and only partially available (see next section for more detail)[5]. Other efforts have looked only a parts of the total pattern, such as various studies in Austin, TX, which studied commuting (Mahmassani, 1997; Mahmassani and Hatcher, 1992; Mahmassani, Hatcher and Caplice, 1997). Recent research into the processes by which travellers allocate their time (Doherty and Miller, 1997; Ettema, Borgers and Timmermans, 1994; Doherty and Axhausen, 1999) has clearly revealed that the most widely used paradigm to model travel behaviour, utility maximisation, is incomplete. It is in particular incomplete in its lack of an understanding of the rhythms, routines, scripts and habits (Gärling, 1998) making up daily life. The purpose of our study is to contribute to improving this understanding through data collection and modelling[6]. The core of the data collection effort is the conduct of a survey with a reporting period long enough to observe the rhythms of daily life in detail and long enough to capture monthly frequencies at least once.

[5] The Hamilton Travel Diary is a partial exception with its two week duration (Webber, 1979).
[6] The study, Mobi*drive* (www.ptv.de/Mobidrive), is being funded by the German Ministry for Research and Education through its programme "Mobilitat besser verstehen" (Understanding mobility better) (See www.tuev-ptmuv.com/hf5.htm for details)

The purpose of this paper, which will be supplemented later by further papers addressing the modelling of the data, is to describe this data collection effort and the resulting data in detail. We pursue two aims with this documentation. First, we want to invite the field to use this data to answer their own research agendas[7]. Second, we hope to encourage other researchers to replicate our study elsewhere, so as to enrich our understanding of the patterns of daily life further.

The structure of the paper is as follows: The next section briefly presents the prior example and the design consequences for the current effort. The following sections describe the survey (instrument, protocol and data obtained), the survey administration and the sample obtained, while the next two discuss the incidence of item non-response and the imputation methods adopted and finally an initial analysis of possible fatigue effects in the data. The concluding section highlights the modelling issues and research questions, which are raised by the data and can now be addressed.

2 THE PRIOR EXAMPLE: UPPSALA 1971

The Uppsala study observed a sample of residents of this Swedish university town continuously for five weeks in the spring of 1971. It arose out of a contact between researchers at the university there and researchers from Northwestern University (Evanston, Illinois). The data collection is documented through various papers by Hanson (e.g. Hanson and Burnett, 1981), the main analyst of the data, and more detailed field work reports[8].

The protocol of survey was strongly based on the personal contact between the field work team and the respondents. An initial face-to-face interview was used to obtain the usual socio-demographic details from the sample households and to explain the diary and to instruct the respondents in its completion. The diaries were collected weekly by a member of field work team with the opportunity used to check the forms and to answer questions. Further telephone contacts helped to motivate the respondents. The drop-out of recruited persons was small, as was the share of respondents showing reporting fatigue.

[7] The data will be deposited in a social science data archive for common use after the end of the project, but collaboration is invited at this time as well.
[8] The field work reports were made available to the authors by Susan Hanson.

The diary instrument was based on the idea of the journey[9]. For each stop of the journey the respondents recorded activity type, exact location, land use type, expenditures, arrival and departure time mode of travel. An open question was used for activity type, which was coded to 70 categories. Locations were geo-coded to a 10m accuracy.

A representative stratified sample was drawn from the Swedish population register. A total of 296 households participated. The shares of household types by life-cycle status were matched with the sample. About two out of three households approached participated[10]. All households which completed the survey received a ticket to a lottery organised by the survey and an invitation to a party organised around the drawing of the lottery tickets. The total price money was US$ 900 (approximate value in current US$ 3300).

The Uppsala survey is the proof, that surveys with such long reporting periods (five weeks in this case) are possible given proper attention to the respondents throughout the reporting period. The lack of a control makes it difficult to judge, if the number of contacts used in Uppsala during the reporting period is required, but the number is an indication of what is needed to maintain the commitment of the respondents. The paper-and-pencil format was no problem then and there is no reason, that is should be a problem for households recruited today. The missing analysis of those households not recruited makes it difficult to assess, if the households were representative beyond the socio-demographics. The very high retention (low sample unit drop out) and the reported near absence of reporting fatigue can be interpreted in two ways: negatively by assuming that the respondents were unusually diligent and civic minded, which might or might not influence their observed daily patterns; positively by concluding that persons, once recruited and well informed about the task ahead, are able and willing to participate for such extended periods. Given the experiences in other research areas, in particular medicine or the social sciences, the second interpretation seems more likely without reducing the need to verify the representativeness of the respondents on the other dimensions of interest.

[9] A journey is a sequence of trips from home back home; a trip is a sequence of stages between two meaningful activities; a stage is a continuous movement with one mode (See Axhausen, 1998 and forthcoming).
[10] Personal communication with Susan Hanson

3 THE SURVEY: MOBI*DRIVE* 1999

3.1 Development

Given the project's interest in the rhythms of daily life and by implication in the process by which these are produced through scheduling, pre-commitment or chance the design process started with considering a computer-based self-administered instrument as having the best chance of capturing the various variables of interest. The recent success of CHASE (Doherty and Miller, 1997) and SMASH (Ettema, Borgers and Timmermans, 1994) supported that view. Both had been able to conduct complex surveys, in the case of CHASE for seven days, focussing on the process of activity scheduling (see Doherty and Axhausen, 1999 for example results). CHASE had employed researcher-owned laptops and an incentive of Can$ 50 for the participating households. Scaling these resources to the sample size and reporting period aimed for in this project would have required a substantially larger budget than was available. A split sample approach using both CATI and PAPI was also not possible due to time and staff time constraints. In addition, the time was missing to properly pretest and revise an adapted and translated version of CHASE. The survey was therefore based on a paper-based diary supplemented by face-to-face and further paper-based elements.

The following contents, which will be described in more detail below, were included:

- Socio-demographic characteristics of the households and their members (face-to-face)
- Commitments to specific regular activities, both private, social and civic (face-to-face)
- Details of the car fleet and the public transport season tickets owned (face-to-face)
- Six-week continuous travel diary (in six weekly installments) (self-administered)
- Attitude and value inventory (towards the different modes and towards general values respectively) (self-administered)

In addition, the following items were added from other sources:

- Weather forecast from the previous day
- Weather details of the day
- Event calendar covering civic, cultural, media and sports events

3.2 Protocol and survey conduct

The Uppsala experience was deemed to still hold, that such a long duration survey can only succeed, if the survey team builds up a personal relationship with the respondents, supported by an incentive, which is larger then symbolic, but smaller then a true payment for the time spent by household. Recent practise (Erl, 1998) in Germany and elsewhere supported this view. The need to introduce and explain the diary to the household required a face-to-face interaction, which allowed the conduct of an initial interview covering the socio-demographic and other temporally stable variables. Assuming that different household types had different likelihoods of participating, in particular the large student population in both cities, and the lack of access to the official register of population as the sampling frame, it was decided to implement a quota sample through a telephone screening and recruitment process. The household types of interest were single person households, couples and families with children over six years of age (100, 150 and 200 DM incentive payment respectively in the main study (€ 51, 77 and 102)). The pre-test showed that the recruitment was more difficult then originally assumed. A second wave of recruitment had therefore been necessary in the pre-test. This two wave structure was retained for the main study both to reduce the workload of the survey firms, but also to provide a control for the necessary test of reporting fatigue independent of seasonal effects.

