DESIGN FOR NEXT
EAD12-ROME

Design for Next

12th EAD Conference
Sapienza University of Rome
12-14 April 2017

Lifelogging in User Experience Research: Supporting Recall and Improving Data Richness

Mattias Arvola*, Johan Blomkvist, Fredrik Wahlman

Linköping University, Sweden
*Corresponding author e-mail: mattias.arvola@liu.se

Abstract: The purpose of lifelogging is to help users collect data for self-monitoring and reflection. We have in this study explored how lifelogging technology (a camera and a heart rate monitor) can change user experience (UX) research, and we describe a novel approach. Data was collected for three days with four participants, and a 4–6-hours co-creation workshop with stimulated recall interview was held with each of them to create an experience timeline. The timeline includes self-reported key experiences, lifelog stimulated experiences, heart rate, decisions, and valence. The results show that the number of experiences in the timeline that come from data points stimulated by the lifelogging, are as many as the self-reported data points. Lessons learned include that the use of lifelogging produces highly detailed UX research, but it is very time consuming, due to the sheer amount of data.

Keywords: Lifelogging, life log, user experience, user research, design, stimulated recall interviews

1. Introduction

Lifelogging and other personal informatics systems help users collect data for self-monitoring and reflection (Li, Dey & Forlizzi, 2010). These technologies can potentially also be used to support user research during e.g. ’stimulated recall interviews’ (Dempsey, 2010). In this paper, we report our experiences of using a *Narrative Clip 2* lifelogging camera and a *Fitbit Charge HR* activity tracker to collect additional data about users’ daily lives.

Specifically, we looked at students’ experiences of places for studying and working in relation to daily routines. The reason for the study was a hypothesis that students would not be tied to one physical place for performing their daily work, and that their expectations and preferences would vary in some way.

2. Related work

There is prior research concerning life logging technology, and there is related user experience (UX) research approaches. The idea that qualitative interviews can benefit by visual cues is the basis for the stimulated recall technique (Dempsey, 2010). The idea of supporting recall by visual material permeates also the lifelogging, quantified self, and personal informatics literature, with the addition that biometric data can do the same (Sellen, Fogg, Aitken, Hodges, Rother, & Wood, 2007; O'Hara, Tuffield, & Shadbolt, 2008). The value of logging and making this otherwise invisible data available for reflection, is evident in the large number of people who log their own lives and activities. Oh and Lee (2015) found that people use personal informatics to quantify their life in terms of body information, psychological states/traits, daily activity (exercise, food and sleep), social interactions, and environment/property states.

Lifelogging has been used to assist in recall for people with dementia (Dobbins, Merabti, Fergus, & Llewellyn-Jones, 2014). It has also been used to support people with episodic memory impairment (Lee & Dey, 2008). An advantage of automatic lifelogging technologies is that they relieve people of manually collecting information (Kärkkäinen, Vaittinen, & Väänänen-Vainio-Mattila, 2010). An issue in lifelogging and personal informatics is privacy (Oh & Lee, 2015; Kärkkäinen et al., 2010). It is not only about the privacy of primary users, but also about the privacy of bystanders (Hoyle, Templeman, Armes, Anthony, Crandall, & Kapadia, 2014). Research has also shown that lifelogging can empower users when they have access to the collected information (Li, Dey, & Forlizzi, 2012; O'Hara et al., 2008).

People go through several the stages when collecting personal information, which can provide important insights for the design of lifelogging technologies (Li et al., 2010). For instance, people generally follow a pattern of preparing, collecting, integrating, reflecting, and then acting based on collected data. However, when going through the stages, problems in one stage affect the later stages (Li et al., 2010). The questions that people who use lifelogging technologies ask about their own data and why those questions are relevant to them, can also provide relevant information for the design of lifelogging technology (Li et al., 2010). One of the questions users have is related to context, and how to understand "how other events may explain what was happening to them *in the present*." (Li, Dey, & Forlizzi, 2011, p. 409, emphasis in original). For example, understanding mood changes based on blood sugar levels and thus combined those data points. In the integration stage, data is "prepared, combined and transformed for the user to reflect on" (Li et al., 2011, p. 5). In the reflection stage, which is the focus of the current study, the participant reflects on the information gathered.

