

# Effects of Different Data Collection Procedures in Time Use Research

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A field that might play an important role in the future of travel demand analysis and modeling is time use research, although some issues need to be resolved. One such issue deals with the data collection procedure. To provide guidelines to researchers, the strengths and weaknesses of three data collection systems are reviewed. One system relied on the traditional paper-and-pencil diary; another system was a self-administered electronic diary (computer-assisted self-interview, or CASI), and the third was based on an interviewer-administered electronic procedure (computer-assisted telephone interview, or CATI). These systems are compared in terms of the validity of the time use statistics, the unit response rate, and time involved in conducting the survey. The results show that none of the data collection systems is best in all aspects: the unit response rate is highest in CATI, and the time to conduct the survey is lowest in CASI. As far as the validity is concerned, one method was not found to be best for all activities. The comparison clearly shows that relatively large differences exist among the procedures. Consequently one must be careful using the results of studies that are based on different data collection systems. One specific activity that is of increasing interest to policy makers, that is travel, is illustrated.

One of the challenges facing the field of time use research today is to clearly show its usefulness in guiding policy. A policy issue that can be addressed with time use data is travel behavior. According to earlier reports (1,2) time use research could play an important role in the development of new travel demand models (especially from the perspective of the activity-based approach), although there are some issues yet to be resolved. One of these issues is related to the fact that many researchers who work in the time budget field prefer to measure time use by means of a diary. In this approach respondents are asked to report their activities for at least 24 hr chronologically. Traditionally this is done with paper and pencil.

The use of a diary is preferred, because this type of data collection technique is expected to produce the most accurate results [see, for instance, work by Juster (3), Niemi (4), and Gershuny and Robinson (5)]. However, diary surveys are expensive, and they demand a lot of time, from both respondents and researchers, who fill in the diary and process the data, respectively. These disadvantages and the fact that advances in computer technology have changed the methods of data collection have led to the development of an alternative diary form; the electronic diary. This electronic diary resembles the traditional one to a great extent, but the coding of activities is done by a computer-assisted tree-structured questionnaire (6,7). It was expected that this form of diary avoids many of the disadvantages of the hand-written diary.

In the first place, the use of a computer in data collection can considerably reduce the amount of work. A second advantage is that coding is automatic. Another presumed advantage of computer-assisted data collection is that it can improve data quality, if careful

attention is given to automatic branching and coding, consistency checks, and help screens (8,9).

Until now little evidence has been given for these general findings. Although the literature on (time use) data collection mode comparisons is extensive (10-15), comparisons with computer-assisted data collection are rare. Therefore, a comparison was made between the electronic and the conventional paper-and-pencil procedure (paper-and-pencil interview, or PAPI). One environment was a self-registration method (computer-assisted self-interview, or CASI) and the other an interviewer-administered procedure (computer-assisted telephone interview, or CATI). In this study these data collection procedures are compared in terms of the validity of the time use statistics, the unit response rate, and time to conduct the survey.

The simplest measure to establish is the unit response rate because the maximum number of possible participants is known or is possible to estimate. The time to conduct the survey is the most difficult criterion, as the design of the surveys differed considerably, and some time components were unknown. Therefore, attention is paid to only two aspects: interviewers' time and assistance; and coding and editing time. These aspects reveal, for the surveys compared here, how much time can be gained by using the computer-assisted interviews instead of the PAPI.

Validity is measured indirectly, because it is not normally known what real time use is actually like (15). Juster (11) formulated criteria that implicitly assume that greater detail in reporting and the ability to account for time lead to more valid reporting. Besides this, the number of mistakes made by respondents and coders was evaluated.

For the purposes of this comparison, a strict experimental design was not used to evaluate the effect of the various aspects of the data collection modes. In the first place, the designers had no influence on some of the design characteristics. Second, systematic variation in characteristics does not appear to be practical for the specific surveys that were considered. Therefore, three existing procedures designed to be as efficient as possible given the mode of data collection were compared. Consequently, the data collection method is not the only factor that differs among the procedures: there are also differences in the methodology of the diaries (report and coding of activities and time and the kind of information requested) and the implementation aspects of the surveys (selection of households, individuals, and days).