The sample of addresses used for recruitment was drawn randomly from the address data base of a German Telekom owned publisher of phone books. Households without valid telephone numbers in July 1999 in the main study (December 1998 in the pre-test), the latest available month, were removed.

To support the recruitment each household was sent a letter explaining the study and its aims. The letter was on official stationary of the respective city and signed by its mayor. The weekly diary was personalised for each member of the household by a label with the person's name. For the purposes of survey administration a household and person number was also included on the label. A post-paid return envelope was included each week. The household was contacted each week by phone and could itself contact the survey firm anytime during its survey period.

The incentive was paid at the end of the reporting period and excluded the attitude and value instruments. To improve the motivation of the respondents for these final elements, they received the attitude and value instruments together with a cover letter explaining them and a four page leaflet showing first results from the pre-test. The package also include the receipt for the incentive, which the households had to return signed to the survey firms.

The resulting time tables are shown in Table 1. They reflect the different school years in Halle and Karlsruhe and the wish to avoid the Christmas season for the main study. The second wave included a week-long autumn school vacation in both locations. The pre-test in Karlsruhe was scheduled to avoid the start of the summer holidays.

Table 1 Timetable of the Mobi*drive* 1999 survey in Halle and Karlsruhe

Step	Pretest	Main study	
	Karlsruhe	Halle	Karlsruhe
Distribution of announcement letter	From 15. 5.	18. 8./2. 9.	28. 8/9.9.
Start of screening period (2 weeks)	From 22. 5.	23.8/6.9	30.8/13.9.9.
Start of face-to-face interviews (2 weeks)	From 22. 5.	30.8/13.9.	6.9/20.9.
Start/end reporting period 1. Wave	31.5.-11.7.	13.9.-24.10	20.9-31.10.
Start/end reporting period 2. Wave	14.6.-25.7.	4.10-14.11.	4.10-14.11.
Distribution of attitude/value instrument	-	13. 10/3.11	5.11-23.11
Last attitude/value instrument received	-	29.11/15.12	14. 12.

3.3 Instruments and further data

3.3.1 *Household, person and vehicle forms*

The decision to use an initial personal interview opened up the chance to reconsider the usual set of items included in a household travel diary survey (Axhausen, 1995 or Richardson, Ampt and Meyburg, 1995). The study interest in the regular patterns of behaviour directed the interest to those prior decisions of the household, which strongly influence behaviour, in particular the available resources in terms of the number and characteristics of parking spaces at home, composition of the vehicle fleet, membership in an organized car-sharing scheme and ownership of telecommunication devices. In addition, household income was queried, which is unusual in German travel diary surveys. The items are listed in Table 2.

At the person level a detailed inventory was made of mobility resources, i.e. licence holding, ownership of season tickets and pre-paid heavy rail discount cards. In addition, the respondents were asked to describe their firm commitments to out-of-home activities, such as sports, care giving or civic engagements and offices.. Training and education were covered separately. See Table 3 for the details.

The essential characteristics of the vehicles (cars, motorcycles, but also bicycles) owned and available to the household were established, including the mileage during the last twelve months. The household members were linked to the different vehicles by querying for all users, but also the main user of each vehicle. Equally, each vehicle was linked to its usual parking space at home. See Table 4 for a complete listing of the questions.

The contents were tested during the pre-test and the respondents were found to have no difficulties with any of the items, with the exception of the detailed description of the household bicycles, which was simplified for the main study.

3.3.2 *Travel forms*

German practise is based on trip-based diary forms (Axhausen, 1995) and due to the length of the reporting period a change to a stage-based or activity-based format was not considered. A journey-based approach was felt to be not detailed enough for the purposes of the study. The instrument adopted is based on a variant of the KONTIV-format (see Brög, Meyburg and Wermuth, 1983 or Axhausen, 1995), which had been used by one of the project partners, PTV AG, successfully in past studies. The main difference to the standard form is the request to the respondents to indicate not only the modes they have used, but also the time with each mode. In addition, the walk only mode is highlighted through the design, as well walking to and from the main mode (see http://www.ptv.de/mobidrive for images of the forms and their translations).

The usual activity coding is not detailed enough to re-identify different types of leisure activities. Experiences elsewhere (Erl, 1998, Götz, Jahn and Schultz, 1997) had confirmed, that open categories work well in such diaries. The usual codes were therefore expanded by both a “Leisure, please describe” and an “Other, please specify” category. The entries to these were either recoded to the existing categories, if the respondent has misallocated it or to one of the additional categories established by the City:mobil project (Götz et al., 1997). These detailed categories had been developed from an time budget survey and successfully tested in a travel diary in a city in Western and Eastern Germany (See Appendix A for the complete list of 23 categories).

Table 2 Contents of the household questionnaire (Main study)

Item	Coding and comments
Number of residents	(excluding family members, which only visit occasionally)
Number of family members residing elsewhere	
Number of dogs	
Composition of vehicle fleet	Numbers of cars, bicycles, motorised cycles, small motorcycles, motorcycles, trucks, other (please specify)
Household membership in a car sharing organisation	Yes, no
Permission to use vehicles of other households and frequency of use	Yes, no; about daily, more then once a week, once a week, twice or trice a month, once a month, less than once a month
Private parking space in a garage	Number, for up to three: type (below building, below building elsewhere, garage on the lot, garage elsewhere); distance [m or min], monthly rent or purchase price
Other private parking spaces	Number, for up to three: type (yard, driveway, marked space, covered space, on public right-of-way); distance [m or min], monthly rent or purchase price
Distance to the closest bus stop	[m or min]
Distance to the closest tram stop	[m or min]
Distance to the closest heavy rail station	[m or min]
Size of accommodation	[m^2]
Type of accommodation	Apartment (in building of 7 and more), apartment (in building of up to 6), free standing single family home, duplex, terrace, flat within single family home
Ownership status	Owned, rented
Type of subsidy for accommodation	None, company housing, subsidised housing
Year of construction of accommodation	
Year of move	
Costs (rent or mortgage)	[DM] (excluding service charges, heating, electricity etc.)
Additional costs of housing	[DM]
Presence of	One balcony, multiple balconies, terrace, roof top terrace, basement, attic, laundry room, drying room, garden, other (please specify)
Size of garden	[m^2]
Telecommunication resources	Number of land lines, mobile phones, fax machines, private email addresses, work-related email addresses
Monthly household income net of taxes and social security payments	-1000, 1000-1799, 1800-2499, 2500-2999, 3000-3999, 4000-4999, 5000-7499, 7500 DM and more

Table 3 Contents of the person questionnaire (Main study)

