

Every Step You Take

Tracking Physical Activity at Work and at Home

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Every Step You Take
Tracking Physical Activity at Work and at Home

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Cover photo

Photos of activity tracking experiences by participant P3M, research paper 5.

PART I: INTRODUCTION COVER

ACKNOWLEDGEMENTS	I
SUMMARY	III
SAMMENFATNING	IV
1. INTRODUCTION.....	1
1.1. RESEARCH QUESTIONS AND RESEARCH PAPERS	6
1.2. CONTRIBUTIONS.....	8
1.3. KEY TERMS	9
1.4. BACKGROUND.....	11
1.4.1 <i>The origins of self-tracking technologies</i>	11
1.4.2. <i>Technical aspects</i>	12
1.4.3. <i>Effectiveness</i>	13
2. THEORETICAL POSITIONING	15
2.1. STUDYING ACTIVITY TRACKING IN THE WORKPLACE.....	15
2.1.1. <i>Articulation work and the social-technical gap</i>	16
2.2. THE SELF IN SELF-TRACKING.....	18
2.2.1. <i>The self as contingent and culturally specific</i>	18
2.2.2. <i>Lived experiences</i>	18
2.3. HEALTH: A SOCIAL ECOLOGICAL MODEL.....	21
2.3.1. <i>Strategies of health promotion</i>	22
2.3.2. <i>Social ecological model of health</i>	22
2.3.3. <i>Health promotion in a digital space/age</i>	23
2.4. SURVEILLANCE	25
2.4.1. <i>Three levels of surveillance allowed for by activity tracking</i>	26
2.4.2. <i>Considering accountabilities rather than beneficial or adversarial outcomes</i>	28
3. GROUNDED THEORY	30
3.1. THE ROLE OF REVIEWING LITERATURE.....	31
3.2. DATA COLLECTION PROCESS	32
3.2.1. <i>Visualization of empirical studies</i>	33
3.3. CODING PROCESSES	38
3.4. THE ROLE OF THE RESEARCHER	42
4. SUMMARY OF FINDINGS	44
4.1. RQ1: WHAT IS STATE-OF-THE-ART IN QUALITATIVE STUDIES OF SELF-TRACKING PRACTICES?.....	44
4.2. RQ2: WHAT ARE THE EXPERIENCES OF EMPLOYEES PARTICIPATING IN A SHORT-TERM, STEP-COUNTING CAMPAIGN? ..	45
4.3. RQ2A: WHAT ARE PRIVACY CONCERNS IN THE CONTEXT OF A STEP-COUNTING CAMPAIGN?	46
4.4. RQ3: HOW ARE ACTIVITY-TRACKING TOOLS ADOPTED IN MORE LONG-TERM HEALTH AND WELLNESS PROGRAMS?	47
4.5. RQ4: HOW CAN ACTIVITY-TRACKING PRACTICES BE STUDIED AS PART OF EVERYDAY LIFE?	48
4.6. RQ5: HOW ARE ACTIVITY-TRACKING TECHNOLOGIES INCORPORATED AS PART OF EVERYDAY LIFE?	48
5. CONCLUSIONS AND FUTURE WORK	50
REFERENCES	54

Part II: RESEARCH PAPERS

PAPER 1	61
Gorm, N., Chung, C., Shklovski, I., & Munson, S. (2018). Literature Review: 10 Years of Qualitative Self-Tracking Studies. <i>(Submitted)</i>	
PAPER 2	104
Gorm, N., & Shklovski, I. (2016). Steps, Choices, and Moral Accounting: Observations from a Step-Counting Campaign in the Workplace. <i>CSCW '16</i> .	
PAPER 2A	117
Gorm, N., & Shklovski, I. (2016). Sharing Steps in the Workplace: Changing Privacy Concerns Over Time. <i>CHI'16</i> .	
PAPER 3	123
Chung, C., Gorm, N., Shklovski, I., & Munson, S. (2017). Finding the Right Fit: Understanding Health Tracking in Workplace Wellness Programs. <i>CHI'17</i> . <i>Honorable Mention Award</i> .	
PAPER 4	136
Gorm N., & Shklovski, I. (2017). Participant Driven Photo Elicitation for Understanding Episodic Activity Tracking: Benefits and Limitations. <i>CSCW'17</i> .	
PAPER 5	149
Gorm, N. & Shklovski, I. (2018). Episodic Use: Practices of Care in Self-Tracking. <i>Submitted to New Media and Society, 2018</i> . [Revise and resubmit]	
APPENDIX:	166
Co-author statements	

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Summary

Technologies built to support activity tracking are growing increasingly ubiquitous. Devices that measure physical activity such as steps, runs, pulse, blood pressure and sleep are marketed with high hopes that consumers will wear them and improve their health. Although research reveals that users do not always engage in sustained tracking, users are now incentivized to engage in activity tracking through insurance schemes, for example, and via workplace health and wellness programs. This development makes abandonment of self-tracking practices a financial decision, and even when the workplace health and wellness programs do not include financial incentives, the power dynamics involved in workplace settings cannot be ignored. Through an extensive literature review of research in the area, this dissertation shows that the implications of introducing tracking devices in workplace settings have not received due attention. Furthermore, research in self-tracking practices beyond the workplace has so far employed traditional research methods such as interviews and surveys.

Based on the gaps identified in the literature, this dissertation conducts three sets of empirical work: an observational study of a workplace step-counting campaign in a Danish workplace, an interview and survey study among employees in insurance-based health tracking programs in the US, and a 5-month photo-elicitation-based study of Danish self-trackers. These three studies together comprise the core of the dissertation's five main contributions. First, this dissertation presents a literature review of 84 qualitative studies of self-tracking practices and provides a roadmap for future research in this field. Second, this dissertation investigates the introduction of activity tracking technologies in workplace settings through observational studies, interviews and surveys, thus providing substantive empirical contributions. Third, in order to conduct longitudinal studies of everyday activity tracking practices, this dissertation further develops participant-driven photo elicitation methods, thus adding valuable methodological considerations to the field. Fourth, the main theoretical contribution of this dissertation is the concept of episodic use. Rather than dismissing episodic use as a problem to be addressed or fixed by improved activity trackers, with the language proposed, episodic use is conceptualized and discussed as a practice rather than a problem. Finally, the emphasis on episodic use holds practical implications for the introduction of activity trackers in workplace health and wellness programs and beyond. It therefore presents practical suggestions for research and the implementation of activity trackers in the future.

Sammenfatning

Teknologier, der måler fysisk aktivitet såsom antal skridt, løbeture, puls og søvn, er blevet mere og mere almindelige. Forskning har vist, at brugerne sjældent bærer deres aktivitetsmålere i længere tid ad gangen. Aktivitetsmålere introduceres dog alligevel nu i sundhedskampagner på arbejdspladser, og nogle steder kan medarbejdere opnå økonomiske fordele eller rabatter på deres sundhedsforsikring ved at leve op til bestemte mål og dele deres data med arbejdspladsen eller forsikringselskabet. Hvis brugeren ikke længere vil måle fysisk aktivitet er dette derfor en økonomisk beslutning, og selv på arbejdspladser, hvor der ikke er økonomiske citamenter forbundet med aktivitetsmåling, kan arbejdspladsens dynamikker og hierarkier spille en rolle for, hvordan teknologierne bruges. På baggrund af et dybdegående litteratur studie viser denne afhandling, at introduktionen af aktivitetsmålere på arbejdspladsen ikke tidligere har været tilstrækkeligt undersøgt. Ydermere har brugen af aktivitetsmålere udenfor arbejdspladsen indtil nu kun været undersøgt ved kortere studier og ved brug af traditionelle metoder såsom interviews eller spørgeskemaundersøgelser.

Denne afhandling præsenterer forskning fra tre empiriske undersøgelser: et observationsstudie fra en dansk arbejdsplads, hvor medarbejdere deltog i en skridttæller-kampagne, en interview-, og spørgeskemaundersøgelse fra arbejdspladser i USA, hvor aktivitetsmåling er koblet sammen med sundhedsforsikring, og endelig en 5-måneders lang undersøgelse af danske brugere af aktivitetsmålere udenfor arbejdspladsen. Disse tre empiriske studier danner grundlag for afhandlingens fem grundlæggende bidrag til området. For det første danner litteraturstudiet overblik over status-quo indenfor forskning på området, og danner dermed et solidt grundlag for at pege på, hvilken forskning der fremover bør bedrives. Dernæst bidrager afhandlingen med konkrete og dybdegående empiriske studier af introduktionen af aktivitetsmålere på arbejdspladsen, både i Danmark og USA. Afhandlingen præsenterer et længerevarende studie af brugen af aktivitetsmålere i hverdagen ved udvikling af foto-eliciterings metoder, og bidrager således med metodeovervejelser, der belyser hidtil uudforskede vinkler. Som det fjerde bidrag står det teoretiske koncept episodisk brug. I stedet for at afvise episodisk brug som et problem der kan løses ved udvikling af teknologien, som størstedelen af forskning på området gør, fremhæves denne praksis som en måde, hvorpå brugeren håndterer de mange, ofte modsatrettede, prioriteringer som livet bringer. Endelig fremhæver denne afhandling, at sådan episodisk brug af aktivitetsmålere indebærer at introduktionen, og evalueringen af disse, både i hverdagen og på arbejdspladsen, må gentænkes og præsenterer dermed praktiske forslag til videre forskning og implementering.

PART I

1. Introduction

This dissertation explores how activity-tracking technologies are used in everyday life, both in workplace settings and at home. Compared to simple pedometers in the 1990s, activity trackers now include quite sophisticated technologies that can track a wide range of activities. Since the Fitbit was introduced in 2008, these devices have rapidly developed, and now tracking steps, runs, blood pressure, calories burnt, active minutes, and sleep etc. is both easy and relatively affordable. The rhetoric surrounding these devices is often starkly divided. Proponents of tracking technologies assert that tracking health indicators can help people gain insights into their health patterns, thus creating support and motivation to change to healthier habits. This will increase overall population health levels, and it has also been proposed that data can be used to research health (Haghi, Thurow, & Stoll, 2017). On the opposing side, critics are alarmed about the implications of tracking everyday behaviors at such a granular level. Technologies have certain intrinsic assumptions of how one might lead a healthy life, assumptions that do not fit everyone, and signal an increasingly individualized responsabilization regarding health, which research has long shown is greatly impacted by matters beyond individual reach (Tones & Green, 2004). Furthermore, data from these devices are collected by the huge tech corporations, which thus have insights into sensitive data that can be used in unforeseen ways. For example, Fitbit data has been used in courtroom cases (Olson, 2014), and data from the activity-tracking platform Strava has shown geographical hotspots of users lit up in war zones, presumably where the US has secret facilities and military bases (Whittaker, 2018). As I began my PhD project in 2014, I found that these opposing stories of activity tracking were rarely accompanied by research exploring how activity tracking is actually adopted in everyday lives. At the same time, researchers were calling for the necessity of such investigations (Copelton, 2010; Patel & O’Kane, 2015; Rooksby, Rost, Morrison, & Chalmers, 2014; Ruckenstein, 2014). Thus, everyday experiences, both of potential benefits and challenges, run the risk of being overlooked, without entering into the dominant metaphors and rhetoric of what activity tracking allows or hinders users from doing.

In discussions of self-tracking practices, researchers have paid great attention to the first-mover community of the Quantified Self (referred to in the following as QS). Initiated by a group of tech enthusiasts in Silicon Valley in 2007, this community gathers, and shares, experiences of self-tracking. The experiences of the members of this group are often brought to the fore when

discussing self-tracking, so much so that self-tracking and QS are often conflated (Didžiokaitė, Saukko, & Greiffenhagen, 2017; Lupton, 2016). Some have argued that in terms of “what” and “why”, QS members and the wider population are similar (Neff & Nafus, 2016). While studies of QS members are valuable, I argue, as have others (Didžiokaitė et al., 2017), that focusing only on first movers risks furthering the dominant discourses on what self-tracking allows users to do, overlooking challenges, or benefits faced by more “mundane” users. As activity trackers are spreading to a larger group of users and into a variety of settings, such as workplace health and wellness programs, “what” is being tracked may be already decided upon by someone other than the user. Furthermore, “why” to track can be motivated by financial incentives or a wish to be included in social conversations with co-workers, for example. Therefore, experiences of activity tracking involve more than simply the dedicated and often very well-reflected practices of QS members.

Another significant body of research in the area of activity tracking has considered the extent to which these devices “work”, in the sense that they provide support or motivate people to be more active. The evidence of this is not yet settled (see section 1.4.3). These types of studies are often clinically run quantitative studies with little or no detail of the experiences of the participants. Again, research in this perspective runs the risk of overlooking potential benefits and limitations as activity trackers are adopted in the context of everyday life. As I began to gain more of an overview, I found that there was, in fact, quite a lot of qualitative research on this subject. However, the research had not yet been sufficiently connected. This may be due to the fact that researchers interested in self-tracking practices come from a wide variety of fields, such as Human Computer Interaction, Health Promotion studies, Communication studies, and others. This led me to the first research question of this dissertation:

RQ1:

What is state-of-the-art in qualitative studies of self-tracking practices? RQ1

By conducting a rigorous literature synthesis, I¹ gathered and analyzed 84 qualitative studies of self-tracking. While some of them did consider some aspects of everyday experiences, these were

¹ All papers have been developed in collaboration with various researchers. Throughout this text the first-person pronoun is used for consistency and to avoid confusion. Please refer to co-author statements for details on distribution of work.

greatly outnumbered by research considering how to improve devices (please refer to paper 1 in Part II). Furthermore, I revealed a dearth of studies considering how activity trackers are being increasingly introduced into areas beyond private use, namely, into workplace health and wellness programs.

Activity tracker technologies are increasingly offered to employees, either as presents or for use in health and wellness campaigns. Researchers have argued that this introduction signals “*a heightened Taylorist influence on precarious working bodies within neoliberal workplaces*” (Moore & Robinson, 2015). However, others have argued that “*a distanced theorizing of personal analytics is not sufficient*” (Ruckenstein, 2014). Thus, the first empirical study of this dissertation concerns the lived experiences of activity tracking in the workplace. I proceeded to ask:

RQ2:

What are the experiences of employees participating in a short-term, step-counting campaign?

In Denmark, I found the Tæl Skridt (count steps) campaign an example of one such implementation of activity trackers in the workplace. To answer RQ2, I conducted an observational study of a Danish workplace participating in this campaign. Reading literature in this space, I found a report stating that users are growing “*increasingly comfortable with the risks as the rewards become more appealing*” (PricewaterhouseCoopers, 2014). Something jarred with my experiences in the workplace, so I re-visited my data, asking:

RQ2A:

What are privacy concerns in the context of a step-counting campaign?

As I conducted the observational study of the step-counting campaign in Denmark, I was aware that this campaign provided very specific structures that were likely to impact on how the campaign unfolded. This, however, is not the only way activity trackers are introduced in workplace settings. In the USA, devices are introduced as part of more long-term programs and directly linked to health insurance schemes. Walking a certain amount of steps, for example, can give points that count towards purchasing company merchandise or obtaining discounted health insurance premiums

(Christophersen, Langhoff, & Bjørn, 2015). Therefore, deciding not to track can become a financial decision. Again, I wondered how this might play out in workplaces. In collaboration with Christina Chung and Sean Munson from the University of Washington, I investigated experiences of American employees. The third research question of this dissertation is thus:

RQ3:

How are activity trackers adopted in more long-term health and wellness programs?

RQ2, RQ2A and RQ3 provide different angles on the experiences of activity-tracking practices in the workplace. In general, activity trackers are increasingly common, with recent statistics showing that 30% of all Danish homes have such devices lying around (Danmarks Statistik, 2018). My next step was to gain empirical material that allowed me to gain insights into everyday uses of activity-tracking practices, beyond workplace settings. It was clear and supported by the findings of the literature review that relatively few researchers had conducted long-term studies of everyday tracking outside members of the QS. This, in part, is due to the fact that studying activity-tracking practices poses methodological challenges. Activity tracking takes place throughout everyday life, checking steps when waiting for the bus or considering the number of active minutes while doing the laundry. As I was aiming to include a large group of participants, and follow their experiences for longer periods of time, conducting observational studies in the same way as I had in the Danish workplace proved challenging. Consequently, RQ4 concerns the methodological challenges of studying activity tracking in everyday life. Here I ask:

RQ4:

How can activity-tracking practices be studied in everyday life?

In answering this question, I drew on methods of participant driven photo elicitation in the third, and final, empirical study. For this study, 25 participants were recruited and submitted photo material throughout the course of 5 months. Based on this study, I was able to investigate the final research question of this dissertation:

RQ5:**How are activity-tracking technologies incorporated in everyday life?**

By developing the theoretical concept of *episodic use*, I challenge the underlying logic of how activity trackers are most often promoted as technologies to be used continuously and indefinitely. My participants often used their devices episodically, and by interpreting the theoretical framework of Mol I suggest that participants use their devices in this way as a part of a practice of care (Mol, 2008). That being the case, I argue that such *episodic use* is a feature of use, not a bug to be fixed. This concept also suggests avenues for future research in the field of activity tracking and has implications for the way these technologies may be imagined to play a part in workplace health and wellness programs, which is further discussed in the final chapter of this dissertation.

This introduction chapter has briefly outlined recent developments in the area of activity tracking, discussed existing research and identified gaps in literature. The presented research questions will be discussed and answered in corresponding papers included in part II of the dissertation. Taken together, the papers empirically investigate lived experiences of activity tracking in workplaces as well as in the home. In the following, I restate the research questions, connect them to their empirical studies and briefly summarize the main findings.

1.1. Research questions and research papers

This dissertation investigates how activity trackers are used in everyday life, both in workplace settings and at home. It does so by conducting three separate, yet connected, empirical studies, asking the following research questions:

RQ1: What is the state-of-the art in qualitative studies of self-tracking practices?

Through a substantive literature review, I analyze 84 qualitative studies of self-tracking practices from 2006-2016. The literature review presents main research goals of the papers, showing a clear emphasis on the development of new technologies. The analysis highlights gaps in the literature, such as a lack of empirical studies in the workplace and longer-term studies in everyday life, upon which this dissertation builds.

Paper 1:

Gorm, N., Chung, C., Shklovski, I., & Munson, S. (2018). Literature Review: 10 Years of Qualitative Self-Tracking Studies. *(Submitted)*

RQ2: What are the experiences of employees participating in a short-term, step-counting campaign?

RQ2A: What are privacy concerns in this context?

Based on an observational study and interviews, I conclude that steps are a socially negotiated quantity, and discuss how employees engage in moral accounting, as activity trackers are adopted as part of this step-counting campaign. Employees who chose not to participate were also impacted by the campaign, at times feeling left out or excluded from conversations amongst participating colleagues. Finally, I use a social ecology lens to show how step-counting, experienced as one element among several health initiatives, has implications for what is construed as a success.

Paper 2:

Gorm N and Shklovski I (2016) Steps, Choices, and Moral Accounting: Observations from a Step-Counting Campaign in the Workplace. *CSCW'16*.

Paper 2A:

Gorm, N., & Shklovski, I. (2016). Sharing Steps in the Workplace: Changing Privacy Concerns Over Time. *CHI'16*.

RQ3: How are activity-tracking tools adopted in long-term wellness programs?

Looking at more long-term health tracking programs in the US, these are generally positively received by employees. However, the interviews and surveys among employees and program managers show that there is a gap between what the programs offer and the goals or motivations of the employees. The findings also highlight that even if these gaps are minimized, activity tracking will not be for everyone.

Paper 3:

Chung, C., Gorm, N., Shklovski, I., & Munson, S. (2017). Finding the Right Fit: Understanding Health Tracking in Workplace Wellness Programs. *CHI'17. Honorable Mention Award.*

RQ4: How can activity-tracking practices be studied in everyday life?

While developing methods of photo elicitation, I discuss the benefits and limitations of using this method for investigating everyday experiences of activity tracking.

Paper 4:

Gorm, N., & Shklovski, I. (2017). Participant Driven Photo Elicitation for Understanding Episodic Activity Tracking: Benefits and Limitations. *CSCW'17.*

RQ5: How are activity-tracking technologies incorporated in everyday life?

The third and final empirical study utilized participant driven photo elicitation methods to follow the activity-tracking practices of 25 Danish users throughout the course of five months. I argue that an important, previously overlooked practice is that of *episodic use*. With this concept, I propose that the expectations of continuous use prove difficult, perhaps at times even damaging, in terms of incorporation in everyday life, whereas *episodic use* allowed my participants to deal with complex social situations and life changes. In other words, *episodic use* enables participants to involve activity trackers in a practice of care.

Paper 5:

Gorm, N. & Shklovski, I. (2018) Episodic Use: Practices of Care in Self-Tracking. *Submitted to New Media and Society.* [Revise and resubmit]

1.2. Contributions

Based on a substantive literature review, three empirical studies and five research papers, this dissertation makes five main contributions.

First, this dissertation presents a rigorous *literature review*, synthesizing qualitative research on self-tracking from 2006-2016. By looking across fields, approaches and research questions, the research synthesis provides much-needed connections across disparate studies, thus providing a roadmap for future research in this area.

Second, by presenting findings from a short-term step-counting campaign, long-term health and wellness program, as well as a longitudinal study of everyday experiences of activity tracking, this dissertation makes substantive *empirical contributions*.

Third, this dissertation presents a *methodological contribution*. Self-tracking practices are an increasing part of everyday life for many people, and in this dissertation, I argue that there is a need to sharpen the methodological tools in the proverbial toolbox to better understand these everyday practices. While the most commonly used interview and survey methods provide useful insights, paper 4 shows how participant driven photo elicitation is a valuable addition in this field.

Fourth, based on empirical work, the dissertation presents a *theoretical contribution*; namely the concept of *episodic use*. I argue, by interpreting the theoretical framework developed by Mol, that the participants using self-tracking devices episodically do so as an element in a process of care (Mol, 2008). Rather than dismissing episodic use as a problem to be addressed or fixed by improved activity trackers, with this language, episodic use is conceptualized and discussed as a practice rather than a problem. Finally, the concept of episodic use allows me to consider *practical implications* of the dissertation research. As we move forward in the area of activity tracking, this dissertation explores with a nuanced understanding both the joys and challenges of using activity trackers. I suggest that what my participants found most challenging was not necessarily the activity tracking in and of itself, but rather the prevailing assumption of continuous use. Allowing for episodic use accommodates that activity tracking is episodic by nature, which has consequences for the way these technologies may be introduced in workplace health and wellness programs.

1.3. Key terms

In this section, I list and describe the key terms and types of technologies in the field of research covered by this dissertation. With the emergence of more self-tracking technologies, and more research in this field, there are differing ways of referring to the same technology or phenomenon. Conversely, a term might be used to describe things or practices that are in fact different in important ways. This section provides an overview of how the most important key terms and technologies in this dissertation are applied, but also briefly clarifies other important terms in this area. The list is presented in alphabetical order.

Activity trackers refers to the type of technologies that are developed and used to register the movements of the wearer. This can, for example, include steps, runs, elevation (stairs), pulse and/or sleep. Many smartphones now include a variety of sensors and are thus also used as activity trackers. Pedometers are early versions of activity trackers, see more in section 1.4.2. and 1.4.3.

Biosensors are devices with inbuilt sensors that touch and analyze a liquid or gas (e.g. saliva or sweat). These are quickly becoming commonplace components of activity trackers. However, at the point of writing this dissertation the “dry” type of sensors are still most common (for a more detailed explanation of how activity trackers function please refer to section 1.4.2).

Health and wellness programs is the term I use to describe the variety of health promoting initiatives aimed at the workplace. Across the two countries included in the empirical work of this dissertation (Denmark and USA) these types of initiatives go by various names, but they all seek to improve the overall health and wellbeing of the employees in their workplace. These programs vary from workplace to workplace, and include a variety of different initiatives, ranging from healthy canteen food, to in-house gyms and personal health coaches.

Life-logging refers to technology-supported tracking of a range of activities, not just pertaining to physical activity. Life-logging is often used as a more all-encompassing term that includes, for example, wearable cameras. Preservation of events and memories is in the foreground here rather than tracking for the purpose of self-improvement. Bell and Gemmel, the greatest proponents of life logging, claim it will lead to humans being able to recall all memories at all times (Bell & Gemmel, 2009).

Personal Informatics is the preferred name for self-tracking practices in academic literature (Lupton, 2016). Studies of Personal Informatics, most often conducted in the area of Human Computer Interaction, studies self-tracking practices broadly, meaning that these studies also explore financial tracking or location tracking. In this dissertation, I am specifically interested in physical activity tracking, and therefore use this specific term rather than the more general Personal Informatics.

Quantified Self in this dissertation, specifically refers to the Quantified Self community. Lupton points out how this term has developed from referring to the QS website and community only, to being used as a common noun. In this way, Quantified Self is often used in the same way as the “self-tracking” term (Lupton, 2016).

Self-tracking is the overall umbrella term for the phenomena studied in this dissertation. Self-tracking is also sometimes called self-monitoring. Self-tracking practices may refer to a wide range of tracking activities, such as keeping track of weight, the duration of weekly visits to the gym, or even how many words are produced on a dissertation every day. Self-tracking practices can be conducted using simple paper and pen methods, but can also be supported by technology. The research in this dissertation is rooted in the area of self-tracking, but specifically deals with technologically supported physical activity tracking.

Wearables is a popular term for the technologies that can be worn on the body, such as fitness bands or smartwatches, or even T-shirts, sports bras and shoes with embedded sensors. To most precisely situate this dissertation, I do not refer to physical activity trackers as wearables, since the category wearables is more general and includes many types of technologies that fall outside the scope of this research.

1.4. Background

A variety of activity trackers are available to consumers in the market today. This section describes the most prevalent and presents a short overview of studies that investigate the effectiveness of tracking physical activity.

1.4.1 The origins of self-tracking technologies

Activity trackers have developed rapidly and gained increasing attention in the last 10-15 years, yet the devices come with a much longer historical trajectory. An early type of pedometer has been traced back to drawings of Leonardo Da Vinci that was originally invented as a tool for producing maps (Brabazon, 2015). However, it was not until 1780 that the actual mechanisms were developed by Swiss Abraham-Louis Perrelet. Thomas Jefferson has also been accredited as the inventor of the pedometer, despite the fact that he merely introduced Perrelet's idea to North America in 1789 and never filed for any patents (Brabazon, 2015). Pedometers remained curiosities throughout the 19th century, most often with devices worn on the ankle rather than the wrist as many of the devices we know today.

By the 1960s, pedometers were further developed in Japan, under the name of “manpo-kei”, which translates into “ten thousand steps meter” (Tudor-Locke & Bassett, 2004). By the 1990s, pedometers were considered reasonably accurate and research using steps to quantify physical activity intensified (Bassett, Toth, LaMunion, & Crouter, 2017). In 2008, Fitbit launched its first activity tracker, and in 2009, Apple's iPhone 3GS was the first smartphone to come equipped with an accelerometer (see more detailed explanation below) (Felber, 2015). Today, Fitbit and Apple still hold the majority of the market share, with Xiaomi as a close third (IDC, 2018). Reports on the exact number of activity trackers sold vary. However, estimates from an industry report suggest that a total of 115.4 million units were shipped in 2017.

Self-tracking technologies are among those referred to as persuasive technologies. Some of the earliest persuasive technologies were developed in the area of health promotion and workplace productivity (Fogg, 2003). Fogg suggests that “self-monitoring” is one of the basic types of persuasion strategies and speaks to “*the natural human drive for self-understanding*”. Self-monitoring works to change behavior in two ways. First, by tracking a certain behavior, i.e. steps, the user is able to be more efficient; e.g. tracking steps may show that walking briskly for 10 minutes may result in more steps than walking slowly for 15 minutes. Second, for many people,

seeing their numbers makes the activity they are doing more interesting and perhaps more fun. The basic idea is that the new knowledge and change in attitude towards the activity will make the person more likely to change the behavior in question (Fogg, 2003).

