Participant Driven Photo Elicitation for Understanding Activity Tracking: Benefits and Limitations

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ABSTRACT
Studying in-situ technology use over time can be difficult and this is especially so when considering technologies such as activity tracking devices explicitly designed to be unobtrusive. Yet understanding activity tracking in practice is crucial, as tracking technologies become important tools for health promotion and health insurance programs. In this paper, we describe a method for a longitudinal participant-driven photo elicitation study of activity tracking. During the five-month long study, our drop-out rates were low and we observed idiosyncratic practices with lapses and particular use patterns among participants along with significant self-reflection on activity tracking as a practice. We describe our method in detail, discussing the necessary adaptations for the study of activity tracking practices. We offer our experiences of benefits and challenges of this process, and suggest points for consideration for future studies in the area.

Author Keywords
Activity tracking; photo elicitation; research methods.

ACM Classification Keywords
H5.m. Information interfaces and presentation: Miscellaneous

INTRODUCTION
Activity trackers (such as FitBit, Jawbone and the like) are increasingly popular with industry reports asserting that just over one quarter of Americans use some sort of digital device to track health and fitness [27]. The uptake of wearable activity tracking devices is accompanied by an excited rhetoric about the health benefits to be gained from their use. Yet most of these devices are abandoned within six months of first use [15]. Anecdotal stories also suggest that people often cheat in creative ways to log more steps than they actually walked by shaking their tracker or mounting it on a dog's collar for example [19]. Yet despite the proliferation of research in this area, we still know very little about the lived experience of everyday usage of activity trackers and how this usage develops over time in order to understand why the failure rate of intended use is so high. This is in part due to the fact that studies of technologies 'in use' are notoriously difficult, having to rely on either extensive ethnographic and participant observation approaches or, most often, on self-report that is sometimes complimented by sensor-based behavioral data. The problem is exacerbated because activity trackers are an example of technologies designed to be unobtrusive and largely forgotten when in use.

Researchers have produced several models for understanding self-tracking practices addressing both differences in use practices and lapses in use [1,8,20] and investigated real-world use of persuasive technologies for activity tracking [11]. Most often, these studies are survey or interview-based [8,11,18], with some studies conducting follow-up interviews with very active users after shorter periods of time [23]. With a different approach, Clawson et al. analyzed Craigslist advertisements for used devices being sold [6]. Although these studies provide valuable insights, understanding how activity tracking use develops over time has proved elusive as all of the above-listed approaches primarily rely on verbal self-report with all the attendant problems with memory and recall accuracy [31]. As such, researchers continue to call for more empirical research on everyday uses of self-tracking [24].

Part of the problem is that activity tracking happens alongside other daily activities, with only occasional moments of direct engagement. Users might check step-counts while making breakfast or look at sleep-data while waiting for the bus. Following these developments over several months is difficult. There is no one fixed place where the activity can be observed and focused on one aspect of use. Despite the expectation of continuous use of trackers for health management purposes, research cited above suggests that much of the use is episodic, with frequent lapses and "creative uses". Such episodic use is difficult to study through traditional approaches. Yet as these devices become ever more central to discourses on behavior change efforts, health promotion campaigns and even health insurance discount programs, understanding the lived dynamics of activity tracker use over time is crucial.

In this paper we detail a methodology and study design that relies on participant-driven photo elicitation. The use of

photo elicitation may seem counter-intuitive for studying devices that are designed to be largely invisible when in use but we found our approach to be successful. Our study allowed us to gain significant insight into dynamics of activity tracker use over the course of five months, working with novice, occasional, and experienced users. Here we describe our adaptation of photo elicitation, experience sampling, and photo diary methods for studying intermittent and often idiosyncratic use of activity tracking devices. We discuss the methodological considerations, successes and failures that arose in the course of our research and conclude with suggestions for how this approach may be successfully employed to further our understanding of activity tracking in practice.

STUDYING TECHNOLOGY IN USE

Studying technologies "in use" means investigating the very experience of use. No automatic measurement of data produced in the course of usage activities or external observations of practices can get at understanding how technologies are experienced by individuals. Thus self-reports of why and how technology use had occurred are usually collected alongside the automatic methods. Research has suggested various methods to support self-report and to mitigate associated memory and recall issues.

A significant concern in self-report research is that participants may answer in socially desirable ways that do not necessarily align with actual experience [25]. Projective interviewing is one approach attempting to circumvent this issue [12]. Projective interviewing techniques make use of materials such as objects, photos, or diagrams as part of the interview process. These techniques were originally developed in clinical and psychoanalytical research to gain better insight into patients' problems, trying to get participants (or patients) to more easily communicate experiences, that might otherwise be hard to study [25]. For example, the Rorschach Inkblot Test can help patients project their own thoughts and feelings onto others (or in this case onto an object) [25]. Projective interview techniques have also been employed in consumer research because consumers may fear being judged negatively if they revealed their opinions or attitudes towards the subject, or in most cases brands and products, under study.

Diary studies is an alternative approach to understanding mundane practices that are difficult to externally observe [4]. Paper- and pencil-based diaries have been followed by experience sampling methods, made possible as personal technologies became ubiquitous. Early experience sampling methods (ESM) studies added ways of pinging participants to remind them to fill out their diary entries [3]. In more recent studies, participants are typically asked at random times throughout the day about what they are doing via an app [32:1545]. Yue et al. also suggested allowing participants to also add media for later use in interviews [32]. One of the biggest issues with conducting diary or ESM studies is that the demand of commitment and workload from participants can be quite high, reducing participation and increasing dropout rates.

Methodological developments of the approaches described above have resulted in a variety of media elicitation methods. 'Media elicitation' involves participants capturing audio, photo or video and even collecting objects, in order to reflect on their experiences. In media elicitation studies participants are later interviewed about the items they have chosen to capture or collect.