Item	Coding and comments
Given name	Abbreviations were possible
Sex	Female, male
Relation to other household members	Spouse/partner, parent, child, other (please specify)
Currently married	Yes, no
Types of education completed	None, primary school, minimum required years of schooling, intermediate exam, subject limited baccalaureate, baccalaureate, East German baccalaureate, apprenticeship, craft master, 3 year degree, university degree (sciences/engineering or other), other (please specify)
Status	Pupil, student, homemaker, part time employed, full time employed, self employed, in retirement, supporting family member, unemployed
Number of employers	
Number of work locations	
Number of working hours	[/week]
Address of work location	Street address of most frequently visited work location
Duration of employment	Starting years with different employers
Profession	Open
In education/further education	Yes, no
Number of qualifications sought	
Number of hours in education	[/week]
Name and addresses of schools	
Presence of fixed time commitments	Yes, no
Type of fixed commitments	Clubs, civic, political, charitable, self improvement, care of family or friends, other (please specify) (tick all which apply)
Number of fixed commitments	[/week]
Number of hours spent on those	[/week]
Day of week and location of those	
Licence ownership	Yes, no
Types of licences	Motorised bicycle, small motorcycle, motorcycle, car, truck, coach
Ownership of heavy rail discount card	Yes, no
Ownership of heavy rail season	Yes, no and type (open) and area of validity
Ownership of local public transport season	Yes, no and type (monthly, academic term, senior, pupil, other (please specify)) and area of validity
Nationality	German, other (please specify)

Table 4 Contents of the vehicle questionnaire (Main study)

Item	Coding and comments
Type of vehicle	Bicycle, motorised bicycle, small motorcycle, motorcycle, car, truck, other (please specify)
Producer	Open (motor vehicles only)
Year of production	(motor vehicles only)
Year of purchase	(motor vehicles only)
Power	[PS] (motor vehicles only)
Motor size	[ccm] (motor vehicles only)
Type of fuel	Gasoline, diesel, other (please specify) (motor vehicles only)
Current odometer reading	[km] (motor vehicles only)
Type of bicycle	Mountain bike, racing bike, city bike, children's bike, other (please specify) (bicycles only)
Age of bicycle	Less than two years, more than two years (bicycles only)
Mileage with the vehicle during the last twelve months	[km]
Owner of the vehicle	Personal (Name, if household member); employer (Name of the household member employed); other (please specify)
Main user of the vehicle	Name of household member
Other users	Names of household members
Most frequently used parking space	Yard, driveway, marked space, curb, garage, covered parking space, bicycle shed, basement, other (please specify)
Distance from parking space to home	[m or min]

Travellers are not only constrained by time, but also by their income. To capture these income effects, the respondents were asked to indicate their direct expenditures on each trip (fares, taxi fares, parking fees) and their expenditures on the activity following the trip. The activity expenditures were categorised to be less intrusive. The categories used were changed from zero, to 10 DM, 10-50 DM, 50-200 DM and 200 DM and over in the pre-test to zero, >10 DM, 10-25 DM, 25-100 DM and 100 DM and over in the main study reflecting their relative usage in the pre-test. Some respondents were initially reluctant to reply to this question, but could be convinced by the survey team through an explanation of its purpose.

The final change was that the respondents could not only indicate human company, but also the presence of the (family) dog during the trip. All questions and their coding are listed in Table 5

The diary was an A4[11] spiral-bound booklet of 10 portrait-formatted pages; readability was given precedence over portability. Each of the nine diary pages had space for 3 trips in a columnar format, but for the first movement page, which included only one column plus explanations. The first page of the booklet provided space on the front to indicate immobile days and the reason for them and to indicate trips with overnight stays including destination and purpose. On the reverse example activity types were given for the different activity categories. The respondents had to indicate the day of the trip by ticking a "day of trip" question at the top of the column. The front page gave the name of the respondent (household and person number) and highlighted the dates of the respective week of the reporting period.

Table 5 Contents of the trip diary (Main study)

Item	Coding and comments
Day of trip	Days of the week
Starting time	Military time
Purpose	Work, education, daily shopping, shopping for mayor items, personal business, work related business, leisure (please specify), other (please specify)
Modes used	Walk only, walk to mode, bicycle, motorcycle, car driver, car passenger, bus, street car & light rail, heavy rail, other (please specify), walk from mode; time spent on each
Accompanying persons	Number of household members, number of other persons
Presence of a dog	Yes, no
Exact destination	Street address and municipality
Activity costs	Zero, up to 10 DM, 10-25 DM, 25-100 DM, 100 DM and over
Expenditures on travel	Open
Arrival time	Military time
Estimated distance travelled	[m]

3.3.3 *Attitude forms*

Recent research in Germany (Gawronski and Sydow, 1999; Götz et al., 1997), but also elsewhere has shown that attitudes and values can be used successfully to segment travellers with respect to their travel behaviour. This dimension in the description of the respondent had originally not been included in the study, but contacts with the relevant researchers during the course of the project opened up the possibility to use the scales they had developed. The scales of the City:mobil project address the attitudes of the travellers to the different modes (walking, bicycling, bus, public transport, car and mobil-

[11] A4 paper is at 21.0 * 29.7 cm slightly taller and thinner than US letter-size paper.

ity in general and car driving in particular, but for licence holders only). The scale of Gawronski and Sydow is more general and looks at the dimensions “traditional values “ and “humanistic values“, as the core of political and personal values.

The late inclusion of these instruments into the study meant that they could not be tested in the pre-test. So as to not jeopardise the success of the diary, it was decided to add these instruments as a further survey after the conclusion of the diary study. They were distributed jointly with the receipt for the incentive. The accompanying letter stated clearly that these were in addition to the diary study. As a general motivation the respondents received a four page leaflet showing first results from the pre-test. Only respondent 16 years and older were asked to fill in this instrument.

The original City:mobil scales contained 117 items and the Gawronski and Sydow scale 25 items. To limit the response burden the set of the City:mobil items was edited to exclude those items, which had had low factor loadings in the original study. All scales were from 1 to 5. A “Don’t know” category was added in the case of the City:mobil scales and retained for the value scales. The resulting set of 96 items covered 6 pages A4. The forms were retyped and their presentation made as uniform as possible (See http://ww.ptv.de/mobidrive for scanned images of the forms and their translations). Introductions and explanations were added. Each form was personalised on the front page with the first name of the respondent.

3.3.4 *Additional data*

The duration of the survey period (8 weeks in the pre-test, 9 weeks in the main study) implies substantial seasonal variation in the weather (spring to early summer, late summer to late autumn respectively). An analysis of travel behaviour should consider these effects. The data set was therefore enriched by the weather forecasts of the previous day with the following items: temperature, rainfall, cloud cover and by the weather during the reported day with the following items: mean and maximum temperature, average cloud cover, rain fall during the active hours (6:00 to 18:00) and the daily total.

Furthermore, an event calendar was collated for the two cities to document events, such as major soccer games, civic events etc., which might influence behaviour.