A persuasive technology “... allows people to monitor themselves to modify their attitudes or behaviors to achieve a predetermined goal or outcome” (Fogg, 2003). In terms of health, there are a variety of prevalent predetermined goals, and most people will probably have heard of the “10,000 steps a day” goal. As mentioned, this goal originally came from popular walking clubs in Japan, and especially from one particular manufacturer that used it as its slogan (Tudor-Locke & Bassett, 2004). Essentially 10,000 was chosen because it was a nice round number. Today, the popularity of this goal remains, although there are discrepancies between this goal and official health guidelines. In Denmark, adults are advised to be physically active for at least 30 minutes every day. Although people with weight problems are advised to walk 10,000 steps a day, it is also acknowledged that 10,000 steps a day is “more than 30 minutes of fast walking”, and thus more than the daily recommendation (Sundhedsstyrelsen og Komiteen for Sundhedsoplysning, 2015). However, the goal of 10,000 steps a day has the advantage of being easy to remember and provides a very clear, and measurable, goal. As such, many health authorities have accepted this goal of 10,000 steps a day alongside their own health recommendations (Tudor-Locke & Bassett, 2004).

1.4.2. Technical aspects

Initially, pedometers were based on a particular set of relatively simple technologies. Every time a step is taken, the body tilts first one way, and then the other way. This movement can be counted by a pendulum swinging from side to side pushing on a lever, and the early versions of pedometers showed the counting of the steps in much the same way as an analogue watch moves the pointer on the dial. Thus sensors in the early pedometers were mechanical. Some later pedometers were developed that were partly electronic (Woodford, 2018). Neither of these require any advanced technology nor coupling with apps nor other devices in order to show the user a step-count.

Today, the technologies used are more complex. Activity trackers are electronically updated versions of the pedometers, with no moving parts. Rather than counting steps by using a pendulum, the activity trackers have implemented accelerometers, often a 3-axis accelerometer (based on micro-chips), with the axes at angles to each other, that registers when the body moves. However,

this is not an exact science, as body movements can, for example, be caused by bumps in the road when driving a car, or sometimes a step might even be too “small” to be counted. The movement of your body also depends very much on your age, weight, height, stride, and a range of other factors. The sensor registering a movement is not useful in and of itself, but relies on algorithms. This is also partly why modern activity trackers ask users to enter details on height, weight, etc., when first using the device. The data collected by the sensors is run through algorithms that attempt to take these factors into account. It is difficult to directly compare the accuracy of these algorithms and which factors they take into account, to say the least, as companies most often guard these as trade secrets (Nield, 2017; Woodford, 2018).

1.4.3. Effectiveness

At the end of the day, the million-dollar question remains: Do these devices actually encourage people to be more physically active?

Overall, much research supports that using a pedometer can, in fact, increase physical activity and reduce body mass index and blood pressure (Bravata et al., 2007; Shuger et al., 2010). Yet, these results are most likely impacted by the often very limited participant demographic, the limited timeframe of the studies, and the limitations of simple pedometers. Yet, studies with more advanced trackers, such as Fitbit’s, also show some tentatively positive results; people seem to be encouraged to exercise more (Mackinlay, 2013). However, Jakicic et al. conducted a 2-year study and found that those who had used activity trackers actually lost *less* weight. Activity trackers might not have a direct goal of helping people to lose weight – but rather support people in being more active. However, in the study by Jakicic et al. the participants with wearables were no more active than the control group (Jakicic et al., 2016). Perhaps unsurprisingly, then, evidence on the impact of introducing activity trackers as part of workplace health and wellness programs is also lacking (Moore & Piwek, 2017) and researchers have pointed to the need for more controlled trials (Freak-Poli, Cumpston, Peeters, & Clemes, 2013).

While more research on the outcomes of using tracking technologies would be interesting, the fact remains that at this point they are already used by many people across the globe in a range of different contexts. As Ruckenstein and Dow Schüll argue: “*An important starting place for social-scientific scholarship on the datafication of health is the recognition that this vision is mostly*

speculative, promissory, and as yet unrealised; what is needed, above all, are rigorous accounts of the actual reality of datafication as it takes shape in diverse practices and, quite often, twists in unforeseen directions” (Ruckenstein & Schüll, 2017, p. 3). The aim of this dissertation is therefore to accept this challenge as a starting point and to the extent possible map the uncharted territory of datafication in relation to activity trackers at home and at work.

2. Theoretical positioning

In this chapter, I consider literature relevant to the positioning of this dissertation as a whole. Four areas are particularly relevant for understanding the theoretical positioning of activity tracking in the workplace and in the everyday lives considered in this dissertation. First, when investigating activity tracking as part of workplace practices, I draw on research from Computer Supported Cooperative Work (referred to in the following as CSCW). Second, the dissertation has particular perceptions of “the self”, and “health”, which are explained. Finally, the topic of surveillance inevitably arises in discussions of activity tracking and is thus considered in the last section of this chapter.

2.1. Studying activity tracking in the workplace

The introduction or changing of technologies in workplace settings and the subsequent influences on work practices and collaboration are the main focal points of traditional computer-supported cooperative work (CSCW). With a CSCW lens, I draw on the concepts of articulation work and the social-technical gap in my work. As with all theoretical concepts, this allows me to focus on some aspects in particular while others remain in the background.

CSCW is well-equipped for researching cooperative work and the role information technology plays in this context, with its inherent complexities and challenges (Lee & Paine, 2015). Yet, to date, the introduction of activity-tracking technologies in the workplace has not been investigated in the field of CSCW. One notable exception (Vyas, Fitz-Walter, & Mealy, 2015) involves 17 university staff members who had participated in a workplace step-counting campaign. Interviews were conducted with the staff after the campaign, with no observation during the campaign and no consideration of employees who had chosen not to participate. Although the researchers highlight the importance of considering social aspects, the findings are used mainly to consider how a future app could improve the user experience. The minimal attention paid to the lived experiences of introduction of activity tracking in the workplace may be due to the fact that activity-tracking technologies are not introduced in order to influence work practices directly. Rather, the idea is that improving the health of the employee will in turn reduce sick days and thereby improve productivity. Whereas at first glance, workplace productivity tools (such as self-monitoring software (Meyer, Murphy, Zimmermann, & Fritz, 2017)) can be considered a mainstream workplace practice, activity-tracking technologies are not “key” to getting work done. However, as

the goal of using activity trackers is to increase physical activity every day, most people would be required to make some changes in their work life. For example, increasing something like steps demands restructuring of time; in the guise of walk'n'talk meetings or walking further to get coffee or water. In this way, activity tracking with its imperative to be more active, does potentially influence work practices. It was with this in mind that I conducted the observational studies in a Danish workplace participating in a step-counting campaign. I made sure to also observe the working environment before the campaign began as well as during and after, as this takes into account how a person's working day might change. Indeed, I found in my empirical research that activity tracking did influence work practices. For example, participants in the step-counting campaign (described in paper 2), changed meetings into walk'n'talk meetings in order to increase step counts. They made such changes and talked so much about the campaign that at times employees who did not participate felt left out. Some of this talk about the steps centered around how to understand the numbers from the devices and how to compare performances between colleagues, how to log-in to the system and how to gather their teams. Equipped with the concepts of articulation work and the social-technical gap, I begin to critically engage with these practices.

2.1.1. Articulation work and the social-technical gap

CSCW literature guided me to consider the articulation work emerging with the introduction of activity trackers. Miller et al. had already shown how teachers in a school-based step-counting program engaged in great amounts of articulation work, also referred to as "hidden work" (Miller & Mynatt, 2014). I therefore wondered how that might play out in the context of a workplace step-counting campaign and in other long-term activity-tracking programs. In the context of the short-term step-counting campaign in Denmark, I found that employees negotiated what actually constitutes a step, as well as when to ask team-members to walk more steps and when to back off (paper 2). While on the surface, the step-counting campaign seemed to run smoothly, with a majority of employees in the department participating in the campaign, a CSCW perspective provided me with a lens to consider the more underlying, yet pivotal, hidden work and negotiations among employees.

In CSCW literature, the concept of articulation work is fundamental for making work processes "work". Incentives are used to promote activity tracking (either positively backed by the company or with financial incentives), but not as part of formal requirements. Thus, activity tracking takes place on top of everything else the employee is required to do. Yet I find that articulation work still

occurs in the context of a step-counting campaign. My empirical work also reveals that the negotiations between colleagues involve more than simply making the step-counting campaign run smoothly. While articulation work is still valid, I suggest that steps are socially negotiated quantities, and show how colleagues strive to be perceived as moral and fair participants in the campaign (paper 2).

Another key concept in CSCW literature is that of the social-technical gap. This is the gap between “*what we know we must support socially and what we can support technically*” (Ackerman, 2000). Thus, research in the space of CSCW considers both the social demands of a certain system and the technical feasibilities of the system. From this perspective, I consider the technical systems, those of the trackers and the reporting systems, as well as the experiences of the employees. This approach has shaped my research to the extent that I have investigated challenges and benefits as experienced by employees, but also interviewed and surveyed program managers to get better insights into the details and aims of the programs. By doing so, I show how the health and wellness program managers were already aware that there is often a discrepancy between what the tracking systems can offer and what some employees want from them (paper 3).

In my study of activity tracking in everyday life, I show how the social-technical gap is also prevalent here (paper 5). Participants were motivated by tracking, yet most often, the systems are built to be used continuously and rigorously, which does not accommodate the complexities and shifting demands of everyday life. In paper 5, I introduce the theoretical concept of episodic use, which shows how participants engaged in substantial amounts of work to make their devices truly of value in their everyday lives as a way to care for themselves. Rather than pointing out how this gap exists, research should aim to better understand this gap and work to “*ameliorate the effects of the gap*” (Ackerman, 2000). Thus, I proceed beyond just identifying this gap and discuss the consequences of perceiving episodic use as a feature, not a bug, of activity-tracking practices (paper 5).

2.2. The self in self-tracking

As mentioned previously, activity tracking falls under the umbrella term of self-tracking (see key terms, section 1.3). In this section, I discuss the “self” in “self-tracking”. I ask who, or what, this “self” is, and identify the associated consequences. The answers to these questions have guided my approach to this research area.

2.2.1. The self as contingent and culturally specific

A discussion of a “self” alludes to a bookcase of literature and has been the focus of many philosophers. A full review of this topic is not the aim of this PhD. The point of relevance here is that how the self is understood, influences the affordances humans are believed to have, and in turn, how I can study self-tracking.

The “self”, in the same way as “love” or “health”, is a term that we use in everyday language, but is challenging to define. In part, because these words mean different things to different people. The anthropologist Geert, suggested that in western cultures, the self is viewed in very particular ways. Over time, we have become accustomed to thinking about ourselves as a bounded entity, as naturally unique with an *“inner life of the psyche”* (Rose, 1998). Rose argues that the self is a much more *“culturally relative notion than it purports to be, dependent on a whole complex of other cultural beliefs, values and forms of life”* (Rose, 1998). This becomes clear when one investigates other cultures and sees how the understandings contrast with one’s own. The main point here is that the self is understood to influence the affordances humans are believed to have. In other words, for example, if the self is understood as a rational entity, then informing about unhealthy behaviors (i.e. smoking) will lead that person to change towards healthier behavior (quit smoking). However, if the self is seen as irrational and purely controlled by seeking pleasure, then rational information about side-effects will have little influence on smoking cessation.

2.2.2. Lived experiences

Self-tracking technologies are most often modelled around a certain way of seeing individual behavior and behavior change. From this view, self-tracking is a process by which the individual tracks a certain behavior, gains information and perhaps suggestions on how to change this behavior, and then proceeds to change it. Tracking devices are therefore modelled around the idea of a rationally acting and autonomous “self” (Cosley, Churchill, Forlizzi, & Munson, 2017). Mol asserts that this is one of the great clichés of “the west” (Mol, 2008). We are not autonomous

islands, we rely on each other: as babies we need others to survive, as adults we need others to thrive. Furthermore, our ability to change behavior is largely facilitated or hindered by structures beyond our reach (access to healthy food, walking paths, etc.) (see section 2.3). Critical studies have thus discussed adversarial outcomes of self-tracking, both at societal and individual level. The solution proposed by some researchers in this field is a *“refusal of data - a refusal to track the body, a refusal to subordinate the qualitative to the quantitative”* (Moore & Robinson, 2015). These objections are often concerned with the self-improvement paradigm underlying many self-tracking technologies, i.e. the “self” is viewed as something that should continuously strive to improve, where “improve” is a predefined size (be fitter, more active, lose weight, etc.). Yet, current research in the field of personal informatics has asserted a need for considering self-tracking beyond the self-improvement paradigm, and researchers are beginning to investigate what form this may take. For example, as an introduction to a recent special issue on personal informatics shows, researchers are calling for *“deeper reflection of this ‘self’ that is being improved, maintained, cared for, and reflected upon, positioning the self as embedded in both time and in social relations”* (Cosley et al., 2017; Rapp & Tirassa, 2017). As a way to engage with this call, I have used a variety of qualitative methods, spanning from observations and interviews to surveys and participant-driven photo elicitation. Theoretically, I interpret the framework of logics of choice and logic of care, as developed by Mol, to consider the findings of my empirical work (Mol, 2008). This is discussed in more depth in paper 5. With this framework, I question the underlying assumptions of the self that shape technologies and practices in this field, and the disparity between the way many of my participants use their devices.

In this dissertation, I investigate experiences of the introduction of activity tracking in everyday life and at work. I ask individuals about their choices and experiences, which indicates a positioning of my study participants as autonomous and as possessing agency. However, I also include empirical work, conducting fieldwork in offices and homes, in order to understand social processes and structures. In this way, I engage with self-tracking by asking individuals about their experiences, yet I also align with research that acknowledges social and structural premises of lived life. I address self-tracking as a lived experience, acknowledging the critiques that have been put forward. However, based on the studies in this dissertation, like others in this field (Nafus & Sherman, 2014; Neff & Nafus, 2016), I maintain that activity trackers are in some cases used in personally meaningful ways. Such a broad call to renounce tracking is not necessarily the best way forward as

it would overlook potentially positive experiences of tracking. In this dissertation, I suggest that investigating lived experiences alongside structures and social processes may help us to understand tracking technologies from a perspective that can guide development of these technologies and their implementation in, for example, workplace health and wellness programs without renouncing the idea of tracking.

2.3. Health: A social ecological model

Activity tracking, with its focus on physical activity, is inextricably linked with notions of “health”. The way we perceive health dictates the way it can be improved, and the way health promotion initiatives and health technologies are designed. Thus, the way we define and perceive health holds great consequences (Tones & Green, 2004).

One prevailing definition of health is as the absence of disease. With this definition, the focus of health promoting initiatives will be to treat illnesses, so that people can return to good health. The definition of health as the absence of disease is referred to as a deficit model of health (Tones & Green, 2004). The deficit model of health is often linked to biomedical research and therefore tends to suggest medical solutions to support health (Stokols, 1996). This definition of health, however, is criticized from many perspectives. First, it does not acknowledge that an individual may be physically “well” but might not feel healthy. Likewise, some patients may technically have a diagnosis, but feel that they are, in fact, healthy. Second, a deficit model of health tends to place responsibilities for health on the shoulders of the individual, negating the influences of the environment, social status, and psycho-social aspects that all play parts in individuals’ health status (Tones & Green, 2004). Acknowledging the role that these environmental elements play, changes the view of how to improve health. It is not, in this way, possible for an individual to control and influence all aspects of health. Instead, it is up to the state and other large organizations to create conditions that positively influence the determinants of health.

The World Health organization has presented a different definition, asserting that health is: “*a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity*” (Saracci, 1997). Although unlike the deficit model, this definition includes psychological and social aspects, it has been widely criticized for not being easily operational, as it too closely resembles a definition of happiness (Saracci, 1997). Any factor that influences happiness: “*however minimal, may come to be seen as a health problem*” (Saracci, 1997). Nonetheless, this broader definition of health prompted an interest in health promotion and consequently interest in preventing illnesses as well as promoting health more broadly grew, including a focus on mental and social wellbeing (Stokols, 1996).

2.3.1. Strategies of health promotion

A deficit model of health often highlights behavioral change strategies, which focus on single factors that are known to cause illnesses (smoking, sedentary lifestyle, unhealthy eating). These strategies are influenced by different theories of social influences; cognitive changes, affective changes and behavioral modification (Stokols, 1996). However, *“persons’ efforts to modify their own health practices are often impeded by economic, social and cultural constraints”* (Stokols, 1996). A different strategy for health promotion is that of environmental change, more often applied when the definition of health aligns with the very broad health definition proposed by WHO. Stokols argues that improving overall health levels by targeting environmental structures, such as providing paths to encourage walking, are powerful in that they have the potential to reach a large group of users. However, the limitations of environmental change strategies are that they also tend to focus on single aspects, and that these easily ignore individual or group preferences (Stokols, 1996). Taking a starting point in the WHO definition of health, but seeking to make it operationalizable, the social ecological model of health introduces a framework that presents a view of health promotion that includes both behavioral and environmental levels, as well as tools for analyzing initiatives that are developed to support both levels.

2.3.2. Social ecological model of health

Many initiatives to improve health focus either on a behavioral level (for example urging people to stop smoking by use of smoking cessation classes or hotlines) or on an environmental level (raising tobacco prices). Behavioral-level initiatives that center on the individual are most common in HCI research (Baumer et al., 2012), following such models as the health belief model or the theory of planned behavior. These models place the responsibility for health change on the shoulders of the individual (Maitland, 2011). In opposition to this, social ecology is a framework for *“understanding the diverse personal and environmental factors in human health and illness”* (Stokols, 1996). Working within the framework of the social ecological model means acknowledging that working at both behavioral and environmental levels is pivotal.

An important part of the social ecological model is to involve both passive and active elements in each initiative. Environmentally focused initiatives often include only passive elements, such as improving food quality in workplace canteens. On the other hand, individually oriented behavioral change initiatives tend to highlight active elements, which could include the promotion of calorie counting by use of an app or weight-loss program. Because the framework of social ecology

assumes that health is influenced by a variety of factors, initiatives that include both active and passive elements while also targeting both levels of influence (behavioral and environmental) are more likely to have successful outcomes (Stokols, Pelletier, & Fielding, 1996). Moreover, the social ecological framework emphasizes the diversity of reasons for using or not using technology, thus making it imperative to consider non-use in any technology-based intervention or health promotion initiative.

The social ecology model relies on a definition of health that sees the key determinants for health and illness as the “*degree of fit between people’s biological, behavioural, and sociocultural needs and the environmental resources available to them*” (Stokols, 1996). With this as a chosen framework, this dissertation joins a recent stream of literature emphasizing a need to take into consideration the broader contexts of health (Maitland, 2011), and go “*beyond health behavior change*” (Schraefel & Churchill, 2014). Maitland highlights how the shift from health behavior change to a health promotion paradigm is developing, noting that more research is needed (Maitland, 2011). Stokols argues that when health is viewed from a social ecological perspective, it would not make much sense to rely on unidisciplinary theories and methods (Stokols et al., 1996). HCI research also often spans multiple fields and methods. Thus, adopting a social ecological framework in HCI health literature could help move such broader initiatives forward. In the following section, I briefly review the cross section of digital technologies (from the HCI perspective) and health promotion.

2.3.3. Health promotion in a digital space/age

Although a proliferation of technologies has been seen in recent years that seek to improve health via means of self-tracking, and health promotion literature directly encourages working with many different methods, the exchange between these two spheres is lacking. This creates two main problems.

First, the field of health promotion could gain crucial insights into how technologies are implemented and used in everyday lives by drawing upon research from HCI (Lupton, 2014). Second, the development of health-oriented technologies largely ignores the insights and developments in health promotion, at best not leading to any long-lasting results, at worst leading to accusations of victim-blaming and individual-based initiatives that have repeatedly proved to be

less efficient. Schraefel and Churchill have pointed out that digital technologies and computer science developments must consider the “*environment and ethos*” of individuals (Schraefel & Churchill, 2014). I see this as an opening towards what a social ecological framework has supported for years; that broad, holistic health cannot be improved without considering both behavioral and individual levels. In this dissertation, I take a closer look at activity-tracking technologies, as implemented across workplaces and at home. Rather than evaluating the implementation of these technologies based on individual levels alone, with a social ecological framework it is pivotal to consider a wider range of factors. As such, I consider the broader context of use by conducting fieldwork in offices and in-home interviews, also including participants who have actively chosen not to use activity trackers.

2.4. Surveillance

In my area of research, the subject of surveillance inevitably arises. For many, whether or not they have a professional or academic interest in the field of activity tracking, the process of tracking bodily movement at such a detailed level as is now made possible by activity trackers is alarming. This phenomenon leads to feeling surveilled and prompts concerns of potentially negative outcomes of surveillance. Here, I first draw on the work of surveillance theorist Gilliom to define surveillance in the context of activity tracking and show how this definition guides my research approach. I then consider three levels of surveillance that activity tracking allows for (technology company → user, employer → employee, peer ↔ peer), and use these to delimit my area of research to considering only the latter two.

Surveillance practices are part of our society, with a vast majority of our behavior captured and stored in databases as we go about our everyday lives. To Gilliom:

“The very idea of “surveillance” – roughly translated as watching from above – implies that the observer is in a position of dominance over the observed (...) surveillance is not a mere glance exchanged between equals – it is both an expression and instrument of power”

(Gilliom, 2001, p. 3).

With this, Gilliom takes a strong stand on a definition of surveillance as inherently unequal and about expressions and experiences of power. This does not mean that surveillance is inherently bad or negative, but rather that surveillance is inevitably linked to notions of power. Surveillance, in many shapes and forms, is part of our society today and it makes little sense to simply argue that surveillance should not take place. As other surveillance scholars have argued, constructive engagement and critique is vital, otherwise *“we run the risk of forgetting the actual challenges we are facing”* (Albrechtslund, 2016, p. 18).

In the area of activity tracking, I discover at least three different levels or areas of surveillance that activity tracking allows for: technology companies that build the activity trackers can surveil the device users, employers can surveil employees when activity trackers are introduced in the workplace, and finally peer-to-peer surveillance is enabled among colleagues in a step-counting campaign, for example.

2.4.1. Three levels of surveillance allowed for by activity tracking

Activity tracking technology company → User
Employer → Employee
Peer ↔ Peer

First, the data collected by the companies that develop the tracking hardware and software (i.e. Fitbit, Garmin, Apple, etc.) can be used to benefit or constrain the individual user. Wearing an activity tracker makes the user a “*treasure trove of information for advertisers*” (Chang, 2016) with information on location, habits, and bodily measures streaming off their bodies and into the vast datasets of the tech-companies and beyond. In this context, companies act as data brokers, and hold the power to use this data as they please or potentially sell self-tracked data to other companies (Lupton, 2015). The ultimate goal here, critics argue, is to use data to profile users, potentially connecting tracking data to other data streams, such as which web-browsing tools are used and online purchases. Such profiles can be used to further personalize advertisements, but also to evaluate credit scores or even to determine whether a certain person should be hired for a certain position (E.H., 2013). Till suggests that because self-trackers produce data that is then monetized by data brokers, self-tracking should rightly be seen as a type of unpaid labor (Till, 2014). What is actually going on is opaque to the user of the self-tracking devices, and critics assert that objections to these practices are impossible (Nissenbaum & Patterson, 2016). Overall, the important point related to surveillance here is that the technology companies have the *power* to use the information gained from the devices in ways that could be used for both good and bad.

Second, concerns regarding surveillance are voiced when activity tracking is introduced in settings with direct power hierarchies such as in the workplace. An employer holds the power to hire or fire people, and a main concern in this area is the extent to which activity-tracking data may play a role in this. Critics are alarmed with developments, calling the introduction of activity trackers in health and wellness programs in workplaces a “*heightened Taylorist influence on precarious working bodies within neoliberal workplaces*” (Moore & Robinson, 2015). A much-used metaphor, both in relation to the technology companies and employers, is that of the panopticon developed by Foucault to describe developments in surveillance mechanisms (Foucault, 1977). The panopticon is

an architectural structure in which a guard stands in the middle of a prison building and is able to see all prisoners, but they cannot see when they are being watched. Not knowing when they are being watched, they thus adhere to the prison rules at all times to avoid repercussions. Foucault applied this metaphor to describe the controlling mechanism in society whereby citizens internalize articulated behavioral norms. However, as we have argued in a workshop paper, setting up a structure is not the same as determining the outcome (Shklovski & Gorm, 2016). The panopticon metaphor can thus be criticized for not granting individuals any agency to fight back. For example, research on members of the Quantified Self movement argues that QSers engage in what can be called soft resistance. Rather than simply adhering to the general health advice, QSers critically engage with this advice and consider what works for them and what does not (Nafus & Sherman, 2014).

Beyond these two levels of surveillance, I find that there is also a third level made possible by activity-tracking technologies, namely peer-to-peer surveillance. Results of activity tracking, such as how many kilometers and how fast one ran the distance, may be shared in direct communication with friends and family, or shared with other members of social media platforms. Sometimes this is linked by GPS location or other details. In a recent example, users of a biking app shared their location with others on the app, yet this information was picked up by thieves who were able to deduce that fast speed often means fast bikes, which equals expensive bikes (Friis Jensen, 2017). Instead of going from house to house, breaking into random sheds, they were able to hand-pick bikes. This is an example of lateral surveillance, a term used to describe the development of how tools that were previously in the hands of governments or intelligence services (such as GPS) become commonplace amongst civilians (Andrejevic, 2006). Users of activity-tracking devices can quite precisely pinpoint the location, activity levels and daily routines of other users who share these details via for example leaderboards on the social platforms provided by the tracking companies and are thus examples of lateral surveillance. As Shklovski et al. have argued *“technologies do not enter into power-neutral spaces”* (Shklovski & Vertesi, 2009), and it is thus important to consider the contexts and pre-existing power dynamics in place where activity-tracking technologies are adopted.

As the sections above show, data created by activity trackers travel far and have potentially unforeseen uses and consequences. The above-listed differentiation between areas of surveillance

arising with the uptake of activity trackers is at once informative and misleading. I use this division to think through some of the developments in the area, but note that the different types of surveillance may occur simultaneously and are not easily disentangled. For example, introducing activity tracking in the workplace cuts across all three areas: data from the activity trackers can be used by the technology company, the employer and colleagues. Nevertheless, I use this differentiation to note that research in the area of data brokering, and what happens with activity-tracking data at this level, is an important area to investigate, yet extends beyond the scope of this dissertation. More precisely, then, this dissertation engages with what happens when devices are introduced in everyday life, especially in workplace settings. Furthermore, following an understanding of surveillance as inherently unequal yet complex, I cannot make blanket statements of what this introduction means. Rather, I must investigate the particulars of the situation at hand. In the following, I discuss how I do so by analyzing shifts in accountabilities.

2.4.2. Considering accountabilities rather than beneficial or adversarial outcomes

Discussions of surveillance often end up debating whether the increased surveillance is beneficial or adversarial to the individual or groups being surveilled. However, this type of “impact” discussion is positivist by nature, overlooking how users negotiate and interpret technologies. Context-specific negotiations make it impossible to define exactly how technologies, such as activity trackers, impact on workplaces. As Zureik argues, *“In the case of technolog the social reality is quite complex. Very different technologies are brought into very different social settings for very different reasons, often with completely opposing effects...”* (Zureik, 2003). The question then evolves into how we can investigate or understand what happens as technologies are introduced in specific contexts, though clearly there are no clear-cut answers. Zureik underlines the need to go beyond questioning the “impact” of the technology by also considering affordances – that is, the possible actions the technology allows for (Zureik, 2003). In my research, I have proceeded beyond discussing impacts of activity-tracking technologies by considering the negotiations my participants engage in and the resulting potential shifts in accountabilities. For example, quantification of steps makes it seemingly easier to compare activity levels to those of co-workers’. However, as I found in the workplace observation study, this comparison is not easily made (paper 2). Trackers do not measure in the same way, and other activities such as gardening or yoga could be “translated” into steps using an online step-converter on the campaign web-site. Employees would ask each other how certain step-counts were reached, and they counted on each other to walk as much as had been

agreed in the teams. Some employees immediately welcomed the step-counting competition, while also finding it strenuous in the long run. These are but some of the experiences and negotiations of accountabilities I encountered. However, this shows that considering accountabilities enables a view of the introduction of activity trackers as not *a priori* good or bad, as not having a clear-cut “impact”, but as technologies that at once constrain and enable certain behaviors.