Besides including photos in research studies, some research has investigated using video-methods for understanding everyday use of technologies. This entails that the user captures video of the system they are working with. While this "trouble-spotting" is useful for understanding specific systems and their use [30], there are other shortcomings of the method. For example, setting this up in the context of activity tracking would only give access to the experiences people have when they are already in the app or working directly with the tracking system. There are many aspects, however, that connect to use beyond the minutes the participant is looking at the app. Many experiences and contingencies outside the actual use of the device influence individual self-tracking practices [8,23]. Looking purely at the data, or at the interaction with the device alone can tell very little of the overall lived experience.

In the area of design, researchers have used 'cultural' or 'design' probes to engage participants, using designed objects, photographs or tasks to provoke reflective responses from participants [2]. Some such studies have used probes to collect reactions and reflections over time, typically to support and inspire an on-going design process [13]. The materials used in the probes are designed and produced by the researchers specifically for the study and can function similarly to other projective methods. Some studies have also used open-ended prompts and instructions to the participants to generate their own media by taking pictures with their own cameras or those provided by researchers [17]. These latter iterations of probes have been critiqued as alterations of the original design of cultural probes without sufficient attention to epistemological concerns [2]. While such engagements are similar in form to the media elicitation methods we describe here, the goals and purposes of the method we describe is different in its emphasis on understanding lived experience with pre-existing technology over time.

Photo elicitation

Photo elicitation refers to the idea of using photographs during an interview interaction with a participant, and was first suggested by Collier in 1957 as an augmentation to the qualitative interview [16]. The images used in most photo elicitation interviews vary from generic images to images capturing known prior events to images capturing the interviewee and everything in between [16]. These images can be produced either by the researcher or the interviewees themselves. In the latter case this is often referred to as

"auto-driven" [5] or "participant-driven". We use "participant-driven" to avoid confusion with automatic capture systems, such as those that have been used in other HCI studies.

Inclusion of images as part of a self-report interview interaction with participants has several benefits. First, images can often lead to more specific recall [4,16]. By creating conditions for more precise recall of activities of interest, the researcher may become aware of aspects that might have been overlooked in traditional interviews [5]. Second, photo elicitation eases rapport between the interviewer and interviewee, facilitating which questions to ask, while lessening potential akwardness in the interview situation by providing an object of focus. Third, the process of discussing photos can allow the particpant to *"take the leading role"* during the encounter with the researcher [21]. Especially in participant-driven photo elicitation (as opposed to using photos chosen by the researcher) photos can become an important element in the research process making the interview into a sense-making collaboration [21]. The meaning arises from the conversation betweeen participant and researcher, rooted in the visual record of the lived experience of the participant [16].

As with all methods, however, photo elicitation studies come with a set of challenges. Some challenges are similar to those encountered in any sort of qualitative engagement with research participants, while others are particular to this method. Considerations of confidentiality and ethics, while a concern in any study, become especially important with photographic material. Photographs can create more intimate situations or produce unintended disclosures. By asking participants to take and share photos, the possibility to gain more insight comes with the risk of intruding on participants' private sphere. This is a delicate balance that demands that the researcher be attentive to and aware of this boundary, causing a potentially negative or stressful experience for the participant. Social desirability bias is another common aspect of any research engagement. By virtue of agreeing to participate in a study participants tend to try to produce helpful and socially desirable content for the researcher. The challenge with photos is ensuring that participants do not focus on producing photos that are somehow judged to be inherently interesting. Instead, the goal is to generate photos that would allow researchers to expand on their questions, while providing a way for participants to communicate various dimensions of their lives [3].

Other challenges in photo elicitation studies have changed as devices have changed and experience with them vary between communities. Clark-Ibáñez found challenges pertaining to inexperience with photographic devices, and costs of distributing disposable cameras to research participants [5]. While this could still be challenging if one wishes to do research in underserved communities, these were not relevant in our study. At the same time, cameras have developed rapidly, and as such the opportunities and challenges now relevant to these types of studies are in need of revision. For example, phone cameras are so commonplace that people have developed complex habits around their use. Participant-driven photo elicitation may require altering these habits, which could prove difficult to accomplish.

The use of visual research methods is common in CSCW research [22], where photography and videography have been used to analyze interactions and uses of computing artifacts in a variety of settings [26]. It might be the case that even though studies use photos, not just of research settings but also as a part of the interview, few of these are written up as photo elicitation studies [14], as is often the case in anthropology [16]. The collaborative element makes participant driven photo elicitation study a particularly good fit for research in the area of CSCW. Yet clarifying the benefits and challenges of participant driven photo elicitation studies can help move research forward.

Activity tracking technologies are in rapid development, and pose many challenges. This includes understanding how people manage lapses in use [1,7], and what might lead to "happy abandonment", where the user for example learned new fitness habits and thus no longer needs the device [6]. Understanding these practices better could lead to better designed devices, and potentially better experiences of use. However, the use of activity tracking technologies is difficult to observe or survey over extended periods of time, for reasons stated above. As such, many studies so far have focused on members of the Quantified Self community, where self-tracking practices are more easily observed. Other studies have used secondary data such as Craigslist listings [6]. We believe that studies of activity tracking need a greater variety of tools in our methodological arsenal. Photo elicitation is perhaps a counter-intuitive method as the "doing" of self-tracking does not obviously and easily lend itself to photo capture. Yet the challenge of it can lead to important self-reflection on self-tracking practices, facilitating and enriching self-reporting in interviews. Thus photo elicitation is way to encourage continuous reflection rather than a way to closely observe tracking practices in-situ. Contact with participants over time through photos can help the researcher to follow changes in experiences and attitudes as images help trigger recall. Below we detail the benefits and challenges of participant driven photo elicitation as we adapted this method to study activity tracking in practice.

RESEARCH DESIGN

The photo elicitation study of activity tracking users we describe here was conducted in Denmark between August 2015 and February 2016.