In the next section an overview of the characteristics of the time use diaries and the implementation features of the three surveys are presented. Because the interest of this study was mainly in the influence of the registration method, some methodological issues are discussed briefly. These issues concern the corrections that have to be made before possible effects of the data collection procedure could be examined more clearly. Then a summary of the results of the comparison is given, and finally the impact of the differences

between the data collection procedures for the time use on one specific activity, travel, is illustrated.

## METHODOLOGY OF DIARIES

The information gathered with a diary "can show for an individual what activities were done during the defined period, how many times, in what order, at what time, for how long, where and other objective and subjective information connected with the activities" (16).

The diary itself can be designed in many different ways. The activity categories may be precoded or open, the time interval may be fixed (periods of 5, 10, 15, or 30 min are the most common) or open (asking until what time an activity lasted), the activity code itself can be varied, and the diaries may provide space for recording only one (primary) or multiple simultaneous (primary and secondary) activities (17,18).

It is difficult to tell which design is preferred. The most important problem seems to be the balance between the task of the respondent and the processing of the data (10,19). This problem has been the major reason for designing an electronic diary. In the opinion of the author an electronic diary is less demanding for the respondent and it handles the data processing very well. However, before the features of the electronic diary are outlined, the design of the PAPI diary that was used for the comparison will be presented.

## PAPER-AND-PENCIL INTERVIEW

Between 1987 and 1988, the Netherlands Central Bureau of Statistics conducted time use research. On the basis of a pilot study from 1986 in which several methodological variants of the design were examined on response rate, selectivity of the response, and data quality, a design was chosen for the main survey (8).

The diary design included the following features: for registering activities the closed variant was chosen with a precoded list of activities. In total, the list contained 106 activities divided into nine groups. The activities were registered in fixed intervals of 15 min, and secondary activities were ignored. Thus, the respondents had to

specify their activities and code them for each interval of 15 min. Next to the code, a verbal description of the activity could be given. In the events that concurrent activities were performed during a certain interval, the respondent had to choose either the activity that had lasted more than 7 min or the so-called productive activity. For the productive activities, supplementary questions had to be answered in the diary.

## COMPUTER-ASSISTED SELF INTERVIEW AND TELEPHONE INTERVIEW

The electronic diary was developed by the Sociometric Research Foundation, and the main purpose of the study performed with this diary was the registration of time use. The diary is characterized by the following features: activities are recorded by answering a tree-structured questionnaire, the time interval is open, and activities that last for 10 min or more—with the exception of travel—and secondary activities have to be reported. In total, 368 activities are distinguished.

