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Monitoring daily time-use by an electronic time use app (ETUS)

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One important dimension of everyday life is how time is spent during an ordinary weekday with focus on how daily activities are structured and on the participation in activities known as proxies for wellbeing.

It is well-documented that to promote wellbeing, people, particularly young people, needs to live a regular life with enough sleep, a sufficient number of meals including breakfast, not too much time spent on sedentary activities, and with some physical activity every day. (Bonke & Greve, 2012; 2013).

The usual instruments used to monitor people's time-uses are time-diaries, which allow reporting events in the sequence they occur in daily life usually within a 24-hour context. A telephone, face-to-face or web-based interview is conducted by asking questions about the activities the respondent was involved in the day before the interview (Hofferth & Stafford, 1985; Bonke & Fallesen, 2010). However, the response-rates are often small in particular among vulnerable people for which reason smart-phones will be used as the data collection tool. In Holland CentERdata and the Netherlands Institute for Social Research have developed a smart phone app enabling the collection of auxiliary data, i.e. GPS location and communication behavior when downloading the app onto their smart phone. Data about the respondent's time-use are also collected applying the smart phone app either as experience sampling – replies to frequently beeper messages – or the respondent reports the number of episodes, the frequency with which people updated their diary and the general time-use pattern (Sonck & Fernee, 2013).

II Smartphone in survey research – an instrument to measure time allocation in different population groups.

There is a series of studies investigating people's daily time allocations, many of the studies are based on guidelines developed by Eurostat (2000). These guidelines stress the importance of focusing on people's behavior over one or two weekdays. In most cases, the samples are drawn from population registers, ensuring randomness and that the sample is representative of the (sub-)populations to be investigated. The time-allocation or time-use surveys include either open-ended activity categories prescribed for post-coding or a pre-coded activity list from which the respondent chooses the most relevant activities he or she is involved in from 04:00 to 04:00. These sequences are then divided into 10-minute intervals to allow for interpersonal comparisons of the activities people are involved in during every moment of the day in question; an activity must be at least 5 minutes' duration to be classified as a dominant activity. In some surveys, as in the present app, the day is divided into 10-minute intervals from the start where the respondent gives the main activity in which he or she is involved. In both cases a longitudinal dataset for one or two days is established for each respondent.

To date, most time-use studies have been done using self-completion, paper-based interviews or telephone interviews (CATI) and only very few by using web applications (CAPI) available on people's personal computers. The Danish Time-Use and Consumption Survey (DTUC) was one of the first time-use surveys to apply both the CATI and CAPI interview mode by giving a representative sample of 18–74-year-olds the opportunity to choose the most appropriate mode for them. Inspired by the Danish experience, the same procedure was followed in Belgium by Minnen et *al.* (2013), who also translated the paper diary into an online version.

An evaluation of the sampling procedure and the qualities of the two modes used in DTUC Bonke & Fallesen (2010) shows that introducing lottery prizes with double the chance of winning if using CAPI increased the number of responses – the quantity – significantly. Moreover, the number of sequences and activities – the quality – was also higher because of the higher quality of web interviews relative to telephone interviews. Nonetheless, only 20 percent of the diaries were completed using CAPI.

The low participation rate obtained by using the web mode in time-use surveys has not prevented the forthcoming time-use surveys in the Scandinavian Countries combining telephone

interviews with web-based interviews (Bonke is a member of the Nordic time-use group). The simple reason is that the CAPI mode is less costly to use and that the coverage of personal computers in most countries is growing rapidly, making the web-mode accessible for more people.

The newest development in time-use surveying is the use of Smartphone applications. The number of people, and in particular young people, who own a Smartphone and use it for communication and information purposes has increased considerably within the recent years with a coverage rate of 51 for 16–74-years-old in Denmark in 2013. As people already use their Smartphones many times throughout the day to obtain short news updates, to send messages and to check social media sites, short survey questions and reminder notifications using an app installed on the Smartphone could easily be used to complete a mobile questionnaire (The Netherlands Institute for Social Research, 2013).