The access to data along with how accurate it is, how different logs are integrated, how the data is visualized, and what can be done with the data from the users point of view are important UX issues to consider when designing technologies that collect personal data. Hence, important issues for lifelogging technologies is what and how data is presented to the user. The characteristics of the collected data often depends on the technology that is used, and some systems attempt to "read" the user or the activity to capture relevant information based on e.g. movement, changes, timing etcetera. However, as Lee and Dey (2008) have pointed out, some data can be difficult for users to interpret, and sometimes an important job is to find the relevant sections of huge data sets. To address this issue for people with memory impairment, Lee and Dey (ibid.) designed a system that uses "automated computer analysis and the expertise of the caregiver to select out the most salient cues from the lifelog to produce a salient summary of the experience" (ibid., p. 3). We will in this paper present how photographical data can relate to a user generated experience timeline and heart rate data to find relevant memory cues.

Inspired using *probes* in design research (Gaver, Dunne, & Pacenti, 1999), Ståhl, Höök, Svensson, Taylor, and Combetto (2009) designed a system where users collected biosensor data on arousal and movement, which was later visualised to help users reflect on their daily activities. This idea is very similar to the one used in the current study. While Ståhl et al. (2009) intentionally chose a highly ambiguous way to communicate the collected data, supposedly a better way to re-examine the embodied emotional experiences; this study uses the photos taken by the Narrative Clip and actual heart rate data from the Fitbit without an added ambiguous layer.

Our approach is similar to how Gouveia and Karapanos (2013) strengthened diary studies in their Footprint Tracker. They showed that lifelogging in diary studies increased participants' ability to recall and reflect upon daily activities and experiences. Their results indicated that visual cues (photos) often were the starting points for recollections. They also note that the approach lead to large amounts of data. Wang and Smeaton (2013) have suggested using data reduction techniques for automatic creation of a profile of a person's daily activities.

There are many aspects to consider when designing systems that collect personal data, including what existing technologies to combine. There is an ever-growing number of devices that can automatically collect lifelogging data (Hoyle et al., 2014). When it comes to photographic data there is also a distinction between automatically captured photos and leaving control of when to take photos to the users. When users have control, it is referred to as *autophotography* (Fox-Turnbull, 2009), which limits the problem of privacy, but also relies on users who remember to take photos. There is also a risk of failing to capture moments where the user is not aware that something of potential relevance is taking place. Using a lifelogging camera where photos are taken automatically has been shown to improve recall also of information not shown in the photos (Mair, Poirier, & Conway, 2017). Hence, in our study, photos are collected automatically, to complement user generated data plotted on an experience timeline. Finally, there is a risk that people who wear lifelogging technologies change their behavior and thus influence the collected material. Previous studies show however, that users appear to stop paying attention to the data collection technology, even when the information is of a private nature (Kärkkäinen et al., 2010).

3. Method

The method we employed covers a process including a lifelogging data collection, co-creation sessions, and a semi-structured interview about the users' experiences of places for working and studying. A timeline visualisation of the collected data was also created. Attitudes to lifelogging were gathered using a questionnaire both prior and post of the participants' data collecting sessions. A 7-days pilot study was conducted by one of the researchers prior to the main study, to examine the lifelogging technology, and any personal reactions to carrying the technology.

3.1 Lifelogging data collection

The lifelogging technology used included a Narrative Clip 2 lifelogging camera capable of taking photographs 8 MP at 86° angle (see Figure 1). The camera takes one photo every 30 seconds and it is worn on the clothes by a clip. The pictures taken by the Narrative Clip are uploaded to an online account through Wi-Fi. The photos were viewed through the Narrative Clip web interface and through the iOS application.

Figure 1. The Narrative Clip 2 lifelogging camera that can either be worn as a necklace or worn on the clothes with a clip.