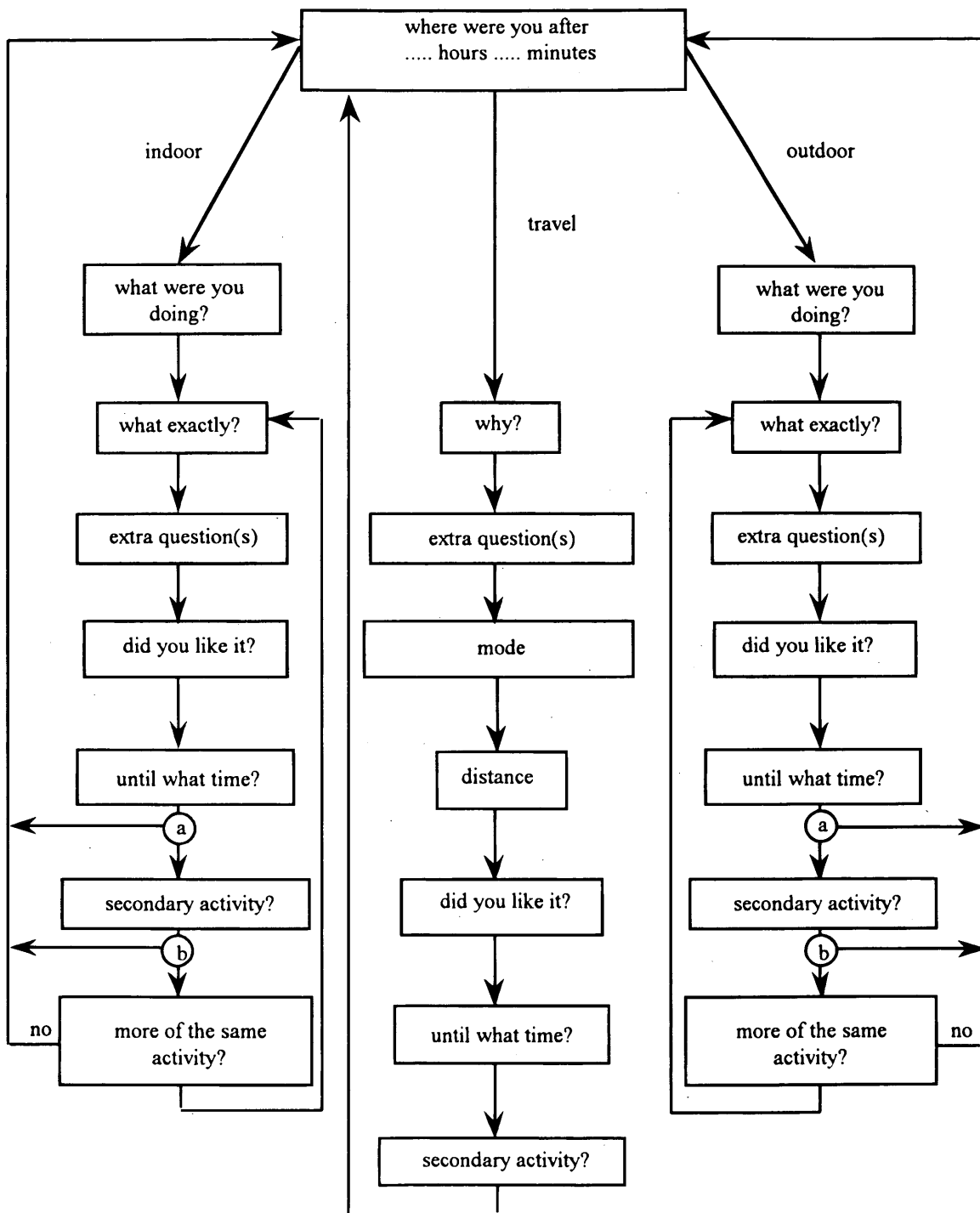
What is meant by "activity coding by answering a tree-structured questionnaire" can best be illustrated by showing part of the questionnaire (Figure 1). First, the respondent has to choose between a number of main categories. Subsequently, the activity is recorded in more detail. The code of the activity is generated automatically as it consists of the sequence of chosen answers in the tree. This procedure leads to a unique code for each activity.

If, for example, the activity is "preparing supper," the activity code is 213: first the respondent chooses the main category "running the household" (2), second "preparing food" (1), and then "supper" (3). It is obvious that this procedure saves the respondent and the research organization a lot of time with respect to coding and that more activities can be distinguished than in a coding list because the task for the respondent is easier: answering questions rather than referring to a list.

An overview of the questionnaire is presented in Figure 2. In this figure the central question in the electronic diary is: Where were you after . . . hours . . . minutes? The answer to this question determines whether indoor, outdoor, or travel activities are shown. Next, the activity is registered in detail.

What were you doing?	What exactly?	Further?
1. job	1. main job 2. second job 3. unpaid job	
2. running the household	1. preparing food  2. washing up 3. making tea or coffee 4. cleaning the house	1. breakfast 2. dinner 3. supper 4. other
3. personal care	1. taking a shower 2. etc., etc.	1. dust 2. etc., etc.
4. etc. etc.		

FIGURE 1 Part of electronic questionnaire.



Conditions:

a: all activities, excluding night sleep

b: if the reported activity is doing the housework, obtaining goods/services, work/job, media activities

FIGURE 2 Flow chart of electronic questionnaire.

Specific additional information on the activity can be easily asked and may apply to all activities or to a specific kind of activities (for the latter see, for instance, the questions asked about travel in Figure 2). For all activities, the respondents were asked whether they like performing the activity, and for nearly all activities, whether they performed another activity concurrent with the primary activity. The amount of inadequate information in the electronic diary is kept to a minimum by having immediate checks on the upper and lower boundary of answers, the time measure, and the sequence of activities, for example, report of travel between indoor and outdoor activities.

Two drawbacks of the electronic diary are that it uses an open-time interval and that respondents are not provided with a list of activities. These could lead to confusion about the level of detail expected in the diary (19). To compensate, an example was given as an introduction to the diary exercise and an extra question was placed after each activity to check whether the answer given represented the activity performed and its duration. Possible mistakes could be reported in answer to this question and in the response to an open question at the end of the questionnaire. To get an accurate account of time use, if the duration of the reported activity exceeds a certain length of time (4 hr or more where "work" or "job" is reported, and 3 hr or more for all other activities), the respondent is asked whether he or she is certain that all activities have been reported.