III Smartphone apps - experiences from other countries

There are two smartphone apps developed for time-use studies right now: a Dutch and a Belgian. However, as it is argued below, none of them fulfills the purpose of the RF's Youth at Risk project or other RF and RFF-projects aiming to measure other groups' everyday life, and that of the whole population.

The Dutch experience

The Netherlands Institute for Social Research/SCP and CentERdata (Tilburg University) has developed a time-use application for Smartphones designed for the Android and iOS systems (iPhone). 2009). The survey material comprises a short questionnaire about the respondents' current mental state and whether the day of the interview is an ordinary day, etc., and a diary. In the diary, the participant reports the primary and secondary activities in which he or she engages during the day of the interview, and with whom he/she is together with in every time-sequence of the day. There are 41 pre-coded activities, and in cases of doubt about which one to choose, a facility offering a list of examples is easily accessible. The respondents were asked to complete two diaries, one for an ordinary weekday and one for a weekend day. They receive reminders several times during the two days, and diary entries can be made up until noon on the second day – the diary days last until 04:00 am. For ordinary time-use surveys, the diaries pertain to the day

before the interview to avoid the problem of affecting behavior by doing the reporting simultaneously.

The quality dimension was measured by the number of different episodes – a continuous period of time with the same activity – reported by the participants (see also Bonke & Fallesen, 2010). The assumption is that a higher number of sequences indicates a greater accuracy of the reported time use and, accordingly, a higher quality of the responses. The result was that the inexperienced Smartphone users did the best job, probably due to feeling more responsible because of borrowing the phone (Fernee & Sonck, 2013; Sonck & Fernee, 2013).

Another quality measure used was the number of times the Smartphone diary was updated during the day. The idea is that a higher number means a shorter time between the performing and the reporting of the different activities, implying more accurate reporting. Again, the inexperienced users produced the highest quality, i.e. 12.5 times a day as opposed to 10 times a day for the experienced users. A video demonstrating the use of the Smartphone app was evaluated positively, albeit more so for inexperienced than for experienced users.

To avoid complicated procedures and the expense of sending data to the database, an automatic synchronization procedure was established enabling the data to be sent each time there was Internet connection, i.e. through WiFi.

The implementation and evaluation of the use of the Dutch Smartphone

RFF did some tests of the Dutch app to investigate if they fulfilled the requirements and to test the quality of the data. There were problems with 1) how to connect to the data-server at centERdata, and 2) the screen-pictures were not found as user friendly as expected. This implies that we cannot merge data with register information at Statistics Denmark. Lastly, 4) changes of the app, e.g. including new activities for new groups of respondents, are to be negotiated and done by centERdata.

The overall conclusion drawn from the Dutch pilot project was that the collection of time-use information by Smartphone apps is recommended even for inexperienced users of such phones. Accordingly, Smartphones will also be used in the RFF project (US 1335)

The Belgium experience

Another app is developed by MOTUS, which is a Research Group (TOR) at Vrije Universiteit, Brussel. The purpose of that app is also to collect time-use information based on a diary-setup and in many ways it is similar to the app from centERdata. A very preliminary version of the MOTUS-app has been tested by Jens Bonke, who found it hard to evaluate the functionality etc., The conclusion based on the prepilot of the centERdata app and the knowledge about the MOTUS app, was that RFF developed a new version of a time-use app following the guidelines for time-use studies in general.

IV The Danish Time-use app – ETUS (Electronic Time-Use Survey mode)

Time-use information collected through time-use diaries offers an excellent way of collecting data to be used for analyzing different population groups' everyday lives or wellbeing.

The fact is that diaries shows how days are structured activity by activity from the early morning to the late night – 04:00 am to 04:00 am – and for that reason constituting a longitudinal dataset. At the same time the different activities involved can be aggregated measuring the total amount of time spent here during the actual day. By asking about the social environment of every sequence of time – who one was together with if not alone – an additional dimension is included in the diary of a traditional time-use survey.