Recruiting participants

We recruited participants using Facebook and snowball sampling. 67% of all Danes have a profile on Facebook, making this the social network site with the highest

penetration in the country [29]. We recruited participants by posting in relevant Facebook groups and in the networks of the authors. An invitation to participate in the study was posted in a Facebook group for women in start-ups ('Ladies First'), in FitBit Denmark, and in Fitness.dk (Danish fitness chain). Anyone with familiarity of the study, or the authors personally, was thanked for their interest, and asked to share the post in their network. Posting on Facebook was initially meant to be just one step towards finding participants, followed by posters in cafés, libraries or other public places. In the end, however, 64 interested respondents replied either directly on the post, via e-mail or via private messages on Facebook. In order to have as broad a picture of activity tracking practices as possible we sought to include users with various levels of experience, educational background, geographical location (rural and urban), gender and age. All participants were asked about other potential participants, thus making use of the snowball sampling method.

Of the 25 final participants, nine participants had little or no experience with activity tracking devices, and were given the choice of a Fitbit One or Fitbit Flex to use as they wanted throughout the course of the study. Eight participants we categorized as occasional users, as they would sometimes lapse in the use of their devices, but also come back to them. Finally, eight participants we categorized as continuous users, as they had used their device consistently for at least four months prior to the study. It is important to highlight that participants switched use patterns throughout the study, however, this initial diversity was useful to give us a broad insight into user experiences. All participants received a written explanation of the purpose of the study, the process of the study, and information on anonymization procedures. Both the initial and follow-up interviews were, when possible, conducted face to face in the homes of the participants or in their workplace. All interviews were conducted in Danish except one conducted in English. Initial interviews were conducted with all participants throughout August and September 2015. At the end of the interview, participants that were new to tracking were given a Fitbit device. Two of these new users lost their devices shortly after the study had started (within 1 and 3 weeks). One of these participants gave a follow-up account of his experience via e-mail, but has been omitted from this study as he had only had a few days with the tracker. The second participant was interviewed over the phone and is included in the study. After the 5 months of the study, two new users did not reply to our invitation to a follow-up interview. In total, this study builds on the findings from interviews, photos, and e-mails from 22 participants.

Study set-up

The study was carried out in three phases. In the first phase, initial interviews were conducted in a semi-structured format. This first interview served as an introduction to the study where participants were asked about their occupation, preferred leisure time activities, and previous experiences with tracking physical activity as well as other types of tracking (finance, location, weight). Participants were also asked about their habits with regards to taking photos. New users were asked about their expectations of the devices, while the rest of the participants were interviewed about previous experiences and uses of various devices. At the end of the interview we instructed participants to take photos for the next five months of events or experiences they felt were related to their activity tracking. We explicitly told participants to capture anything, big or small, that they thought might be relevant to help us understand their particular experiences of using an activity tracker. Participants were asked to send photos via e-mail to the first author once a week and were encouraged to also include one or two sentences describing the photo or any thoughts they might like to share, but this was not compulsory.

The second phase of the study lasted for five months with occasional checking in with participants. We responded to each photo we received, sometimes with a simple thank you and sometimes with a few follow-up questions, depending on the content. If we had not heard from participants in two weeks they would get an individually tailored follow-up e-mail. At the end of the study, participants had sent a total of 313 photos, ranging from 4-125 photos per participant, with a median of 8 photos (see Table 1). Our initial reaction was that the median number of photos was too low. This perhaps had to do with how often we sent reminders and how these were designed. Yet even with just a few photos the follow-up interviews proved very fruitful. We will address this issue in more detail later in the paper. In the third and final phase of the study, we conducted follow-up interviews. In preparation for these interviews, we printed out all of the photos participants had sent throughout the second phase. For each participant we also developed a follow-up interview guide, noting items that were left unclear from the first interview or from the photos and e-mails.

The follow-up interview had a three-part design. First, participants were asked to go through the photos they had sent one by one, and explain what was in the photo and why they took the photo. This often sparked long reflections and explanations, where only a few clarifying questions were needed. Most of the time participants addressed questions in the follow-up interview guide before they were done explaining the photos without prompting. Once all photos had been discussed, participants were asked to complete a sorting task by looking at all of their photos together and identifying any patterns. For example, participants were asked whether their photos represented different experiences, or whether some of them might fit together in certain categories. For example, one participant explained that her photos could be categorized as before, during, and after, exercise sessions. This led to a broader range of considerations, as she saw her own activity tracking practice from a new perspective.

Table 1. Participant information

Parti-cipant	Age	Occupation	Photos sent	Device*
P1F (N)	21	Student	6	Fitbit Flex
~~P2F (N)~~	~~22~~	~~Student~~	-	~~Fitbit Flex~~
P3M (N)	27	Software develop	125	Fitbit Flex
P4M (N)	31	Store manager	0	Fitbit One
P5F (N)	34	Import manager	4	Fitbit Flex
P6F (N)	38	Engineer	8	Fitbit One
~~P7M (N)~~	~~42~~	~~Music teacher~~	-	~~Fitbit One~~
~~P8M (N)~~	~~45~~	~~Carpenter~~	-	~~Fitbit Flex~~
P9F (N)	50	Nurse	12	Fitbit One
P10F (O)	25	Student	9	Garmin
P11F (O)	28	App developer	16	Fitbit Flex**
P12F (O)	28	Consultant	5	Jawbone UP
P13F (O)	31	Office assistant	7	Fitbit Surge
P14M (O)	33	PhD student	5	Jawbone UP
P15M (O)	39	Store manager	10	Suunto
P16F (O)	40	Civil engineer	10	Polar
P17M (O)	47	Dept. manager	8	Fitbit Surge
P18F (C)	25	Student	6	Fitbit Surge
P19F (C)	26	Teacher	16	Garmin Vivofit
P20F (C)	39	Health Care Wrk	21	Fitbit Flex
P21M (C)	40	IT consultant	8	Fitbit Charge
P22F (C)	41	Text writer	8	Fitbit Flex**
P23M (C)	41	Office adm.	4	Garmin Vivofit
P24M (C)	54	Machine engineer	8	Fitbit Surge
P25F (C)	57	Finance	12	Fitbit Charge

F= female, M= Male. (N)= New tracker received, (O)= Occasional use at start of study. (C)= Continuous use at start of study. ** Switched device during study. Strikethroughs indicate participants that left the study before follow-up.