With this electronic diary, data can be gathered in different ways; the questionnaire can be filled out by either a respondent or an interviewer. In this research, data were collected both ways. The same questionnaire was used for both procedures, and therefore the coding structure of the activity and time, the recording of the primary and secondary activity, and the extra information requested about the activities were all the same. In this paper these two forms are compared with the PAPI diary. But first the implementation characteristics are discussed.

## IMPLEMENTATION OF DIARIES

In principle, the selection scheme for obtaining a sample of diaries that fully reflect the time use for activities in the population is as follows: first, a probability sample of households must be selected; second, individuals within the household must be determined at random; and, finally, the dates for which time diaries are to be filled out by each respondent must be selected by a probability method (20). The most important decisions about these aspects follow.

### Paper-and-Pencil Interview

For the PAPI survey a sample of households was randomly drawn from an address directory. All members of these households who were at least 12 years of age were requested to keep a diary for 2 consecutive days. These days were determined at random by interviewers according to a scheme.

One person per family was interviewed face-to-face on characteristics of the household. The remaining information was collected in writing and collated later by the interviewer. The respondents were asked to record their activities as soon as possible after the activities took place. To boost response, each household was offered a gift.

The survey was held over 2 years. As a result, the sample of addresses was spread over the year to make it possible to present

results for periods of less than 1 year. For the purposes of this comparison, data were provided for only one member of a household (where possible, randomly selected) who responded in October and November 1988.

### Computer-Assisted Self Interview

One of the environments in which the electronic diary was used was the NIPO Telepanel. This panel consists of a sample of about 1,000 households that were randomly drawn from an address directory (the same one that was used for PAPI). The NIPO has provided these households with a computer and modem, and with these facilities data are collected entirely automatically (9,21,22).

The time use survey in the Telepanel had to be conducted within 1 week in the 1988. One week in November was chosen because earlier research has shown that time use in the period between October and November is closest to the annual average (23). At the end of October, all individual Telepanel members 12 years and older were asked whether they wanted to participate in the survey. To encourage them, a lottery with one prize was announced. Of the willing respondents, only one person per household was randomly selected. This person was asked to fill in the diary for three different days. A fixed scheme of assigning days to persons was used and respondents were given notice in advance of the days for which they had to report their activities. It was not a requirement that Telepanel respondents should fill in the electronic diary several times a day because during that time the computer would have to be switched on. Instead they were asked to fill in their diaries as soon as possible after each given day.

### Computer-Assisted Telephone Interview

The other environment in which the electronic diary was implemented was a centrally administered telephone survey conducted at the University of Amsterdam. Interviews were conducted 7 days a week during the afternoon and evening in October and November 1988. The sampling source consisted of a telephone directory. Again one person per household aged 12 years or older was randomly selected to report his or her activities for 3 days. During the first call the respondents were asked about their previous day's activities and about their demographic characteristics. Afterwards, attempts were made to make appointments for interviews 2 and 4 days later. If the respondent could not be contacted on these days, the interviewer tried to make appointments for 3 and 5 days later for the same diary day as before. If even this was impossible, another diary day was selected because it was felt that the recall period would otherwise become too long.

These data clearly indicate that dissimilarities in the implementation exist. Consequently, the registration process is not the only factor that differs between the procedures. To see if time use differences resulted from the registration method, some methodological issues had to be resolved. This is the topic of the next section.

## METHODOLOGY OF COMPARISON

Before it is possible to concentrate on whether differences exist between the data collection procedures, two methodological issues need to be discussed briefly. The first one relates to the classification of the activities, and the second one relates to weighting.

To allow a comparison between the data collection systems, the lists of activities had to be brought into line with each other. To do this, the classification schemes were judged by four different researchers; after discussion they came up with one scheme of 75 activities for the different surveys. For the evaluation of the time use estimates, the activities were finally grouped together even more (29 activities) because many activities were performed infrequently, which hampered the comparison.