In the 2017/18 time-use survey, respondents were given the opportunity to answer the survey through a dedicated app or through a web version of the app via a link in the introduction letter. The web version was used in addition to the app to reach as many respondents as possible. This was also decided, because in preliminary tests of the app, some respondents expressed concerns with downloading an app just to submit their time-use survey.

Additionally, if respondents did not submit their time-use diaries within a week of their allocated days, interviewers would call them and ask for an interview covering the same time-use days. Again, this was to reach as many respondents as possible, although inclusion of interviewers increases the cost of the survey significantly.

The app was structured such, that users would begin at 4:00 a.m. They would then be asked to choose what they were doing at that time from a list of 60 predetermined activities. Next, they would turn a wheel of time to show when that activity ended. They would then proceed to the next activity choice, until the day ended 24 hours later at 4:00 a.m. Moreover, the users are also to report one out of three places – shown at the screen – where they actually were in every time slot for some activities. They also chose with whom if anyone they did the activity, thereby measuring a social dimension of everyday life.

The data were sent straight to RFF, who installed them at the RFF-server, Statistics Denmark for analyses, etc.

As RFF is the owner of the time-use app, the intension is to use it in different projects not yet decided upon. The extended use of the app is possible because the contents and functionality follows the guidelines developed by Eurostat's expert group on time-use studies, where senior researcher, Jens Bonke, RFF, is the Danish representative.

V Incentives

In order to achieve a greater number of completed time-use diaries, prizes were introduced 15 weeks into the time-use survey. Consequently, about three fourths of respondents in the entire survey population were exposed to incentive prizes, while a fourth were not, see Table 1.

Table 1 : Incentive structure of DTUS17

Week / Month & Year	Method of notice	Incentives
Weeks 14-35 / April 2017 to August 2017	Letter and possibly phone-call	None
Weeks 36-13 / September 2017 to April 2017		1 x 5.000kr., 2 x 2.000kr., 2 x 500 kr.

In the first 15 weeks of the survey (April 2017 to mid July 2017), respondents did not receive any monetary incentives. In the remaining part of the survey (Mid July 2017 to April 2018), respondents participated in a lottery with five prizes; one of 5.000 kr. and two of 2.000 kr. and two of 500 kr. Prize money was tax-free. The requirement for participating in the lottery was that they filled out all steps of the survey – questionnaire, time-use diary and additional questions. Notice of the lottery was given in the announcement letter for the time-use diary. The condition for receiving the announcement letter for the diary was that the respondent had to have completed the first questionnaire. The lottery was also announced during the follow-up calls interviewers made to respondents who had filled the questionnaire but not the diary.

The largest prize, 5.000 kr., corresponds to about a fourth of average monthly net-of-tax income in Denmark, which was 19.150 kr. in 2017[1].

[1] Based on data from Statistics Denmark, see https://www.statistikbanken.dk

VI Results

VI.1 Response rates

Table 2 shows the overall response rates at the different steps in the DTUS17 survey. The response rate was 52% on the questionnaire and 70% of those who responded to the questionnaire filled in the time-use diaries.

In the announcement letter, the respondents were given the opportunity to choose a mode of participation most convenient for them to use. The app was the least used mode, with 4% of respondents using the app, while 39% used the most popular mode the web browser, and 26 % were interviewed over the phone.

Table 2: Response Rates for DTUS17

	Amount	Share of sample	Cond. on participation in questionnaire
Sample	**10.913**	**100,0 %**	
-			
Refusals	1.087	10,0 %	
Other abstentions	198	1,8 %	
Language difficulties	102	0,9 %	
Phone contact not achieved	472	4,3 %	
No contact information	1.389	12,7 %	
Not contacted	239	2,2 %	
=			
Responses	5.380	49,3 %	
Partial responses	324	3,0 %	
Questionnaire responses	**5.704**	**52,3 %**	**100,0 %**
Time-use diaries (full diaries):			
App	233	2,1 %	4,0 %
Web browser	2.227	20,4 %	39,0 %
Telephone interview	1.508	13,8 %	26,4 %
=			
Time-use diary responses	**3.968**	**36,3 %**	**69,5 %**

VI.2 The app users

Respondents were given a link in the announcement letter to a web version of the survey and a link to the app version. It was possible to click on the link to access the web version right away, whilst to respond via the app, the user had to download the app on their phones. This is the probable explanation of why only 4% of participants in the survey opted for the app vs. the 39% who opted for the web version.