A Fitbit Charge HR activity wristband was also used. It can log heart rate and track physical activity such as steps walked and calories burned (Figure 2). We used it to log the heart rate. The Fitbit Charge HR is synced with a computer using a USB cable and the collected data can be accessed through a web interface or through iOS or Android applications.

Figure 2. The Fitbit Charge HR activity tracker.

Lifelogging data was collected between three and four days by each participant. The participants were asked to use the technology to log as much as possible of their natural behaviour, but it was explicitly stated that they decided when to record and whether they wanted to continue with the study. The collected data varies therefore greatly between the participants. During the data collection, participants were asked to, at the end of each day, note a chronological list of what they had been doing during the day. The Narrative Clip required participants to charge the device overnight. Participants were also asked to remove the Fitbit while showering or bathing. In total, the lifelogging data consisted of around 27.000 files, mostly photos. Figure 3 shows an example of a photo taken by the lifelogging camera.

Figure 3. A photo taken by the lifelogging camera showing the first-person perspective of the person engaged in an activity.

3.2 Participants

Four participants took part in the study (three males and one female). Ages ranged from 23 to 27. Three of them were students, and the fourth was a student on a break from the studies, but working within the university. Convenience sampling was used, and all participants had a friendship relation to one of the authors of this paper. The participants signed an informed consent form.

3.2 Co-creation session

After the data collection, one of the researchers conducted a co-creation session with each participant to examine experiences in the light of the collected lifelogging data, while simultaneously creating a more accessible visualisation of the research insights. The sessions lasted three to four hours, and focused on key experiences to filter out potentially important moments. Each day was walked through and key experiences were noted on sticky notes, which were then placed in chronological order at a table (Figure 4). The participants were in charge during the co-creation session; the researcher asked questions and guided the work. Participants were asked to estimate the time of each key experience.

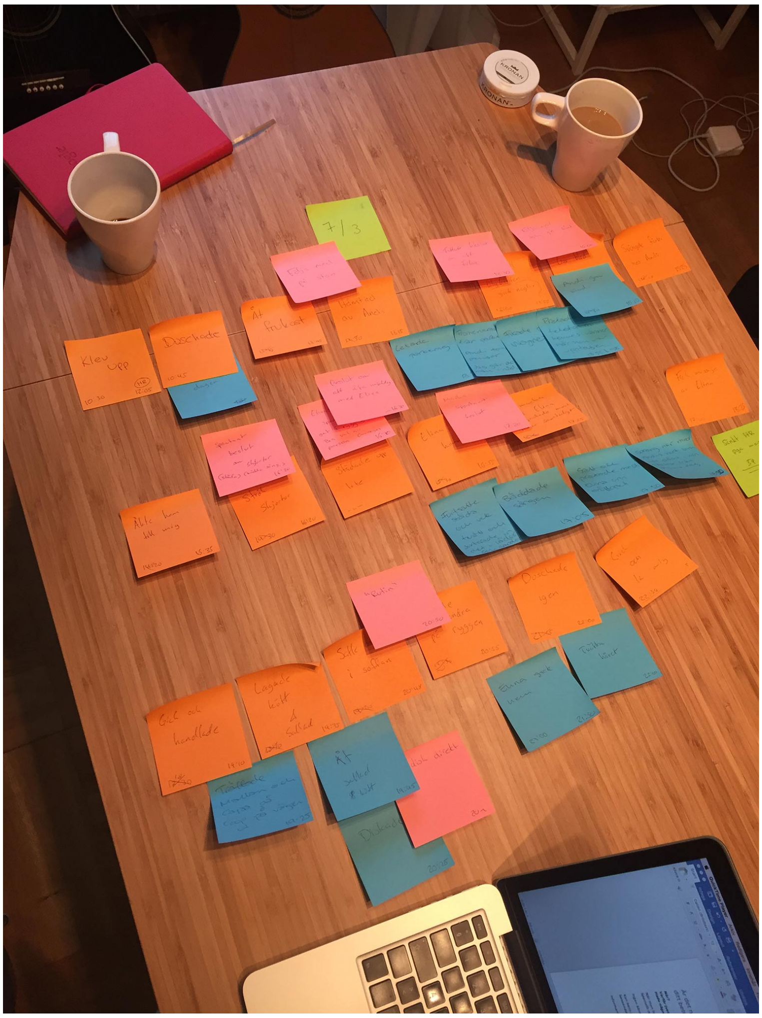

Figure 4. Events and experiences were noted on sticky notes and placed in chronological order.