A second important issue is that it is advisable to correct the data for differences between the procedures with respect to implementation aspects. The most important aspects are assumed to be non-response and the sampling source. The coverage of the population may be selective and incomplete and may therefore bias the results. To examine whether the coverage is selective or incomplete, researchers often search for variables that are expected to be strongly related to the topic of the research and for which the population distribution as well as the distribution for the respondents is known. If differences between the sample and population distributions are found, the sample results can be weighted to adjust for a possible bias. In this study, weighting was done in such a way that all days of the week were equally covered in the three samples and that the distribution of certain demographic variables that are assumed to be strongly related to time use, perceived position on the labor market, age, gender, marital status, and urbanization in the samples corresponded to population estimates. By applying this weighting, it was possible to examine more clearly the influence of the data collection procedure on the time use.

## RESULTS

The most salient finding of this research is that none of the procedures emerges as the outright winner in all respects: PAPI achieves the highest amount of detail (in PAPI, respondents reported on average 22 primary activities, in CASI 20, and in CATI 19), but in CATI there are fewer mistakes (in CATI 2 percent of the total time consisted of mistakes; in CASI, 4 percent; and in PAPI, 7 percent) and a higher response (CATI, 52 percent; PAPI, 45 percent; and CASI, 38 percent). The cost in terms of time is favorable in CASI (CASI, 120 h; CATI, 1,240 hr; and PAPI, 1,460 h), whereas social desir-

ability has less of an effect in PAPI and CASI. For more details about these results the reader is referred to other work by Kalfs (24).

Further, it was found that each of the data collection procedures gives more valid results than the others for certain specific kinds of activity. The registration of routine activities is best in PAPI because in this procedure the recall period is short and respondents have the time to think about their time use thoroughly and are confronted with them in a list. Activities that may lead to a lack of understanding on the part of the respondent (for instance travel, child care, and social contacts) are best reported in CATI, because a well-trained interviewer is in a position to significantly improve data quality by posing additional questions and clearing up misunderstandings. On the other hand, the interviewer can also have a negative effect on the validity because the respondent may try to create a positive impression of him or herself on the interviewer by reporting socially desirable activities. This was found to be true for the time people spent watching television: in CATI a tendency was found among more highly educated respondents to answer in a socially desirable way, leading them to underestimate the time they spent on this activity. To get an idea about the impact of the differences, one activity, travel, will be discussed in detail.

One of the activities for which the highest effect of the data collection procedure was found on time use was travel. In Table 1, the deviations between the data collection systems, in terms of the time use statistics that are normally used (mean total time, mean participation rate, and mean participation time), are relatively large.

In Table 1 time use statistics were also included from another study, the "trip diary survey" for 1988, to validate the results of the various data collection procedures. In the trip diary survey (TDS), a one-day PAPI diary is used in which respondents have to fill in all the trips they make during a designated day. Comparison of the results of TDS with the outcomes of the time use surveys reveals that the participation rate in CASI and CATI corresponds to the rate in TDS. In PAPI the participation rate is much lower. Examination of the participation time indicates that about equal estimates are found for TDS, PAPI, and CATI, but the CASI estimate is much higher.

The results suggest that the time use on travel is underreported in PAPI, given the lower participation rate and is overreported in CASI, given the higher participation time. The question then is:

TABLE 1 Time Use Statistics for Travel

Data Collection Procedure	Time Use Statistics <sup>d</sup>		
	Mean Participation Rate <sup>a</sup> (%)	Mean Participation Time <sup>b</sup> (Minutes)	Mean Total Time <sup>c</sup> (Minutes)
PAPI (n=954)	57 (2)	86 (4)	49 (3)
CASI (n=1785)	88 (1)	107 (3)	94 (3)
CATI (n=1208)	91 (1)	84 (2)	76 (2)
Trip Diary Survey (n=21300) <sup>e</sup>	88 (.)	80 (.)	70 (.)

(.) Unweighted Standard Error (.) Unknown Standard Error

<sup>a</sup> Participation Rate = percentage participating per day for all respondents

<sup>b</sup> Participation Time = time use in minutes per day for participating respondents

<sup>c</sup> Total Time = time use in minutes per day for all respondents

<sup>d</sup> It is possible that participation rate x participation time ≠ total time due to rounding

<sup>e</sup> CBS (1989). *De mobiliteit van de nederlandse bevolking*. Centraal Bureau voor de Statistiek, Voorburg.