In this chapter I have considered the theoretical positioning of my dissertation at more length than is allowed for by the limited paper format. I have presented and discussed how I draw on key concepts from CSCW literature, and how this stream of research has sensitized me to considering subtle negotiations between colleagues in work processes. I have also discussed how self-tracking technologies are often built around a particular perception of a rationally acting and autonomous individual. In alignment with other researchers, I position the self as “*embedded in both time and in social relations*” (Cosley et al., 2017; Rapp & Tirassa, 2017). This has shaped both my investigative choices and research process, pushing me to consider the broader social and material environments of my study participants. Drawing on a social-ecological theoretical framework this dissertation defines health as more than the absence of disease (deficit model of health), prompting me to look beyond whether the activity trackers motivate users to engage in more physical activity. Finally, studying activity tracking provokes questions of surveillance. I go beyond discussions of whether activity trackers are “good or bad”, and rather, consider the accountabilities and affordances that arise in each specific case.

3. Grounded Theory

In this section, I present Grounded Theory (GT) and discuss a constructivist development as the specific approach underpinning the methodological choices and process of the empirical studies in this dissertation. I discuss the role of the literature review, as literature reviews are not a part of traditional Grounded Theory. I then present the empirical studies and the coding process, before discussing my role as a researcher in this project.

Grounded Theory arose in the 1960s in opposition to dominant quantitative, positivistic scientific approaches of sociology and science (Bryant & Charmaz, 2007; Howard-Payne, 2016). The two founding authors, Barney Glaser and Anselm Strauss, emphasized how Grounded Theory worked to develop new theories from data, and how researchers should enter the field without predetermined theoretical frameworks or hypotheses (Thornberg, 2012). This was in clear opposition to much scientific work at the time, where research was mainly conducted to support existing theories (Bryant & Charmaz, 2007). In this dissertation, I set out to explore lived experiences involving activity tracking in workplaces and at home, without seeking to test hypotheses developed in advance. Grounded Theory therefore provides an apt framework for this research.

Since its origins in the 1960s, Grounded Theory has developed in several directions. These can be roughly divided into three separate schools (Bryant & Charmaz, 2007): first, the so-called Glasserian Grounded Theory, also sometimes referred to as “classic” GT. Second, the developments by Strauss, who later teamed up with Corbin, are often referred to as the Straussian school. Finally, a third approach is the constructivist approach, such as the one developed by Charmaz (Thornberg, 2012). However, these different schools of Grounded Theory share a focus on abductive inference (2014, Muller): “*The logic of abduction is to find a surprising phenomenon, and then to try to explain it*” (Muller, 2014). The approach relies on researchers making choices about data collection throughout, letting initial data collection guide the next step, which is also referred to as theoretical sampling (Kenny & Fourie, 2015). For example, as I had conducted observational studies in a Danish workplace participating in a step-counting campaign, this prompted questions of how that might be similar to or different from more long-term tracking campaigns. Thus, I proceeded to study employees and health program managers in a US workplace, where some had experiences with long-term activity-tracking programs. Ideally, theoretical sampling is conducted until a point of *saturation*, when “*no new data are emerging*” (Kenny &

Fourie, 2015). In each of the empirical studies, I conducted interviews or observational studies until I experienced this sense of *saturation*.

Beyond these basic areas of agreement, the different schools of Grounded Theory Method (GTM) have different stances on various important points, one of which is the role of conducting a literature review.

3.1. The role of reviewing literature

One stark difference between the schools of Grounded Theory involves the role of reviewing pre-existing literature and theory. In the “classical” GTM, Glaser maintains that the researcher should enter the field without considering existing literature. This, he claims, assures that the researcher is not contaminated by preconceived notions but remains open to the phenomenon being studied. In my PhD process, I have aligned with the constructivist Grounded Theory approach, and have consequently considered existing literature to gain an understanding of how the phenomenon of activity tracking has been considered thus far. This alignment was prompted by both epistemological and pragmatic reasons. I align with researchers who believe that a *tabula rasa* is impossible, and thus it is better to try to lay bare the pre-existing knowledge on which the research builds, to the extent to which this is even possible. Furthermore, my initial interest in the datafication of health in broad terms led me to a wide range of sources, which ultimately drew me towards the phenomenon of activity tracking. By the time I decided to focus on activity tracking as the object of my research, I had already engaged with different strands of literature in the field (in the words of classical GT I was “contaminated”).

While conducting a literature review, I found that the qualitative studies conducted already focused mainly on developing new tracking tools or investigated self-tracking practices by using interview and survey methods. Although these methods provide interesting results, there were also limitations on the use of these methods. To address this, I expanded upon the methodological tools and developed an approach suitable for studying self-tracking technologies rooted in participant-driven photo-elicitation studies, as discussed in paper 5. The literature review also sensitized my approach to the material in a theoretical sense. This means that as I analyzed the material, I was able to ask myself to what degree the events that I observed were similar or different to those already presented

in literature. This revealed that *episodic use* was occurring in my empirical data that had not yet been explicitly covered in the literature thus far. Such processes underlined the abductive inference.

3.2. Data collection process

This dissertation is a paper-based dissertation, with the papers included in part 2. Each of these papers had to meet the strict and confined length limitations, ranging from 4-12 pages, of the various publication venues. As such, although I discuss methods in each of the separate papers, these are brief versions of the research process. The exception to this rule is paper 4, which focused exclusively on my application of photo elicitation as a method for studying self-tracking. Corbin and Strauss highlight how: “*A grounded theory publication should help the reader to assess some of the components of the actual research process on which it reports*” (Corbin & Strauss, 1990, p. 16). In the following section, I therefore report in more detail on how the empirical studies were conducted.

This dissertation is based on three separate, but related, empirical studies. First, I conducted an observational study in a Danish workplace participating in a step-counting campaign in the spring of 2015. Chronologically, the long-term participant-driven photo elicitation study was conducted following the observational study, namely in the fall of 2015. However, before presenting the empirical material, I have chosen to first discuss and explain the survey and interview study conducted in collaboration with Christina Chung from the University of Washington during spring and summer 2016. In this way, the dissertation first presents and discusses the two sets of empirical material directly related to activity tracking in workplace contexts, before turning to the results of the third empirical study, which steps away from the specific context of the workplace; the participant-driven photo elicitation study.

3.2.1. Visualization of empirical studies

Study 1:

Observational study of step-counting campaign in the workplace (Denmark)

Study 2:

Interview and survey study of American employees and program managers (US)

Study 3:

Participant driven photo elicitation study (Denmark)

Study 1: Observational studies of a step-counting campaign in the workplace (Denmark)

As my research began to focus on activity tracking being introduced in the workplace, I encountered the Tæl Skridt (Count Steps) campaign in Denmark, which was a prime example of this. However, establishing contact with a company that would allow me to conduct observational studies and interviews, essentially granting me access to the workplace to come and go as I pleased, proved difficult. I reached out to the campaign managers of the Tæl Skridt (Count Steps) campaign and received a list of companies they knew would participate in the campaign. Ultimately, it was with the support and contacts of a fellow PhD student, Christian Østergaard Madsen, that I finally found a workplace in which I could conduct the observational study. As someone the employees already trusted, Christian was able to explain to them that the aim of my study was not to criticize work processes or whatever they might imagine. Thus, in the spring of 2015, I participated in the daily life of one department for 12 workdays over the course of four weeks, including days before, during and after the campaign in order to gather as much insight as possible. I also conducted interviews with 9 employees from this department, consisting of both employees who had chosen to participate in the campaign, and some who had chosen not to.

Tæl Skridt (Count Steps) is a Danish, national bi-annual step-counting campaign, aimed at workplaces. Dansk Firmaidrætsforbund (Union of Danish Company sports, translated) organizes and administers the campaign. This Union develops a range of initiatives aimed at improving the

health of Danish employees, and focuses mainly on increasing physical activity levels. The Union is funded by “Danish Games”, which is obliged to donate profits to organizations and causes for the public good (Dansk Firmaidræts Forbund, 2018). The campaign managers of Tæl Skridt informed me that the campaign started in 2010-12, with participants being encouraged to register minutes of exercise. When pedometers gained popularity, this became the main element of the campaign, accompanied by a website. The participation level had risen from 10-12,000 participants to 20,000 by the time I conducted my study.

In order to introduce myself and present my project, I attended a department meeting, where I received a generally warm welcome. The employees were curious, and perhaps amused, that I wished to spend so much time with them “*just looking at our steps*”, as they said. Consequently, as employees introduced me to others in the department, I was referred to as “*the step-counting person*”. At the beginning of the study, observational studies were not easy to conduct at this workplace, as I was not part of any specific projects or work tasks. Consequently, something as basic as figuring out where to place myself was a challenge. However, as I continued to show an interest in their work and experiences, this became easier. By the end of the study, I almost felt like part of the department, and the employees would ask me if I had enjoyed my weekend, or where I had been if I was gone for a day. Often, employees would ask me to join them for coffee or sit with them at lunch and introduced me to other departments and told me how “*things worked*” in their company. Over time, these conversations became increasingly detailed.

The employees in this department were spread out across two open office spaces, and I was allowed to sit at unoccupied desks in either space whenever I wished. I soon discovered that one of the most important times to be present was early in the morning when everyone came in. The office would buzz with small talk, including chit-chat about activity tracking. Eventually, this chatter would subside, and people would sit down and continue their work. To gain the employees’ trust and confidence, I did not take any photos during this study, and also informed them of this. For my own sake, however, I sketched details of the office space and who was sitting where. At all times, I kept a notebook with me, where I would jot down observations and notes. On returning to a desk, I would write up notes straight away. By the end of the study, I experienced how employees would sometimes forget I was present, and I would be standing right next to them as they discussed quite personal matters or issues concerning other employees. A few times, I physically moved away, as I

wanted to show respect and did not want to be involved in these personal matters that were so clearly outside the scope of my project. In the spring of 2017, I returned and presented my study findings. Although this presentation was after working hours, a large group of the employees showed up and were interested in the outcome, commenting and asking questions. Two research papers in this dissertation are based on the observational studies and interviews from this workplace study:

Paper 2: Gorm, N., & Shklovski, I. (2016). Steps, Choices, and Moral Accounting: Observations from a Step-Counting Campaign in the Workplace. *CSCW'16*.

Paper 2A: Gorm, N., & Shklovski, I. (2016). Sharing Steps in the Workplace: Changing Privacy Concerns Over Time. *CHI'16*.

Study 2: Interview and survey study of American employees and health and wellness program managers (USA)

The observational nature of study 1 focused on activity-tracking practices as part of a short-term campaign. However, activity trackers are also included in more long-term projects that are especially prevalent in the US. In order to investigate how the introduction of activity-tracking technologies would play out in this particular context, I teamed up with Christina Chung, a PhD student from the University of Washington.

Until our study, no research had systematically mapped the different ways tracking is implemented in workplace health and a wellness program in the US, nor considered the experiences and opinions of the employees experiencing these implementations. First, we investigated the ways that activity trackers are introduced in US workplaces. As employees might not always know exactly why a workplace health and wellness program is designed as it is, we decided to interview health and wellness program managers working directly in this area. These participants ranged from employees in companies such as LimeAde (corporate wellness platform (LimeAde, 2018)), but also employees, often in HR departments, who had employee health management as one of their main tasks. With this background knowledge, we were better able to understand the situations of the employees, and the range of different ways they might be acquainted with activity trackers in their particular workplace. We decided to conduct a survey study as we wanted to understand a broad

range of experiences. We also conducted follow-up interviews in order to validate and further explore some of the survey findings. The study was therefore conducted in three phases:

Phase 1: In the first phase, we conducted exploratory interviews with three health and wellness program administrators and seven employee participants, all from different US companies. We enquired about the details of their particular health and wellness programs, and asked open-ended questions about their opinions and experiences with these initiatives.

Phase 2: Based on the information from the interviews in phase 1, we developed a survey aimed at both health and wellness program administrators and employees. Fortunately, our exploratory interviews enabled us to ask more precise questions about the type of program offered at the respondent's company. The survey then explored experiences and opinions related to their specific program participation. We also actively sought out participants who had the opportunity to engage with activity trackers as part of their workplace health and wellness program, but who had declined to participate.

Phase 3: In the third phase of the study, we conducted follow-up interviews in order to investigate questions that had arisen from the material we had previously gathered. We conducted 11 follow-up interviews with both employees and health and wellness administrators. We analyzed the material as soon as we gathered it, and continued to include more until we reached a point of saturation, thus following the process of *theoretical sampling* (Charmaz, 2006).

Paper 4: Chung, C., Gorm, N., Shklovski, I., & Munson, S. (2017). Finding the Right Fit: Understanding Health Tracking in Workplace Wellness Programs. CHI'17. (*Honorable mention award*)

Study 3: Long-term self-tracking study using participant-driven photo elicitation method (Denmark)

In my first empirical study, I gained insights into how activity tracking might play out in an organizational setting. However, as I had limited material for comparison purposes, I could not decipher which parts of usage to attribute to personal use, and which elements were influenced by the strict campaign set-up. I found it beneficial to develop a study that could provide the material

and kinds of insights against which the first empirical data set could be contrasted and compared. However, studying activity trackers in practice presents a range of challenges. Trackers are built to be largely interwoven in everyday practices, and interaction with devices could occur while participants are in bed (checking sleep statistics), or out walking (counting steps), which makes observational studies difficult. I also wanted to conduct a study that investigated activity tracking with more than interviews, which is the basis of most studies in this area. I therefore designed the project based on the tradition of photo-elicitation methods by asking participants to take photos of what they found relevant in relation to using their activity trackers.

The participant driven photo-elicitation study was conducted from August 2015 to February 2016. Participants were recruited by posting a call for participants in a variety of Facebook groups, and by snowball sampling. Out of 64 interested participants, I combined a list of 25 participants. I compiled a list of participants from three big cities in Denmark (Copenhagen, Odense, Aarhus), as well as rural areas on Zealand, Funen and in areas of Jutland in Denmark.

In order to gain a broad perspective on use experiences, I recruited participants with varied use patterns. The nine participants who had little or no experience with activity tracking were given a choice between a Fitbit Flex (armband) and Fitbit One (clip on). Of the remaining 16 participants, eight had some experience with activity tracking, and eight had tracked for at least four months prior to the study. Initial interviews were conducted in August and September 2015, and where possible, in the homes of the participants. New participants received their trackers, and all participants were introduced to the study set-up. In the following 5 months, participants sent photos of their use (or non-use) of the devices. In total, 313 photos, (median of 8, ranging from 4-125 photos per participant) were sent throughout the course of the study. These photos were printed out and presented to the participants in the follow-up interview, conducted as close to 5 months after the start of the study as possible. Again, whenever possible, interviews were conducted in the homes of the participants.

Paper 4: Gorm, N., & Shklovski, I. (2017). Participant-Driven Photo Elicitation for Understanding Episodic Activity Tracking: Benefits and Limitations. *CSCW2017*.

Paper 5: Gorm, N. & Shklovski, I. (2018). Episodic Use: Practices of Care in Self-Tracking. *Submitted to New Media & Society*. [Revise and resubmit]

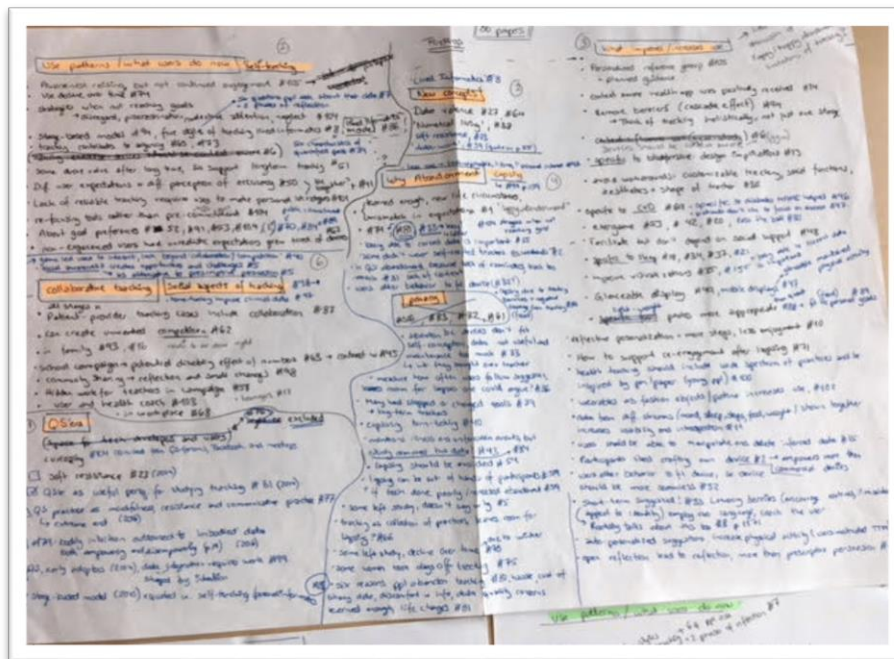
3.3. Coding processes

The approach to coding the empirical data is a point of contention between various schools of GT. Charmaz works with two stages of coding: first initial and open coding, followed by a focused coding process (Charmaz, 2006). This differs from the other two GT approaches in that this is not a prescriptive approach (Kenny & Fourie, 2015). Thus, Charmaz' view on how to proceed with coding is more flexible and interpretivist than classical and Straussian GT (Kenny & Fourie, 2015).

For each of the papers presented in this dissertation, I have conducted initial, open coding followed by focused coding. Often the process alternated between these two phases. Furthermore, the different material on which the papers are based called for slightly different coding processes. In the following, I briefly present the coding process for each of the papers.

Paper 1: Gorm, N., Chung, C., Shklovski, I., & Munson, S. (2018). Literature Review: 10 Years of Qualitative Self-Tracking Studies. (Submitted)

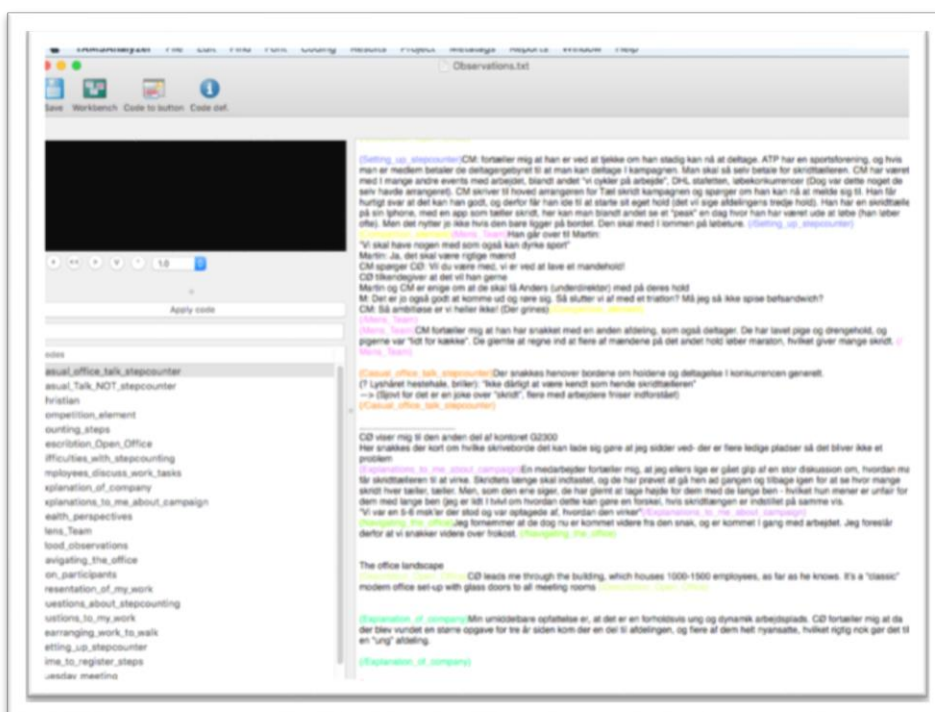
In order to make collaborative coding possible, we used the online coding software SaturateApp.Com. Upon initial open coding of all papers, we proceeded to discuss how some codes would fit into broader categories or not (focused coding). We also worked with handwritten "maps", which we used to compare and contrast emerging categories. After many Skype meetings, drafts and revisits to codes, we settled on the findings presented in the review.



*Screenshot 1:
Map of emerging
categories in literature
review*

Paper 2: Gorm, N. & Shklovski, I. (2016). Steps, Choices, and Moral Accounting: Observations from a Step-Counting Campaign in the Workplace. *CSCW '16*.

For this paper, I imported all empirical material, both interview transcripts and observational notes, in the coding software TAMS (Weinstein, n.d.). I conducted line-by-line open coding of all material and then proceeded to compare and discuss codes, gathering them in overarching categories (focused coding). I then exported all the codes included in a category and wrote summaries and notes for each, discussing these with Irina Shklovski as they emerged. Some examples of initial codes were “difficulties with step counting”, “casual office talk step-counter”, “time to register steps”, which I later gathered in an overarching category of “social negotiations of steps”.



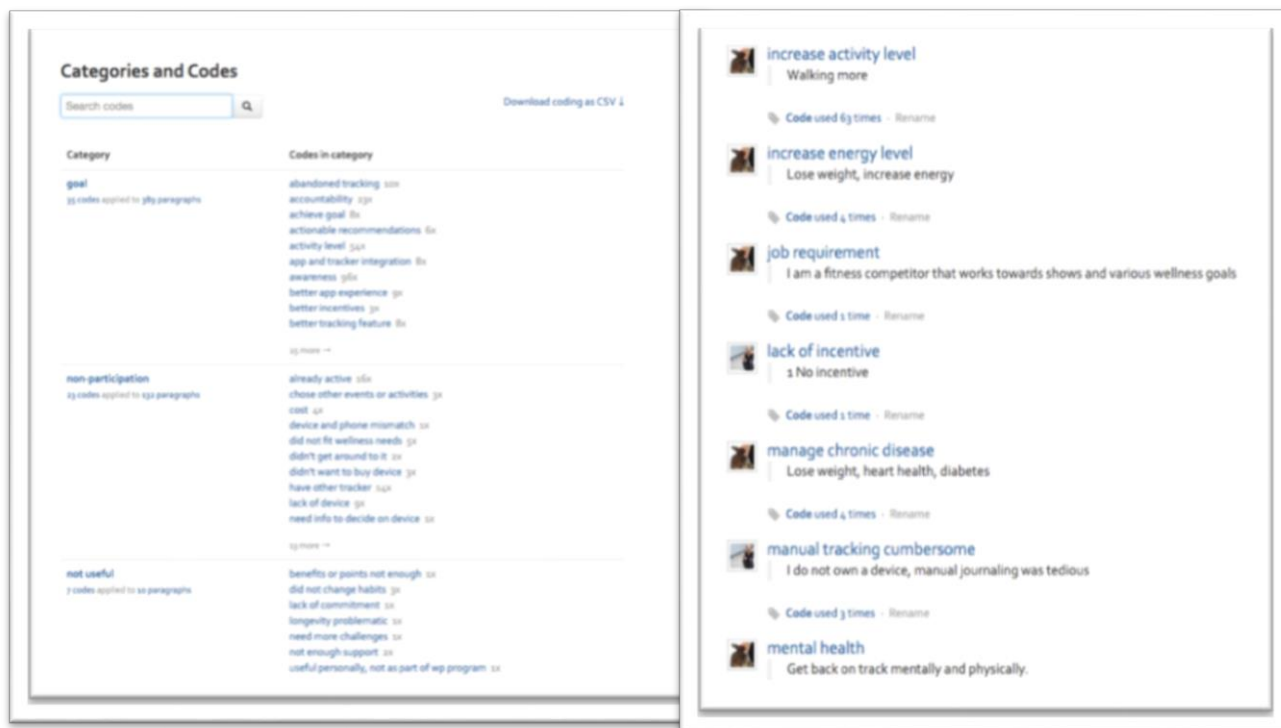
Screenshot 2: Snapshot from coding of workplace step-counting campaign material (blurred text as it contains participant names)

Paper 2A: Gorm, N. & Shklovski, I. (2016). Sharing Steps in the Workplace: Changing Privacy Concerns Over Time. *CHI'16*.

Paper 2 does not explicitly deal with concerns of privacy, yet this issue was often raised by other researchers whenever I presented my area of research. I thus revisited the empirical material, paying special attention to any conversations or observations related to privacy. In this way, for this paper, the initial open coding had already been conducted, and I was able to produce focused coding to engage with the question I had in mind.

Paper 3: Chung, C., Gorm, N., Shklovski, I. & Munson, S. (2017). Finding the Right Fit: Understanding Health Tracking in Workplace Wellness Programs. *CHI'17*.

For this paper, Christina Chung and I conducted initial open coding together at the University of Washington and proceeded with focused coding using SaturateApp.Com. Emerging categories were discussed during frequent Skype calls with all authors.



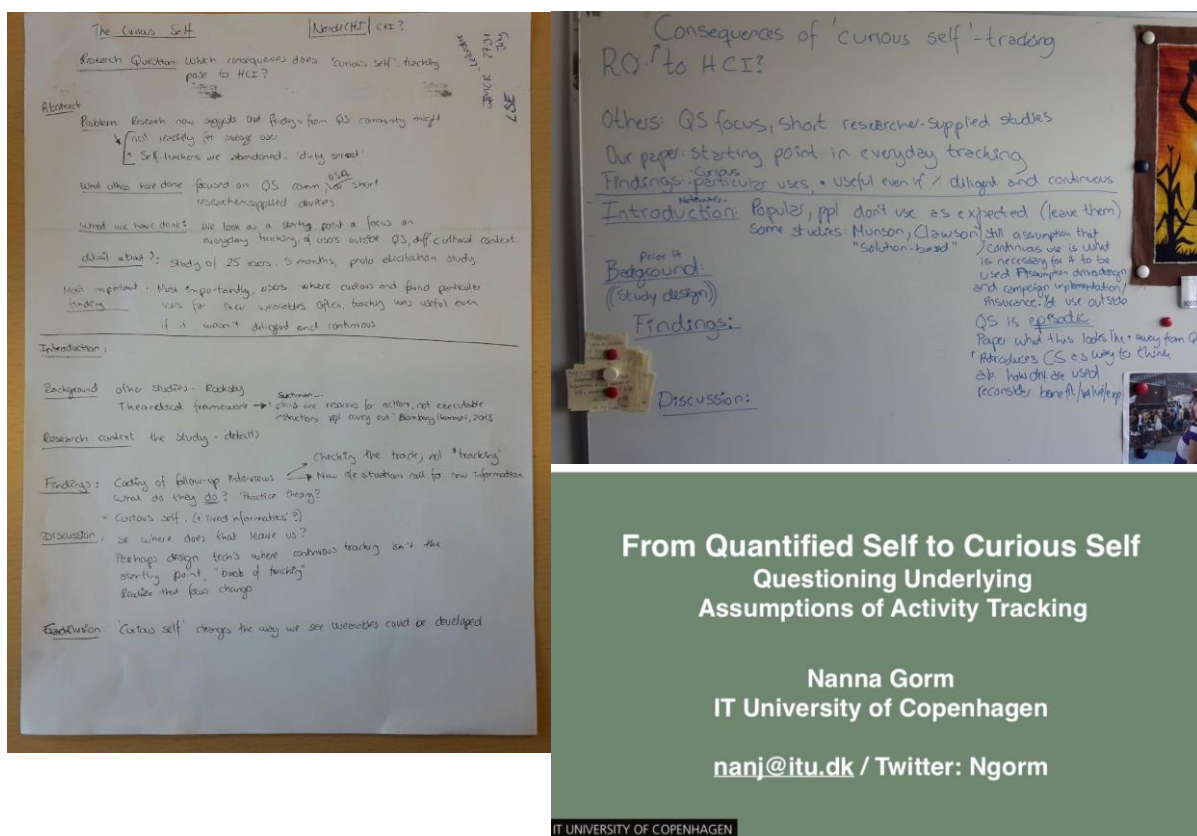
Screenshot 3: Categories, codes and coding process from paper 3, SaturateApp.Com

Paper 4: Gorm, N. & Shklovski, I. (2017). Participant-Driven Photo Elicitation for Understanding Episodic Activity Tracking: Benefits and Limitations. *CSCW'17*.

I started analyzing the first round of interviews before proceeding with the second round of interviews. This allowed me to follow up on participants' experiences and expectations when I returned for the follow-up interview. All interviews in this study have been recorded and transcribed. As I coded interviews and e-mail material from this study, I noticed how many of the codes revolved around the experience of using photos as part of the research project. I decided to proceed with focusing on this aspect, which led me to write this particular paper. Thus, this is a good example of how I have let the coding process guide the writing process.