In this section it is shown that there is some selection into the group which opted to use the app. Figure 1 shows the share of respondents who opted for the app across age groups. The figure shows the expected negative correlation between age and choosing the app.

Figure 1: Share respondents who opted to use the app across different ages.

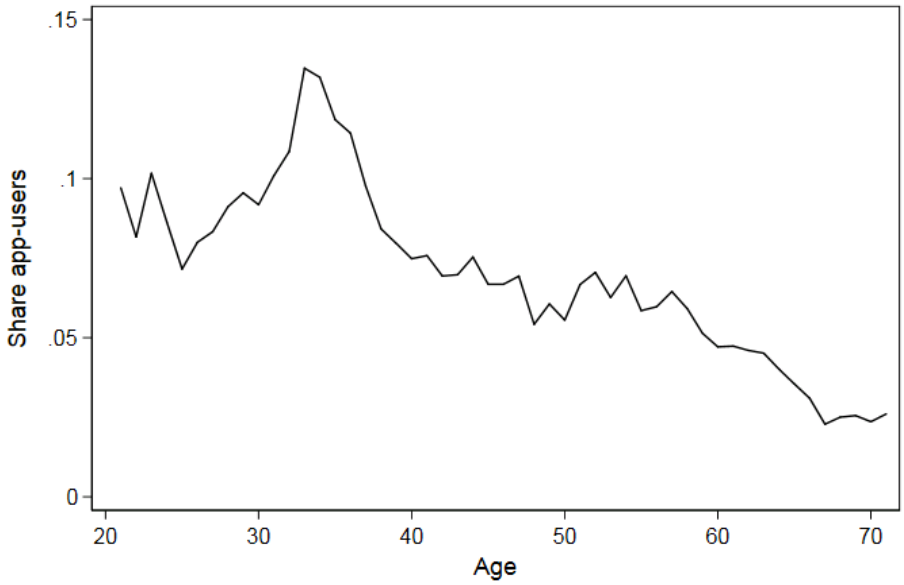


Table 3 shows several correlations between opting for the app and different socioeconomic characteristics. The significant correlations are age and education, where younger and more educated respondents had a higher propensity to respond to the survey via the app.