How can we explain the lower participation rate in PAPI and the higher participation time in CASI?

The lower estimate for the participation rate in the PAPI procedure is probably generated by the time interval and the lack of a check on travel. Because of the fixed interval of 15 min, travel of short duration was not reported in the PAPI diary, whereas these activities had to be reported in the electronic diary, which included a check on travel. It was thought that the lack of a check on travel would strongly influence the time use on travel concerning shopping and leisure (especially entertainment) because this kind of trip is often not viewed (and thus not reported) as trip making by respondents (6,25).

The time use for travel seems to be overestimated in CASI because of the mistakes respondents made. A closer inspection of the data showed that some respondents in CASI had made mistakes with respect to shopping and leisure time trips (B. Bosch, unpublished data, 1991). Diaries were found in which only one trip was reported, when in fact three activities were expected: two trips—one from home to another location and vice versa—and the activity performed away from home. When this kind of mistake was made, the time use for the activity performed between two trips was added to the time use on travel. It is possible that more respondents have filled in the diary in this way than the ones who reported that such a mistake was made.

These explanations for the deviations in the time use for travel in PAPI (time interval, omission of certain trips) and CASI (omission of certain activities performed between two trips) were examined further. The influence of the time interval was estimated on the basis of the total time in CASI and CATI for travel activities of short duration. The missing trips in PAPI were reconstructed in two ways. First, the activity performed was determined when a change in the activity's location took place. Second, the total time for travel was divided by its purpose on the basis of major clusters of activities (11 categories). The purpose of a trip was inferred from the activity at the origin or the destination of that trip (25,26). Besides this information, data were available in CASI and CATI with respect to the

distance traveled; this information made it possible to examine whether the duration per distance unit traveled (1 km) differed between CASI and CATI or, in other words, in CASI whether the time spent on the activity performed between two trips could have been added to the time use for travel.

In the first place, an estimation was made of the total time involved in trips of short duration. Calculated in minutes, the total time involved in trips of short duration was only 3 to 4 min. This result illustrated that the time interval can explain only some of the large differences in the total time among the three procedures.

More support was found for the idea that certain trips were not reported in the PAPI diary. The distributions of activities before or after a change in place (moving back to or away from the dwelling) indicated that, overall, in PAPI, travel was reported in only 36 percent of the activities. Activities that are realistic alternatives for travel (active leisure, such as walking or cycling for recreational purposes or walking the dog) consisted of 6 and 10 percent, respectively.

If these estimates are taken together, it is found that in 52 percent of all changes in the activity's location trips were reported and in 48 percent trips were not reported. This 48 percent mainly consisted of everyday needs (25 percent), visit/party, and similar social activities (21 percent), other shopping (15 percent), and working time (11 percent). Thus, trips with respect to these latter activities were underreported in PAPI. Further evidence for this statement is provided by the data in Table 2, in which the total time for travel is distinguished by the purpose of the trip. Moreover, if the CATI estimates are taken as criteria, one can see that the time use for shopping and entertainment trips in particular are underestimated in PAPI. The trips related to these activities are also underestimated in CASI, but the differences between CASI and CATI are smaller.

Looking now at CASI, a more striking result was found with respect to the category "traveling around." This activity concerns trips that are undertaken without a specific purpose of the trip. This estimate is much higher for CASI than for PAPI and CATI. It supports the idea that respondents in CASI tend to forget to report the activity they performed between two travel activities.

TABLE 2 Mean Total Travel Time for Specific Activities

Activity	Mean Total Time (n=954) Minutes	PAPI (n=1785)	CASI <sup>a</sup> (n=1785)	CATI <sup>a</sup> (n=1208)
Work	13	13	15	15
Domestic activities	1	1	3	3
Child care	1	1	1	1
Shopping	5	5	7	13
Personal needs	4	4	5	6
Education	7	7	7	6
Organisations	1	1	3	3
Entertainment	8	8	12	16
Active leisure	2	2	5	6
Passive leisure	2	2	1	1
Travelling around	6	6	29	5
Total <sup>b</sup>	49	49	87	75

<sup>a</sup> The total times for CASI and CATI are corrected for mistakes

<sup>b</sup> Details may not add to totals due to rounding

TABLE 3 Mean Duration for Travel Activities (min/km)