This interaction sparked reflections at a broader level, looking across one-off uses and often led to a wider range of considerations. Finally, participants were asked to reflect upon their experience of participating in the study as a whole. All interviews were transcribed and then coded using the TAMSanalyzer tool. Research notes and email correspondence with participants from the whole research period were also included in the analysis.

EXPERIENCES FROM RUNNING THE STUDY

In the following sections we discuss our research experience by detailing first the particular benefits and then the challenges we encountered as we conducted this participant-driven photo elicitation study.

Benefits from photo elicitation methods

1. Familiar medium made sign-up barrier low

Even though all participants had experience taking photos with their own cameras, they had different ideas about taking photos and different habits. To some taking photos was already related to physical activity. For example, P10F often took photos as part of her running, sometimes posting these on her Endomondo account, which she associated with her tracking practices. On the other hand, we also had participants who did not use their cameras often: *"I'm not good at photos, that's not something I usually do"* (P22F, follow-up interview). Throughout the study we reminded participants that photos did not have to be "good" but rather needed to convey some experience or thought they had. Participants were also welcome to send screen shots, if they felt that described something they had experienced. Even if some participants did not see themselves as "good at taking photos," the design of our study allowed for a broad range of participants to contribute to the study. For example, we noticed that those that sent few photos sometimes added more detailed text explanations in the email. This design also appealed to those who might decline to participate in other types of studies: *"(…) if you had asked me to send a report every week, and then it has to answer these 7 bullet points and attach a photo, in that case I think it would have been too much work (…), where this has more been just using it and then sensing how you use it"* (P5F, follow-up interview). Even though participants had prior habits of taking photos, using the camera in their phone required no set-up or introduction, which meant that there was no initial hurdle to overcome for participating in the study.

2. Uncertainty about an open task lead to reflection

Even though the medium was familiar, the act of taking photos for a research study was new to the participants. As the study was exploratory in nature we had intentionally left the task open. Perhaps because of this new context and the very open task, we noticed that some participants were often tentative. Our participant-driven photo elicitation method created a situation where research participants were not able to easily tell what would be the correct and socially desirable fulfillment of the task at hand. This became obvious when towards the end of the follow-up interview many participants asked how others had solved the task.

Some participants sent very similar photos throughout the study. Initially, we worried that this might give us too little insight, rather than the broad perspective we were hoping for. However, Clark-Ibáñez highlights how one of the children in her study had taken 38 photos of her new kitten, and she dreaded the interview. How could anything important arise from so many similar photos? It turned out that the kitten was particularly important to this child, because she had recently moved to a new area, and conversations about the kitten revealed many important insights about her living situation, the family's economic conditions, etc. As such, *"the kitten was not just a kitten"* [5]. We therefore did not put restrictions on how many photos of the same type participants could send and we did not comment on that similarity in email exchanges. By design we did not give participants a specific task to solve, but left the choice of what to capture open. Even though such an open task created uncertainty it also allowed space for individuality and for reflection on personal use of activity tracking devices. Some participants explained that one particular challenge had been to capture episodes of "non-use". This was especially so for novice users who lost interest in the device, or for episodic users. Yet their photos reflected creative ways of still capturing this, which led to detailed explanations and discussions of these non-use episodes during follow up interviews.

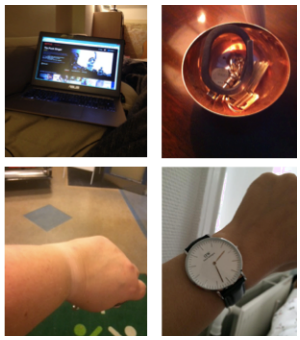


Figure 1: Examples of photos of non-use. Clockwise from top-left P6F, P14M, P20F, P12F

The photos in Fig. 1 show examples of non-use. The top-left photo allowed P6F to describe the paradoxical feeling of wearing the Fitbit, but due to medical reasons not being able to do much physical activity, thus not "using" the Fitbit even though she wore it. P14M took a photo of the bowl in his entrance hall where the tracker inevitably ended up. He explained that seeing the device in the bowl he was forced to consider what he actually gained from wearing it, eventually deciding to leave it behind. P20F (bottom-left) was annoyed she had forgotten to wear the tracker to work on a busy day and felt the walking she had done was somehow "lost". P12F in contrast wanted to wear a watch she had gotten as a graduation present. She explained how she saw her Jawbone more as a 'usable object,' whereas her watch was more aesthetically pleasing. These photos demonstrated the very different ways participants experience non-use, and allowed us to discuss non-use more directly in interviews.

Wearing an activity tracker can at times be demanding. Fulfilling the pre-set goals of activity levels can require changes in ones life, reminding users of failing to reach their goals even in situations where there is little room to do anything about it. Not wearing the devices surfaced as a way to retain a feeling of control, to not be reminded of low activity levels in times when this was difficult to change (for example due to work or family). Supported by the photos participants explained what we understood as strategies for making the trackers effectively empowering. For many participants increasing activity levels required more than merely taking more steps every day. We found that photo-driven narratives of non-use were crucial to our understanding of these strategies as these offered opportunities to discuss the rich diversity of practices around tracking devices.

3. Struggles of what to capture led to individual insights

In the follow up interviews, several participants noted that even though they found photos more challenging than other types of research participation, they appreciated that the photos helped them reflect on their own use of the device. For example, P16F compared the experience of being in this study to other types of studies: *"Don't we all know this thing where (consultant company) has developed something you need to answer and it takes 8 minutes of you work day and then you have to answer all sorts of things where you don't feel it fits to your situation (...)"* (P16F, Follow-up interview). P16F and her partner both participated in the study, but had not been particularly active with sending photos (10 for both of them combined). Both had found it challenging to decide what to capture. Even so, she explained: *"Generally, I would say this has started a lot of thoughts, to be a part of this, we've often discussed what you can use them (trackers) for and where the development is going"* (P16F, follow-up interview).