Paper 5: Gorm, N. & Shklovski, I. (2018). Episodic Use: Practices of Care in Self-Tracking. Submitted to *New Media & Society*. [Revise and resubmit]

For this paper, I once again imported all the empirical material from the photo-elicitation study into the TAMS software. I started again by conducting open coding of the material, this time proceeding beyond experiences of participating in the study, as that had already been covered in paper 4. Throughout the process of writing this paper, I re-visited the categories and photo material many times, and many versions of this paper were produced accompanied by discussions with Irina Shklovski, before it was submitted. In previous versions, I worked with notions of “the curious self”, in trying to engage with the empirical material. I presented early versions of my data analysis at the 4S EASST conference in 2016, before settling on the final version of this paper in 2018.



Photos of notes, supervisor meetings, and conference presentations

3.4. The role of the researcher

As is clear from the previous two sections, a project following grounded theory methods is very much shaped by the researcher. While classical grounded theory strives for an objective observer (Howard-Payne, 2016), this is seen as impossible with a constructive stance. With this perspective: *“Data are co-constructed by researcher and participants, and colored by the researcher’s perspectives, values, privileges, positions, interactions, and geographical locations”* (Thornberg, 2012, p. 7). Looking at the analysis process from a grounded theory perspective, codes and categories do not just “appear” from the material, but are also shaped by the researcher (Charmaz, 2006). However, this does not mean that one can just adopt any approach. On the contrary, in order to evaluate a grounded theory research process, the researcher should clearly reveal what has been done, which I have sought to do in this chapter.

In the data collection phase, my presence as a researcher will have influenced the material I have collected. When I approached my participants, I always thoroughly considered how to present myself and my research interests, in order to present the area of the research but without being so specific that participants may have felt inclined to answer me in specific ways. This was not always easy. In study 1, the employees in the department had difficulty processing the fact that I *“just wanted to observe how the campaign happens”* and that they should just go about their day as if I were not there. I often experienced how participants would start talking about steps when I approached them, out of what I assumed was their eagerness to try and help me out with my research. As I was a part of the workplace for an extended period, this seemed to fade over time.

In study 2 in US workplaces, we had to very carefully consider our questions as phrased in the questionnaire. We framed questions in such a way that we aimed to receive experiences of both benefits and challenges, yet some people may not have wished to participate in the survey if they strongly disagreed with activity tracking being conducted in the workplace in the first place. Furthermore, we asked survey participants to consider sharing the questionnaire link with colleagues, something that may in and of itself have prompted conversations and reflections about activity tracking. Finally, in the third study, some participants acknowledged that they had, in fact, thought more about their activity-tracking experiences, or used their devices more, because they were part of my study.

Overall, the same studies conducted by a different researcher would have led to different interviews, observations, surveys and results. How should one then evaluate the studies I have conducted? Charmaz argues that a main criteria for the evaluation of grounded theory studies is that of credibility (Charmaz, 2006). In this chapter, I have discussed my familiarity with the topic, such that the reader can evaluate whether the gathered data is sufficient to merit the claims of the research papers. I have aimed to provide enough detail of the research projects, to enable the reader to assess the process and, hopefully, substantiate my claims.

4. Summary of findings

In this chapter, I restate the research questions posed in chapter 1 and answer them by summarizing key findings from the papers presented in part II. When reading this chapter, it may seem as if both research questions and answers have followed a straight and linear process and perhaps as if I had these questions ready at the beginning of the project. However, I hope the previous chapters have clarified that the studies were very much accumulative in structure i.e. built on top of each other, and that extensive messiness and the explorative nature of the studies and analytical process are concealed by an overview such as this. The aim of this chapter is to present an overview of main findings of the six papers included in part II to create the basis on which I will discuss future directions in the following, and final, chapter.

4.1. RQ1: What is state-of-the-art in qualitative studies of self-tracking practices?

Based on the analysis of 84 qualitative studies of self-tracking practices, I found that these papers can be divided into four different groups according to their main research goals. 38 papers deployed or tested new tracking tools or software. 30 papers investigated attitudes, behaviors and challenges experienced by users. 10 studies used ethnographic methods to understand use in particular settings, while 6 papers analyzed existing online material. Overall, this reveals a great focus on the development of new technologies, and less focus on uses in a broader variety of settings. As activity-tracking technologies are spreading to a greater variety of contexts, such as workplaces, it is becoming increasingly important to consider these contexts. Furthermore, longer studies of everyday experiences with activity tracking are called for. This dissertation therefore takes steps to consider both of these gaps in the literature.

The second part of the literature reviews and discusses the findings of the 84 included papers. The papers represent five different trends, two of which are particularly important in relation to this dissertation. A body of research considers the fact that users often abandon their tracking technologies sooner than expected. Overall, the tendency is to portray abandonment as a problem, one that can be fixed with the right technological solutions. In this dissertation, I go beyond this view and consider how abandonment can take the form of episodic use. This is achieved by users in a skillful way to manage the often many, and varied, claims on time and as such may constitute a way to care for the self. Bearing this in mind, episodic use is not a problem to be fixed but an inherent, and important, part of using activity trackers in caring ways.

In the literature review, I find that social aspects of activity tracking have started to gain some attention. Researchers now recognize that self-tracking is rarely just about the “self”, yet again a majority of the research considers how these perspectives can be used to improve the set-up of the technologies. In this dissertation research, I highlight the ways colleagues, but also users in the private settings of their own home, negotiate the use of activity trackers with those around them.

Paper 1: Gorm, N., Chung, C., Shklovski, I., & Munson, S. (2018). Literature Review: 10 Years of Qualitative Self-Tracking Studies. *(Submitted)*.

4.2. RQ2: What are the experiences of employees participating in a short-term, step-counting campaign?

Supported by the findings of the literature review (paper 1), I find that the introduction of activity-tracking technologies as part of health and wellness programs in the workplace has not, thus far, been empirically investigated. Based on an observational study of a Danish workplace participating in a step-counting campaign, I explore this gap in the literature by investigating employees’ experiences.

Several important findings arose from this observational study in a Danish workplace participating in a national step-counting campaign. First, participants in the campaign enter into social negotiations concerning the step counts and spend time and energy on ensuring that their numbers will be evaluated as fair to avoid any potential negative spill-over effect. This revealed that participation in the step-counting campaign allowed participants to bond over the shared experience of the step-counting competition, yet it was also a kind of social currency that demanded participants engage in moral accounting. The group competition set-up of this particular campaign thus resulted in new forms of intercollegiate accountabilities, which expanded beyond the workday and into the everyday lives of the participants. Joining the step-counting campaign created ways for participants to open up for conversations of non-work-related activities, which non-participants could not easily join. Finally, I argue that even though participants were relieved to leave their devices behind at the end of the campaign, and routines from during the campaign did not in any obvious way “stick”, this campaign can still be construed as a success if viewed from the perspective of the social ecological model.

Paper 2: Gorm, N. & Shklovski, I. (2016). Steps, Choices, and Moral Accounting: Observations from a Step-Counting Campaign in the Workplace. *CSCW '16*.

4.3. RQ2A: What are privacy concerns in the context of a step-counting campaign?

After concluding the observational study in the Danish workplace, I read a report on “The Wearable Future” from PricewaterhouseCoopers, which stated that consumers are now “*growing more comfortable*” with revealing personal information (PricewaterhouseCoopers, 2014). I found this problematic for several reasons; first, this view appeared to jar with what I had observed in the workplace. True, privacy and concerns of data security had not been the main conversation point throughout the campaign, but that did not mean participants and non-participants had not considered it. Secondly, I did not see a move towards “*growing more comfortable*”. I went back through all of the collected data; 12 days of observational study and 9 interviews with participants and non-participants. In this round of analysis, I paid special attention to any concerns or negotiations of privacy that participants and non-participants engaged in. The results of this analysis merited a paper on its own and covered ground that had not been considered in paper 2. The results of this analysis were included in a note-sized paper at CHI 2016. What became clear from revisiting my empirical material was that concerns arose as the campaign proceeded. For example, participants found out how seemingly “innocent” step-counts actually made it possible for colleagues to infer things about a co-participant’s behavior. In other words, participants learned that the steps were not necessarily harmless, in the sense that they did reveal aspects of their personal lives outside the workplace. At times, this created uncomfortable situations, which participants then had to deal with. As they had already agreed to participate for three weeks, it did not seem like an option to withdraw, as that would mean the team would not reach its goal. Instead, I observed renegotiations of boundaries between participants.

The analysis showed that participants’ expectations of the campaign and what that would bring with it were shaped by the positive rhetoric in promoting the campaign. However, as they discovered what steps could reveal about personal lives outside the workplace, they had no choice but to renegotiate their boundaries with colleagues. At this point, it was too late to change the conditions of disclosure. Returning to the report by PricewaterhouseCoopers (PricewaterhouseCoopers, 2014), I argue that participants might not initially expect or foresee any privacy-related concerns arising. However, as they experience the use of trackers, as for example in this workplace campaign, the concerns are handled *in situ* to accommodate the device. As stated in the paper title, privacy concerns change over time.

Paper 2A: Gorm, N., & Shklovski, I. (2016). Sharing Steps in the Workplace: Changing Privacy Concerns Over Time. *CHI’16*.

4.4. RQ3: How are activity-tracking tools adopted in more long-term health and wellness programs?

Activity trackers are now also introduced as part of health insurance programs in the US, often as part of more long-term initiatives. In order to investigate employee experiences with this type of program, I collaborated with Christina Chung and Sean Munson from the University of Washington.

The research presents an overview of the various ways in which activity tracking are introduced in US workplaces. This shows a variety of ways in which this is actually achieved, spanning from short-term campaigns to long-term more advanced programs with either virtual point systems or direct financial economic incentives.

The research followed three phases: initial exploratory interviews with health and wellness program administrators as well as employees in the programs, a survey sent to a broad group of participants (581 responses), and subsequent follow-up interviews with 11 of the survey participants, again including both wellness program administrators and employees.

The study revealed that more than half of the employees who had chosen to participate in workplace health and wellness programs found that the tracking programs supported them towards reaching their health goals. Having said that, the broad group of participants also expressed reservations and dissatisfaction with the activity-tracking parts of the health and wellness programs. For the employees who had chosen not to use activity tracking in the workplace, a main concern related to time commitment. Only a small group of these employees voiced concerns with regards to sharing health data with their employer. This might be because at this point, the program fit is of more immediate concern, companies were often transparent with regards to how the collected data is handled, and currently, health tracking data is not used in any systematic way besides calculating participant numbers and how they might improve.

Paper 3: Chung, C., Gorm, N., Shklovski, I., & Munson, S. (2017). Finding the Right Fit: Understanding Health Tracking in Workplace Wellness Programs. *CHI'17*.

4.5. RQ4: How can activity-tracking practices be studied as part of everyday life?

Studying activity tracking as part of everyday life is a challenge, as tracking occurs alongside everyday events such as checking steps when walking to work or considering sleep data when waking up. I wanted to include a wide variety of participants, considering their everyday experiences, yet explore beyond the often-used words-only interviews and surveys. To achieve this, I drew on photo-elicitation methods. Photo elicitation refers to the idea of using photographs during interview interaction with a participant. When participants in a study carry out the capturing, this is referred to as participant-driven photo elicitation. The inclusion of images has been shown to lead to more specific recall, which would be particularly interesting for more long-term studies. Also, the higher levels of recall spurred by the images mean that we, as researchers, might be made aware of more, or new, kinds of perspective than traditional word-only interviews. While this is still self-reporting and very active, it changes the dynamic – participants are very much in charge of what is brought to the foreground and what is not, and they can choose to focus on what matters most to them. In this study, I found that the challenge of capturing moments of activity tracking, both use and non-use, can lead to important self-reflection on self-tracking practices, facilitating and enriching self-reporting in interviews.

While conducting this study, I found that using a participant driven photo elicitation method for studying activity-tracking practices in everyday life worked well, revealing aspects of users' practices that had not surfaced in other studies. The study was not without challenges, however, and in the paper we argue how some of this could be avoided by perhaps having short cycles of photo elicitation, subsequent participant follow-up, and at a later point asking participants to capture photos again.

Paper 4: Gorm, N., & Shklovski, I. (2017). Participant-Driven Photo Elicitation for Understanding Activity Tracking: Benefits and Limitations. Published. *CSCW2017*.

4.6. RQ5: How are activity-tracking technologies incorporated as part of everyday life?

The final research question of this dissertation focuses on experiences of activity tracking as part of everyday life, exploring beyond workplace contexts. Based on a 5-month empirical study of Danish users of self-tracking devices, I found that self-tracking efforts often clash with other priorities in life, such as completing a lot of work at the computer or caring for sick family members. Tracking technologies with their goal to sustain engagement, are relentless and do not take such considerations into account. For instance, being reminded to walk more when other things in life

take priority can elicit feelings of guilt. While recently, greater sensitivity has emerged concerning the variety of self-tracking experiences of lapsing (Epstein, Ping, Fogarty, & Munson, 2015) and flow (Lomborg, Thylstrup, & Schwartz, 2018), this leaves us with little understanding of how self-trackers deal with the pressure of tracking, day in and day out, and how they deal with feelings of guilt.

In this long-term study of Danish self-trackers, I present the concept of episodic use as an important way to care for the self. I draw on Mol's theoretical framework for understanding care practices. By doing so, we show how the logic of choice guides how participants felt they should use their devices, and how it contrasts with their preferred use patterns. By using devices episodically in idiosyncratic ways, participants remain in control of their tracking experiences, which I suggest leads to practices of care.

Paper 5: Gorm, N. & Shklovski, I. (2018). Episodic Use: Practices of Care in Self-Tracking. *Submitted to New Media & Society*. [Revise and resubmit]

5. Conclusions and future work

This dissertation explores how activity trackers are used in everyday life, both in workplace settings and at home. Drawing on research from three empirical studies, I consider how activity trackers are adopted and used both at home, and as part of short-term as well as more long-term health and wellness programs in the workplace. Empirically, this dissertation builds on a variety of methods, spanning from interviews and participant driven photo-elicitation interviews, to observational studies and surveys.

In the short time since I began my research in this area in 2014, much has happened, and new tracking technologies and tracking software have emerged. For example, posture sensors attached to the back or built into T-shirts buzz when you slouch (Sawh, 2018). Social media posts, such as tweets, can predict whether you are likely to adhere to diet goals set in the calorie-tracking app MyFitnessPal. This makes possible a range of “just-in-time” notifications or even punishments (De Choudhury, Kumar, & Weber, 2017). Discounts based on activity levels and sharing with insurance companies now go beyond employees and are offered to individuals by companies such as Vitality and Oscar. In the workplace area, Cardea is a system that not only collects activity data from employees, but also connects it to information already stored in HR departments, such as which projects employees are working on, days off, etc. (Lingg, Leone, Spaulding, & B’Far, 2014). Tracking technologies can now be added not just “on to” the body, but also *into* the body. A few companies have begun offering employees the option of having RFID tags implanted subcutaneously, so that the employees can access offices and buildings, and buy food and coffee in the workplace with the swipe of a hand (Astor, 2017). Of course, these swipes come with time stamps, and can be used to infer who has been where at what time and can potentially also be used for “measuring” productivity. Taken together, these examples show that activity trackers and the data collected both from implants, social media and HR databases are starting to be connected in ways that were not available at the time of my research. In this light, what can we learn from the studies I have conducted? My studies, of a short-term step-counting campaign, early versions of activity tracking connected to health insurance, as well as voluntary everyday tracking beyond the workplace, focus on particular contexts at a particular moment in time. What can the findings in the research papers of this dissertation be used for as we consider the developments in the area?

In order to consider how my findings are relevant to the rapidly developing technologies in this area, I take a step back to consider discretionary use of technologies. The technologies we choose to use, and use at our own will, are discretionary technologies. Conversely, if there is little choice, the use is nondiscretionary (Grudin, 2012). What I have shown in this dissertation is that discretionary use of activity trackers tends to be episodic even when the participants involved initially claimed they used these technologies continuously. In the participant-based photo-elicitation study, I found that many participants were happy to use their activity trackers and learned much about themselves and their habits. They were at times quite motivated to change some unhealthy behaviors. However, the relentlessness of activity tracking was tiring, and could result in feelings of guilt and pressure. Contrary to the whole point of buying such a tracker, the users felt it could harm them to use it as prescribed, *all of the time*. For many, a caring way to self-track was to engage with the technology episodically (paper 5). As I have observed in a short-term step-counting campaign, employees signed up precisely because the campaign was *short-term* (papers 2 and 2A). This campaign was designed to be episodic, which ultimately led to very few employees continuing tracking after the campaign ended. Such a lack of up-take of technology post-campaign could be interpreted as a failure to some extent if viewed with the expectation that continuous use of step-counting is the goal. Yet I argue that perhaps it is best to redefine the notion of success here, because the employees who participated learned a great deal and found value in the experience. Turning to longer-term tracking activities, I found that these were relatively positively received in the US, but the programs' "one-size-fits-all" tendency annoyed the employees (paper 4).

It is important to highlight here that my study participants were relatively fit and healthy individuals. While some were trying to lose weight, none suffered from any serious chronic illness. Of course, if your life depends upon it, tracking activity and vital signs, such as blood pressure or blood sugar levels, plays a completely different role. Episodic use, in such cases, could be hazardous to one's health. Yet my research highlights that for healthy fitness-minded people, episodic use is perhaps the most natural approach to self-tracking and a way to manage the many aspects of one's life that compete for attention and time. The next steps will be to investigate whether supporting episodic use may produce better and more beneficial outcomes for self-tracking. While my research suggests this may be the case, empirical proof is clearly required.

The findings related to the importance of episodic use assume new urgency as developments, such as implanted RFID tags and systems such as Cardea, signal a move towards nondiscretionary use. With these systems, employees will be tracked at all times with, in all likelihood, fewer possibilities for “opting in or opting out” than today. The option to choose which features to use at which times may become increasingly difficult, especially as continuous use becomes more closely connected to financial outcomes. What is lacking is a discussion of the ways in which activity tracking can be used to help users gain insights into their habits, perhaps motivating healthier behaviors. My research sets out to explore these points but acknowledges that allowing for autonomous living and discretionary use is pivotal.

Future studies based on the research in this dissertation should thus consider in more detail what episodic use might look like and how to best support it. How might episodic use be best supported through design of technologies and programs? For some, participating in short-term campaigns will be enough to learn about their regular habits and consider ways in which they could change small, but important, habits in everyday life. For others, wearing an activity tracker day in and day out continuously may be fun, yet having something like a “flight mode” button, that allows them to *not* track, will allow for much needed Sundays on the couch (paper 5). We need more research to consider when activity tracking is the appropriate measure to take, and in which ways episodic use can be implemented to make activity tracking fit in with other demands in life. Rather than short-term, interview-only studies, future research should consider that users are likely to come and go in their use of their devices, and make sure studies are built to consider this. It will be important to develop a more detailed vocabulary for discussing episodic use, in order to better understand it. For some users, it will be sufficient to simply mute reminders. Others have to physically leave their devices behind in order to shed the guilt that accumulates from constant reminders. What can be learned from observing such different practices? When is one preferable to another? What other types of episodic use may arise as this is considered in more detail? Clearly, more work is needed in order to further understand and operationalize episodic use.

By considering the broad use of activity trackers both at home and at work, I suggest that although there are some benefits and challenges that differ across settings, one main tension point persists regardless of the context. I show that the expectation that activity trackers should be used consistently causes significant levels of annoyance across all participants, and even leads to feelings

of guilt when this is not how they are used. In a literature review of 84 qualitative papers of self-tracking studies, I find that when users leave their activity trackers behind, this is portrayed as a problem that should be fixed (paper 1). Based on my research, I suggest that not using activity trackers all of the time is not necessarily a fixable problem, but part and parcel of what it means to meaningfully use activity trackers as part of everyday life. When it fitted in with other priorities, my participants did walk extra steps when their devices reminded them to and were motivated to be more active when they saw numbers on their screens. Using their devices episodically was not due to laziness, but was rather a skillful way to manage the complexities of life.

As my research shows, technologies are often built around the logic of continuous use, though they are often used episodically. As it is possible to use activity trackers episodically now, why pay special attention to how to build technologies around this concept in the future? The main problem of not taking episodic use seriously arises when the notion that ‘the continuous use of activity trackers is optimum’ is transferred to workplace health and wellness programs or other insurance-type programs. In these cases, users may be financially incentivized to use activity trackers in ways they are not permitted to fully control. This view of behavior change reveals a specific perception of the individual as someone who needs the right information and incentives to do what is “best” - in this case being active in a certain way and at a certain level. This leaves little room for individuals to decide for themselves what is “healthy” in their lives and is therefore a downright paternalistic approach to the use of activity trackers. At best, individuals may cheat, at worst, feel annoyed and stressed about the increasing demands on time. One could argue, then, that activity trackers should not be used at all if there are such negative potential outcomes. Importantly, however, this dissertation does not argue that activity trackers should not be used nor play a role in workplace health and wellness programs. Other researchers have suggested rejecting quantification in general as an option (Moore & Robinson, 2015). I suggest that it is a matter of considering the right scope of such tracking and the right ways of building, introducing and considering how to evaluate the use of these technologies. The answer, I believe, will be to allow users a substantial amount of control, which will ultimately result in episodic use.

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PART II

Paper 1

Gorm, N., Chung, C., Shklovski, I., & Munson, S. (2018). Literature Review: 10 Years of Qualitative Self-Tracking Studies. *(Submitted)*

10 Years of Qualitative Self-Tracking Studies: A Literature Review

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Abstract:

The uptake of modern activity trackers has increased greatly within recent years. Researchers in HCI and related fields have engaged with this phenomenon in a variety of ways. In this paper, we present a literature review of 84 qualitative empirical studies focusing on technology supported self-tracking practices, published from 2006-2016. We identify four major research goals and five main themes through the analysis of these studies. The analysis also reveals opportunities for future research to engage with more diverse populations, to consider abandonment and non-use as part of the practice, to understand the use across a broader variety of social contexts, and the issues arising through social aspect of self-tracking, in particular related to privacy and trust.

KEYWORDS

Self-tracking, activity tracking, personal informatics, quantified self, qualitative studies, health

1. INTRODUCTION

Tracking activities such as steps, sleep, or heart rate by using sensor-filled technological devices is increasingly common. Devices for tracking activities, such as AppleWatch and Fitbit, have flooded the market. A simple search on Amazon, for example, now presents more than 800 tracking products (Schüll, 2016). Even if someone does not own a separate device for tracking activities, regular smartphones have built-in sensors making it possible to track movement, pace, and pulse.

The rise of technology-supported activity tracking has caught the attention of researchers from many fields. In the area of medicine and health promotion, studies have tried to determine whether these devices improve levels of physical activity. While the evidence for this is tentatively positive, most research has focused on very limited participant groups and mostly short-term studies. Long-term effects of activity tracking are, so far, not well-established, although rhetoric of what these devices can help users accomplish remains unflaggingly positive (Bravata et al., 2007; Mackinlay, 2013).

Previous research in HCI have repeatedly called for more studies to focus on the experiences of activity tracking in everyday life (Copelton, 2010; Patel & O’Kane, 2015; Rooksby, Rost, Morrison, & Chalmers, 2014; Ruckenstein, 2014). To answer this call, conducting qualitative studies is necessary as these are best equipped to reveal benefits and challenges of using these devices in everyday life. While there have been many efforts to address this call, so far there exists no overview connecting research endeavors across the many disciplines engaging with this topic. The question thus remains to which extent this call has been answered, and whether research efforts may be focused on some areas and potentially overlook others. The aim of this literature review of 84 qualitative studies engaging with self-tracking practices is to specify what types of studies have already been conducted, with what methods and theoretical frameworks. Based on this analysis, we discuss potential next steps for future studies in HCI and related areas.

Our research questions in this literature review are:

- Which research goals are prevalent in qualitative studies of self-tracking practices from 2006-2016?
- What are the main themes and discussions?
- What are the potential areas for future research?

Ayobi et al. have presented an informative literature review including papers from 2010-2015, excluding hardware and concept papers. The authors argue that there are three streams of self-tracking research in HCI: psychological, phenomenological, and humanistic (Ayobi, Cox, & Marshall, 2016). On this foundation, the authors suggest that future research should pay more attention to the context of tracking as well as historical, social, and cultural underpinnings of self-tracking. Furthermore, they call for studies to consider more deeply challenges of real world use and translating knowledge between disciplines. In this literature review, we expand on both the timeframe and disciplines from which papers have been reviewed. This expansion provides more context and history of self-tracking, which Ayobi et al. suggested as a future research direction. Translating knowledge between disciplines is no easy task, yet we have taken first steps towards discussing papers across disciplines, which HCI researchers have drawn from, and showing which areas HCI research feeds into. Ayobi et al.’s literature review can be used alongside the review at hand, by the reader who wants to gain insight into the field of self-tracking.

This literature review is structured as follows. First, we present historical and technical background of activity tracking devices, as well as a taxonomy, before turning to the methods of the review. We then present the details of the studies (country, number of participants, etc.). In the finding section, we first categorize the papers into four categories based on their research goals. Then we present and discuss five themes emerging across the papers included in the review.

Based on the findings from our analysis, we argue that future studies should consider how to include a more diverse set of participants and a wider variety of methodological tools. We suggest this development should be accompanied by attention to when introduction of tracking technologies may not be the appropriate solution. Future studies should pay more attention to lapsing, abandonment, and nonuse, topics which have gained recent, but still not sufficient, attention. Finally, privacy concerns have gained very little attention in the papers of this review, something we hope to see come through more in future research.

2. BACKGROUND

Self-tracking is not a new phenomenon. The most common application of self-tracking technologies, step counters, has a rather long history. Some date the beginning of the history of pedometers as far back as Da Vinci's drawings of an odometer (a mechanism to measure length traveled by a small cart). Others mark the 1780 invention of the mechanism for pedometers by Abraham-Louis Perrelet as the actual starting point of the modern self-tracking technologies (Brabazon, 2015). In the 19th century pedometers took the same shape as pocket watches, and in the beginning of the 20th century pedometers became "wearable", and were worn on the ankle (Felber, 2015). During the 1960s in Japan, Dr. Hatano focused on steps as a proxy for daily activity levels, and walking clubs became increasingly popular. The Japanese company Yamasa built, and successfully marketed, the "manpo-kei", which literally means the 10,000 steps meter (Bassett, Toth, LaMunion, & Crouter, 2017). In the 1990s, simple pedometers gained increasing interest, but were often imprecise and did little but report step numbers. Self-tracking technologies in their earlier version were mechanical, with a pendulum swinging from side to side as the wearer moved his or her body. These devices gradually turned partly electronic, and today there are no "moving parts" in the trackers. Instead accelerometers detect movement, and, supported by algorithmic processing, send feedback to the user.

In 2008, the first Fitbit was launched and since then a variety of technology companies have brought other devices to the market. These newer types of self-tracking technologies include a variety of sensors, measuring for example orientation, altitude, temperature, pulse, and actigraphy (used for measuring sleep). Sales within the overall category of wearables broke new records in 2017, with 115.4 million units shipped worldwide. Leading companies include Apple, Fitbit, and Xiaomi, followed by Garmin and Huawei (IDC, 2018).

There exists a range of studies considering how precisely these devices measure physical activity (Price et al., 2017), and whether or not the wearer is indeed more active when wearing such a device (Bravata et al., 2007; Jakicic et al., 2016). However, these studies tend to be conducted in clinical settings, and thus do not consider the influences and challenges that may arise as self-tracking technologies are introduced in everyday life (Rooksby et al., 2014). Thus, we analyze the body

of literature in HCI and related fields that have considered how users experience the devices, focusing on qualitative studies only.

2.1 Taxonomy

Because this literature review brings together research from different fields, there is a need for a clarification of the variety of terms used to describe self-tracking as a phenomenon. Self-tracking is a broad umbrella term encompassing any type of tracking of activity, whether by pen-and-paper or supported by technology. When referring to self-tracking in this paper, however, we refer specifically to technology supported tracking. We use this interchangeably with *activity tracking*. The academic term often used in this space is *personal informatics*. We define self-tracking as individually tracked data, which is then displayed back to the individual mainly for individual health purposes.

In some literature, '*Quantified Self*' (QS) is also used as a catch-all term for self-tracking practices. This term, however, originates from a very specific movement starting in 2007 in Silicon Valley. We refer to QS only when the research pertains to the members of this community.