Direction of Travel	Duration in Minutes CASI Mean	CATI	Difference
At home → travel → not at home CASI (n=1859), CATI (n=1685)	5.8 (0.3)	6.0 (0.2)	-0.2
Not at home → travel → not at home CASI (n=548), CATI (n=548)	6.1 (0.4)	5.5 (0.2)	0.6
Not at home → travel → at home CASI (n=1873), CATI (n=1645)	5.5 (0.3)	6.1 (0.2)	-0.6
At home → travel → at home CASI (n=792), CATI (n=157)	38.0 (2.0)	16.5 (1.4)	21.5

(<sup>1</sup>) Unweighted Standard Error

This possible effect was examined further by calculating the mean duration per kilometer for various situations in which travel was reported. The results are indicated in Table 3 and clearly support the existence of this effect. In the table, one can see that large deviations between the two procedures are found for only one category: at home → travel → at home. The mean duration per kilometer for this category in CASI is more than twice as high as the estimate in CATI. Thus, it appears that in this situation the time use for the activity performed between two travel activities is added to the time spent on travel.

In general, Table 3 results show that in PAPI as well as in CASI, trips associated with shopping and entertainment are particularly underreported. Consequently, the time spent on activities for which the trips are missing is probably overestimated in PAPI. The situation in CASI is different; despite underreporting of shopping and leisure time trips, the time use for travel is overestimated primarily because of the time spent on traveling around. Most of the time use for this latter activity consists of the time spent on shopping and entertainment trips, and the time actually spent on these activities. Therefore, if the total time for shopping and entertainment is added to the total time for travel, one would expect roughly equal results for PAPI and CASI. This is indeed the case, as one can see in Table 4; the overall estimate for PAPI is 168 min, and for CASI it is 169 min.

In summary, it is concluded that the time spent on travel is underreported in PAPI because of a lower participation rate. The overreporting in CASI is because of a higher participation time. This under- and overreporting is mainly caused by the same factor: a problem in correctly classifying trips related to shopping and entertainment. In PAPI, respondents forgot to enter these kinds of trips

in the diary. In CASI, however, trips associated with these activities were reported because there was a check on travel in the electronic diary, but at the same time the shopping and entertainment activities were themselves omitted relatively frequently. The CATI interviewer was well trained to clear up misunderstandings with respect to these activities and therefore less-biased estimates were obtained.

## CONCLUSION

In this paper, two forms of an electronic diary have been compared with the traditional PAPI. These diary forms are compared in terms of the validity of the time use statistics that are normally used, the unit response rate, and the time involved in conducting the survey. The results show that there is no single method that is best in all aspects. Each of the data collection procedures examined here reveals aspects for which better results are obtained if the results of the other procedures are compared. The same result was found with respect to the time spent on specific activities, which would suggest that one should use different methods if one is interested in the time use for all kinds of activities. However this use would be both expensive and impractical. Thus, the question remains: Which method should be chosen if one has to rely on only one method?

Of course improvements in the questionnaire are still possible, particularly in the electronic diary. Given the large differences between the procedures with respect to the time involved in conducting the survey, which especially favors CASI, it is clearly worthwhile to put extra effort into improvements. To start with, sound training of the respondent, especially for problematic activi-

TABLE 4 Mean Total Time for Shopping, Entertainment, and Travel

Activity	Mean Total Time Minutes	PAPI (n=954)	CASI (n=1785)
Shopping		36 (2)	15 (1)
Entertainment		83 (4)	60 (3)
Travel		49 (3)	94 (3)
Total		168 (5)	169 (5)

(<sup>1</sup>) Unweighted Standard Error

ties, can help every data collection method to provide better data. Besides this kind of assistance, it is also possible to improve the precision of time use reporting in the electronic diary by implementing additional checks on activities and time reports. However, it is difficult to see any way of avoiding bias because of social desirability. In general, therefore, if more effort were made in the design of the diary and if equivalent guidelines were applied to each diary, it would be possible to get data of comparable quality from PAPI and CASI, although some problems still remain in the case of CATI.

Although the analyses have touched on only three particular data collection procedures within one specific topic, and although they have been mostly concerned with aggregated measures, there is much more to be learned from data collection procedure comparisons in which computers are used, especially given the technological advances being made nowadays. Therefore computer-assisted data collection is a topic to research more closely in the years to come. Travel behavior is another topic for future research.

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