The initial idea for instructing participants to write a sentence or two about their photos was meant to be purely a clarification of the content of the photo for the researcher. However, adding some text to photos gave some participants an opportunity to describe something that they simply could not find a way to capture in a photo. It also opened up for some participants to describe the challenges they were facing when they were not sending photos. P17M explained in an email without a photo enclosed: *"I've been racking my brain as to what I should write about (and take a photo of). But this time I am blank. Maybe the message this time around is that life and existence is extremely everyday like at the moment, and that therefore there's not so much focus on pulse, steps, calories, etc. But there will be soon, when Christmas is over and the weight scale comes out"* (P17M, e-mail). This quote itself gave us much to think about because Christmas time is not at all "*extremely everyday like*" in Denmark, filled as it is with a myriad of social and celebration events throughout the month of December for most residents. This is highlighted by the statement that *"the weight scale comes out"* when Christmas is over. Instead, this is an indication of episodic use – the context when "*there's not so much focus on pulse, steps, calories, etc."* (P17M, e-mail). Such reflections and explanations became critical for our understanding of lapses of use and episodes of life when less attention is paid to health data, even without a photo. As researchers, we found that we learned a great deal, not only from the photos, but also from instances where participants struggled to take photos. In this example, P17M had been tracking various aspects of his health for a very long time, and could have been categorized as someone who really had activity tracking deeply integrated into his everyday practices. Yet in the "*extremely everyday*" moment in his life, as he put it, activity tracking is not included.

P21M explained how he had found it difficult to photograph how he used the device. As he explained: *"I don't really use it to say I've been out walking in the forest this day, or now I've walked 10km, so in that way it's been a bit difficult"*. He then reflected on the study and elaborated *"I think it's been great that the task has been so open, because that makes you more aware of what you are doing, and what it's like"* (P21M, Follow-up interview).

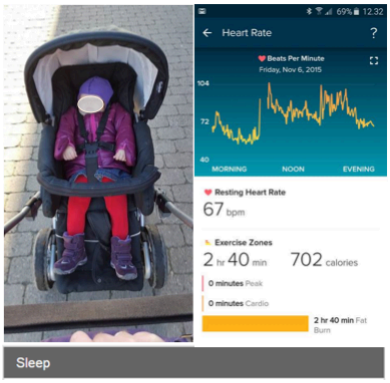


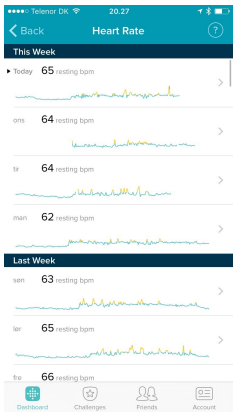
Figure 2: Example of photos sent by P21M. "It was nice that even someone like me, who doesn't use the tracker for training purposes could tell about it, and what you can use it for besides focusing on exercise, exercise, exercise" (P21M).

Thus participants were challenged, and offered an opportunity, to consider their activity tracking practices in a new way and explain it in their own terms. In this way, the research process became an exploration of the patterns and meanings of participant's own activity tracking practices, done in collaboration with the researchers.

4. Following experiences and attitudes over time

Activity tracking is often emotionally charged [23]. The five month length of the study and its open format seemed to make participants feel confident and comfortable enough to express deeply felt worries and concerns both via e-mail and during the follow-up interview. We believe several factors such as: the extended period of time of the study, direct feedback from the researchers whenever a photo was sent, and the fact that the follow up interview was clearly grounded in their own experiences rather than researcher's prepared questions, may have influenced this.

For example, P17M had noticed some irregularities in his body, and had been worried for two weeks that this might be a sign of something being very wrong. He finally convinced himself to see a doctor, and found out that there was nothing to worry about two weeks later. This is when we received a photo of his pulse measurements. In the email accompanying the photo P17M explained:



"When you receive this photo of the days pulse measurement it's because I Monday evening discovered that my almost-resting-pulse (the one I see when I have been laying on the couch watching TV) had fallen with about 10 beats per minute. That's when I realized how much I have stressed myself out the last couple of weeks" (P17M, e-mail).

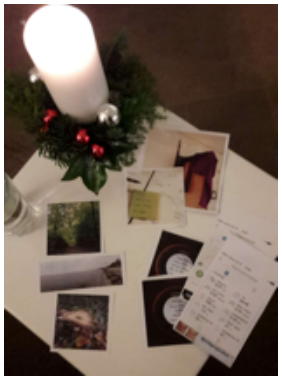
Figure 3: showing the lowered pulse (P17M)

In the same e-mail he expressed doubts of whether he should describe this episode at all, as he wasn't sure he felt it was relevant to us as researchers: *"I don't know if you can use it for anything, but at least it's been 4 weeks where the tracker played a role above the usual"* (P17M, e-mail). He then explained in detail how the episode made him reflect on the use of his tracker in a particular way: *"It may be that a tracker, in all reality, might just not be a good invention for someone like me, that is, at least not when I had an experience like these 4 weeks. But then again it might be a good invention, when I then afterwards see the very concrete results of how the body's basic pump reacts when it is then allowed to relax again"* (P17M, e-mail).

During the follow-up interview, we once again discussed this experience, which meant that we were able to get both a more immediate reaction from the e-mail, and considerations after the episode had time to be processed. In the follow-up interview P17M practically dismissed the experience: *"I self-diagnosed completely, and that was silly."* In this later reflection he explained how he over-reacted, while his initial e-mail revolved around the benefits of tracking. Having him explain this experience as it happened, but also following up some time later, allowed us to note this change in attitudes over time. By using photo elicitation as a method for understanding experiences both as they occur and as they 'sink in', we could begin to explore this. The fact that the activity tracker played a role for P17M in this situation was not a scenario we as researchers might have imagined. These findings allowed us to consider the 'worried well', a concept of much concern in the health promotion literature [10,28]. This was possible because participant driven photo elicitation allowed us to follow participants long enough for these worries to surface, and gives us an opportunity to observe how these attitudes might change over time.