The technologies that enable self-tracking practices go under a variety of names. Pedometers are the early, perhaps most simple type of technology, counting only steps, shown on a small screen, but without necessarily being connected to a computer or phone. Activity trackers and fitness bands often track more than steps, for example active minutes, pulse, elevation (stairs), pace and sleep. These more complex devices typically rely on connectivity with users' smartphones or computers as well. Activity trackers are often, but not exclusively, worn around the wrist. They are also sometimes combined with chest-worn heart rate sensors. In a smartwatch, the tracking sensors can be combined with a wrist worn watch that can also display texts, calendar, and calls. A smartphone app can use various sensors on the smartphone to automatically collect data or ask users to manually input data. It can then present the data back in various forms. Finally, 'wearables' include activity trackers, but also refer to smart clothing that includes trackers such as t-shirts and bras with built in posture sensing. This review includes studies looking at pedometers, activity trackers, smartwatches, and smartphone apps, but none of the more recent wearable technologies (for example posture sensors).

3. METHOD

The purpose of this review is to analyze empirical studies of self-tracking practices in HCI and related fields. In this section, we present our literature search process and inclusion criteria, as well as the list of excluded papers. We followed a grounded theory method approach as developed by (Wolfswinkel, Furtmueller, & Wilderom, 2013), building on the rigorous and detailed approach of (Webster & Watson, 2002).

3.1. Literature search methodology

In the beginning of 2017 we conducted a systematic search first by querying the keywords and search strings below in the ACM Digital Library as well as Google Scholar:

“Self-tracking”
“Quantified Self” + “qualitative” or “literature review” or “ethnography”
“Activity tracking”
“Personal health technologies”

These searches resulted in a large number of returned titles. For example, at the time of our literature search, querying “personal health technologies” + “qualitative” in ACM Digital library resulted in 3721 papers. We reviewed the titles and abstracts of these search results according to the inclusion criteria described in the next section, and continued to do so as long as we found relevant titles in the lists. This initial search resulted in 39 papers.

We then checked all references of the 39 papers, a “going backward” technique common in such reviews (Webster & Watson, 2002). Any papers added to the review were submitted to this process too, which resulted in a list of 61 papers. We searched all papers in Google Scholar to include papers citing them, following the “going forward” technique (Webster & Watson, 2002). We then iterated the process of going forwards and backwards for all the new papers adding to the list of literature. This process resulted in an additional 46 papers, at which point we no longer encountered new papers relevant to our inclusion criteria. This search process produced a list of 107 papers, which received a closer reading.

3.2 Inclusion criteria

We include papers reporting on studies using qualitative methods in settings beyond in-lab use. Our review focuses on devices or apps that are commercially available or developed by the authors of the studies. We decided to include papers published from 2006 to 2016 published in HCI or HCI related venues. Self-tracking devices go back further than 2006 (see introduction), however, in 2006 three, now widely cited, studies on self-tracking were published in main HCI venues (Consolvo, Everitt, Smith, & Landay, 2006; Lin, Mamykina, Lindtner, Delajoux, & Strub, 2006; Toscos, Faber, An, & Gandhi, 2006). None of these papers refer to

previous self-tracking papers from HCI-related venues. Finally, this review considers only studies written in English.

3.3 Excluded papers

Upon more detailed reading of the 107 papers, we excluded 23 papers that did not meet our inclusion criteria, resulting in a total of 84 papers. We list the reasons for exclusion in Table 1.

Reason for exclusion	Papers
No tracking elements (only game)	(Grimes, Kantroo, & Grinter, 2010)
Reported on in-lab use only	(Andrew, Borriello, & Fogarty, 2013; Hicks et al., 2010)
Insufficient detail on methods (how many participants, how were they recruited, how long did they track)	(Ruckenstein & Pantzar, 2015)
Including only quantitative methods	(Chen et al., 2013)
Tracking focused on non-health concepts (teaching math to children, energy consumption, sharing economy)	(Barta, Kristen & Neff, 2015; Ertzberger & Martin, 2016; Kuo & Horn, 2014; Lee & Drake, 2013; Lee & Thomas, 2011)
Based on theory only, or discussing findings from other studies only	(Ayobi et al., 2016; Gilmore, 2015; Kristensen, Bode, & Lim, 2015; Pantzar & Ruckenstein, 2014; Purpura, Schwanda, Williams, Stubler, & Sengers, 2011)
Not peer-reviewed	(Butterfield, 2012; Rapp, 2014; Sjöklint, 2014)
Insufficient details from work in progress	(Caon & Carrion, 2015; Harrison, Berthouze, Marshall, & Bird, 2014; Meyer, Heuten, & Boll, 2016)
Duplicate (Included: (Fiore-Gartland & Neff, 2015))	(Fiore-Silfvast & Neff, 2013)
Older than 2006	(Heesch, Dinger, McClary, & Rice, 2005)

Table 1: Reasons for exclusion of papers, 23 papers excluded in total

3.4 Analysis

Having excluded papers that did not fit with the inclusion criteria, we proceeded to a more thorough reading and analysis of the included papers. In this section, we first categorize and summarize the studies according to their research goals (See Table 2). This analysis resulted in four categories: Testing to improve new tools or software (38 studies), enquiring about attitudes, behaviors and challenges (30 studies), ethnographic methods to understand use in particular settings (10 studies), and investigating existing materials (6 studies). We describe the characteristics of papers belonging to these categories in section 3.5.

Papers divided by research goal	Papers
Testing to improve new tools or software (38)	(Ananthanarayan, Lapinski, Siek, & Eisenberg, 2014; Bauer et al., 2012; Baumer et al., 2012; Bentley, Tollmar, & Stephenson, 2013; Cercos & Mueller, 2013; Choe, Lee, Kay, Pratt, & Kientz, 2015; Chung & Danis,

	<p>2016; Consolvo, McDonald, et al., 2008; Consolvo, Klasnja, et al., 2008; Consolvo et al., 2006; Consolvo, Klasnja, McDonald, & Landay, 2009; Consolvo, McDonald, & Landay, 2009; Cordeiro, Bales, Cherry, & Fogarty, 2015; Epstein, Cordeiro, Bales, Fogarty, & Munson, 2014; Gouveia, Pereira, Karapanos, Munson, & Hassenzahl, 2016; Grimes & Tan, 2009; Jensen, Krishnasamy, & Selvadurai, 2010; Kay et al., 2012; Kendall, Morris, & Tan, 2015; Klasnja, Consolvo, & Choudhury, 2009; Klasnja, Consolvo, McDonald, Landay, & Pratt, 2009; Lawson et al., 2013; Lee, Cha, & Nam, 2015; Lee, Kim, Forlizzi, & Kiesler, 2015; Li, Dey, & Forlizzi, 2012; Lin et al., 2006; Macvean & Robertson, 2013; Mamykina, Mynatt, Davidson & Greenblatt, 2008; Miller & Mynatt, 2014; Munson & Consolvo, 2012; Munson, Krupka, Richardson, & Resnick, 2015; Parker, 2014; Rabbi, Aung, Zhang, & Choudhury, 2015; Rajanna, Behera, Goldberg, & Hammond, 2014; Rooksby, Rost, Morrison, & Chalmers, 2015; Ryokai, Michahelles, Kritzier, & Syed, 2015; Saksono et al., 2015; Toscos et al., 2006)</p>
<p>Enquiring about attitudes, behaviors, and challenges (30)</p>	<p>(Altenhoff, Vaigneur, & Caine, 2015; Barua, Kay, & Paris, 2013; Boulard Masson, Martin, Colombino, & Grasso, 2016; Burton, Walsh, & Brown, 2008; Cheon, Jarrahi, & Su, 2013; Chung et al., 2016; Drew & Gore, 2014; Elsdon, Kirk, & Durrant, 2015; Epstein, Caraway, et al., 2016; Epstein, Kang, Pina, Fogarty, & Munson, 2016; Epstein, Ping, Fogarty, & Munson, 2015; Fritz, Huang, Murphy, & Zimmermann, 2014; Gardner & Campagna, 2011; Harrison, Marshall, Bianchi-Berthouze, & Bird, 2015; Karapanos, Gouveia, Hassenzahl, & Forlizzi, 2016; Kim, 2014; Lazar, Tanenbaum, Koehler, & Nguyen, 2015; Li, Dey, & Forlizzi, 2010, 2011; Lomborg & Frandsen, 2015; Lynch & Cohn, 2015; Mackinlay, 2013; Meyer & Hein, 2013; Patterson, 2013; Rapp & Cena, 2016; Rooksby et al., 2014; Ruckenstein, 2014; Schaefer, Ching, Breen, & German, 2016; Shih, Han, Poole, Rosson, & Carroll, 2015; Sjöklint & Trier, 2015)</p>
<p>Ethnographic methods to understand use in particular settings (10)</p>	<p>(Copelton, 2010; Fiore-Gartland & Neff, 2015; Gorm & Shklovski, 2016b, 2016a; Grönvall & Verdezoto, 2013; Marcengo, Rapp, Cena, & Geymonat, 2016; Miller et al.,</p>

	2012; Nafus & Sherman, 2014; Patel & O’Kane, 2015; Sharon & Zandbergen, 2016)
Investigating existing materials (6)	(Choe, Lee, Lee, Pratt, & Kientz, 2014; Clawson, Pater, Miller, Mynatt, & Mamykina, 2015; Cordeiro, Epstein, et al., 2015; Smith & Vonthethoff, 2016; Whooley, Ploderer, & Gray, 2014; Yang, Shin, Newman, & Ackerman, 2015)

Table 2: Four categories of research goals

We then conducted an open coding of all 84 papers. We used SaturateApp.com and frequent Skype calls for collaborative coding. Through axial coding, we challenged the broader categories as new sub-categories emerged. The last of the analytical steps, according to Wolfswinkel et al., is selective coding, which is the process of identifying and relating between main categories (Wolfswinkel et al., 2013). Five themes emerged through this analysis: 4.1 Who are the users? 4.2 Conceptualizations and models of use, 4.3 Why do people stop tracking? 4.4 What improves user experiences and increases use of devices, and finally, 4.5 Social aspects of tracking. We discuss these themes in section 4.

3.5 Characteristics of papers

Overall, we see an increasing number of studies in the years included in the review (Figure 1). However, as we conducted our literature search in the beginning of 2017, papers from late 2016 may not yet have been available, which may explain the drop of numbers of papers in 2016. The majority of the papers (53) were conducted in the United States (Figure 2). 30 studies were conducted in other countries, and 3 across multiple countries. 51 papers focused on practices of single type of data people tracked (e.g. physical activities) and 35 papers investigated two or more types of tracking. Physical activities, sleep, and food intake are by far the most examined types of data (Figure 3).

Across studies, there is often a lack of detail about the participants and the structure of the study. For example, not all studies clearly state the age group of their participants or the length of the study. Length of study is of course more relevant for field studies than surveys, however, we could not always see in which year surveys were conducted. We encourage future studies to include this information to better situate the findings. Furthermore, we suggest that future studies clearly describe the functionalities of the devices being studied. Mentioning only brand name, such as Fitbit, is not useful and will become less so as functionalities of devices grow. Just naming devices, thus, makes it difficult to compare across studies.

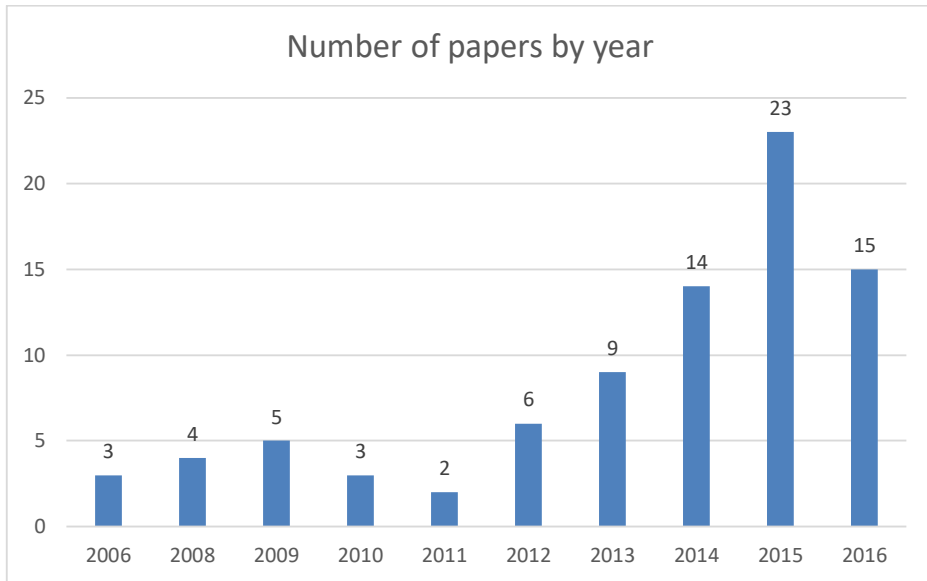


Figure 1: Number of papers by year

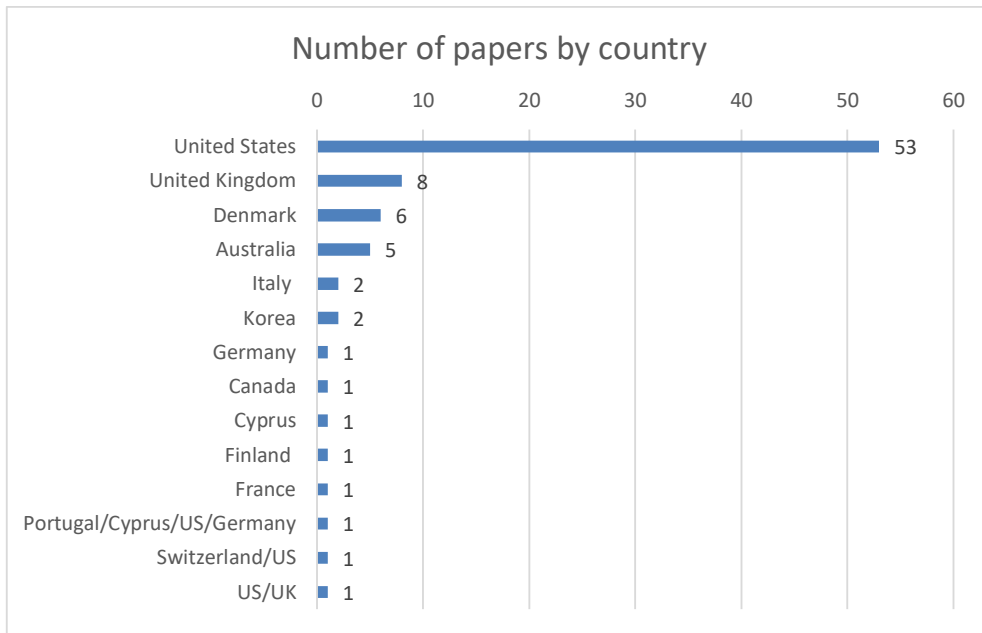


Figure 2: Number of papers by study sites (countries)

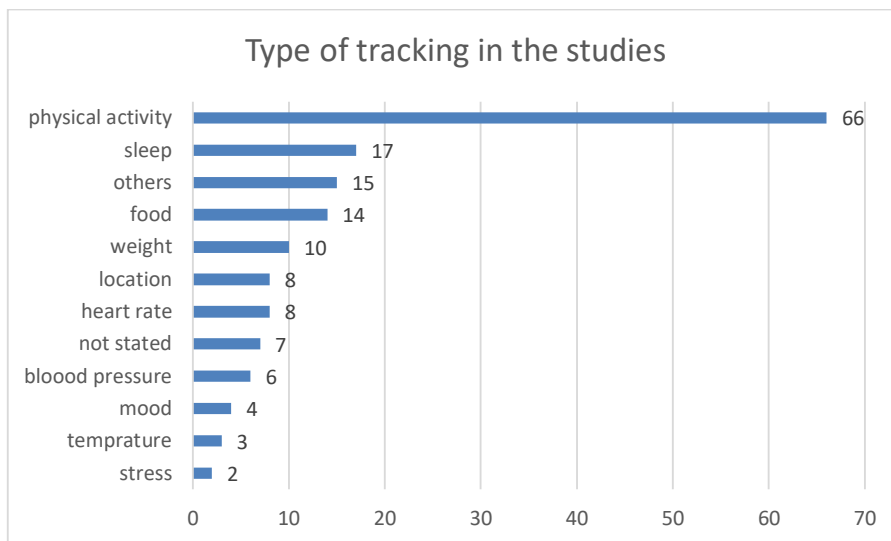


Figure 3: Type of tracking examined in the studies

3.5.1 Testing to improve new tools or software (38)

38 studies in this category have a goal to test, and thus improve, specific tracking tools or software. This is by far the largest of the categories in this literature review.

There is a great variety in the length of the studies in this category. The shortest of the studies in this category reported on one time use of a tracking game (Jensen et al., 2010), for one day of use (Rajanna et al., 2014) while the longest studies reported 14 weeks of participation (Lin et al., 2006; Munson et al., 2015; Rabbi et al., 2015) (Figure 4). When people move from novice to more advanced users, their needs might change. To offer insight into how tracking techniques and goals change over time, there is a need for studies to return to test the same tracking technologies over time.

Number of participants in the studies also vary widely, from 4 participants (Kay et al., 2012; Rajanna et al., 2014) to 199 participants (Munson et al., 2015) (Figure 5). We were not able to consistently identify age or gender of the participants as many papers did not report this information or report it as a general description (e.g., college students) rather than a specific age group. However, we note that most studies focus on participants under 40 years old. We return to a discussion of the demographics of studies later in the paper.

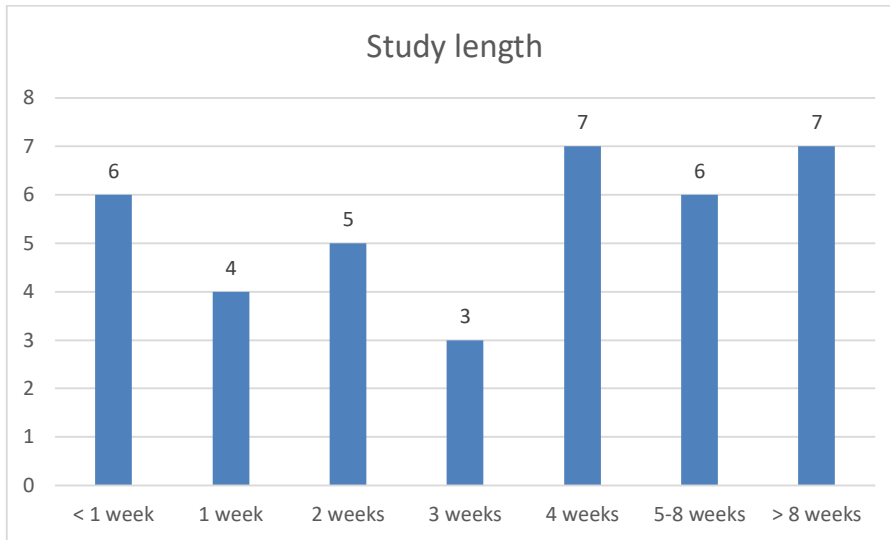


Figure 4: Study length of studies testing to improve new tools or software

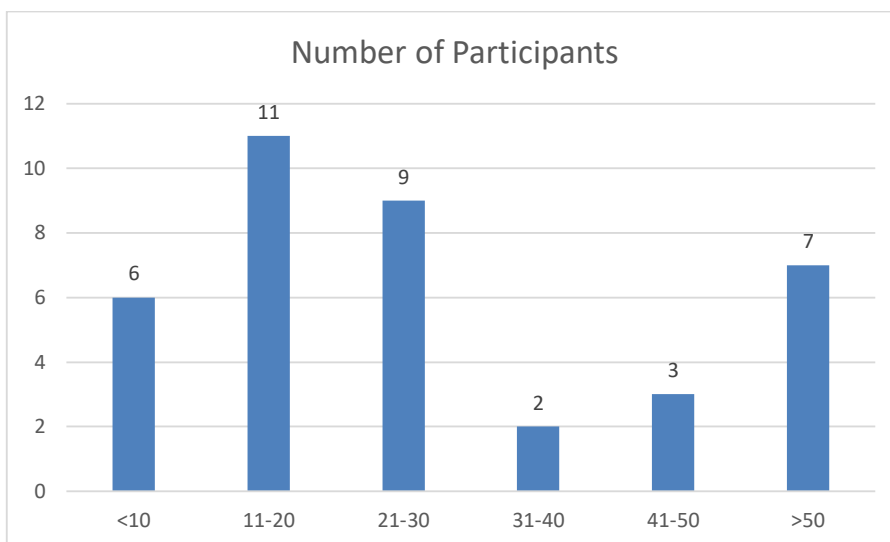


Figure 5: Number of participants in studies testing to improve new tools or software

3.5.2 Enquiring about attitudes, experience, and challenges (30)

The 30 studies in this category seek to describe participant attitudes about and experiences of using self-tracking technologies in everyday lives. All studies in this category investigate the use of commercially available devices. There are two major approaches researchers have used to achieve this goal:

- 12 papers set particular structures for the use of devices, for example choosing the device participants are offered or defining how long it should be used.
- The remaining 18 papers conduct interviews (10), surveys (5), or interview and survey combined (3). These 18 papers have recruited only participants who had gained prior experience with tracking independently.

For the 12 studies with particular study set-ups, researchers often prescribed participants with a recommended length of study time but allowed participants to use the devices as long or as little as they wish. Therefore, the amount of time each participant spent in the study may not be the same across the entire participant group. For example, some participants would leave the study early or choose to only track for shorter amounts of time. The maximum amount of time a participant could spend in the study ranges from 3 days (Altenhoff et al., 2015) to several months (Boulard Masson et al., 2016; Kim, 2014; Lazar et al., 2015; Schaefer et al., 2016), with the majority of studies allowing participants to use the devices for up to 6 weeks (Gardner & Campagna, 2011; Lomborg & Frandsen, 2015; Lynch & Cohn, 2015; Meyer & Hein, 2013; Rooksby et al., 2014; Schaefer et al., 2016; Shih et al., 2015). Most (8 out of 14) studies recruited 10-20 participants. Five studies had more than 20 participants (Burton et al., 2008; Rooksby et al., 2014; Ruckenstein, 2014; Schaefer et al., 2016; Shih et al., 2015), among which two studies had up to 39 participants (Burton et al., 2008; Ruckenstein, 2014). Among these 12 studies, 8 studies provided the devices, 3 studies allowed participants to use their own devices (Burton et al., 2008; Lomborg & Frandsen, 2015; Rooksby et al., 2014), one provided funding for participants to buy the device they wanted to use (Lazar et al., 2015). Fitbit is the most common device as it was used in 5 out of 13 studies (Altenhoff et al., 2015; Karapanos et al., 2016; Kim, 2014; Meyer & Hein, 2013; Shih et al., 2015). Three studies included the use of Jawbone (Altenhoff et al., 2015; Boulard Masson et al., 2016; Rapp & Cena, 2016). Garmin (Meyer & Hein, 2013) and Withings (Boulard Masson et al., 2016) were included in one study each.

18 studies that inquired about participants existing experiences did not give devices to participants, but found users who had taken up self-tracking on their own volition. Studies that use interviews as their only research methodology had around 7-42 participants. Survey studies often involve more participants, with a majority of them including more than 100 participants (Burton et al., 2008; Chung et al., 2016; Epstein, Caraway, et al., 2016; Epstein, Kang, et al., 2016; Epstein et al., 2015; Karapanos et al., 2016).

The two types of research investigating use of commercially available devices present challenges and limitations. In studies that set up particular structures of use, researchers can focus on a particular set of research interests; however, participants may feel obliged to use devices in ways they otherwise would not, which challenges the usability of the findings. On the other hand, the 18 studies that considered voluntary uptake of tracking devices used one-off interviews and surveys. These studies may offer a more naturalistic picture of how people adopt (or struggle to adopt) and use trackers outside of research studies, but participants may have problems and biases when recalling previous experiences.

Paper	# of participants	Study Length	Type of devices
Examining before and after use			
(Rooksby et al., 2014)	22	4 weeks	User's own devices
(Kim, 2014)	18	12 weeks	Fitbit
(Lazar et al., 2015)	17	8 weeks	\$1000 devices chosen by participants
(Ruckenstein, 2014)	36	1 week	Vivago and Firstbeat
(Shih et al., 2015)	26	6 weeks	Fitbit
(Lomborg & Frandsen, 2015)	12	4 weeks	User's own devices
(Rapp & Cena, 2016)	14	4 weeks	Jawbone Up (7); three apps on participant phones (7)
(Meyer & Hein, 2013)	10	4 weeks	Fitbit and Garmin
(Schaefer et al., 2016)	24	6 months	Fitbit
(Boulard Masson et al., 2016)	13	"A number of months"	Jawbone UP (2), Pulse (10), Runtastic (1)
(Gardner & Campagna, 2011)	10	4 weeks	RadioShack pedometer
(Altenhoff et al., 2015)	14	3 days	Fitbit (7), Jawbone UP (7)

Table 3: Length of studies, number of participants, and type of devices used in studies enquiring user experiences with particular structures

Paper	# of participants
Interview prior/current experience	
(Li et al., 2011)	15
(Elsden et al., 2015)	15
(Mackinlay, 2013)	7
(Fritz et al., 2014)	30
(Drew & Gore, 2014)	9
(Lynch & Cohn, 2015)	30
(Patterson, 2013)	21
(Cheon et al., 2013)	13
(Sjöklint & Trier, 2015)	42
(Burton et al., 2008)	39
Survey prior/current experience	
(Harrison et al., 2015)	24
(Barua et al., 2013)	54
(Epstein, Kang, et al., 2016)	141
(Karapanos et al., 2016)	133
(Li et al., 2010)	68
Survey + Interview prior/current experience	
(Epstein, Caraway, et al., 2016)	193 + 19
(Epstein et al., 2015)	287 + 22
(Chung et al., 2016)	211 + 39

Table 4: Number of participants used in studies enquiring user experience through interviews and surveys

3.5.3 Ethnographic methods to understand use in particular settings (10)

Ten studies used ethnographic methods, including ethnography, autoethnography, observational studies, and fieldwork. These studies focused on the use of activity tracking devices in particular settings, such as workplace, schools, or QS meetups.

The exact length of these studies is sometimes hard to determine from the papers, as researchers might spend several years engaging with the target group in a variety of ways. Others, such as observations in the QS meetings, can be determined by number of meetings researchers attended. In general, studies in this category span longer timeframes, from two weeks to more than two years. Other than the two autoethnography studies which involve one participant (Marcengo et al., 2016; Patel & O’Kane, 2015), studies in this category vary from 11 (Patel & O’Kane, 2015) to more than 200 participants (Miller et al., 2012).

Paper	# of participants	Study Length
(Patel & O’Kane, 2015)	11 participants + 1 autoethnography	4 weeks
(Nafus & Sherman, 2014)	Not stated	Not stated
(Miller et al., 2012)	More than 200 participants	2 years (3 iterations)
(Copelton, 2010)	30 participants	5 months (14 observations)
(Fiore-Gartland & Neff, 2015)	43 participants	More than 2 years
(Gorm & Shklovski, 2016b, 2016a)	28 participants	4 weeks
(Sharon & Zandbergen, 2016)	Not stated	Not stated
(Grönvall & Verdezoto, 2013)	27 participants	Not stated
(Marcengo et al., 2016)	1 autoethnography	4 weeks

Table 5: Length of studies and number of participants in studies using ethnographic methods to understand use in particular settings

3.5.4 Investigating existing materials (6)

Six studies analyzed data that is available online. For example, the Quantified Self community often records presentations and make them available on their website. The QS website was the main focus for three studies. The three remaining studies in this category analyzed posts in online food community forums (Cordeiro, Epstein, et al., 2015), sales ads on craigslist (Clawson et al., 2015), and product reviews (Yang et al., 2015).

Paper	# of empirical materials
(Clawson et al., 2015)	1600 ads on Craigslist
(Choe et al., 2014)	52 QS videos
(Yang et al., 2015)	600 product reviews
(Smith & Vonthehoff, 2016)	30 QS videos
(Cordeiro, Epstein, et al., 2015)	5527 posts in online food forums
(Whooley et al., 2014)	51 QS videos

Table 6: Number of data points of studies analyzing existing materials

4. TRENDS IN QUALITATIVE STUDIES OF TECHNOLOGY SUPPORTED SELF-TRACKING PRACTICES

A thematic analysis of the 84 papers included in this literature review revealed five major conceptual clusters.