4 SURVEY ADMINISTRATION

The Halle/Karlsruhe survey confirmed the experiences of the Uppsala study, that respondents, once they have committed themselves to such a long survey, rarely drop out. The difficulty lies in finding willing respondents, who also meet the screening criteria: all children over 9 years (pre-test)/6 years (main study) and no continuous absence longer than one week during the reporting period. The quota requirements increased the difficulty of conducting the survey for the survey firms. The pre-test aimed to include twenty households, while the main study had a target of three times twenty households in each city. Table 6 describes the screening experience.

Slightly more then 20% of those eligible was recruited, while just under 20% participated fully indicating that the survey firm explained the task in general well on the phone. Those dropping out did so at the face-to-face interview or normally shortly after. A total of 39 households dropped out: 28 before the full in-home interview (Halle 20, Karlsruhe 8), 7 during the interview (Halle 2, Karlsruhe 5) and 4 afterwards (two in each city).

In the absence of directly comparable results and of experimentation during this effort (changed incentive structures, different lengths of reporting period etc.) it is difficult to judge, if these 20% are a high or a low number. German survey firms routinely achieve response rates of 60-70% for one-day travel diaries with an intensive regimen of reminders and motivation phone calls. The German government funded national travel behaviour panel (one one-week diary for three years achieves a recruitment rate of 19 % of those eligible with a lottery ticket per returned diary as an incentive. The 19% is without attrition losses over the three year period[12]. The panel and the six -week survey are hard to compare with regards to their response burden, but the similarity in recruitment success is reassuring, although it is considerably lower than the two out of three achieved in the Uppsala study[13].

While the final participation rates are equal, the two cities differ in some noticeable ways: the much larger share of potential respondents, who phoned in their refusals in Karlsruhe; the larger share of quality neutral non-responses such as wrong telephone numbers due to moves or disconnections in Halle. These differences reflect the attitudes and economic conditions prevalent in these two cities: one in the former East Germany and the other in the Western part of the country.

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[12] Personal communication with Bastian Chlond, research officer with the German Travel Behaviour Panel Study. (2.2. 2000)
[13] The Swiss National Statistical Office achieves a response rate of 37.4% of eligible households (30.1 % of the sample) for its very detailed four week household consumer expenditure survey (BFS, 2000). As neither sponsor,

The desired quotas were exceeded in five out of six cases. Only 18 instead of 20 single households participated in Halle, a minor deviation (See Table 7).

Table 6 Screening experience

Step	Pretest			Main study					
	Karlsruhe			Halle			Karlsruhe		
	Number	% of sample	% of available	Number	% of sample	% of available	Number	% of sample	% of available
Total sample	240	-	-	720	-	-	720	-	-
Wrong phone number	40	16.7	-	98	13.6	-	34	4.7	-
Pre-emptive refusal by household	12	5.0	-	21	2.9	-	87	12.1	-
Not reached after seven attempts	20	8.3	-	190	26.4	-	200	27.8	-
Available for screening	168	70.0	-	411	57.1	-	399	55.4	-
Not eligible	26	10.8	15.5	77	10.7	18.7	59	8.2	14.8
Not used, as quota was filled	-	-	-	4	0.6	1.0	5	0.7	1.3
Refused on contact	116	48.3	69.0	238	33.1	57.9	249	34.6	62.4
Recruited	26	10.8	15.5	92	12.8	22.4	86	11.9	21.6
Dropped out at interview/shortly after	3	1.3	1.8	24	3.3	5.8	15	2.1	3.8
Completed households	23	9.6	13.7	68	9.4	16.6	71	9.9	17.8

Table 7 Structure of sample by household type

Household type	Pre-test		Main study			
	Karlsruhe		Halle		Karlsruhe	
	House-holds	Persons	House-holds	Persons	House-holds	Persons
Singles	11	11	18	18	22	22
Couples	7	14	23	46	24	48
Family households	5	19	27	94	25	89
Total	23	44	68	158	71	159

nor topic is directly comparable, it is difficult to use this information as other then an indication of the problems of non-official statistics.

The screening interview was used during the main study to obtain a minimal set of information about the refusing households to compare those with the participating households. Still, many households refused even this interview. The comparisons in Table 8 are based on this information. The number of cases differs between the different questions due to differential item non-response.

The recruited households are more economically active, have more cars and more working members. The more detailed break-down in Table 9 gives a more balanced picture by looking at the different household types. While there are differences between the recruited and non-recruited couples and family households they are not glaring with the exception of season ticket ownership which is lower for the recruited households. In addition, the recruited family households have higher averages incomes in comparison with the non-recruited households. This indicates that interest in the research itself must have been a strong motivation for this group and not the incentive payment.

The differences for the singles are more pronounced on all variables. Here the study was able to recruit in the main the younger and economically active households, which in this case had both more cars and season tickets.

These results clearly indicate, that the sample results need to be reweighted, when population totals are calculated, but see below for further discussion of the sample in comparison with the known travel behaviour of the residents of the two cities.

With regard to the main interest of the study, the rhythms of daily live, an assessment of a possible bias is not feasible, as suitable comparison data is missing. In the future comparative work with the Uppsala data might shed light on this issue.

Table 8 Socio-demographic comparisons of the recruited and non-recruited sample households

Variable	Reached, Question not answered	Question answered, but not recruited		Question answered and recruited		All answers	
	[]	[]	[%]	[]	[%]*	[]	[%]*
Household size							
One		64	23.4	50	28.1	114	25.2
Couples		103	37.6	67	37.6	170	37.6
Couples with children over 6		54	19.7	59	33.1	113	25.0
Other**		53	19.3	2	1.1	55	12.1
All	358	274	100.0	178	100.0	454	100.0
Number of motorised vehicles							
N.A.				18		18	
None		115	32.4	29	18.1	144	28.0
One		168	47.3	83	51.9	251	48.7
Two		56	15.8	44	27.5	100	19.4
Three and more		15	4.5	4	2.5	20	3.9
All	277	355	100.0	178	100.0	533	100.0
Household income							
N.A.				36		36	
Under 1800 DM		63	22.7	20	14.1	83	19.8
1800 – 3000 DM		92	33.1	38	26.8	130	31.0
Over 3000 DM		123	44.2	84	59.2	207	49.3
All	354	278	100.0	178	100.0	456	100.0
Age of oldest person							
N.A.				23		23	
Under 30 years		29	8.1	21	13.5	50	9.7
31 – 45 years		85	23.7	43	27.7	128	24.9
46 – 60 years		84	23.4	52	33.5	136	26.5
Over 60 years		161	44.8	39	25.2	200	38.9
All	273	359	100.0	178	100.0	537	100.0
Number of working members							
N.A.				23		23	
None		151	44.7	42	27.1	193	39.1
One		91	26.9	60	38.7	151	30.6
Two and more		96	28.4	53	34.2	149	30.2
All	294	338	100.0	178	100.0	516	100.0
Number of season tickets							
N.A.				23		23	
None		172	52.9	86	55.5	258	53.8
One		119	36.6	51	32.9	170	35.4
Two and more		34	10.5	18	11.6	52	10.8
All	307	325	100.0	178	100.0	503	100.0

* Excluding N.A. from the calculation of the shares [%]
** The two erroneously recruited “other” households were later dropped.