5. Photo sorting task as a way to discuss absent images

Similar to Frith and Harcourt we found that information was not necessarily lost even if not all experiences were photographed, but only if participants were *"encouraged to reflect on the research process and on images that may be absent from their collection"* [9]. After all photos had been discussed, the participants were asked to look across their photos and consider whether they themselves could see emerging patterns or categories and whether something was missing from this overall picture. Often, this resulted in broader reflections on their activity tracking behaviors. In one case, P10F took out her phone and took a photo of the photographs sorted into piles on the table that had just been discussed in the interview. From the photos she discovered a pattern in her use of activity tracking device and her exercise pattern that she had not been aware of herself. As we concluded the interview she explained:



"The most fun thing has kind of been seeing that you printed the photos and that there's this before, during and after procedure. That was more than I had myself thought about." (P10F, follow-up interview).

Figure 4: Three categories of photos: Before, during and after exercise. P10F.

As we were discussing whether photos fit into categories or represented separate experiences P11F explained: *"I don't know, it's also kind of funny, I've been thinking that these photos I sent you were mostly sport so I actually don't have these small ones during the day, I haven't thought about that. I have been thinking that I bought this watch for sports and that's why I take sports photos for you"* (P11F, Follow-up interview). In this case, as P11F looked across her photos, she realized that her use of the activity tracking device had come to mean more to her in the everyday activities than she had initially anticipated. She realized this because to her surprise photos, stories and memories that were unrelated to sports events kept surfacing. She had bought the Apple Watch mainly to track her running and exercise sessions, and thus thought of it mostly as a sports or fitness tracker. In P11F's case, had we prompted her to reflect on her use via survey or questionnaire, she would have perhaps answered with a starting point in her *intended* use. Had we done interviews without photo elicitation, she might not have realized that using the tracker in her everyday activities actually was a bigger and more pervasive practice than she had previously thought. Thus allowing participants to step back and look across their experiences opened up to a new level of reflection and findings. Overall, what we saw was that participants were processing their experiences as they were looking at the photos, both as they were sending them and as photos were discussed during the follow-up interview. The fact that the photos so clearly sparked new insights and reflections for the participants is a strong point of participant driven photo elicitation studies.

6. Participant-driven aspect led to substantial commitment

Whenever participants sent photos they received a personalized follow-up thank you e-mail, which sometimes included short follow-up questions. We made sure to alternate between asking follow-up questions and simply acknowledging that we had received their e-mail. Otherwise, those who sent photos often would just keep getting more questions, which could deter them from sending more photos. This feedback loop gave us an idea of how tracking experiences developed over time, which we were able to explore in the follow-up interviews. We believe that this feedback loop also ensured that the number of dropouts was very low. We had 25 participants, and out of these we were able to follow up with 23. Two were contacted after they had lost their devices within a few weeks of the beginning of the study, while 21 were interviewed in full at the end of the study. Only two participants never answered the invitation for the follow-up interview. Out of the participants who completed follow-up interviews, several expressed that they had enjoyed trying to capture their experiences in photos. P9F explained:

"*Well it could be motivating, and we have had some fun doing it, when we had to find a good motif, so this photo with the red jacket, I am actually not walking at all, I am standing still actually and we had some great laughs because of that"* (P9F, follow-up interview).

Figure 5: P9F depicting an evening walk.

Despite the fact that the photo in Fig. 5 was posed, the image enabled us to discuss the social experience of walking and the role activity tracking played in this practice. We had hoped that participants would find it interesting to capture their experiences by using photos. Yet our design had an unexpected side effect. Frequent contact in the form of thank you and follow up emails strongly signaled to the participants that this study was important to us. P24M explained: *"I think that this way you are doing it, I mean, there are many who just send out an electronic questionnaire and then it's like, this is more a testament that you want to get more in-depth with this"* (P24M, follow-up interview). The very open structure of the photo elicitation task demonstrated to the participants that we were deeply committed and very much interested in their particular experiences, with participants trying hard to convey those experiences to us. This resulted in a relatively high level of commitment in study participation.

Challenges of using photo elicitation methods

As we conducted the study we also faced specific challenges worth considering for future studies.

1. A range of interpretations of appropriateness

The relative lack of structure to the longitudinal task of taking photos that might have something to do with activity tracking had many benefits as described above. Yet it also had one significant drawback. Because the task was open, participants chose different strategies, varying from a very narrowly focused to what we call a "catch all" strategy. Many participants tended to focus on the tracking device itself, but sometimes other apps or devices became important in relation to activity tracking practices. This was not always evident from the photos, but came up in the follow-up interviews. For example P18F used LifeSum, an

app in which she tracked her food intake. This would automatically feed into her use of the Fitbit, and be a part of how she used her tracking device. However, throughout the study she did not send any photos of LifeSum. We realized that participants may have been so focused on the tracker itself that other related apps or devices were not so much in focus, and thus they would not send photos of these. Yet as we discussed the photos these practices surfaced ensuring a fuller picture of the ecology of tracking devices and systems that participants used. For other studies that are exploratory of nature it might be beneficial to emphasize to participants that not only the device (or whatever might be the focus of the study), but any related or supporting technologies might be of interest, and that they would be welcome to reflect on the use of those too. In contrast, at least one participant had chosen a more "catch all" strategy, which meant that by the end of the study he had sent 125 photos. During his interview he explained how he had both sent photos that he had taken because he was in the study, but he also sent photos he had taken anyway, and these did not necessarily say anything about his activity tracking experiences. This made the follow-up interview quite challenging:

"Yes, photo nr. 37 is a photo of an egg. I wonder what that's supposed to mean… It's at my parents' place because I can see it's my sister sitting there with the egg. And then this is also a photo from my parents' place where we are playing a card game" (P3M, follow-up interview).