In 4.1 we discuss the papers that focus on *who* the users of self-tracking technologies are, noting the transition in how users of self-tracking technologies have been referred to. This leads to a discussion of self-tracking practices, focusing on *what* users do with their technologies. Models and conceptualizations that result from this are presented in 4.2. Over time researchers find that users leave their devices behind sooner than expected. In 4.3. we turn to the studies that discuss *why users stop tracking*. Because it is by now a well-established fact that many users leave their technologies, a growing body of studies focus on *how to improve the user experience* (4.4.). There is also a growing understanding of self-tracking practices as a social experience, and in 4.5 we identify studies that attend to the social aspects of tracking, asking *how users track and share in collaboration with others*. As papers often have more than one finding or implication, some papers appear in more than one of the following five categories.

4.1 Who are the users?

The term “Quantified Self” was first used by Wolf and Kelly to describe a group of users who would like to “*know what these new tools of self-tracking are good for, and we want to create an environment where this question can be explored on a human level*” (Wolf, 2011). Over time, “quantified self” and “self-tracking” have come to be used interchangeably to describe users who adopt self-tracking technologies. This interchangeable use sometimes creates confusion around whose practices researchers chose to study and whether the results are relevant to other populations.

Translating findings outside of the quantified-self community

Nine papers (Choe et al., 2014; Epstein et al., 2014; Fiore-Gartland & Neff, 2015; Li et al., 2010; Nafus & Sherman, 2014; Sharon & Zandbergen, 2016; Sjöklint & Trier, 2015; Smith & Vonthethoff, 2016; Whooley et al., 2014) recruited participants or use participant materials from the Quantified Self community. However, there is a tension concerning whether and under what circumstances the findings can be seen to represent all users of self-tracking technologies and/or can be transferred to outside of the QS community.

Li et al. defined Quantified Self and “self-tracking” as interchangeable terms: “*Personal informatics goes by other names, such as “living by numbers”, “quantified self”, “self-surveillance”, “self-tracking”, and “personal analytics”*” (Li et al., 2010). Li et al. highlighted that although they have used extreme examples to explain the definition of personal informatics, “*regular people are tracking one or two types of personal information and using computer technology in the form of personal informatics systems to do so*”. Sjöklint et al. recruit participants from QS

Forums and meetups and generalize their findings to all user behavior (Sjöklint & Trier, 2015). However, they also noted that future studies should further explore different reactions to the devices from different group of users. Whooley et al. characterized QS members as “early adopters” and generalize their findings to other user groups (Whooley 2014). Members of the QS community, from this perspective, are perhaps more extreme users of self-tracking technologies, but there are parallels to be drawn to “regular people”.

However, others have pointed to the homogeneity of the QS community as a reason for questioning whether learnings based on studying the members of this community can be transferred to all users of self-tracking technologies. For example, Epstein et al. recruited their participants from both QS forums and other sources and emphasized the goal of designing for casual self-trackers: “*Quantified Selfers tend to be more data-driven than the casual audience, and thus may feel more comfortable analyzing a graph*” (Epstein et al., 2014). Choe et al. also expressed a more cautious view of learnings from the QS community: “*In light of the barriers they face, Q-selfers offer us a useful perspective from which to re-examine the current design of self-tracking technologies and ways to improve them*” (Choe et al., 2014).

This unresolved tension—how and under what circumstances findings from studies of the QS community can be transferred to a broader user context—can be broken down to whether members of the Quantified Self are seen as first movers, which all other users will eventually follow, or if they are extreme users who are interesting to study, but that their use practice will inevitably differ greatly from more mundane uses.

Beyond the quantified-self community

43 out of 84 papers describe their participants as tech savvy or as having used one of more self-tracking technologies before. Furthermore, these studies most often focus on healthy, young participants between 20-45 years of age. Increasingly, however, research has begun to consider children, young people, and families.

The level of familiarity with tracking seems to play a role in relation to how easily accepted new activity tracking technologies are. Rapp et al. found that users with no previous experience in Personal Informatics had unrealistic expectations of tracking and thus easily grew tired of the devices (Rapp & Cena, 2016). But not just inexperienced users show decrease in use over time. While tracking can help increase or sustain motivation towards increasing daily step-counts (Chung & Danis, 2016; Gardner & Campagna, 2011), and some people derive value from continued tracking (Fritz et al., 2014) and develop routines (Lazar et al., 2015), people also often decrease their use over time or abandon devices altogether (Cheon et al., 2013).

Supporting teenagers and children as they adopt and continue self-tracking often requires more than providing an app or a device. For example, young people might experience a mismatch between their preferred information practices and those offered by the devices (Cheon et al., 2013). Wearable devices alone were not enough to lead to physical activity changes in an under-resourced youth setting (Schaefer et al., 2016). One type of support is to encourage social comparison. For example, Chick Clique, a mobile app integrated with pedometer data, encourages teenage girls tracking their steps and food intake with friends and showed that these practices increased awareness of food, exercise, and health in general (Toscos et al., 2006). Taking a school-based approach can have beneficial outcomes (Macvean & Robertson, 2013): in one study (Miller & Mynatt, 2014) even the least-active students increased daily activity. However, social comparison among children and teenagers might create antagonistic body relations (Drew & Gore, 2014). Therefore, research has investigated other social mechanisms, such as peer social support and observational learning, rather than direct social comparison (Miller et al., 2012). Besides system design, school-based programs often require a substantial amount of maintenance work to keep this program running, which often relies on the “hidden work” by school teachers (Miller et al., 2012).

Only three papers (Burton et al., 2008; Copelton, 2010; Gardner & Campagna, 2011) focused on participants over 45 years old. These three studies all use traditional pedometers. Gardner et al. found that pedometers served as motivating function and encouraged their participants to be aware of their daily steps and to walk more over the course of 4 weeks (Gardner & Campagna, 2011). However, the other two studies showed that using pedometers might not be the best strategy to encourage physical activity for users within this age range. Copelton et al. found that older adults in a hospital walking group felt the use of pedometers created pressure and competition in the group, which were detrimental to the group’s social dynamics (Copelton, 2010). Burton et al. found that middle-aged men (aged 45-65) thought that pedometers were only useful to create awareness in short-term and that counting the steps was not motivating to them (Burton et al., 2008). These participants suggested that program initiatives involving workplace or family could be more motivating than step counting alone.

Researchers have also investigated how self-tracking technologies are used by participants with health concerns (Chung et al., 2016; Grönvall & Verdezoto, 2013; Mamykina et al., 2008; Munson et al., 2015). As we will discuss in section 4.5, three of these studies examined using self-tracking data with health professionals and how that affects the individual tracking practice. (Chung et al., 2016; Grönvall & Verdezoto, 2013; Mamykina et al., 2008).

Looking across the variety of users that have been studied, we find that using self-tracking technologies is often not enough to encourage and improve health behavior. Inexperience with the technologies can lead to setting unrealistic goals,

while being tech-savvy or more experienced can set challenges for how technologies should play a role together with other technologies that are already in use. As we will discuss in section 4.4, including other design considerations, such as helping people to make sense of their data or incorporating social interactions, are often suggested in these studies to create positive outcomes.

4.2 Conceptualizations and models of use

Most marketing materials for tracking devices portrays self-tracking as a practice suitable for any type of user, for an undefined amount of time (Schüll, 2016). In reality, self-tracking technologies induce curiosity and attention, but often fail to meet the high expectations of better fitness levels and thereby greater health. People use these devices in idiosyncratic ways, which has led to calls for more research in actual user practices (Cheon et al., 2013; Fritz et al., 2014). Eight papers in our literature review focus on how to understand user practices, presenting a variety of aspects in interactions with self-tracking data.

Research in this space suggest that self-tracking practices can be seen as a communicative phenomenon. People who self-track communicate with themselves, the systems, and social network of peers (Lomborg & Frandsen, 2015). Using self-tracking technologies, thus, also involves people beyond the individual users and shapes practices and bodies (Lynch & Cohn, 2015). Fiore-Silfvast and Neff found that different stakeholders have very different expectations for data produced by tracking technologies. Across technology designers, clinicians, advocates, and users of tracking technologies, the authors observed six types of “data valences”, namely: self-evidence, actionability, connection, transparency, connection, “truthiness”, and discovery (Fiore-Gartland & Neff, 2015). Nafus and Sherman, looking specifically at the Quantified Self movement, suggested that in this community members can shift between various roles, such as project designers and data collectors, while also being critical sense-makers. This shifting becomes a way of dealing with the data, which Sherman and Nafus argued can be seen as “soft resistance”, as it resists more traditional and authoritative modes of data aggregation (Nafus & Sherman, 2014). Ruckenstein drew on the notion of the data-double and suggested that “numerical living” is promoted by tracking, in ways that can be fun and engaging (Ruckenstein, 2014). Overall, research suggests that data from self-tracking technologies can act “*as both enabling and constraining forces in the production of bodily and social relations*” (Smith & Vonthehoff, 2016), changing the way people reflect on themselves (Ruckenstein, 2014).

A body of work has considered how to include knowledge of self-tracking practices into models of use. For example, Kim et al. developed a model based on the general Technology Acceptance Model (TAM) to specifically consider factors pertaining to self-tracking technologies (HI-TAM II) (Kim, 2014). The “Stage-based Model of Personal Informatics systems”, however, goes beyond adoption and describes how people use their tracking technologies (Li et al., 2010). The model introduces

five stages of self-tracking: (1) preparation stage, (2) collection stage, (3) integration, (4) reflection, and (5) action. For each stage, the authors noted barriers and introduced the notion of barriers cascade, meaning that problems in earlier stages impedes the user progress to the next stages. The authors also stressed that the stages are iterative, and that each stage can be user-driven or system-driven. In 2014, Rooksby et al. criticized this technology-centric view of the stage-based model, arguing that “*Li et al. ’s vision reminiscent of the idea in health informatics and information systems that computerization can and should set the rational underpinning for (a consequently rationalized) human action*” (Rooksby et al., 2014). To improve upon this, Rooksby et al. suggested five overlapping styles of tracking: directive tracking, documentary tracking, diagnostic tracking, collecting rewards, and fetishized tracking. They also pointed out that tracking is often social, which we discuss in more detail later in this paper.

Inspired by this critique and the notion of Lived Informatics, Epstein et al. introduced the “Lived Informatics Model of Personal Informatics” in 2015 (Epstein et al., 2015). A key argument of this model is that collection, reflection, and integration are seen as on-going and co-occurring in the process of “tracking & acting.” Furthermore, this model argues that lapsing is a part of self-tracking processes. Epstein et al. used this focus on lapsing as a springboard for considering how to best help users resume tracking.

4.3 Why do people stop tracking?

It is well known that self-tracking practices are challenging to maintain, and many users abandon their devices sooner than tech-companies and designers expect. Surprisingly, however, we found that across papers there is not a great amount of attention given to abandonment. As Clawson et al. state: “... *the adoption use, and particularly abandonment of these technologies in everyday life is relatively unexplored*” (Clawson et al., 2015).

Some papers do not spend time considering why some participants left their study (Baumer et al., 2012). Of course, not being able to follow up with all participants is normal, and even to be expected. However, because abandonment is an important issue in tracking studies, we suggest that future studies might consider reflecting upon whether leaving the study was due to the study set-up or the burden of the tracking activity, and what might be learned from this.

Some studies mentioned how external factors influence tracking usage, such as illness and unforeseen events (Consolvo et al., 2006; Gardner & Campagna, 2011). Tracking can also be impacted by seasons, as it is not as easy to be physically active in areas with cold or harsh winters. However, we find that for those papers that do mention abandonment, this tends to be framed as a technological problem that can, and should, be solved. There tends to be a focus on solutions to abandonment, which we will discuss in more detail in the following section.

It is almost self-evident that if technologies are “*done poorly, the technology is likely to be abandoned*” (Consolvo, McDonald, et al., 2009). In their study of activity tracking, Lazar et al. found that abandonment occurred if devices did not fit with participant conception of themselves, if the data was not useful, or if the devices required too much maintenance and work (Lazar et al., 2015). Apart from being burdensome, current designs of self-tracking technologies can even make users feel ashamed or judged, as research looking at food-tracking has shown (Consolvo, McDonald, et al., 2009). Epstein et al. point to the cost of collecting and integrating data as well as concerns about data quality as other reasons for abandoning tracking (Epstein, Caraway, et al., 2016).

Researchers suggest that it is important to recognize that “*for physical activity, individuals are unlikely to perform the desired behavior all of the time for any number of reasons, many of which are perfectly legitimate*” (Consolvo, McDonald, et al., 2009). The implication here is that no matter the technological fixes and adjustments, technology designers and stakeholders in this area should recognize that continuous tracking over longer periods is, to many people, simply not realistic. Epstein et al. thus also pointed to the cost of having or sharing data, discomfort with revealed information, having learned enough, and changes in life circumstances as reasons for abandonment (Epstein, Caraway, et al., 2016). These reasons for abandonment cannot be easily fixed by technological solutions.

As a response to this, research has suggested that short-term interventions, as an addition to standard long-term use, need to be investigated as well (Lazar et al., 2015) (Gorm & Shklovski, 2016b). Whooley et al. pointed to the value of immediate feedback, “*rather than asking people to embark on long self-tracking project to reflect on their lifestyles*” (Whooley et al., 2014).

Functions/set-up

Across research in the literature review, we find a group of research, which has considered not just data visualizations and data handling, but the process of activity tracking more broadly. In this section, we focus on the studies that have considered the set-up or assumptions of tracking flows more generally.

Although researchers still debate which and how many phases or stages exist in self-tracking processes (see section 4.2), it is generally well supported that there are different phases of tracking. Not recognizing and working to solve barriers in some phase of tracking can create a cascade effect, wherein users then never reach the next stages (Li et al., 2010). As such, Li et al. suggested that self-tracking technologies should better support these different phases as well as a wide spectrum of practices (Li et al., 2011).

Finally, there is also a growing recognition of the fact that trackers are not just abandoned because of either changes in life circumstances or mismatch in

expectations, nor because of technological shortcomings, but also due to what can be interpreted as “*happy abandonment*” (Clawson et al., 2015). This can happen when users reach their goals or if they upgrade to newer or different devices (Clawson et al., 2015).

Summing up, studies that have considered abandonment often portray it as a shortcoming of the technology and something that should be fixed. While it is important to continue to improve technologies so that they may be as useful as possible, there is also a point to be made about the expectations of long-term tracking. There is a growing recognition that factors out of the hands of the user can influence use and are unlikely to be fixed technologically. This has resulted in calls for more focus on short-term tracking as an alternative to the standard of continuous and long-term tracking. Furthermore, abandonment of devices is also sometimes due to trackers having fulfilled their role, and users having moved on.

4.4 What improves user experiences and increases use of devices

In the previous section, we pointed out how studies have found that trackers are far from a one-size-fits-all technology. Different user groups have different expectations of their tracking technologies, and tracking is also often hindered by technological barriers. Not surprisingly, a large body of research has focused on how to improve user experience, both in general and catering to specific user groups. 33 papers point to specific improvements and considerations for a better user experience.

Shape and aesthetics

Research points to the fact that the shape and functions of the tracker are important. These findings are perhaps unsurprising, but they show how commonly available devices, in many instances, fail to live up to the expectations of the users. As early as 2006, Consolvo et al. pointed to a main problem of wearable tracking: designers should consider the “*practical constraints of users’ lifestyles*” (Consolvo et al., 2006). Many wearables at the time were bulky, unattractive, and difficult to wear when, for example, wearing a dress. This last annoyance was also voiced, nearly ten years later, by participants in a study by (Shih et al., 2015). Although devices are certainly smaller and more durable today, we recognize from our own studies how bracelet-type trackers can be in the way or that clip-ons are at times difficult to place on clothes. Shih et al. found that 8 of 26 participants felt that Fitbit devices were uncomfortable and intrusive (Shih et al., 2015). Harrison et al. also noted that the findings of Consolvo et al. were still a factor in their 2015 study, meaning that many barriers to tracking have yet to be solved (Harrison et al., 2015). Some of these challenges pertain to aesthetics and form, and the authors suggest more attention should be paid to making customization possible.

In this vein, Ananthanarayan et al. suggested studying DIY tracking devices. However, with a small sample of participants, it is unclear how much attraction this would gain among other types of users (Ananthanarayan et al., 2014). Lee et al.

suggested that trackers that show patina of use over time motivate participants to increase their exercise levels (Lee et al., 2015). Shih et al. pointed out that the problems of device aesthetics leads participants to remove the devices and subsequently forget to put them back on. They speculated that tracking technologies might successfully be implemented into other more critical everyday objects, such as key fobs, glasses, and smartphones (Shih et al., 2015). These research efforts are important steps towards opening up to a broader understanding of what activity tracking devices might look like.

Data visualizations and data handling

Apart from the physical shape and aesthetics of activity tracking devices, attention has also been paid to visualization of the gathered data and data handling in general.

As trackers become smaller and have perhaps overcome some of the initial barriers (due to longer battery time, more different types of devices available, etc.), it is critical to study how the growing amounts of data can best be presented to be of true value to the user. (Altenhoff et al., 2015) found that the app is pivotal to the user experience, and can weigh more in the final evaluation than the tracker itself.

In 2008, (Consolvo, McDonald, et al., 2008) started exploring visualizations shown on mobile displays, not just on the tracker itself or on a computer. Using a garden that grew as the wearer increased physical activity, this system also took a step away from the more common visualization of graphs and pure numbers. In a different paper, participants with access to the displays maintained their activity levels, whereas activity levels for participants without the displays declined (Consolvo, Klasnja, et al., 2008).

Reminders can be crucial for sustained engagement, but getting this right is a challenge. Shih et al. suggested reminding users to wear the devices rather than reminding them of their activity goals (Shih et al., 2015). Furthermore, glanceable display of activity numbers incorporated into watches increased amount of times users engaged with their watch (Gouveia et al., 2016). In 2012, researchers found that peripheral displays also proved to be effective for informing users about their sleep habits (Bauer et al., 2012). Rabbi et al. showed how feedback, which is personalized and based on low-effort suggestions, is an interesting avenue for further research as technologies gather more and more data and the user group grows in diversity (Rabbi et al., 2015). These results showed lightweight, here-and-now checking of data, rather than prolonged “data-tinkering,” can be more interesting to users.

Whooley et al., focusing on members of the QS movement, suggested that there are at least three ways of representing data that can support reflection well. Binary representations allow users to see whether a certain goal has been reached or not. Structured representations are in the form of visualization, such as tables or graphs.

Abstract representations are more artistic in their expression and often demand more explanation from the user. The authors suggested that self-tracking technologies should allow for better export and combination of data (Whooley et al., 2014). Again, we note that these results are based on members of the QS movement, who are likely to have greater data and technological familiarity as well as be willing to spend much more time on arriving at personally meaningful visualizations. Overall, research has found that personal preferences play an important role but have not yet found clear-cut patterns for how this plays out (Shih et al., 2015).

(Epstein et al., 2014) explored which visualizations that people with varying specific goals might find appropriate. They found no clear patterns. Instead, they encouraged future device developers to present the user with different kinds of visualizations and leave it to the user to explore and evaluate which are most useful and appropriate in their situation. As such, research supported that devices with a variety of visualizations, with which the user can explore and then settle on which they prefer, are likely to be positively received compared to those devices that only present numbers or standard graphs and charts. Furthermore, when considering which visualizations users will need if returning after lapsing in use, designers should take into consideration user previous experiences (Epstein, Kang, et al., 2016).

Data handling is yet another aspect of the tracking device design, which seems to be important to users and needs to be addressed if user experience is to be improved. Data handling refers to the ways in which users are allowed, or not allowed, to handle the data gathered by the devices. To ease the burden of data collection, many devices infer that certain types of movement can be equivalent to numbers of steps or running. However, most devices are far from accurate and thus often confuse users. Several studies suggested that activity trackers should support increased transparency of what these devices can and cannot detect (Mackinlay, 2013; Marcengo et al., 2016; Yang et al., 2015).

(Harrison et al., 2015) suggested allowing users to customize “*their own activity classifiers,*” which would allow users to train their trackers to record the type of exercise that they engage in. Others noted that it is important to make it possible for users to add, edit, and delete inferred data (Consolvo, McDonald, et al., 2008). It seems there is still work to do in figuring out how to help the users find exactly how much, and which, data to collect (Cordeiro, Epstein, et al., 2015). This is further complicated by the fact that while easing the burden of data collection improves user experiences, this has negative effects on immediate awareness (Li et al., 2012). Elsdén et al. investigated not just how data is used here-and-now, but also how users reconstruct their past based on streams of quantified data. Using the notion of “data-work,” Elsdén et al. suggested that data is used to “*re-construct particular narratives, such that their data gains enduring personal meaning*” (Elsdén et al., 2015). We expect such research to be of increasing importance as

self-tracking practices continue to add to the growing amounts of data collected about people.

Open reflection and context awareness

Going beyond the mechanics of data handling, researchers have looked at supporting reflection as a process. In 2009, Consolvo et al. found that users prefer setting their own goals or getting support by a fitness expert (Consolvo, Klasnja, et al., 2009). Munson and Consolvo confirmed this finding and showed that setting secondary goals seems to be beneficial (Munson & Consolvo, 2012). Despite this, in 2012, Baumer et al. found that most technologies in the health behavior change area tend to be prescriptive. That is, they tend to tell the user “*implicitly or explicitly what to do*” (Baumer et al., 2012). Their research suggested that user experience might be improved if open-ended social awareness is supported. While activity tracking elicits feelings of accountability, it seems that making goals public (shared on Facebook, for example) can make users avoid setting goals in the first place (Munson et al., 2015). Lee et al. suggested taking a step back and supporting users in finding what matters to them, in order to be able to better personalize devices to fit their needs (Lee et al., 2015). In food tracking, photo capture showed promising results in regards to supporting users in capturing what is relevant to their eating context (Cordeiro, Bales, et al., 2015). Chung and Danis suggested that personalized reference groups can also support motivation and enables users to incorporate activities into their daily or weekly plans (Chung & Danis, 2016).

The proliferation of research in this area illustrates well that context of use varies greatly and should be taken into consideration. Looking specifically at the gym setting, and how wearables were adopted in this context, Patel and O’Kane showed that even this seemingly familiar environment turns out to be surprisingly complex (Patel & O’Kane, 2015). In the Step Up Life system, users were reminded to do physical activity, but the system also considered practical constraints such as location, personal preferences, calendar events, time of the day, and weather. Responses to this approach were positive, based on a small participant sample (4 in ethnographic observation, 47 in survey, 4 in deployment) (Rajanna et al., 2014). Context of everyday living, such as food intake and emotional state, can also have great impact on people’s blood pressure (Kendall et al., 2015) and sleep (Choe et al., 2015; Kay et al., 2012). People often need to connect their tracked data with daily activities and events to explain the variation shown in the data. However, hypothesizing and verifying these associations can be challenging and burdensome. There is a need for systems to identify anomalies and relationships, to help people understand their data, and to make decisions based on these relationships.

In general, it seems that there is a tendency towards developing trackers that can collect increasing amounts of data about the user. More data, however, might not necessarily make the user experience better in and of itself. In their study of Health Mashups, Bentley et al. argued that “*with more sensors and contextual attributes*

comes longer lists of observations. Discovering ways to properly sort and filter these lists based on the user's interest will become critical to the wide deployment of these types of services" (Bentley et al., 2013). Understanding which activities and contexts to track as well as how to present these to the user is important as tracking technologies are increasingly capable of tracking more and more activities and contexts. It seems clear by now that simply setting prescribed standard goals, with inflexible ways of capturing data, will not do the trick for most users. Research, fortunately, has begun to explore how to best support users in finding achievable, yet motivational goals and to support them in the process to reach these goals.

Exergames

One area of research has deliberately used game features to improve the user experience, often under the term *exergames*, which stands for exercise games. In a now widely known study in 2006, Lin et al. investigated how a social computer game, Fish'n'Steps, might influence the participant physical activity levels by tying the growth of an animated fish to the amount of walked steps (Lin et al., 2006).

The study also introduced social elements, as some participants could see the fish of other participants as well. Although the initial engagement with the game decreased within the first few weeks, some participants did walk more steps. With a different strategy, Jensen et al. worked deliberately to hide exercise elements in their PHANTOM game. They found that the storyline was important if the game should be developed to sustain engagement. Authors also emphasize the challenge of developing exciting, but not consuming, games so that users can be aware of important details, such as traffic conditions (Jensen et al., 2010).

Research in exergames has increasing focus on children. In a school based study, (Macvean & Robertson, 2013) found that after initial excitement, the intensity of exercise reached a plateau. Similar to (Jensen et al., 2010), they also encouraged development of storylines in the game to sustain engagement. For some, competition elements were not helpful, and how to set goals that fit with user self-efficacy profiles remains a challenge (Macvean & Robertson, 2013). Miller et al. found that the game elements of their school based system, StepStream, supported students toward increased daily activity, even for the least-active students (Miller & Mynatt, 2014). This system discouraged direct competition, designing specifically for collective efficacy rather than self-efficacy, to motivate all students rather than only top performers. Such an approach clearly has potential.

Family settings are also an important context for developing health and active habits in children. With this in mind, Saksono et al. focused their SpaceShip system on low-income families. Again, we see how the authors worked to design collaborative game elements in an attempt to sidestep negative outcomes of competition elements. Specifically, SpaceShip Launch was designed to encourage parents and children to work together. Interestingly, Saksono et al. found that

participants specifically asked for competition elements to be introduced into the system (Saksono et al., 2015).

Overall, the research in the area of exergames shows some promising results, meaning that the game elements can create engaging experiences. However, long-term engagement remains unknown with these strategies, and study results generally support that games should develop over time to keep engagement sustained. These research efforts have started to take on challenges of engaging particular user groups, such as school children or families, but more work in this space is needed. Specifically, it is pivotal to understand how to utilize the motivational aspects of competition elements while avoiding negative consequences, such as only encouraging top performers or generally discouraging users.

In general, these research efforts build on the realization that users differ widely in their demands to the technologies. We find, however, that this body of research has focused rather one-sidedly on the “problem” of less-than-expected-uptake. That is, they focus on how the tracking technologies should be altered to increase use, without necessarily considering more underlying reason for why technologies might be abandoned. Of course, solving obvious technological barriers is important. However, focusing on other reasons for abandonment is also crucial.

4.5 Social aspects of tracking

Although self-tracking technologies by design focus on individual behavior, researchers have long recognized the inherent social aspects of self-tracking in general. As more people start to record their behavior and activities, possibilities for more social engagements also increase. People could potentially connect with others who engage in similar forms of tracking or whose habits and life routines might overlap. Such social configurations could involve family, friends, or even strangers. (Harrison et al., 2015) suggest that as self-tracking becomes popular, many people start to consider sharing or performing tracking activities with people they know in their everyday life. In this way, self-tracking can lead to new types of social experiences (Karapanos et al., 2016). These studies investigated the design space to support tracking in various context that connected with people’s everyday lives, such as family (Grimes & Tan, 2009; Saksono et al., 2015) or workplace context (Boulard Masson et al., 2016; Gorm & Shklovski, 2016b, 2016a). As part of the process of seeking health advice from health professionals, using self-tracked data can also support health-related decision making or education (Chung et al., 2016; Grönvall & Verdezoto, 2013; Mamykina et al., 2008; Ryokai et al., 2015).

In some studies, “social” means being able to connect to or share their data with people who perform similar health behavior or tracking activities (Baumer et al., 2012; Harrison et al., 2015; Lin et al., 2006; Rooksby et al., 2015). These studies use collaboration or competition approaches to motivate their users to be more

active by leveraging the social features. For example, some studies include in-person friends (as opposed to online, virtual friends using particular tracking apps) or people in the same local community to motivate more sustainable healthy behaviors (Copelton, 2010; Drew & Gore, 2014; Miller & Mynatt, 2014; Parker, 2014; Toscos et al., 2006).

Research in the social sciences asserts that social support can promote engagement and motivation toward healthy behavior (e.g. Consolvo et al., 2006; Lin et al., 2006). Much research has since studied how systems should support competition versus cooperation and provided more nuanced understandings around social support. Participants of Houston (Consolvo et al., 2006) and Fish'n'Steps (Lin et al., 2006) showed mixed reactions to designs supporting competitions. People felt that comparing their own results to other's performance was helpful but could cause unnecessary stress. (Klasnja, Consolvo, McDonald, et al., 2009) further reflected on whether social support should be the main motivator for behavior change and called for more research for how to design for social support. Similarly, "Pass the Ball" found that their participants went through conflicting experiences between competition and cooperation, with some part of the experience motivating and others discouraging (Rooksby et al., 2015). In recent years, there has been more research approaching for a more "open-ended" social experience to allow users to define what level of information they would like to share (Baumer et al., 2012) and with whom they deem appropriate to share (Harrison et al., 2015).