Table 9 Socio-demographic comparisons of the recruited and non-recruited sample households by household type

Variable	Single person Households		Couples		Couples with children over 6 years	
	Answered, but not recruited [%]*	Answered and recruited [%]*	Answered, but not recruited [%]*	Answered and recruited [%]*	Answered, but not recruited [%]*	Answered and recruited [%]*
Number of motorised vehicles						
None	82.6	42.6	19.7	11.5	9.8	3.4
One	17.4	48.9	63.4	65.4	51.2	42.4
Two and more	0.0	8.5	16.9	23.1	39.0	54.3
Household income						
Under 1800 DM	61.5	37.2	8.3	6.8	6.7	1.8
1800 – 3000 DM	35.9	41.9	36.7	31.8	26.7	10.9
Over 3000 DM	2.6	20.9	55.0	61.4	66.7	87.3
Age of oldest person						
Under 45 years	10.6	28.3	8.5	11.3	9.8	1.8
31-45 years	12.8	26.1	9.9	11.3	53.7	46.4
46 – 60 years	14.9	15.2	32.4	37.7	31.7	42.9
Over 60 years	61.7	30.4	49.3	39.6	4.9	8.9
Number of working members						
None	77.5	42.2	40.0	40.4	9.8	1.8
One	22.5	57.8	20.0	26.9	36.6	32.1
Two and more	-	-	40.0	32.7	53.7	66.1
Number of season tickets						
None	46.3	66.7	46.8	61.5	50.0	35.7
One	53.7	33.3	41.9	28.8	34.7	41.1
Two and more	-	-	11.3	9.6	15.3	23.2
Number of cases	64	50	103	67	107	61

* Excluding N.A. from the calculation of the shares [%]

The response to the attitudes and values instrument was high with 88% and 96% of persons in Karlsruhe and Halle, 85% and 93% complete households respectively. This reinforces the picture of a sample of co-operative and interested respondents. The response rates by household categories (Table 10) show that the singles and couples co-operated best, while the families participated least. Overall, the respondents in Halle were more willing to reply to the attitude and value instruments.

Table 10 Response rates for the attitudes and values instrument [%]

Base and city	Household type			
	Singles	Couples	Families	All
Of households (all eligible members responding)				
Halle	88.9	91.3	96.3	92.6
Karlsruhe	91.7	91.7	80.0	84.9
Of eligible respondents of 16 years and over				
Halle	88.9	93.5	98.6	95.6
Karlsruhe	91.7	100.0	79.8	87.6

5 CODING, ITEM NON-RESPONSE AND IMPUTATION

The coding of the data was performed using Microsoft Access masks, which assured that only proper codes were used. The share of missing items in the instruments administered face-to-face was low (see Table 11). Where logical corrections were possible these were used, otherwise the hot deck imputation method implemented in SOLAS (Statistical Solutions, 1999) was used to replace the missings.

The diaries were filled in well, but the survey firms performed the usual error checks and logic corrections on receipt of the weekly form. Respondents were called back to clarify error and ambiguities. Initial problems of some respondents with ticking multiple purposes per trip did not reoccur after explaining the form again. The remaining missings were concentrated in the reported activity expenditures and in missing walk stages.

The addresses were geo-coded to geo-decimal format using the Geocode-Engine 2.0 developed by PTV AG. The public use files employ the traffic zones of the cities within the city limits, municipalities in the vicinity of them and larger zones for destinations further away..

Table 11 Shares of missing values by questionnaire and selected variables (after initial editing)

Instrument/Variable	Share [%]
Household instrument	
All variables	5.4
Household income	12.6
Person questionnaire	
All variables	1.7
Licence holding	-
Local season ticket ownership	-
Vehicle questionnaire	
All variables	5.1
Owner	0.7
Main user	3.7
Attitude instruments	
All variables (excluding unit non-responses)	2.2
Missing unit for licence owners only	9.3
Missing modal units (all except the unit for licence owners only)	2.2
Value scale	
All variables	0.1
Don't know	6.6

The data sets generated and the number of cases are listed in Appendix B.

6 FATIGUE

The central issue for the quality of this survey is presence or absence of reporting fatigue, as drop out has not been a problem. No indications of fatigue had been visible in the pre-test. A first stage of the analysis has to be a description of the response behaviour. Table 12 gives the shares of mobile, immobile and days completely out of town by city for each of the survey weeks. The very small share of non-reported days (1%) is ignored here, as most can be assumed to be immobile days. Days for which both trips inside the study area and a trip to a destination outside were reported are counted as mobile days, whereas trips for which only the outbound or return trip to a destination outside were reported count as wholly out-of-town.

Table 12 Shares of reported days by city, wave, location and level of mobility [%]

Week starting	Halle						Karlsruhe					
	Mobile		Immobile		Wholly out-of-town		Mobile		Immobile		Wholly out-of-town	
	W1	W2	W1	W2	W1	W2	W1	W2	W1	W2	W1	W2
13. 9.	90		8		2							
20. 9.	89		7		4		86		5		9	
27. 9.	86		9		4		90		5		5	
4. 10.	87	88	11	9	3	3	92	91	3	4	4	4
11. 10.	88	88	11	8	1	3	93	94	3	4	4	3
18. 10.	87	90	9	8	4	2	92	92	3	4	5	4
25. 10.		79		8		13	89	91	3	5	8	3
1. 11.		92		8		1		86		8		6
8. 11.		87		12		1		95		3		2

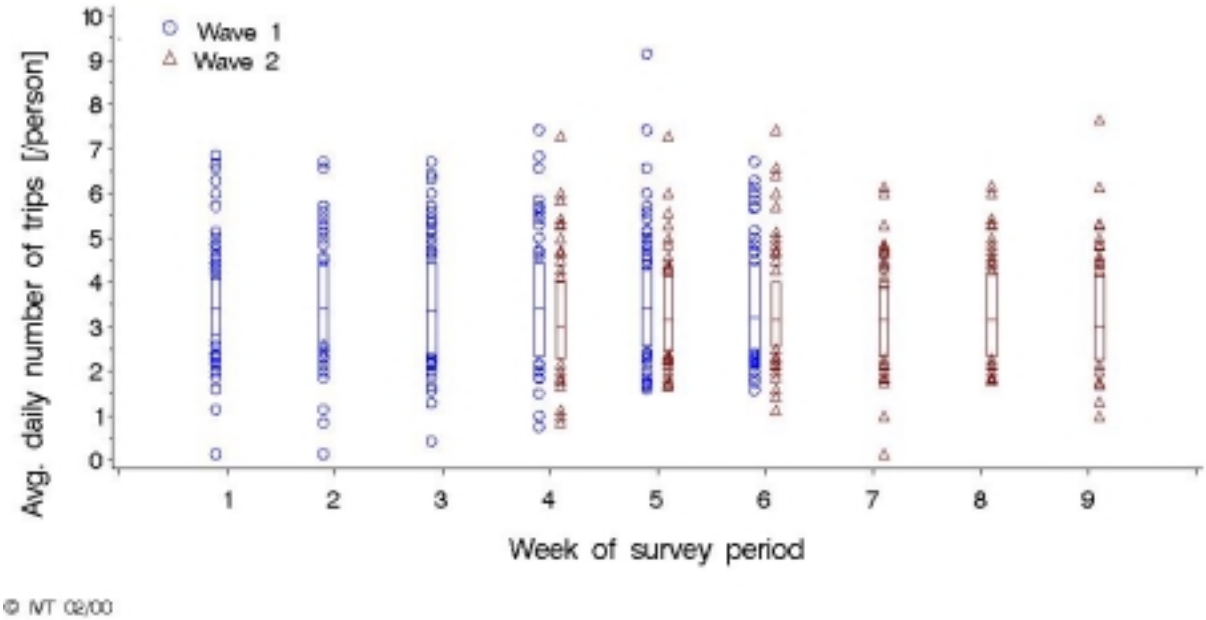
The weeks with school vacations are shaded