Figure 6: Photo, P3M.

Here the interview drifted very far from what we had expected. This does, however, serve as an example of the potential of participant-driven photo elicitation methods. In the first interview, P3M was challenging to interview because he was not as outspoken as others. Our first interview with P3M lasted only 32 minutes, whereas most of the other interviews took an hour or more. P3M would give short answers and not elaborate much, even with prompting. It was therefore surprising to us that the second interview with him was one of the longest follow-up interviews in our entire study, lasting approximately 1.5 hours, with P3M talking uninterrupted for long periods of time, explaining his photos and his experiences with the tracker. Here the photos acted as *"a medium of communication between researcher and participant"* [5]. P3M enjoyed explaining his photos, and the follow-up interview using the photos was a very different experience from the short, and at times awkwardly silent, initial engagement. In the second interview P3M felt more on "home turf" because of the photos. His own life included a great many experiences: visiting his parents, concerts, a book club, etc. While not all of this will be interesting or directly used in our analysis, it made P3M comfortable enough with the situation to also significantly elaborate on activity tracking experiences.

As such, while we as researchers were eager to focus on activity tracking, it took patience to let participants decide which of their experiences to share and let the stories unfold. This might entail sidetracks and background stories. Yet these are experiences that provide essential background knowledge often missing in other approaches. As such, the photo elicitation method makes it possible to gain valuable insights from participants that might otherwise be disregarded. The challenge of participant driven photo elicitation, however, is to let the stories unfold in a tempo set by the participant without getting drowned by irrelevant content.

2. Recall and memory issues remain in longitudinal studies

The longitudinal participant-driven photo elicitation design of the study presented many important benefits. Yet we caution other researchers conducting a study like this against letting it go on much longer than five or six months. During the follow-up interviews five months later we observed that participants had trouble remembering some of the very early photos and explaining why they had sent them. In a few cases, the researcher had to read out loud the accompanying e-mail that had been sent with the photo, and the participant would then pick up on that and describe some their original intent with the photo. Although important for triggering recall, photos alone may not be enough to facilitate recall in longer studies.

Only three of the nine participants who received a tracker at the beginning of the study used that same tracker on a regular basis at the end of the study. Thus six participants abandoned use of their trackers, including two who lost their trackers. P6F, for example, had quickly abandoned her new Fitbit tracker. Although we stayed in contact with P6F throughout the five months to see if she picked up the device again, the experience of tracking was not as present for her as it was for some participants who tracked a larger proportion of the time of the study. Thus the follow-up interview was perhaps less useful. Instead of waiting to do the follow-up interview, we should have asked for an earlier follow-up, and then kept in e-mail contact to monitor any changes in her patterns and perhaps conduct yet another interview at the end of the study.

We chose to end the study after 5 months, as we did not want participants to grow tired or frustrated with the study. Identifying the right length of time for the photo elicitation stage and the frequency of interviews remains a challenge. In the future we plan to deploy such studies for shorter periods of photo-elicitation and to iterate several times to mitigate recall issues. For example, we might conduct shorter follow-up interviews monthly during a five-month study or do two or three month long studies several times over the course of a year.

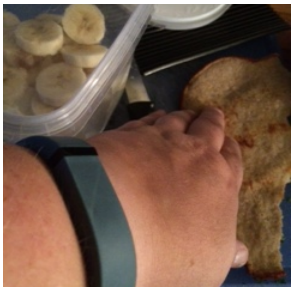
3. Unobtrusive and easy to forget to take photos
Taking photos with a mobile phone can be habitual. Some people do so frequently and others hardly ever. If photographing a situation was not something the participant would have otherwise done, bringing out the phone to take that photo was hard to remember. P19F explained: "*So I would think about it, but then when you are in the middle of it, you just forget it"* (Follow-up interview).

Our hope in doing photo elicitation study was to gain insight into everyday practices with minimal intrusion. However, this also at times resulted in participants forgetting to either take photos or send photos. We sent reminders every second week, if they had not sent a photo the previous week. While most participants felt this was an appropriate level of reminders, a few told us we could have reminded them more often. Future studies might consider sending out more frequent reminders, or asking participants at the beginning of the study how often they would like to be reminded to send photos.

Towards the end of the interview we discussed with participants whether they would have preferred specific tasks to solve, such as "take a photo of your tracker while you are at work". P15M, like most participants, preferred not having set tasks: *"So one could say that by asking us to do specific tasks it might have broken the rhythm of how you would usually use these devices"* (Follow-up interview). Participants agreed that while giving them tasks would have made the job easier to get done, it would have not as clearly represented the way they used their devices. *"Well this is 100% my reality, I promise you that"* (P12F, Follow-up interview). In any study, the researcher must decide how much to ask of the participants, and often this will come at a cost of how intrusive the study might be. In keeping the task open we made participants responsible for identifying relevant situations and generating relevant content. The upside was that participants agreed this did not make them do anything out of their routine, but we could have gathered more photos if we had reminded participants more often or given them more structure. Decisions like these depend very much on the specific goals of the study and must be considered in any design.

4. Expect discontinuity & technical difficulties
Even though all participants owned a smartphone, we encountered minor technical problems that are worth mentioning. For example, writing a few sentences turned out to be important to some participants. However, writing longer messages on smartphones could be a hassle. One participant had some problems sending photos from her phone or figuring out how to connect to her computer and send photos from there (she eventually did). Additionally, some participants took photos but never sent those. Several participants sent forgotten photos during or after the follow-up interview, but it is likely that some photos never came through, and some thoughts were never written down. We recommend clearly encouraging participants to send messages even when they were unfinished, and then remind them to fill out more detail later. Further, providing several different avenues for communication (perhaps a web-form, or even a phone app) can help mitigate such issues. Taken together, these technical hitches clearly influenced the number of photos we received.