Competition and cooperation in the design of activity-tracking can be further complicated in family contexts. Both (Harrison et al., 2015) and (Chung & Danis, 2016) mentioned that their participants prefer comparing their performances with family members or friends. When designing for family tracking, (Grimes & Tan, 2009) showed that family interaction creates different opportunities for competition and collaboration. Family members can help fill out each other's data and create a more complete record. Their natural interaction also allows family members to reflect on their data collectively and promote awareness toward health. Using an exergame to promote physical activity in a family context, participants in (Saksono et al., 2015) explained that properly designed competition led to more connectedness among family members. Leveraging existing relationships among family members, these studies showed a rich research agenda to support tracking via natural-formed groups rather than orienting exclusively towards individuals.

Six studies have also looked at peers as another type of social group to promote health and wellbeing. Peer influences are particularly prevalent in how adolescent makes choices around food and physical activities (Miller & Mynatt, 2014; Toscos et al., 2006). Some of the studies focusing on school-based activity tracking also emphasized on the importance of facilitators, such as teachers and other staff in the schools, and how their interaction with students can have an influence on overall health promotion and health tracking behavior. However, the studies described above worked with small samples and specific populations. We would caution that

families, friends, and other peer-groups could present a variety of social configurations and power dynamics, some of which may not at all be conducive to engaging in collective activity-tracking efforts. Studies are needed to investigate such dynamics more fully.

As companies start to adopt health-tracking programs into the workplace, employees also begin to share their tracked data with their colleagues or employers (Chung & Danis, 2016; Gorm & Shklovski, 2016b, 2016a). Bringing personal health into the workplace has led to tensions between engagement and privacy. On the one hand, these programs hope to leverage collaboration or competition among colleagues as a motivation to improve employee health and wellness. On the other hand, the norms of whether and with whom it is appropriate to share particular details about health and personal life can be obscure when companies sponsor and incentivize self-tracking in the workplace context.

People also share their self-tracking data with health professionals and others in their care network. Sharing this data can help health professionals identify education opportunities (Mamykina et al., 2008), personalize treatment (Chung et al., 2016), and build relationships (Grönvall & Verdezoto, 2013). Patients with chronic diseases or conditions often work with their caregivers to manage symptoms in their everyday lives. Sharing tracking data can help caregivers to be more aware of the patient condition and to provide necessary support (Chung et al., 2016). The goal of sharing with health professionals or caregivers can influence people's motivation and decisions about tracking (Grönvall & Verdezoto, 2013). This line of work also highlighted how people can have different privacy expectations when sharing tracked data with various others in their lives (Chung et al., 2016; Grönvall & Verdezoto, 2013). Understanding whether and how sharing tracking data can support better care is also an important research direction for future studies around using self-tracking data in the context of health.

A growing number of studies have drawn attention to the social aspects of tracking. Their results show that people do not track completely on their own, but with various social groups, as self-tracking technologies increasingly intertwines with their everyday lives. We expect more studies in the future to shed light on nuanced understandings about how people track in social contexts and how systems should be designed to support the social use of tracking.

Privacy

Sharing data with social circles leaves users open to a variety of problematic privacy invasions, such as stalking, criminal activity, or reputational harm, as tracking data may reveal location and sensitive information either directly or through simple inference. Health data is also a commodity traded between companies, leaving users vulnerable to discriminatory action in relation to employment or insurance processes for example (Klasnja, Consolvo, & Choudhury,

2009; Patterson, 2013). Privacy concerns related to self-tracking technologies have gained increasing media and research attention (Moore & Piwek, 2016; Weingarten, 2016). Despite this attention, we see only a few empirical qualitative studies specifically considering privacy concerns.

(Cercos & Mueller, 2013) found that their participants did not have privacy concerns in a study of sharing step-data with a closed social circle. Like Cercos et al., Patterson found that participants were seemingly unconcerned, yet this may have been because they underestimated the amount of data they shared with their Fitbit tracking devices (Patterson, 2013). However, when tracking takes place in a context where others might be around, such as collecting sleep data when partners are in bed, privacy of both parties needs to be considered in the design process (Lawson et al., 2013). In a study of workplace step tracking, in which employees shared step-counts with their colleagues, (Gorm & Shklovski, 2016a) found that privacy concerns developed as the campaign progressed. Participants in the campaign learned how the seemingly innocuous steps actually revealed aspects of their life they would have otherwise kept private. In the context of the campaign they then had to re-negotiate these boundaries with other campaign participants (Gorm & Shklovski, 2016a).

Initial research showed that users have different preferences for data control, depending on which type of sensor is in use (Barua et al., 2013). This means technology developers should consider how to handle data in a way that lives up to the expectations of the user for that particular type of data collected by the specific device. Klasnja et al. suggested three ways to respect privacy while still insuring acceptability of sensing. They detailed that data should only be saved when users are engaging in relevant activities, the systems should be based “on minimally-invasive sensing”, and finally only the data which is necessary for the application to work should be captured (Klasnja, Consolvo, & Choudhury, 2009).

Despite these insights, the amount of research attending to privacy related issues of self-tracking does not match the level of concern raised by theoretical literature, media, or government institutions. The few empirical studies conducted in this area assert that privacy concerns depend on the type of data being tracked, and that concerns develop over time. Clearly more work is needed in this area.

5. STATUS OF 10 YEARS OF RESEARCH AND FUTURE DIRECTIONS

In this literature review we have gathered and analyzed 84 qualitative self-tracking studies, using grounded theory methods. Before turning to a discussion of the implications of our findings, we first consider two limitations of our work. First, the narrow keywords “qualitative” and “ethnography” could have resulted in privileging ethnographies, potentially leading to a lack of studies that include other qualitative methods. However, as we proceeded carefully through the steps of going forward and backwards through citations, we believe we have included relevant

studies using other qualitative methods. As our results show, ethnographic studies are a minority amongst the research in this space, and thus our search terms have not resulted in a lopsided focus on ethnographies. Second, our literature search was conducted in the beginning of 2017, and we are aware that papers published late 2016 may not have been available at the time of our search. To address this limitation, as we point to future research avenues based on the current research, we acknowledge that some researchers have already begun addressing our recommendations. Rather than expanding the timeframe and including more papers (a potentially never-ending approach), we have tried to acknowledge and cite this literature when relevant.

Our first research question asked, which research goals are prevalent in qualitative studies of self-tracking between 2006 and 2016. We find that the studies can be divided into four categories depending on their main research goal. 39 studies had a main research goal of testing to improve new tools or software. In the second largest group of studies, 31 studies set out to enquire about attitudes, experience, and challenges of activity tracking. Studying particular settings by using ethnographic methods is the main research goal of 10 studies, while 6 studies investigate existing material. Our findings support the claims that most research has indeed been focused on developing and testing new technologies (Rooksby et al., 2014) as this is the largest number of studies fall into this category. However, we also found that many studies have begun to examine the challenges of existing technologies in everyday life and the impact to self-tracking practices when people are in different contexts or settings. Future research should continue to investigate how particular settings influence tracking experiences and practices. Answering this question might require a reconsideration of methodologies. For example, (Gorm & Shklovski, 2017) encouraged participants to take photos of everyday experiences with their activity tracking devices. Gouveia et al. combined data from the tracking devices with video recording from wearable cameras (Ruben Gouveia, Karapanos, & Hassenzahl, 2018). These methods allowed researchers to gather insights into continuous reflections of activity tracking over time. We encourage future studies to continue the work of expanding and discussing appropriate methodological tools to understand lived experiences of activity tracking.

When considering the main themes and discussions across the 84 papers in our analysis, we identified five main areas of concern. The first concern focuses on who uses activity trackers and who, necessarily, is the focus of research. We found that the bulk of the research focuses on first movers or relatively young and healthy people, typically between 20-45 years old, highly familiar with technology, and with a desire to become more physically active. As self-tracking technologies keep gaining in popularity, broadening the focus on other age groups and types of users is paramount. Research shows that in the US, older users, aged between 55-64, also

increasingly own activity tracking devices, but their goals differ from their younger counter-parts (Ledger & McCaffrey, 2014). We also see a lack of studies considering whether activity tracking technologies could play a role in combatting health disparities, or be of use in groups of lower social economic status. Some research has begun to consider activity tracking as part of school projects to increase physical activity levels (Miller & Mynatt, 2014). However, future research should expand the diversity in the demographics of study participants, covering a broader range of users, rather than only those who were easily accessible (Saksono et al., 2018).

The second concern addresses the variety of models and conceptualizations of activity tracking as efforts to describe and theorize this space. These models and conceptualizations create a language useful for engaging with activity tracking and its inherent complexities. Yet we find little uptake of many of these concepts and models across the empirical work we reviewed. Greater engagement with theoretical language may enable development of more comprehensive models that would better engage with the boundaries and edge cases of self-tracking as well as addressing the ever-changing average user. For example, previous HCI research has called attention to the need for considerations of when technologies are appropriate or not appropriate (Baumer & Silberman, 2011). We welcome research that apply this lens and incorporate it as part of the language in this space.

The third concern addresses what some have called “the dirty secret” of self-tracking – the fact that despite the popularity of activity tracking devices, more than a third of these are left in a drawer within six months. Such abandonment is often portrayed as a problem that can and should be fixed if technologies are developed in better ways. Indeed, improvement of shape and aesthetics, data visualizations, open reflection and context awareness, as well as exergame strategies, are the focus of 33 papers. These efforts address the fourth concern of user experience and form factor of the devices themselves. Although there is a growing attention to the varieties of reasons for abandonment (Clawson et al., 2015) or lapsing (Epstein et al., 2015), many studies continue to ignore the reasons why participants drop out. Non-use of technologies has been addressed more generally in some HCI research (Satchell & Dourish, 2009; Selwyn, 2003). However, given the increasing integration of activity tracking into workplace and insurance health-incentive programs, understanding the nuances of non-use is paramount. Adherence and a one-sided focus on ongoing use may not be the optimal goal. Rather, activity-tracking tools could be designed to deliver desired benefits with a variety of use approaches and strategies, incorporating different forms of lapsing (Epstein et al., 2015).

The final concern engages with the social aspects of self-tracking practices. Research has thus far highlighted how self-tracking is rarely a purely individual endeavor, but rather influences and is influenced by social settings. One issue to consider when investigating tracking in a variety of social contexts is how privacy

expectations about tracked data might change across contexts and over time (Gorm & Shklovski, 2016a). Across the 84 studies, however, only 7 have explicitly dealt with privacy issues, far fewer than what contemporary media discussions might have lead us to expect. Further research in this area is important to protect the individual user as well as the social groups they are a part of.

Researchers have previously called for more qualitative research in the everyday uses of self-tracking technologies. With this literature review we show how a substantial amount of research has, in fact, already been conducted. What has been lacking, however, is a greater overview and link between research endeavors, to which this literature review provides first steps.

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Paper 2

Gorm, N. & Shklovski, I. (2016) Steps, Choices, and Moral Accounting: Observations from a Step-Counting Campaign in the Workplace. *CSCW '16*.

Steps, Choices and Moral Accounting: Observations from a Step-Counting Campaign in the Workplace

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ABSTRACT

Sedentary work is a contributing factor to growing obesity levels worldwide. Research shows that step-counters can offer a way to motivate greater physical mobility. We present an in-situ study of a nation-wide workplace step-counting campaign. Our findings show that in the context of the workplace steps are a socially negotiated quantity and that participation in the campaign has an impact on those who volunteer to participate and those who opt-out. We highlight that specific health promotion initiatives do not operate in a vacuum, but are experienced as one out of many efforts offered to the employees. Using a social ecology lens we illustrate how conceptualizing a step-counting campaign as a health promotion rather than a behavior change effort can have implications for what is construed as success.

Author Keywords

Self-tracking; workplace; pedometer; health promotion; campaign; step-counter; social ecology;

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

The increasing trend toward desk-based sedentary work appears to contribute to the growing levels of obesity worldwide, which is a known risk factor associated with diabetes, cancer and cardiovascular disease [11]. Research in health informatics [13], health-behavior change [30] and quantified self [2,8] suggests that personal tracking technologies such as step-counters can be used to motivate improvements in daily mobility [38]. In fact, Maitland notes that pedometers are the most commonly used technologies in behavior change efforts [21]. Even though the durability of positive health changes and the long-term effects of step-

counters remain unknown, there is ample evidence that in the short-term, the use of these technologies can indeed improve physical mobility [16,19,35]. As pedometers gain in popularity we see examples of broad health and physical exercise campaign deployments to get people moving, targeting the workplace (e.g. 10000stepsusa.com in the US, and talskridt.dk in Denmark). These campaigns rely on the seeming simplicity of the step-counter technology to facilitate or encourage mobility. As the use of step-counters in the workplace becomes integrated with insurance premiums and other financial incentives [6] it is important to go beyond the question of whether or not these campaigns are successful given the narrowly defined goal of increasing mobility by counting steps. We asked what does a national step-counting workplace campaign look like, in practice? How does the use of step-counters fit with social practices within a workplace where both users and non-users are co-located and interact on a daily basis? Finally, how might we re-define the notion of success of campaign efforts going beyond the quantitative measures of steps and durations?

Based on observations from a Danish workplace we offer insights into practical and social experiences of a voluntary national three-week long step-counting campaign in one particular department of an organization where the majority of employees chose to participate. We address how an individually focused technology, such as the step-counter, can become integrated in and is experienced as part of the workplace. Although many of the technology-design for behavior change interventions tend to narrowly focus on targeting specific behaviors, we illustrate how a behavior change strategy to ‘get people walking’ may not be quite as straight forward and instrumental as expected and discuss insights relevant to future technological interventions targeting promotion of healthier behaviors in the workplace. Finally, we propose that evaluations of these efforts would benefit from including an ecological lens as part of technology use for health promotion [21], concluding with a discussion of broader considerations for CSCW research.

BACKGROUND

Although the actual effect of step-counters is widely debated, a systematic review conducted by Bravata and colleagues concluded that sustained use of pedometers was indeed associated with increases in physical activity that resulted in positive health effects such as decreases in BMI and blood pressure [3]. Step-counters often promote a

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standard goal of 10,000 steps a day, which is an arbitrary and somewhat random number [38]. Nevertheless, research has shown that this number is similar to the recommendations of US public health guidelines, and Danish health authorities¹, recommending 30 minutes of moderate physical activity per day for adults [38].

Off-the-shelf activity sensing wearable technologies such as Fitbit, Jawbone or Nike FuelBand and smartphone trackers and health apps such as My Fitness Pal have been the focus of extensive research in HCI and CSCW [13,30]. Earlier studies demonstrated that positive reinforcements [19], user control over data visualization and interpretation [2] and the ability for users to set their own primary and secondary goals [24] were key for technology-based health interventions to be fruitful. Later work focused on more qualitative and in-situ investigations. Fritz et al. conducted an extensive study of in the wild long-term use of activity tracking devices noting that the goals and needs of long-term users change over time and need to be supported by technology designers [13]. Rooksby et al. explored the lived experience of using multiple step-counting and tracking technologies, emphasizing that people weave the use of these technologies into their everyday practices with behavior change happening across multiple technologies over time rather than through the use of one particular device [30]. Most importantly these and many other studies have noted the decidedly social nature of health technology use that comes with its own issues and benefits [8,10,20].

The Social Context of Health Technologies

Even early on, researchers realized that focusing exclusively on the individual and their internal motivations in health behavior change efforts may not be as productive, and that practical constraints should be considered [7]. For example one early study of women, who wanted to be more physically active, identified key implications for design requirements that included paying attention to practical constraints of users' everyday lives [7]. Later studies, concerned with sharing of personal achievements with physical activity have had to acknowledge the social context within which these activities are conducted, thus addressing privacy concerns [10]. Similarly, the focus on whether these technologies are successful in lowering BMI, increasing mobility and other quantitative markers tends to overlook the more qualitative aspects of the lived experience with these devices. Maitland has proposed to consider a negotiation framework to include a broader range of resources individuals have access to and constraints they may experience as part of the design process [21].

Research shows that social support and social pressure positively influence user motivation [4,18] and participation in teams increases activity levels [1,4,16]. Yet any effort toward behavior change, whether it is internally motivated by

the individuals or externally motivated through health-focused interventions, involves a re-alignment of accountabilities [12,37]. By design step-counters make the embodied physical action of walking into a practice of counting. Why people do the walking that is counted by the device then can become an important point of discussion especially in the context of efforts that rely on forms of gaming or competitiveness [1,19,27]. Buis et al. observed this in their studies of team-based online health interventions [4], showing how individuals participating in team-based step-counting initiatives become accountable to each other for both the number of the steps they take and their reasons for walking.

Activity Sensing in the Workplace

Despite the range of research on behavior change few studies have focused on the workplace – a context where sedentary practices are becoming ever more prevalent. Several studies have recruited from workplace settings, due to ease of access to e-mail lists, but these did not consider the use of the step-counter in the workplace as a focus area, nor the influence of the workplace as a specific social setting [4,19,29]. Current research in HCI on improving workplace activity is preoccupied with adding more sensors to the worker, who can then for example track their posture and stretching statistics [27], or with developing new *physical movement probes*, such as an active desk or an irritating chair [35]. Yet health-incentives in the workplace are not a new development and integrations of technology into health campaigns and insurance incentive initiatives are ongoing.

In an overview of health data collection in the workplace, Christophersen et al. note that such practices can result in significant challenges causing employees to game the system in order to combat potential financial penalties due to low step-count numbers or other health indicators [6]. Zulman et al. conducted a study of one workplace insurance incentivized walking programs and found that despite extremely high participation levels participants disliked the program [41]. In contrast, Chan et al., Vyas et al. and Buis et al. studied voluntary workplace health and physical activity interventions and campaigns, finding that participants had positive experiences and, in the case of Chan et al. and Vyas et al. demonstrating short-term success of the programs [4,5,39]. Miller et al. quantitatively demonstrated an ostensibly successful implementation of a step-counting initiative by increasing physical activity levels in pupils [22]. Yet their qualitative investigation uncovered significant amounts of unpaid “hidden work” conducted by teachers to ensure success, when this seemingly simple initiative rolled out [23]. In all cases, researchers reported that the social aspects of the program were highly influential, especially in those studies that employed a qualitative approach.

Where are the Non-users?

Despite the fact that research has repeatedly recognized the importance of the social and environmental aspects of experience with using activity-tracking technologies, few studies have focused on this. Within the area of health technolo-

¹<https://www.sundhed.dk/borger/sundhed-og-forebyggelse/livsstil/motion/motion/>

gies, Munson has considered the notion of “cessation of use” as an analytical concept worth addressing but this does not cover those that opt out of participation entirely [26]. Rooksby et al. detailed some of the social experiences of the health technology users they tracked [30] and Maitland noted that technology users must negotiate with others around them to enable their successful implementation of behavior change [21]. Yet none of these researchers have considered the role of the non-users of health tracking in the context of use. Non-use of technology has previously received attention in the literature questioning assumptions about appropriateness of technology, considering the social role of non-use, or trying to understand why people might choose to or be forced to not use technology [2,31,33]. In the study at hand we consider specifically what happens when a large proportion of people in a workplace voluntarily begin using step-counters and continue to work alongside those who do not use these technologies for a range of reasons. Considerations of both use and non-use require a broader perspective than individual targeting and to do so we draw on the social ecological approach.

Social ecological approach

One of the most common goals in HCI research on health behavior change is to evaluate the rate of uptake and success of technologies and interventions. Concerns with healthy life-styles and behavior change have also been a staple in health promotion with research in the fields of communication, sociology, psychology, social ecology and public health focusing on identifying processes and practices that may or may not be effective. In this article we rely on Stokols’ “social ecology model for health promotion” which proposes a holistic approach balancing individual and environmental foci [34].

The social ecological approach suggests that the focus of health promotion initiatives should be on *both* behavioral and environmental levels. Social refers to the acknowledgment that individual behavior is shaped by their social and cultural contexts. Yet individuals also have the possibility to influence physical and social features of their settings. The framework relies on the concepts of active and passive elements of health promotion initiatives. Typically, environmentally focused elements are passive, as they require no action on behalf of the user. Active elements, on the other hand, are often at the core of behavioral change models for example, requiring on-going and voluntary effort to reap benefits [34]. Health promotion initiatives incorporating both active and passive elements are more likely to have lasting effects, as they are designed to intervene at both situational and personal levels [34]. For example, offering smoking cessation courses or hotlines (active element), while also introducing smoking bans in public places, or raising tobacco prices (passive elements), jointly increases the chance of smoking cessation.

In this paper we investigate how a nation-wide step-counting campaign is experienced in situ in a specific work

environment. Arguably, a step-counting campaign has a narrow focus on a specific behavior in the service of ‘getting people walking’. The marker of success then might be how many people increased how much they walked during the campaign and how many continued with the use of pedometers after the campaign ends. At first glance, there is little here that might speak to the social ecology model yet our findings suggest that there are plenty of active and passive elements to campaign implementation that rely on both individual and environmental factors.

A social ecological approach makes it possible to discuss non-use more broadly than has been the case in individually focused studies, where non-use is often understood as a shortfall of the individual [28,32]. Social ecology is a way of thinking about behavior change as a social experience, that considers how a combination of active and passive elements is important for lasting impact [34]. Consequently, we can go beyond the common question of ‘did it work?’ By construing the step-counting campaign as a health promotion rather than a behavior change initiative [21] we can focus on how and why users utilize step-counters alongside considerations of non-use and the broader context of campaign deployment [17]. This study adds to prior studies by looking at users and non-users of step-counters in a social setting of the workplace. By investigating what the experience is like for employees in a particular department, our study considers encounters with the health campaign promoting step-counters at both site-level and individual level.

RESEARCH CONTEXT

The campaign

Tæl Skridt (Count Steps) is a bi-annual three-week long health promotion initiative conducted in the spring and fall by the Danish Company Sports association. The goal of the campaign is to walk at least 10.000 steps for 11 out of the 21 campaign days. If this goal is met, the team enters a lottery with a 1st prize of 50.000 DKK. In the 2015 spring campaign 18.112 employees participated across Denmark. Many of the private and public sector employers offer participation in this campaign as a voluntary health promotion initiative to employees who then organize themselves and engage with the campaign directly.

Generally employees have to pay to participate although some companies do cover the fee (50DKK). Employees in participating companies sign up as teams, elect a team captain, and commit to wearing a pedometer sensor of some kind – either a step-counter or an app downloaded to their smartphone, resulting in a significant diversity of devices. Each participant has a personal login and must manually enter their daily number of steps on the website, or have their team captain do it. The campaign website offers manual converters so that participants can include activities such as cycling, swimming, golf or house chores, into their daily step-counting totals. The website provides an overview of step totals for individual participants and teams. Every participant can see step count totals of other teams,

and step counts of other participants they might choose to challenge. Employees can choose to sign up with their own name or company initials. Within the department under study we observed that employees could identify each other on the site regardless of the username choices.

The Tæl Skridt campaign began as a purely internet mediated health promotion program, but as pedometers gained in popularity these were added because it simplified activity reporting, resulting in a substantial increase in the number of participants. In a phone interview the campaign manager noted that the least physically active participants are more active during, and after the campaign, based on subjective measures prior to and 5 months after the campaign.

The company

The Danish company under study is relatively large with more than 2.000 employees, offices in several locations inside of Denmark, and a few offices abroad. The company handles and invests customer savings and thus employees engage with a range of technologies for work tasks, resulting in a generally tech savvy workforce. The site of observation was one of the departments at the headquarters of the company. The department contains three sub-sections spread over two open office spaces, divided by a hallway with a coffee/ tea area. The three sections deal with different focus areas, but work cuts across the sections, and they jointly participate in weekly department meetings.

According to the Tæl Skridt campaign organizers the majority of participants in the campaign were involved in sedentary work practices, and had no direct relation with the self-tracking industry². This defined our criteria for selecting the company to study. The company and its employees were unknown to the authors prior to the start of the study. We were able to gain access through a university contact. Prior to the start of the campaign the first author briefly explained the methods and goals of the study when she was introduced to the entire staff at a department meeting and obtained permission to conduct the study.

METHODS

In conducting the study we relied on traditional ethnographic methods of observation, informal interaction and semi-structured interviewing over the course of four weeks that included the three weeks of the campaign. The first author participated in work meetings, sat at a desk allocated to her in the open office space alongside the employees, joined in the lunch breaks, department meetings and Friday breakfasts, and generally partook in the daily life of the office during 12 workdays in March 2015. Observations were spread out to include time pre-, and post campaign. These observations provided insight into the actual use of the step-counters during office hours, as well as naturally occurring conversations between employees in the open office and during walks to the coffee machine or cafeteria. The author will, necessarily, have prompted discussion of the technol-

ogy merely by her presence, however, only joined in conversations on the step-counter when these were initiated by the employees. The author participated in conversations on all subjects, showing a broad interest in the work practices and life of the employees. Authors did not participate in the campaign as participation requirements prevented this. We conducted semi-structured follow-up interviews with nine employees after the step counting campaign ended, focusing on participation/non-participation reflections and thoughts on self-tracking technologies more generally.

Counting full-, and part-time employees, as well as section leaders and interns, the department consisted of 28 employees (20 females and 8 males). 17 employees participated in the campaign (hereafter *participants*), while 11 employees did not participate for a range of reasons (hereafter *non-participants*). A few participants had devices from the prior year or had their own step counter bought outside of the campaign, some bought new step counters, while others used apps on their smartphones.

Field notes and interview transcripts were coded using open and iterative focused coding [9]. The two authors compared codes, engaging in an iterative process of analysis and writing to identify main themes emergent from the data. To indicate data sources, the quotes presented below are denoted with *interview* for follow up interviews, or *observation* for observations and conversations during the campaign. We use pseudonyms to refer to particular participants.

FINDINGS

We identified four emergent themes from the observations and follow-up interviews. We begin by considering the social nature of counting steps and the new sorts of accountabilities that emerge from this activity. As more than a third of the employees could not or did not participate in the campaign we discuss their reasons and their experience. Finally, we consider the outcomes of the campaign and what insights applying a social ecology lens can produce.

Social negotiations of steps

The technical implementation of step counters calls little attention to just what is this step that is being counted. For the most part, pedometers promote the idea that counting steps is a simple process with step being an obvious currency. Yet from the start of the campaign and continuing into the first week we observed participants putting considerable effort into figuring out what counted as a step. For example, step counters worn on the body may count steps differently than cellphone apps. Participants struggled to figure out whether the differences in their final step counts stemmed from differences across devices or differences between participants (that some were just more active). In the beginning of the campaign participants would jump up and down or shake their device, to see what made it count a step. Colleagues would walk next to each other to the canteen and back, and then compare how many steps their respective devices had counted. While we observed such experiments among participants who used the same type of device, the

² Phone interview with campaign organizers

diversity of step-counting devices used in the campaign no doubt contributed to how frequently and extensively participants engaged in these:

Erica and Jane discussed step counting during a casual talk by the coffee machine. Erica explained how she had been for a run, and knew that the run was 4.5km, but that the mobile app only registered 2km. "So I decided to buy a step-counter" she explained.

Jane replied: "I've had several apps in order to compare them, but right now I use the one called 'Walkabout'. Yesterday I just needed 500 more steps on the way home from the station and I was thinking to myself that that would add up perfectly, but then it ran out of battery. Really annoying!"

(Female participants, observation week 1)

This confusion about step counting was further perpetuated because of the online converter schema. The campaign website allowed participants to convert any physical activities they liked into a number of steps calculated via a formula that included activity type, duration and intensity. Participants looked up an activity, entered the amount of time spent on it, and the level of intensity and the converter calculated the number of steps. In this way, nearly any activity could be reduced to steps. In the office one day, a female participant started a discussion amongst participants when she tried to figure out how many steps her swimming session added up to, puzzling over the level of intensity:

Rachel: Maybe I just felt like it was intense! It just adds up to a crazy amount of steps. Maybe it was only 55 minutes if I have to be completely honest. So I had 6258 steps from yesterday, plus 10577 from swimming. Just imagine that it's so efficient to swim!