No trends are visible, but it is obvious that the respondents in Halle have more immobile days then the Karlsruhe respondents. In Karlsruhe second wave respondents have more immobile days than the first wave respondents. The impact of the vacation week is clearly visible. The total level of mobility is higher then in one day travel diary surveys, which is both the result of the screening which excluded persons with long absences and of the better motivation of the recruited households.

At the level of the number of reported journeys and trips no fatigue can be detected, as Figure 1 and Figure 2 show. The figures are based on the average number of trips or journeys per mobile day for each person and week. The box plots show the quartile values and the persons with values beyond the 25th and 75th percentile by survey wave. There are visible differences between the waves, but the change from week to week follows no detectable pattern. The school holidays in the fifth reporting week of wave 2 in Karlsruhe is visible, but the drop seem to have been anticipated by more trips in the week before and in the week after. For the number of journeys the pattern is even more stable. In Halle the average number of trips and journeys is lower and there is also less variability in behaviour.

Figure 1 Average number of daily trips by wave on mobile days by person and week

Halle



Karlsruhe

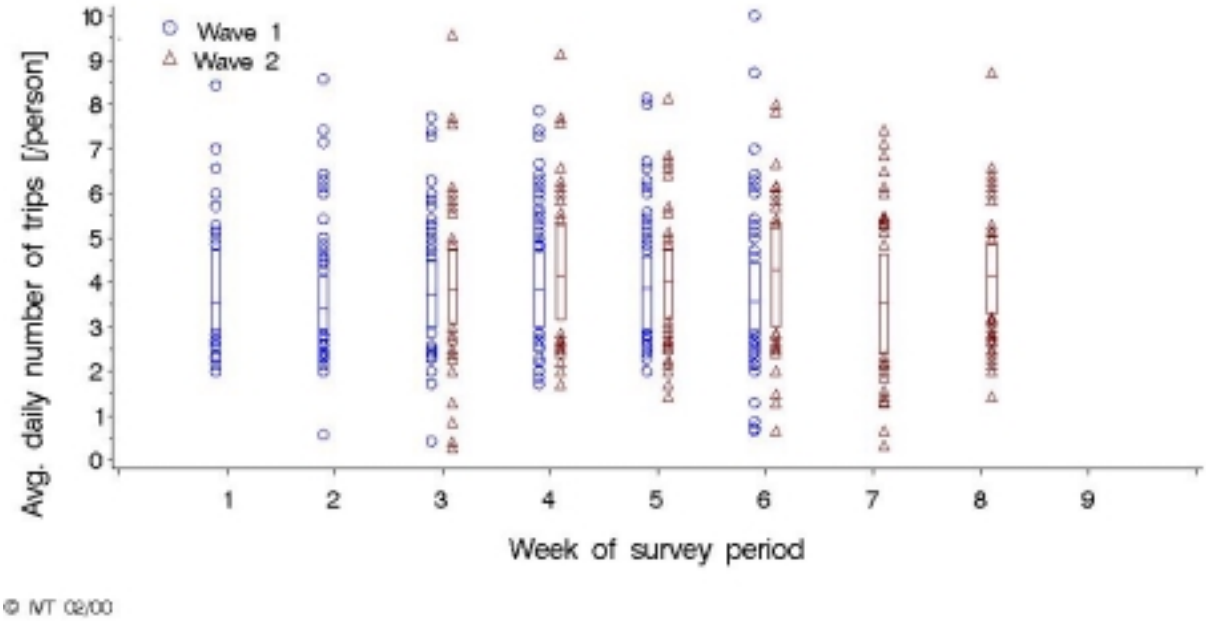
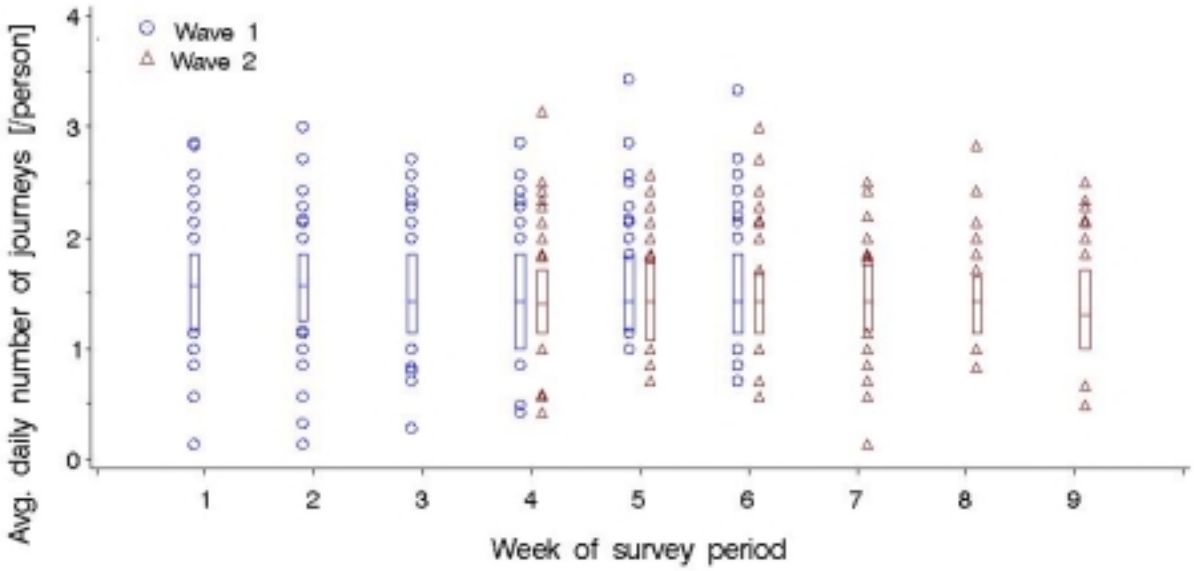