Table 3: The app users – probit regressions

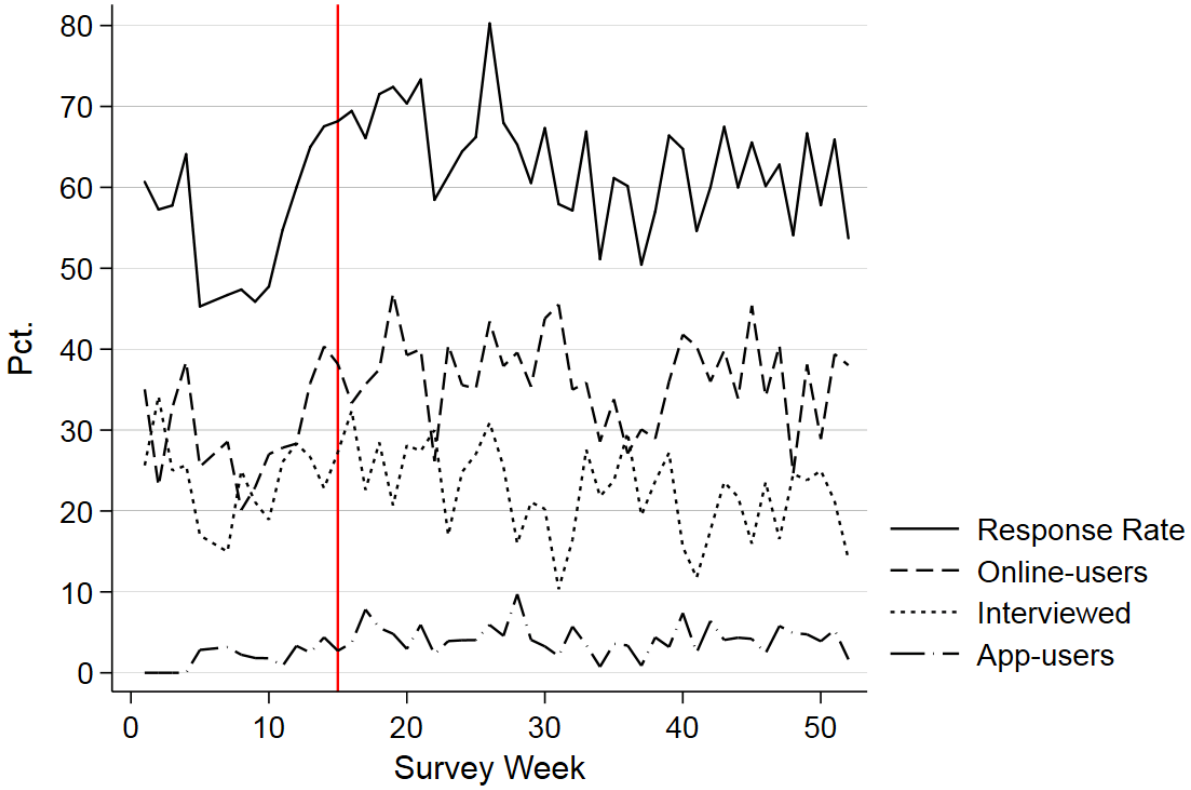
Gender, 1 = male	0.0158
	(0.0661)
Age, years	-0.0118***
	(0.00243)
Couple (single)	0.122
	(0.0902)
Education (no education)	
Vocational training	-0.0128
	(0.0947)
Short University, ≤3 years	0.0697
	(0.143)
Long University, >3 years	0.187**
	(0.0847)
# Children	0.0511
	(0.0752)
Constant	-1.188***
	(0.146)
Observations	3,968

Note: Standard errors in parentheses, * p < 0.05 ** p<0.01 *** p<0.001

VI.3 Response quantity

131 respondents were on average pr. week given the opportunity to submit time-use diaries. These were the respondents, who had already filled the background questionnaire. The average response rate was 70%. Figure 2 depicts response rates over the survey period, where the total response rate and the response rates for the individual modes are shown. The red line indicates the week prizes were introduced.

Figure 2: Overall response rate and response rates of modes across survey weeks



A preliminary probit regression shows that incentives indeed significantly correlates with increased response rates. However, given the number of observations in the beginning of the survey, 421, and the seasonal asymmetry, a causal relationship is questionable.

Table 4 shows the result of Probit estimations of participation on a dummy variable for whether the participant was eligible for prizes or not, conditional on the respondent having answered the background questions. The estimation results tentatively show that respondents eligible for prizes chose to fill the time-use diaries to a greater extent on average. The effect of prizes on participation probability was about 20%, but with the caveats mentioned above.

Table 4: Effect of prizes on participation probability

Probit	Coef.	
Prize dummy	0,23***	0,25***
Controls[1]	No	Yes

[1]Controlled for age, gender, education, family type

VI.4 Response quality – modes and incentives

The different modes of survey participation – app, web interview – could have influenced respondents' reported time-use. The interface and design were more or less the same for the app and the web versions. However, the app was presented on a small smart-phone screen, while the web version was displayed on a full computer screen. Furthermore, as has been shown earlier, app and web-users belong to different groups.