Next, photography data from the Narrative Clip was analysed collaboratively using an iPhone 6 and the web application. The chronology laid out on the table was updated by comparing the time stamps on the photos with the estimated times of the key experiences. When the participant found important missing information in the photography data, new key experiences labelled *Stimulated experiences*, were added on sticky notes and laid down on the table. The researcher sometimes asked questions such as "can you describe what is happening here?" to encourage reflection and to invite further thoughts of whether to log the actual experience or not.

After a complete review of the photography data, the heart rate data was examined. The heart rate data was presented in charts generated by the Fitbit software. In the heart rate data, outliers were examined more closely. If the participant could not answer why the outliers in the heart rate data had appeared, the photos were used as cues. A sticky note was written and a time stamp added of the occurrence if the outliers in heart rate had interesting reasons.

To find events in the data that influenced later behaviours, the participants were asked to note decisions on sticky notes. Participants then reported their *valence* for each hour of lifelogging. Valence is here defined a positive, neutral, or negative feeling states. It was rated on a five point Likert scale ranging from very positive to very negative feelings. They could mark two adjacent values for the same hour if they felt that the scale was too narrow.

The co-creation sessions ended with a semi-structured interview (which is outside the scope of this paper), and a questionnaire about using the lifelogging technologies.

3.3 Creating a visual experience timeline

The resulting experience timeline (Figure 5) is a two-dimensional visualization of the collected data. It was made after the co-creation sessions to make a more accessible representation of the data. This is an important step as visualisations help articulate and communicate insights, and keep empathy throughout the design process (Segelström, 2010). The visualisation consists of a timeline, presented horizontally, and data, from top to bottom; Key Experiences noted before reviewing lifelogging data, Stimulated Experiences added after review of lifelogging data, Heart Rate, Decisions noted by the participant, and reported Valence for every hour.