Figure 2 Average number of journeys by wave on mobile days by person and week

Halle



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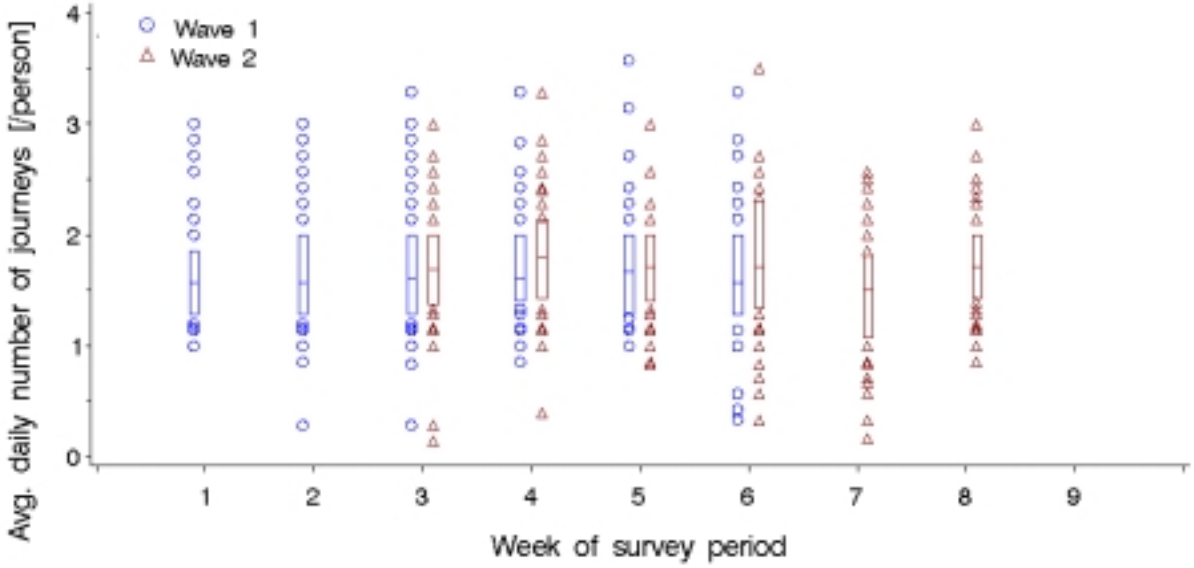
Karlsruhe



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To verify the visual inspection two sets of models were estimated to test for reporting fatigue. Due to the length of the reporting period, it is possible to estimate models both at the person and the sample level. The models were estimated for the number of all types of trips and for the non-work/non-school trips, assuming that the obligatory trips would be less critical and would always be well reported. The usual respondent short cut of reporting an immobile day had not been adopted by the respondents, as discussed above.

Only being interested in temporal trends, the data were standardised to a mean of zero and normalized to a standard deviation of one for each person separately. It is then possible to control for the day-of-week[14], school vacation time and the weather. The weather was described by the total daily amount of rainfall, the rainfall during the daylight hours and their squared values[15]. The position of each day within the reporting period was coded with either dummies for the week of the reporting period or the sequence number of day within the reporting period.

Estimating the parameters for the week of reporting period dummies for each individual allows the detection of possible fatigue. While some of the weeks showed significant differences from the respective personal averages, patterns reveal a pattern consistent fatigue in only a small number of cases (3 persons in the pre-test, 3 in the Karlsruhe main study and 9 in the Halle main study). This held true both for the analysis of all trips, as well as for the analysis of only non-work and non-school trips. Given the small number of persons, it might also just be occurrences affecting the final week of the survey by chance.

Using the day of the reporting period and its square revealed in each of the samples a number of respondents with a combination of two significant parameters: a positive linear and a negative squared term or the reverse. In the worst case the combined effects amount to 0.2 σ. Given the small number of cases it is difficult to decide, if these respondents were fatigued or if there is a different effect.

These results confirm the experience of Uppsala, that it is possible to continue to motivate the respondents over the whole reporting period.

[14] The legal holidays, such as October 3rd, were coded as Sundays irrespective of the actual day type.

[15] More complex variable sets, including measures of cloud cover and temperature and the possible interactions, were tested at the aggregate levels, but found to not add explanatory power. A more detailed analysis involving both lagged and anticipatory effects is outstanding.

7 COMPARISON WITH EXISTING DATA

The size and structure of the Mobidrive sample make direct comparisons with existing data sources difficult, in particular as it was not possible to obtain access to the original data files. In Karlsruhe a travel diary survey had been conducted in 1992 and in Halle in 1998. Both surveys used one-day travel diaries to observe the behaviour on working days. Table 13 and Table 14 compare a number of key indicators of travel behaviour using published results from these two surveys[16].

In general the current data match the comparison data sets well given the massive methodological differences between the various samples. There are a number of interesting differences in detail. The current respondents in Halle reported over twice an many leisure trips in comparison to the 1998 survey, which is due to slightly fewer work trips, but probably also due a more complete response through the more extensive coaching in the Mobi*drive* survey. A reweighting involving not only age and sex, but also working status and car ownership might reduce these differences further. The differences in Karlsruhe are marginal.

Table 13 Comparison of share of trip purposes: Mobi*drive* vs recent one-diary studies in Halle and Karlsruhe (weekdays only)

Trip purpose	Halle		Karlsruhe	
Shares [%]	1998 survey	Mobi*drive*[1]	1992 survey	Mobi*drive*
Return home	40.5	39.4	--	--
Leisure	7.6	18.7	33	33.5
Household maintenance	--	--	32	33.9
Shopping/Services	22.0	19.9	--	--
Work	11.8	9.6	18	18.9
Education	5.4	5.6	9	7.2
Work-related	4.2	2.1	--	--
Other	8.5	4.8	8	6.5

[1] It was possible to reweight the data to match the 1998 survey with respect to age and gender

[16] The tables were made available by Socialdata GmbH, München in the case of Karlsruhe and the Planning Department of the city in the case of Halle.