Table 5 shows the average number of different activities reported and the average number of activity sequences reported in the different participation modes. A sequence could be e.g. work, then the next sequence could be eating lunch, and the next work again.

It would seem, based on these numbers, that app users and interviewees on average give more detailed time-use diaries than web users

Table 5: Sequences and activities and interview methods

Method	Interview	Web	App
Avg. # activities reported	8,61	7,87	8,80
Avg. # sequences reported	13,67	11,41	13,58
Response share	38 %	56 %	6 %

Table 6 shows correlations between number of sequences/activities and different modes of survey participation. It seems that the amount of detail in time-use diaries are dependent on whether the user answered using the app and the web version of the survey.

Table 6: OLS regression, Number of sequences and activities reported in different modes.

	App vs. Interview	App vs. Interview	App vs. Web	App vs. Web
# Sequences	0,13	-0,01	1,90***	1,83***
# Activities	0,28	0,19	0,85***	0,79***
Controls	No	Yes	No	Yes

Note: Controlled for age, gender, job-situation, marital status and # children.

The difference in time-sequences and activities reported between interviewed respondents and app respondents is insignificant. App-users report on average 1-2 more time-sequences than web-users. However, the app-users are, as shown in VI.2, different from non app-

users. It is thus not random whether a respondent opts to use the app or not, and therefore the estimate from the OLS specification is possibly biased.

A treatment model has been employed to estimate a selection bias. The model used is an endogenous treatment-regression model, where the treatment effects are estimated in two steps. In the first step, we used a probit model to estimate the treatment effect of different characteristics. That is, a regression of an app-use dummy on age, gender, number of children, civil status and educational background. Next, the original OLS-specification is used with an additional a correction term, commonly reffered to as λ, where the treatment effect is the OLS estimate of that term[2]. The results are shown in table 7.

When the treatment effects model is used, the effect on number of sequences of app-users disappears. This seems to be because app-users on average reports more activities – not because of the app, but specific respondents opt to use the app. This is further corroborated by the estimates with interaction terms, where age (<30 years vs. >30 years) and education (higher university vs. not) was interacted with app-use. In that case, app use in itself is not a significant determinant of number of sequences reported, but app use and having a higher education is.

Table 7: Treatment effects model and interaction terms

Dep. var.: # of sequences	OLS	Treatment effects model	OLS w. interactions	Treatment effects model w. interactions
App	1,07*** (0,23)	1,31 (1,13)	0,35 (0,78)	0,75 (1,88)
Lambda (λ)	N/A	-0,03 (0,51)	N/A	-0,03 (0,54)
App*Higheduc			1,81** (0,60)	1,55* (0,81)
App*age			0,02 (0,02)	0,01 (0,02)

Note: Standard errors in parentheses, * p < 0.05 ** p<0.01 *** p<0.001

These results suggest that there is no significant difference in time-use reporting across the different survey participation modes. However, different types of respondents opt for different modes of participation. This speaks to the argument of including the app in time-use surveys as a method of reaching respondents who would otherwise not have been reached.

[2] See e.g. Heckman (1976, 1978) for further details of methodology and assumptions.

VII Conclusions

In this paper, we have investigated the impact of app as a survey mode on response quantity and quality in a time-use survey. We have also briefly looked into incentives and response rates.

We found that 4% of respondents who participated in the background survey opted to use the app as a means to report time-use. It could be because of the ease of access to the web version of the survey. We found that younger respondents and respondents with a higher education were more likely to choose the app.

We found that response rates for the time-use diary part of the survey was greater in the period where prize-money was in play, and that that the effect was around 20% greater participation probability.

An interesting finding is that response qualities across the modes were similar. Those who responded via the app generally reported more time-sequences and activities than those who responded via the website, and there was no difference in response quality between interviewed respondents and app-using respondents. However, app-users were a self-selected group of respondents. When we correct for this selection, app, web and interview response qualities are similar. We thus find, that there is no reduction in response quality by using the app as an instrument for time-use reporting.

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