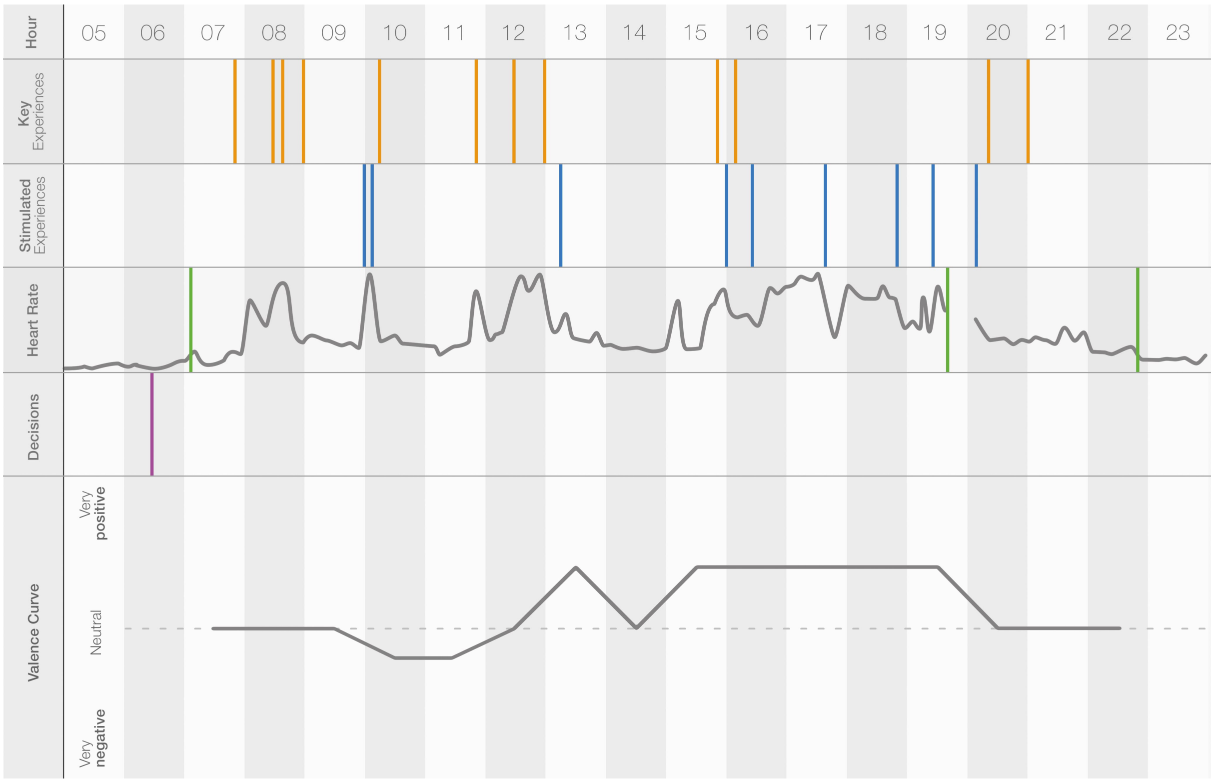

Figure 5. The experience timeline visualization.

Each data point in the experience timeline is presented with a time stamp that corresponds to a brief description of the data point available in a separate document. Additionally, each of the data points from the key experiences and the stimulated experiences can be cross-referenced to their corresponding time in the photography data.

The heart rate data is presented with a line chart, manually extracted from the Fitbit web interface. The self-reported estimated valence is presented over time, horizontally, and vertically over the five points scale.

4. Results

The number of stimulated experiences, cued by the lifelogging photos, were as many as the number of key experiences noted by participants without any cuing (see Figure 6). The number of decision points and experiences cued by heart rate data was low.