Table 14 Comparison of trip dimensions: Mobi*drive* vs recent one-diary studies in Halle and Karlsruhe (weekdays only)

Dimension	Halle		Karlsruhe	
Category	1998 survey	Mobi*drive*[1]	1992 survey	Mobi*drive*
Modal shares (trip level)[2]				
Car driver	25.9	32.9	33	33.3
Walking	30.8	30.4	23	21.8
Cycling	9.1	8.5	17	15.5
Local public transport	22.3	14.4	16	14.1
Car passenger	4.2	12.5	11	13.7
Average trip length by mode[2] [km]				
Car driver	19.3	12.0	10.5	12.5
Walking	1.1	1.2	0.9	0.9
Cycling	2.5	2.6	2.6	2.3
Local public transport	5.6	6.1	6.8	10.1
Car passenger	17.5	12.9	10.2	15.9
All modes	9.2	7.5	6.3	8.4
Average trip duration by mode[2] [min]				
Car driver	28.3	21.4	20	19.6
Walking	17.0	17.7	14	13.5
Cycling	14.0	15.3	14	11.1
Local public transport	30.0	28.1	31	30.9
Car passenger	31.1	23.0	19	22.4
All modes	25.0	21.3	19	23.7
Number of trips by mode[2] [/Mobile Person]				
Car driver	0.91	1.09	1.23	1.44
Walking	1.08	1.09	0.86	0.98
Cycling	0.32	0.31	0.64	0.69
Local public transport	0.78	0.49	0.60	0.64
Car passenger	0.15	0.46	0.41	0.59
Sum of all modes	3.50	3.54	3.75	4.09

[1] It was possible to reweight the data to match the 1998 survey with respect to age and gender
[2] Excluding modes with minor shares

In Halle the main differences at the trip level are connected with the private car. The 1998 representative sample reports fewer trips as a car driver and even fewer trips as a car passenger. It is therefore no surprise that both trip lengths and durations are longer in 1998 survey. For the other modes the differ-

ences are small. In Karlsruhe, the differences are in most cases small. The 1992 survey reports more public transport trips, which are in turn, as expected, shorter in length.

A formal comparison is not possible, but the available evidence shows that the respondents do not differ substantially from the population average. As mentioned above, this does not assure, that they are similar with regards to their rhythms, but it does not suggest that they are not.

8 CONCLUSIONS AND OUTLOOK

The six week survey reported here provides a unique data source for a number of important research issues, which cannot be addressed with existing data. The tests and analyses conducted so far show that the quality of data, especially for the trips, is good: little item- and unit non-response, no initially detectable pattern of reporting fatigue.

The data set is unusually comprehensive including information about traveller attitudes and values, but also external data such as information about the actual weather and weather forecasts. The availability of information about trip costs and activity expenditures is equally unusual, although very necessary.

The primary analysis of the data will be concerned with the temporal rhythms of the travel behaviour of the respondents:

- Identification of the building blocks of the observed activity patterns (Hanson and Hanson, 1981; Hanson and Huff, 1988b or Jones and Clark, 1988)
- Measurement of the similarity between the days observed (Kutter, 1973; Pas, 1983 and 1987; Pas and Sundar, 1985; Pas and Koppelman, 1990; Hanson and Huff, 1986, 1988 or 1990), if possible using multi-dimensional sequence analysis (see Joh, Arentze and Timmermans, 1999) or pattern recognition (Recker and McNally, 1985)
- Development of hazard-models of the activity and trip durations, the intervals between activities of similar kind and of the interactions between them. These models will include the effects of money expenditures, as well as interactions within the couple and households (Hensher and Mannering, 1994; Mannering and Hamed, 1990; Ettema, Borgers and Timmermans, 1995; Bhat, 1996a, b)

The hazard models identify both the rhythms of activity participation, but can also inform future models of activity scheduling and time allocation, as they indicate the build-up of activity desires.

The data allows an analysis of the patterns and rhythms using Fourier-analysis and similar approaches (Schmiedel, 1978 or Herz, 1983). These will be conducted to cross-check the hazard modelling.

The availability of the Uppsala data will be used to compare the two data sets. The comparison will allow to identify trends in travel behaviour, but also time use over the last three decades.

A whole range of issues related to time allocation of individuals and households can be addressed using both structural equation models and choice modelling. The duration of the survey will for example allow the estimation of lagged effects throughout the week between for example trip making and its various attributes or activities and their attributes, which is not possible with one-day or even seven-day survey data (see related work such as Pas and Harvey, 1997; Golob and Van Wissen, 1989 or Golob, 1996)

The modelling of the dynamics of the travel choices is normally severely limited by the lack of information about habits and prior choices (see Srinivasan and Mahmassani, 2000 for an exception). The data available allows to overcome these limitations and to address the issue of inertia in choice in new depth. Equally, the data can be used to verify the complex nested-logit models of travel behaviour, which have recently been estimated to replace the four-step procedure (e.g. Ben-Akiva, Bowman and Gopinath, 1996 or Bradley, Bowman and Lawton, 2000).

The data will also be used to shed new light on the optimal travel diary survey duration (one, two or more days), which was addressed originally by Pas (1986) in the context of a seven-day diary.

The project Mobi*drive* and its six-week continuous survey hopes to expand its scope by further work on the formation of routines, the dynamics of major behavioural change due to structural change of the household. All of these elements are envisaged to be synthesised in a micro-simulation model of travel behaviour which includes activity scheduling as its central core. These efforts will build both on existing approaches to simulation activity scheduling (Gärling, Kalen, Romanus and Selart, 1998 or Ettema, Borgers and Timmermans, 1993), but also on existing models of activity chain performance (Axhausen and Herz, 1989; Axhausen, 1990).

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APPENDIX A: CITY:MOBIL TRIP PURPOSE CODES

Work
Work related business
School
Further education/training

Pick up/drop off

Personal business: Administrative
Personal business: Personal services

Shopping: Grocery and other goods of the daily demand
Shopping: Longer-term goods
Car care and refueling

Window shopping
Meet friends
Meeting relatives/family
Group/club meeting
Pub/restaurant/culture/spectator sports

Active sports
Garden/cottage
Walk/stroll
Excursion: Nature
Excursion: Culture
Short vacation

Home

Other

APPENDIX B: STRUCTURE OF THE DATA SETS

Table 15 explains the contents of the data set, while Table 16 gives the number of observations in each.

Table 15 Content of the data sets

File name	Unit	Comment/Source
hh	Households	Household questionnaire
v	Vehicles	Vehicle questionnaire
p	Persons	Person questionnaire
att	Attitudes/values	Attitudes and values instruments
s	Stages	Known stage details generated from trip diary
t	Trips	Trips including information about previous and following trip
j	Journeys	Journeys generated from the reported trips (summaries of trip-level data)
d_w_ldj	Long-distance journey days	Days with long-distance journeys to locations outside the study areas
act	Activities	Activities based on trip information including some trip information
pdx	Person days	Summary of each day reported (e.g. trip making, activity participation)
pwx	Person weeks	Summary of each week during which the person reported
hhdx	Household days	Summary of each day for each reporting household
hhwx	Household weeks	Summary of each week for each reporting household
d_im	Immobile days	Immobile days from trip diary

Table 16 Size of the data sets (number of records)

File Name	Contents	Pre-test	Main study	
		Karlsruhe	Halle	Karlsruhe
hh	Households	23	68	71
v	Vehicles	72	172	266
p	Persons	44	158	159
att	Attitudes and values	--	129	133
s	Stages (without imputation)	16048	51455	62593
t	Trips	6741	20992	24540
j	Journeys	2801	9323	9664
d_w_ldj	Long-distance journey days	113	214	329
act	Activities	6785	21150	24699
pdx	Person days[1]	1725	6378	6257
pwx	Person weeks	264	946	949
hhdx	Household days	961	2851	2967
hhwx	Household weeks	138	408	426
d_im	Immobile days	100	593	267
	Missing days	10	44	92

[1] Person day file contains the immobile days