5. Self-presentation and self-censorship
Asking participants to send photos of their experiences with activity tracking inherently lends itself to subjective positioning and self-censorship. For example, some participants worried their photos might not make sense to anyone else, and thus didn't send them. Some participants explained to us that they would wait until they had something "really interesting" to send before sending it. The fact that participants were not really aware of what role exactly photos would play in the study or the follow up interviews made choosing what to capture challenging. Discussions in the follow-up interviews demonstrated how some photos were clearly driven by social desirability. P20F, for example, who struggled to lose weight, explained about a photo of a breakfast she had cooked:



"I think this (photo) was a day where I was thinking I wanted to show you that I can actually live healthily" (P20F, Follow-up interview).

Figure 7: Photo, P20F.

We readily admit that the wish to engage in impression management has played a role in what participants chose to send us, and this self-censorship probably led some to send fewer photos. Yet the open nature of the original photo-elicitation task and the focus on the photos in the follow-up study resulted in many participants explaining that they had not felt judged when participating in this study: *"In this way it's fine and comfortable to participate because there has been no finger pointing when I've shown my numbers"* (P21M, Follow-up interview). While we see participants wanted to uphold a positive self-image and present that to us, a careful design can allow for less "finger pointing."

DISCUSSION

Research in the area of activity tracking, despite producing valuable insights, has struggled to find ways to study the role tracking devices play in the everyday lives of people as use develops over weeks and months. This is a difficult nut to crack because activity tracking devices are built to be unobtrusive, with only occasional moments of direct engagement. For this reason, photo elicitation methods might seem counterintuitive, explicitly drawing attention to a technology that is designed to be overlooked. However, we found that with this method we experienced a number of benefits. We were able to gain insights without making too

many initial assumptions about the use patterns of the participants, which is difficult to avoid in survey studies. Most importantly, the method turned out to be useful as a way to begin to understand "non-use" or episodic events or experiences in more detail, as participants found creative ways to capture this. The frequent low-level engagement with the researchers through email became a genuine indication of researcher interest in their particular experiences, which resulted in a very low dropout rate, often a problem in other types of longitudinal studies. We admit that participants' self-censorship might have led to some photos not being sent. However, several participants explained that they felt at ease and willing to discuss their practices in detail in interviews that took a direct starting point in their own experiences and values. Thus participants revealed a great deal about their experiences, even such things as deeply felt worries of disease, struggling to loose weight or balance stressful workdays with being an attentive parent.

Alongside the benefits clearly gained by the researchers, we observed that this method allowed participants themselves to reflect on their own use of their device at several points in time. We believe this is important, and has not been covered by research methods. Here both photo elicitation and the follow-up interview essentially became part of the activity tracking process for our participants. For five months we redirected participant attention to the device at least every two weeks. Then, during the follow-up interview we staged an intense experience of reflection on participant device use and the images they had sent. Our data suggest that despite the device being designed to essentially disappear and become unobtrusive in use, moments of reflection on its use and its function may be integral to productive activity tracking

The participant driven photo elicitation method that we have demonstrated here draws on a rich tradition across various fields, and can allow participants to *"retain control over how and when they engage in the research"* [9]. While this makes this method especially suitable for researchers interested in collaborative efforts, our application of this method to a longitudinal study of activity tracking devices proved fruitful.

CONCLUSION & RECOMMENDATIONS

This paper investigates the benefits and challenges of using participant driven photo elicitation method to better understand activity tracking practices as these develop over days and months. Based on our experience in this study we make the following suggestions for researchers interested in replicating or adapting our methods.

1. **Study duration:** Despite the importance of the longitudinal design, we hesitate to recommend any study to continue longer than 5-6 months without following up on the photos. While photos support more specific recall this effect does not last forever. We **suggest for future studies to have more, but shorter rounds of photo elicitation**. For example, ask participants to take photos the first week of every month and then follow up every 3-5 months. This means that reminders to take photos should be adjusted accordingly; shorter iterations of photo elicitation might allow for more reminders, whereas longer continuous studies should be careful not to overload participants with reminders.
2. **Photo content:** It is important to remind participants that **photos do not have to be "good"** and do not have to always feature the device itself. As long as the photo captures some element of the experience, ensure that participants understand that this is useful in the study. Activity tracker use practices are very diverse and these unobtrusive devices can come to play a role in a range of unexpected daily practices. Thus emphasis on particular content can be counter-productive. Participants will at times struggle to figure out what to capture. We found that this **struggle can lead to significant insight** into how participants figured out what they themselves found to pertain to activity tracking use.
3. **Allow content other than photos:** To support reflection and to gain inside into the breadth of daily practice we suggest allowing participants **to include written text alongside photos but not requiring it.** To mitigate technical issues we recommend reminding participants that it is okay to write keywords and then come back to this at a later point and fill in more detail.
4. **Follow up interviews** benefit from taking their departure in photos**.** Interviewers need to be prepared that follow-up interviews necessarily follow the interests of the participant. Trying to steer the interview in certain predetermined directions leads the study away from the main point of photo elicitation, namely creating a space for participants to explain about their individual experiences.
5. **Sorting task is key to reflection:** We found it highly beneficial to **include a sorting task** in the follow-up interview. In this exercise participants were asked to categorize their photos as they saw fit, and then to explores further what this might mean to them. This task generated important insights for the researchers and also lead to thoughtful reflection on the part of the participants.

Participant driven photo elicitation method is no panacea for all studies exploring activity-tracking in practice. However, the method we describe here can be a useful tool by itself or in addition to other methods as we seek to understand how consumers adopt, implement and push back on wearable activity tracking devices.

ACKNOWLEDGMENTS

We thank our participants and gratefully acknowledge the time and effort they invested in this study. We thank Daniela Rosner, Sean Munson, Christina Chung and Daniel Epstein for feedback on earlier versions of this paper.

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