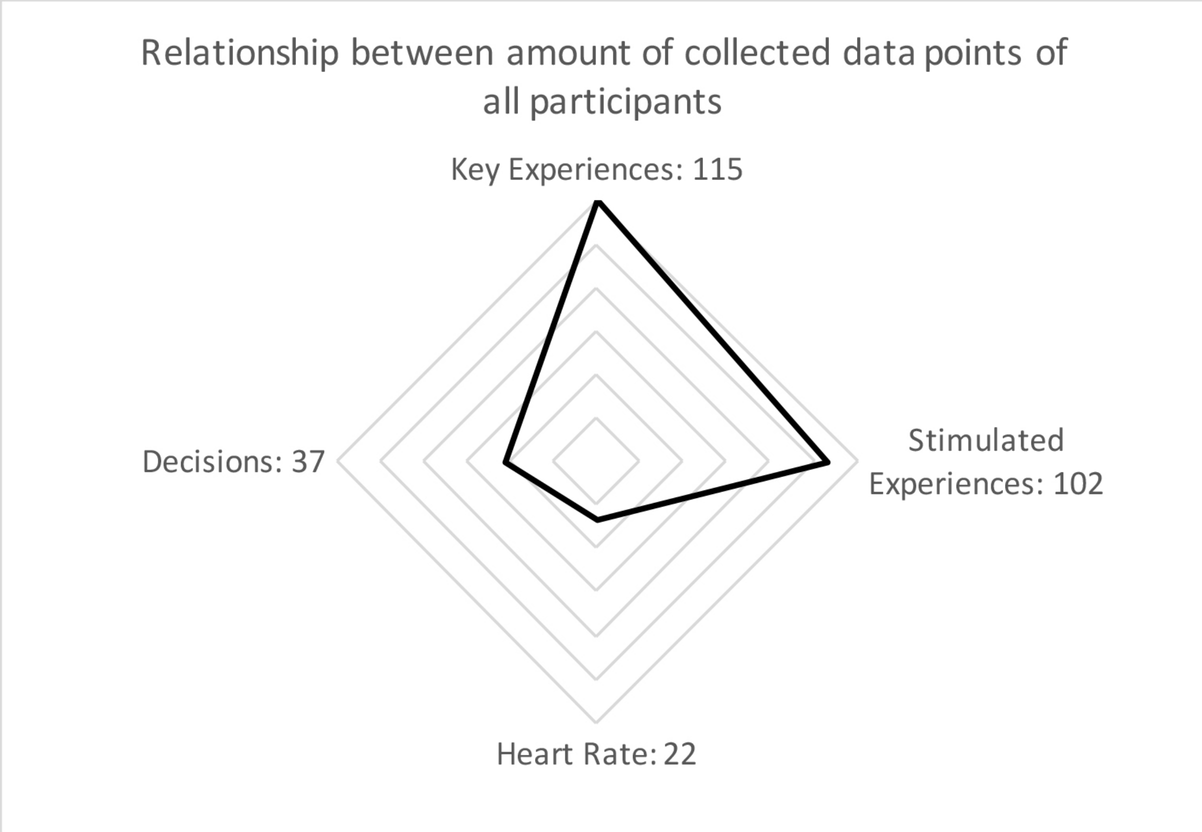

Figure 6. Visualization of the total data, showing that there were as many stimulated experience events cued by lifelogging photos, as there were non-cued key experience events in the total data, while the number of reported decision points and events cued by heart rate data was low.

Key experiences noted by participants without any cues included for examples:

- Answered a phone call from the hospital;
- Had lunch;
- Played disc golf with friends.

Stimulated experienced cued by lifelogging photos mainly consisted of: (a) Parts of larger activities, such as having coffee as part of the overall activity of visiting the city; and (b) spontaneous activities and events, such as bumping in to someone or taking a phone call. Stimulated experiences included for example:

- Bumped into someone at the library;
- Had a phone call with unknown person;
- Prepared for a presentation of a course project.

The Fitbit data revealed activities or moments with unusually high or low heart rate. Since the Fitbit can be carried day and night it also helped identify when participants went to sleep and woke up. It also revealed moments where the participant consumed alcohol or tobacco, and provided an additional level of analysis. Examples of experiences stimulated by heart rate data included:

- Danced to a good song on the radio;
- Took a shower (indicated by missing heart rate data, since the Fitbit could not be worn in the shower);
- Got upset about a news article.

Only a few decision points were documented by the participants. Here are a few examples:

- Decision to play disc golf impacted the time the participant left campus, what to have for dinner and when, as well as studying later in the evening;
- Decision to go home because of forgetting the charger for the laptop;
- Decision to study at the library to be able to focus.

The questionnaire revealed that participants were more cautious of life logging technologies before participating in the study; however, it was also noted that: “if it would have been someone else I believe it might have been different,” concerning reviewing photography data with the researcher. Hence, the personal relationship between the researcher and participants might have impacted their experience when it comes to privacy. Participants felt that it had been interesting to log and examine their everyday behaviour and they believed that their behaviour had not been altered by the logging.

5. Discussion

Interviews facilitated by lifelogging produces detailed UX research results. In our study, we gathered data on twice as many events, compared to what we would have had if we only had gathered self-reported key experiences. The lifelogging photos were accordingly very effective memory cues, as previously shown by Gouveia and Karapanos (2013). However, the number of self-reported key experience and the level of detail of them could have been greater if participants had been given the task of keeping a very detailed record. The participants can also benefit by the opportunity to learn about themselves, especially if they are given control of their data (O'Hara et al., 2008). The participants in this study also reported that it had been interesting to log and more closely examine their actual daily behaviour, which is in line with previous research (Li et al., 2011).

Data can be collected as a basis for stimulated recall interviews in many ways. The lifelogging devices captures data automatically, and thus relieves participants of the documenting task, as well as of the task of remembering to document (Kujala et al., 2011). Using a self-reported log from each day, as in this study, is a useful complement to the logged data since it guides the analysis and highlights what the user has found interesting during the day.

During the current study, we had a broad focus on participants’ experiences of places for study and work. A narrower focus would be recommended in future studies to reduce the amount of data that the lifelogging approach generates. As earlier mentioned, more than 27.000 files were created in this study. Our detailed and costly approach provided twice as many data points as the study would have generated without the cues provided by lifelogging. Our study provides an upper limit both in terms of cost and in terms of level of detail of the results. Future research should focus on developing discount methods to find a balance between cost and benefit. For example, how much could the effort had been reduced if we had aimed for getting 80% of the data points we got? Random sampling of some of the lifelogging photos and data reduction techniques as the ones suggested by Wang and Smeaton (2013) would be interesting to explore in this regard.

One potential shortcoming related to automatic documentation is that users cannot always recall what was going on in the photos. One example in this study was a photo where one of the participants was talking on the phone, but the participant had no recollection of with whom. Hence, the data is ambiguous. Users can potentially create false memories, read something into the photos that either happened some other time, or read in something that did not happen the way they reconstruct the situation. Of course, this also points to the strength that automatic documentation has in capturing even subconscious and seemingly irrelevant episodes in users’ lives. Similarly, heart rate data can complement the visual and self-documented data by highlighting an otherwise invisible side of users’ lives.

Another issue is privacy and the willingness of people to share data with researchers. In this study, the participants were friends of the researcher, and they were more cautious of collecting lifelogging data prior to the study, than they were after doing it. This issue comes to the fore when co-creating the visual experience timeline. During the co-creation session, a researcher and a participant walk through each day together, examining the collected data. In addition to the actual collection of data, this collaborative exercise can potentially lead to ethically problematic situations where the (partially subconscious) lives of users become visible.

None of the participants reported any major conscious change of behaviour due to wearing the technologies. Participants spoke of awareness, mainly concerning the camera – but no change of behaviour. One participant believed that the only effect may have been a lower frequency of smoking cigarettes with the explanation being afraid of getting a wake-up call when reviewing the data at a later point. It is possible that the participants did not change their behaviour in a significant way, although certainly this data collection approach will influence them. The question is how big the influence is. Estimating valence in hindsight to create a UX curve, was problematic and not very useful in this study. However, given a larger data set and a narrower research focus, the valence curve might be more useful in identifying UX-related insights.

6. Conclusions

This paper contributes by exploring and describing a novel way of using lifelogging technology in user experience research. Lifelogging in UX research provides very detailed data compared to pure self-report methods. The results show that the number of experiences in the co-created experience timeline that come from data points stimulated by the lifelogging, are as many as the self-reported data points. The stimulated recall experiences, triggered by the lifelogging photos, bring out more detail to key experiences, or describe spontaneous activities and minor events. Heart rate data provided information about when participants woke up, fell asleep, had coffee or alcohol, danced to a song on the radio, got frustrated, and performed physical movement. The privacy concerns participants had prior to the study about collecting lifelogging data were not warranted in hindsight, but that may be due to knowing the researcher well. Lessons learned include that the use of lifelogging produces a more detailed UX research, but it is very time consuming, due to the sheer amount of data. Automated tools as well as random sampling of lifelogging photos to cue the interviews could potentially elevate some of the effort.

References

Dempsey, N. P. (2010). Stimulated Recall Interviews in Ethnography. Qualitative Sociology, 33(3), 349-367.

Dobbins, C., Merabti, M., Fergus, P., & Llewellyn-Jones, D. (2014). Capturing Human Digital Memories for Assisting Memory Recall. In S. H. Fairclough, & K. Gilleade (Eds.), *Advances in Physiological Computing* (pp. 211-234). London, UK: Springer-Verlag.

Fox-Turnbull, W. (2009). Stimulated Recall Using Autophotography - A Method for Investigating Technology Education. *Pupil's Attitude Towards Technology Conference* (pp. 204-217). Delft, the Netherlands: ITEEA.

Gaver, W., Dunne, T., & Pacenti, E. (1999). Cultural probes. *interactions, 6*(1), 21-29.

Guoveia, R., & Karapanos, E. (2013). Footprint tracker: supporting diary studies with lifelogging. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 2921-2930). New York, NY, USA: ACM.

Hoyle, R., Templeman, R., Armes, S., Anthony, D., Crandall, D., & Kapadia, A. (2014). Privacy behaviors of lifeloggers using wearable cameras. *Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing* (pp. 571-582). New York, NY, USA: ACM.

Kujala, S., Roto, V., Väänänen-Vainio-Mattila, K., Karapanos, E., & Sinnelä, A. (2011). UX Curve: A Method for Evaluating Long-Term User Experience. *Interacting with Computers, 23*(5), 473-483.

Kärkkäinen, T., Vaittinen, T., & Väänänen-Vainio-Mattila, K. (2010). I don't mind being logged, but want to remain in control: a field study of mobile activity and context logging. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 163-172). New York, NY, USA: ACM.

Lee, M. L., & Dey, A. K. (2008). Using lifelogging to support recollection for people with episodic memory impairment and their caregivers. *Proceedings of the 2nd International Workshop on Systems and Networking Support for Health Care and Assisted Living Environments* (p. Article No. 14). New York, NY, USA: ACM.

Li, I., Dey, A. K., & Forlizzi, J. (2011). Understanding my data, myself: supporting self-reflection with ubicomp technologies. *Proceedings of the 13th international conference on Ubiquitous computing* (pp. 405-414). New York, NY, USA: ACM.

Li, I., Dey, A. K., & Forlizzi, J. (2012). Using context to reveal factors that affect physical activity. *ACM Transactions on Computer-Human Interaction (TOCHI), 19*(1), Article No. 7.

Li, I., Dey, A., & Forlizzi, J. (2010). A stage-based model of personal informatics systems. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 557-566). New York, NY, USA: ACM.

Mair, A., Poirier, M., & Conway, M. A. (2017). Supporting older and younger adults’ memory for recent everyday events: A prospective sampling study using SenseCam. *Consciousness and Cognition, 49*, 190-202.

Oh, J., & Lee, U. (2015). Exploring UX Issues in Quantified Self Technologies. *International Conference on Mobile Computing and Ubiquitous Networking* (pp. 53-59). IEEE Conference Publications.

O'Hara, K., Tuffield, M. M., & Shadbolt, N. (2008). Lifelogging: Privacy and empowerment with memories for life. *Identity in the Information Society, 1*(1), 155-172.

Segelström, F. (2010). *Visualisations in Service Design*. Licentiate thesis: Linköping Studies in Science and Technology, Thesis 1450. Linköping University Press: Linköping, Sweden.

Sellen, A. J., Fogg, A., Aitken, M., Hodges, S., Rother, C., & Wood, K. (2007). Do life-logging technologies support memory for the past?: an experimental study using sensecam. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 81-90). New York, NY, USA: ACM.

Ståhl, A., Höök, K., Svensson, M., Taylor, A. S., & Combetto, M. (2009). Experiencing the Affective Diary. *Personal and Ubiquitous Computing, 13*(5), 365-378.

Wang, P., & Smeaton, A. F. (2013). Using visual lifelogs to automatically characterize everyday activities. *Information Sciences, 230*, 147-161.

About the Authors:

Mattias Arvola is an Associate Professor in Cognitive Science, Director of the Cognitive Science Undergraduate Study Programme, and PhD in Cognitive Systems at Linköping University. His research focuses on user experience and design methods in interaction and service design.

Johan Blomkvist is a Postdoctoral Researcher in Design and PhD in Cognitive Science, at Linköping University. His research focuses on prototyping in service design.

Fredrik Wahlman is a master student in Cognitive Science with a specialization in interaction design and UX. He is currently writing his master thesis on the topic of value-in-use in services that enhance truck drivers' performance.

Acknowledgements: We would like to thank Johan Ejdemo and Yasushi Kusume at IKEA of Sweden for the industrial partnership and for supporting this research.