[Participants discuss whether it is really true that swimming amounts to so many steps]

Rachel: Now I am not behind anymore. I am incredibly motivated to swim some more!

(Female participant, observation week 1)

Although many participants appreciated the ability to convert other activities into steps, discussions and self-reflections such as the observations described above were frequent and ranged from figuring out the mechanics of converters to needling each other over whether swimming really should be counted for as many steps as running. In this way, the steps counted by the devices were not taken as objective truths, and questions about intensity levels were genuinely considered as an issue to be reasoned about.

Fairness and moral accounting of steps

The process of becoming familiar with step-counting technologies meant that participants had to discover and negotiate the faults and benefits of their personal choices in which technologies to use. Some participants switched out devices, or tried out new apps, to find something that not only fit

their specific needs, but that they also could perceive as precise and fair in the context of competitive step-counting. Consider the following discussion:

Jonas: Yes, I think it might also count when you bike or something, I mean so I just saw how much I would get when I walked the dog and then of course I would count that in, but some of the other things I didn't count in because that was too much, it was like it counted too many...

Interviewer: It counted too much?

Jonas: I just felt like it was a bit too high

Interviewer: And then you adjusted it

Jonas: So it wasn't unreasonable

(Male participant, interview)

In the excerpt above Jonas can only know that his step counter counted too many steps because he has compared across apps, and compared with other participants. In this way he was able to adjust his step count to a number that was not "*too much*." To Jonas as well as to many other participants step counting was clearly not a straightforward activity, but at least initially required some evaluation and negotiation. The counting of steps then was also a kind of moral reasoning, judging fairness towards other participants as well as personal achievement through numbers [14]. In a discussion of moral action Johnson [14:62] argues that moral reasoning is guided through metaphor and that "the *logic* of the metaphor determines our expectations, our reasoning, and our action." He proposes *moral accounting* as a metaphor that is concerned with what we owe other people and what they owe us – a kind of transaction oriented towards increasing our own and their well being. In the social context of competitive counting of calories, steps or other quantified health-related bodily performance indicators, the metaphor of *moral accounting* is useful for thinking about how people might reason about their "duties, rights and obligations" towards each other [14:55].

Over time participants began to agree on how many steps a given activity ought to amount to, or how *fair* a device was. While the design of the Tæl Skridt campaign allowed participants to engage in the types of activity they preferred and not just focusing on walking steps, the common goal of 10.000 steps a day resulted in people attempting to compete on equal terms. Yet the various athletic endeavors were clearly not easily reducible to the step metric demanding moral choices and extensive social negotiation.

There are several reasons why participants were occupied with the accuracy and fairness of their devices and the converter. The campaign took place in the social setting of the workplace, and participants could at any given time log on to the website and see the step counts of their colleagues. Impressions of how a colleague would do (or how well their count was thought to reflect their actual activity level) in

this campaign could potentially spill-over into the general perception of that person. Since devices at times produced different step counts, figuring out how exactly that worked and where the differences stemmed from became an important topic, to make sure that the accumulated steps (and thus the self) were evaluated as moral, reasonable and fair by others. Thus some participants were concerned with entering a particular amount of steps to the website, because they wanted to be perceived as fair and reasonable colleagues. Others, however, were clearly not above taking advantage of the confusion over activity converters and occasionally nudging their averages higher. We occasionally observed that the numbers entered on the campaign website were suspiciously round – 7000, 8500, 9300, etc.

As such, a step count was not merely an accounting of physical movement, but a socially negotiated quantity with moral valence. Thus for some, counting steps also involved moral accounting [14] that they needed to perform alongside noting down numbers from their devices, pointing to the distinctly social nature of this activity.

Group competition and accountabilities of walking

Having decided how to work out the steps and conversions, the conversation among participants transitioned into frequent discussion of how their steps were reached. Saying for example, “I reached about 15.000 steps yesterday” was followed by questions, which opened up to discussions of who had dogs to walk, who had to drive to work and thus could not walk as much, etc. This became a welcomed ice-breaker, an occasion for colleagues to discuss non-work related activities and to strike up conversations in those few minutes before a meeting starts, at the coffee machine, or with colleagues that are in the periphery of ones core job tasks. While this was mostly seen as a net benefit, this could also at times result in potential breaching of work/private boundaries. Consider the following conversation in a follow-up interview:

Elizabeth: They would have to ask, and say, hey, how did you get to 20.000 steps? You must have been active during the weekend. And (colleague) said, that I had 3400 steps on Sunday, so she said, did you have a hangover, and I did (laughs). So... In that way

Interviewer: But that wasn't something you might have otherwise talked to her about?

Elizabeth: No, I mean I can't remember if it was me or her who said it first, but that's right, you do reveal some things because of this. It is not an excuse to just say, I was lazy then...

(Female participant, interview)

This interest in the source of the steps during both work and non-work hours was obvious and persistent. After all, individual behavior directly affected the team average. In this way, participants became accountable for their level of activity towards their teammates regardless of when said ac-

tivity was supposed to occur. Participants tried in various ways to negotiate these new accountabilities towards their colleagues, for example by creating secondary goals and assuring similar expectancy levels within teams.

Health behavior change studies have previously found that feelings of accountability made people more likely to fulfill their goals. Munson and Consolvo noted however that having different levels of goals (primary and secondary) as well as "non-judgmental reminders" was important [24]. In our study, while the campaign was relatively simple participants tended to jointly invent their own secondary goals. For example, two of the teams in the department had introduced additional internal competitions. One team captain awarded the weekly prize for winning the internal challenge (chocolates). Another team captain gave a chocolate a day to every team-member who reached 10.000 steps. These internal competitions were very important to the participants, sometimes even more so than the general goal of the campaign. The highly competitive nature of some of these internal competitions is evident in the following excerpt. In a follow-up interview, Jonas explains why he was perhaps more active during the campaign:

Jonas: Well, narh, maybe, I mean this weekend I actually biked a lot, I wanted to kill Gitte [female participant], so I biked more than what I would have.

(Male participant, interview)

Participants were well aware of the competitive elements of the campaign, both due to the fact that it is clearly a part of the campaign set-up, but also because some of the participants joined the campaign in the previous year and experienced differences in how much people cared about competing. The website showed both the individual amount of steps, and that of the team. In the campaigns' first iteration all of the participants signed up as one big team, as there are no limits to how many persons can join a team. This year the participants separated into four teams largely based on shared goals and level of competitiveness.

Charlotte and Emma two female participants, discuss in a casual conversation in the office how last year it was difficult when some people wanted to walk 5.000 steps a day and others wanted to walk 15.000 steps everyday. They agreed that it wasn't fun being at the bottom of the list [the website] of the entire department last year so even if you could still compare across teams this year, these separate teams were better.

(Female participants, observation week 1)

Matching expectations within the team became important to ensuring that all participants had a good experience. These new accountabilities of walking resulted in participants feeling motivated to walk an extra round with the dog at night, or bike those extra kilometers. The social ecology model suggests that health promotion efforts should seek to enhance the fit between people and their surroundings so as

to enable people to modify their behavior in accordance with their plans and preferences [34:290] The relatively unstructured nature of the campaign provided participants with the ability to control and negotiate counting steps from walking and other physical activity. Due to the ability to set secondary goals and to select teams that fit their preferences, participants were able to guide their interactions with each other and with their environment by managing levels of physical mobility as they relied on the step-counters to provide the necessary feedback.

Yet persistence of greater physical mobility after the campaign was not assured. Both during observations and in follow-up interviews participants remained positive about having to walk more precisely because this was a temporary requirement, since the campaign duration was just three weeks. For example, Rachel, who had been very active during the campaign explained in the follow-up interview:

Rachel: Yesterday we were all laughing saying how nice it is we're not counting steps [anymore], so now we can't be bothered going to the canteen to get coffee, now we just walk to the café. I mean we walked because we were a part of the campaign, and it doesn't have a health benefit if you're not wearing the step counter. We laughed at that.

(Female participant, interview)

Rachel, of course, was being ironic when she equated the step-counter rather than the actual walking with health. Yet this sentiment is less far-fetched than it might seem. A number of recent studies of various positive behaviors have demonstrated their association with less healthful practices. For example, people who bring their own bags to the grocery store rather than using the paper or plastic bags available at the store also tend to buy more junk food [15]. The count-steps campaign did create new, and for the time period of three weeks, largely positive accountabilities, encouraging greater mobility in a largely sedentary environment, but it also resulted in participants feeling entitled to chocolates and cakes as part of the campaign.

By making the number of steps visible participants became accountable towards their colleagues in ways, which reached out beyond the work sphere. Such accountabilities are not always a clear positive benefit as they might impinge on feelings of privacy and create uncomfortable amounts of social pressure [25]. This could be one motivation for non-participants to refrain from making a commitment of participate in the campaign. As it turned out, though, non-participants had a range of reasons for not choosing to participate, but apprehensions of accountability towards colleagues, while present were not a main concern.

Step counting as social currency

The step counting was a huge subject of conversation amongst participants, and the three weeks of the campaign did not go unnoticed by non-participants. Often, participants would get so caught up in checking the status on the

website, or in other behaviors such as walking to a coffee machine further away, walking to lunch in the furthest corner of the building, and even booking meeting rooms far away, that they did not notice how their non-participating colleagues were affected by this, or how they could not easily join the conversation.

Eleven of the twenty-eight employees in the department did not participate in the campaign, most commonly for administrative reasons. Interns, external consultants and part time employees were not allowed to join the campaign since they were not enrolled in the company sports association. For example, Christina expressed on several occasions that she would have really liked to join the campaign, and that it would perhaps have helped her to have more to talk about with her colleagues. However, given the campaign set up, she felt excluded, and "*couldn't contribute or participate in that conversation.*" When asked about how this resembled other projects in a company, where perhaps inability to participate in every conversation is natural, she replied

Christina: No, to me this was different because it has this social aspect, like, I don't feel outside like that, if someone's sitting there talking about, how far are you on that project, or did you get around to correcting this or that, what's the status, because it's a natural thing that that happens with projects, where this was like something that was accessible for almost everyone and therefore it was, it was a deselect, where in my case I just wasn't allowed. So there was a clear difference.

(Female non-participant, interview)

Diana, a part-time, project-based, employee bought a step counter to try to create "*her own campaign*", as she put it. But since the score on the website was so important to participants, and Diana was not on a team, we observed how she was essentially sidelined when conversations of step counting got going in the open office space. In this sense, participation was not really about technology use per se, but about the social team-based nature of interaction and the administrative hurdles of full time status and membership in the company sports association. Going back to the social ecology model we note that the active elements of owning a step-counting device and wanting to participate must be accompanied by the passive elements of enabling administrative infrastructures for the health promotion campaign to be effective more broadly.

Some employees of course chose not to participate for practical reasons, for example, one non-participant came back from paternity leave one day in to the campaign, and another felt that the hassle of getting a step-counter, and figuring it all out, would be too much. However, neither ruled out participating next time the campaign runs. Very few employees expressed direct resistance towards to campaign. For example, in the beginning of the campaign (week 1) we observed Betina (non-participant) being asked by Jakob (participant) why she wasn't joining in:

“And you even bike and run and stuff,” Jakob added, indicating that participation would not be difficult for her. To this Betina replied: “Yes, but then you have to register stuff and all kinds of things. The others have so far spent a couple of hours running around and setting up teams,” making it clear she felt they were wasting time during their work by doing this. Jakob replied: “I haven’t spent that much time,” and they left the conversation at that.

The situation was clearly somewhat uncomfortable, as Betina was openly criticizing the amount of time spent on setting up the campaign by her coworkers, and the fact that participants would spend time during their workday to register steps and discuss these with each other. In general, however, direct resistance and criticism of the campaign were not as outspoken as in the example above. Non-participants would, mainly, air their concerns or annoyance in casual conversations with the observing author, or in follow-up interviews. Therefore, participants had little reaction to non-participants’ concerns, as they mostly did not encounter them. Although the tensions were present the limited time of the campaign ensured that few were voiced.

Studies of non-use suggest that choosing not to use technology can be a way to keep control over ones life [31,33]. For example, Kirsten, a female non-participant, mentioned several times during the campaign how one of her friends had become obsessed with using a step-counter, ruining her quality of life in the process because everything eventually revolved around steps. Kirsten therefore felt more in control by not using the step counter, avoiding the potential threat of overuse. Frederik expressed a different form of active resistance in a follow-up interview:

I measure more by a feeling in my body, and when I look at myself in the mirror, and whether it is starting to bulge in the wrong places or whether I loose my breath when I go for a walk or something like that. And plus, I know that in order to keep my body well and healthy, then I need to eat reasonably and exercise, and I actually don’t need to count steps to figure that out.

(Frederik, male non-participant, interview)

This difference between the forms of accounting forced by the design of the technology and the valued “*feeling in my body*,” ties to the notion of disenchantment where the non-user feels nostalgic about the practices that are pushed aside by new technologies [31]. It is worth noting that non-use linked to active resistance, and disenchantment, does not mean resisting *all* health initiatives or health technologies. In fact, non-participants as well as participants were often eager users of other health promotion initiatives, such as “We Bike to Work” campaign, where participants registered distance biked. Just because one type of accounting did not fit the needs and goals of some of the employees, other similar forms of accounting of physical activity clearly could.

Regardless of the reasons non-participants were clearly affected by the campaign. They experienced exclusion during the social moments of coffee break or lunch where many of their usual conversants were suddenly out of reach, concerned as they were with discussing how they might manage 10.000 steps or which activities result in most outrageous conversion rates. Some expressed frustration or mild disapproval about this, others considered joining the campaign next time just so that they could avoid the discomfort. Yet participants were largely unaware of this. One participant, Ida insisted on showing us how another department had implemented a public screen listing all participant steps and comparisons with all competitors in their department. Everyone passing through this busy department, whether participants or non-participants, could see how well individuals and teams were doing. To Ida, the absence of such a public screen in her own workspace was an indication that her department was quite relaxed about the campaign – a sentiment not shared by the non-participants.

As participants and non-participants negotiated the goal of 10.000 steps per day socially, they all at times had to make moral choices. Consider the following observation:

End of week 2 of the campaign: Charlotte, a female participant, asks Frederik, a male non-participant, whether he wants to join her in getting coffee from the near-by coffee machine. Frederik questions this, saying: “That coffee machine? What about your steps?” Charlotte looks at him and does not reply, but just repeats her question, whether he wants to join her or not, making it obvious that she does not want to talk about step-counting at this point.

As this participant attempted to engage a non-participant co-worker, she had to negotiate in the moral accounting for her steps with someone who did not participate and yet could still hold her to account. Towards the end of the campaign many participants fatigued from the pressure of having to make their steps, and some commented on how relieved they were that the campaign was “just three weeks long”. Non-participants often expressed a similar sentiment indicating that the social upheaval wrought by the commitment to counting steps was quite significant.

A social ecology approach to health in the workplace

The follow-up interviews and post campaign observations made it clear that participants were relieved to leave their step counters at home, and to be able to resume their normal daily office and activity practices.

Elizabeth: (Would) have suited me fine if it was just two weeks. A bit of the motivation disappeared. And then it just turns in to a kind of control of you, sometimes you just want to be lazy, but you had to get to those 10.000, right?

(Female participant, interview)

Upon completion of the campaign the team who had scheduled to get coffee every morning in the other end of the building stopped doing that, and everyone went back to eating lunch in the nearby cafeteria. The heightened activity level that was kept up during the campaign ended, and from what we could observe after the campaign, employees no longer used their pedometers at work. But does this mean that the campaign failed?

Generally, participants went back to their prior habits, stopped using their step counters or went back to using other types of fitness trackers they had utilized prior to the campaign. Given this, perhaps, the campaign can be seen as a failure, as the technology did not ‘stick’ and the prior activity levels did not translate into new and healthier habits. Yet there are other factors that must be considered. This particular workplace has a variety of health promotion initiatives offered to the employees. In the framework of the social ecological model, this is a way of including both active and passive elements. Passive elements in this particular case included a focus on healthy food in the canteen, with no juice or sodas available for lunch, a restriction on cake (only served on Thursdays), fruits available throughout the day, and every employee having height adjustable tables to support ergonomic posture and the choice for sitting or standing. Active elements included an in-house gym with several types of classes offered, with the option to use the gym with pay for a limited number of hours annually. Many health promotion campaigns were frequently on offer, such as The Sugar Sheriff (focused on leaving out sugar from the diet)³, We Bike to Work⁴ or the Tæl Skridt campaign. Thus just because some employees did not participate in step counting did not mean they were slouches.

In this way employees were able to participate in activities that were to their liking, and fit their own goals, needs and personal preferences, while balancing environmental factors, such as transport or family. For example, Kirsten, who was quite skeptical of the step counting campaign, had previously participated in an initiative where employees were offered to bring home food leftovers from the canteen, seeking to diversify the vitamins and nutrition employees received. She had really enjoyed it saying that it was helpful to bring home food, so she did not have to cook after a long days work, and that it had probably been more diverse and healthy than what she usually cooks.

Vibeke, a female participant, had a goal to go on a summer hike with a friend, and felt she needed to get fit for that trip. The Tæl Skridt campaign gave her the opportunity to work in more steps during the average day, and she enjoyed that this was something she could then talk about with colleagues. Jonas enjoyed the competitive nature of the Tæl Skridt campaign but also kept his eye on other campaigns:

Jonas: I think I biked a lot because I’ve signed up for a bike event, Sjælsø rundt, and then we have this “Bike to work” thing in April, and it’s important to get into shape for that.

(Male participant, interview)

Frederik, a non-participant, was skeptical of what he saw as a narrow focus of the Tæl Skridt campaign, but was adamant about limiting sitting work, and preferred standing up at his desk, which he did almost all day. To him, standing up was the important factor in keeping healthy, not walking and counting so many steps per day.

From a social ecological perspective, the step counting campaign can be viewed as just one part of improving health in this workplace, an active part of the intervention to have healthier employees. Step counters could be seen as purely tackling individual health behavior as it requires “voluntary and sustained effort by target individuals” [34:287]. Where the step counting campaign could be interpreted as less than a complete success by itself, it was nevertheless an important part of the active/passive combination of interventions, recommended by the social ecological approach; just one part of an ongoing drive to improve health in a workplace that clearly communicates to the employees the importance of their health through policy support and financial investment. Non-participation then might not be a failure, but simply a sign of some employees choosing other active or passive elements, which suit their personal health views and environmental factors. So has the Tæl Skridt campaign failed in instituting lasting behavior change? Perhaps in the traditional sense this is the case, but in the context of exposure to new technologies, and facilitating different forms of sociability in the workplace tied to physical exercise, it could be counted as a success.

DISCUSSION

The use of technology as part of health promotion efforts is a laudable goal and our study shows that even narrowly focused and short-lived health-promotion campaigns can get people really excited about participation at least for the period of the campaign. Beyond this, our study highlights three specific points for discussion. First, we demonstrated that a step is not a clear and obvious quantity, but a socially negotiated one. Second, despite the individual nature of the technology and the emphasis on taking charge of your own steps, counting steps becomes a social endeavor often tinged with forms of moral accounting. Third, in the workplace under study employees were able to choose to participate in many different initiatives, while at the same time being targeted through passive health promotion elements (such as healthy food in the canteen, height adjustable tables or cake restrictions). Thus at least in this case, campaigns such as Tæl Skridt clearly do not operate in a vacuum but exist as part of an ecology of workplace health practices. Despite the campaign popularity, our data bear no evidence of healthier practices continuing beyond the three weeks of the campaign. Yet it is hard to say that

³<http://sukkersheriffen.dk/produkter/zukkerfri-zone-21-dages-kampagne/>

⁴<http://www.vcta.dk/>

the campaign failed in its goals. We discuss alternate ways to conceptualize the notion of success in this context.

Steps and walking have social meaning

No matter how simple a technology, the meaning of its output becomes socially constructed and the use of it, through persistent quantification of mundane activity can come to be felt as stressful and limiting [6]. The time spent on negotiating steps was a point of annoyance to some non-participants, as they felt it intruded on time spent on work. The figuring of the meaning of steps, the calculation of conversions, the chocolates and campaign site entries all amounted to what Miller et al. had termed “hidden work” [23]. As walking and steps did not constitute the primary work tasks of the participants, these likely couldn’t be sustained for long especially since these had an effect on non-participants as well. Temporary inconvenience brought about by a technology that can be used as a stepping stone to new skills and habits is not a big issue [26], but there are two important points that this negotiation around the meaning of a step brings up. First, if the goal is to address sedentary behavior in the workplace, then designing technologies or interventions that interfere with the time spent on actual work is unlikely to be popular with employees or employers for long. To be serious about supporting health-behavior change through technologies in the workplace then is to acknowledge and to design for the hidden work and time it will take to participate. Second, and perhaps more importantly, if the very meaning of a step is not an inherently known quantity, but a notion that is socially constructed in part due to technical limitations of step-counting devices, it is important to account for the potential variability in what a step might be in the course of technology design. The step counter is often seen as an incredibly simple technology and it is too easy and tempting to overlook how steps might not be an inherently known quantity. Thus instead of introducing the step-counter as a technology that is so simple users will hardly notice it, it may be more useful to explicitly encourage users to take the time to get to know their devices and to discuss the meaning and the technical implementation of measuring steps.

Furthermore, the findings presented here highlight the stress of competition for steps, which was not welcome past the relatively short duration of the campaign. This suggests that gamification and persistent long-term quantification of activity at work more generally and activities related to health specifically may become detrimental to themselves in the long term even when producing active improvements in the short-term. Perhaps it may be instructive to change the game often and sometimes stop counting.

The social costs of moral accounting

No matter how individually focused the technology design might be, the performance of step counting is distinctly social and can manifest in unexpected forms of moral accounting. In our study few constraints were in place to ensure that participants truthfully reported their step counts.

Yet many worried about their technologies potentially unfairly inflating the evidence of their walking efforts. Moral accounting [14] is based on the notion of wealth, relating moral action to increases in personal well-being. Thus making more steps would lead to increase in personal well being if it is conducted *fairly*, without taking undue advantage of or impinging on the needs of others too much. The notion of moral accounting is useful as it forces us to think in terms of social dependencies and accountabilities beyond the oversimplification of social networks and interpersonal privacy concerns. With deployments of health technologies in workplaces, the kind of accounting individuals might need to do involves not only their personal step goals, but also the social relationships and social dependencies they must maintain despite these.

If we are to take seriously that decision making around the use of step-counters can become a form of moral accounting then it is important to consider both users as well as non-users of the technologies, user obligations outside the individual health goals and the environments within which they operate. The enforced sharing of progress for all participants, visible to all other participants surely resulted in efforts to improve personal performance but it also led to ensuring that the reporting of steps, while still occasionally nudged or rounded up, remained at least visibly fair. Participants worked to renegotiate their own moral accountabilities by creating different teams and thus trying to manage expectations. As part of this effort, participants also created their own secondary goals although this was not directly supported by the campaign [24].

Future health technologies might take this into account and support the creation of preferred goal settings by the user, acknowledging that chocolates or other less healthy treats might become a part of what it means to be healthy. Working seriously with the concept of moral accounting, how might we create tools, that harvest the benefits of creating accountabilities, but respect the delicate work and private life balance that is at times breached in initiatives, that put particular behaviors as the ultimate goal, making all means fair game? After all, while moral well-being can be accumulated, it is not something that comes exclusively from individual action but depends also on the “good actions of other people” [14:54]. Moral accounting then offers a way to tie together the more technologically and individually focused approaches favored by HCI and CSCW with the more holistic approaches proposed in social ecology and health promotion [21,34].

Designing for a social ecology of health

In research on health behavior change and in the body of work on health promotion what constitutes success has been difficult to define and to measure [17,40]. Whether health promotion campaigns are a success or failure in traditional behavior-change terms of influencing changes in habitual behavior remains an open question. Yet the notion of success and the question of ‘did it work’ are not trivial and

should not be dismissed. As the Tæl Skridt campaign repeats twice per year it is possible that after several iterations behavior change does in fact occur. The short run of each campaign cycle may allow people to continue getting excited and not too tired of it. In order to assess the benefit of campaign participation, however, it is important to look beyond the questions of success or failure of one campaign. Individual health interventions such as the Tæl Skridt campaign do not operate in a vacuum and thus do not need to be overwhelmingly successful to raise the overall level of activity among employees. The social ecological approach suggests that in designing interventions for behavior change it is important to think in terms of suites of efforts rather than single technologies or individualized approaches.

CSCW/HCI researchers have already begun discussions of where and how might we set in to improve health (individual/environmental levels) and with which tools (active/passive) [21,32]. A social ecological approach can provide a common starting ground by emphasizing the need to bring in both active and passive tools, and to target individual, group and perhaps environmental levels at the same time [34]. We have argued in this article that participants, and non-participants, already experience health promotion initiatives as one element of many that targets not only individual behavior but also the social context of the workplace. What would it mean for research to stop debating the classic individual/environment gap, but to realize that these are inherently connected, and that initiatives should be built to reflect this?

HEALTH PROMOTION OR BEHAVIOR CHANGE?

Following Maitland [21] in this article we have focused on the Tæl Skridt campaign as an example of a health promotion rather than a behavior change effort. This is a significant shift in focus, enabled by the use of the social ecology lens [34]. Unlike behavior change, health promotion takes its departure from healthy behavior as a baseline to be supported and encouraged rather than addressing sickness and unhealthy behavior as something to be changed [21,36]. That is, health promotion focuses more on leveraging existing resources and addressing the broader context of health behavior practices, rather than driving toward eliciting consistency in behaviors oriented towards one specific goal, such as walking more. This means that health promotion efforts by definition must offer more flexibility and control to individuals because they recognize the diversity of environmental constraints that people encounter.

Single point of feedback technologies such as activity trackers offer obvious solutions for those who have their own motivation and health goals and may only require easy to understand feedback that supports their own efforts towards healthier behaviors. Alternatively, those that may be curious about potentially engaging in healthier practices but lack the motivation to do so are less likely to continue use beyond the novelty effect. From a health promotion point of view it would be a mistake to conceptualize the lack of mo-

tivation in the second group as merely an individual shortcoming that can be overcome through nudges, incentives or threats. Rather, it is important to understand the broader context of available resources and constraints that may have an impact on motivation and healthy behaviors.

The Tæl Skridt campaign is successful as a form of health promotion, rather than as a behavior change effort, for two reasons. First the campaign is designed broadly enough to allow participants significant control over the form of their eventual participation. Second, its success stems not from a single or bi-annual three-week deployment, but from the fact that it is a part of broader effort to promote overall health supported by state and commercial actors. From a health promotion point of view, the goal is to keep notions of health and examples of easily achieved healthy physical activity salient, rather than insisting on repetitive performance of one particular behavior. Whether it is cycling to work, eating less cake or walking 10.000 steps, the idea is to foster a general healthier outlook and not the accumulation of quantitative evidence of walking.

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Paper 2A

Gorm, N., & Shklovski, I. (2016). Sharing Steps in the Workplace: Changing Privacy Concerns Over Time. *CHI'16*.

Sharing Steps in the Workplace: Changing Privacy Concerns Over Time

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ABSTRACT

Personal health technologies are increasingly introduced in workplace settings. Yet little is known about workplace implementations of activity tracker use and the kind of experiences and concerns employees might have when engaging with these technologies in practice. We report on an observational study of a Danish workplace participating in a step counting campaign. We find that concerns of employees who choose to participate and those who choose not to differ. Moreover, privacy concerns of participants develop and change over time. Our findings challenge the assumption that consumers are becoming more comfortable with perceived risks associated with wearable technologies, instead showing how users can be initially influenced by the strong positive rhetoric surrounding these devices, only to be surprised by the necessity to renegotiate boundaries of disclosure in practice.

Author Keywords

Step counting; wearable technologies; workplace practices, privacy

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous;

INTRODUCTION

Excitement around the potential that data derived from wearable technologies represents drives research efforts, health promotion campaigns and even workplace policy implementations. In 2014, 10,000 companies in the US offered activity trackers to their employees; some did so as part of insurance discount programs [4]. In other countries, such as Denmark, trackers are used in health promotion campaigns and competitions. This proliferation of activity tracking and collection of health information has been a matter of concern for privacy advocates who urge people to “take privacy concerns seriously” [3]. But what exactly are “privacy concerns” when looking specifically at the intro-

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duction of wearable health technologies in the workplace? Questions are asked as to who actually owns the data produced when wearing the devices, what it might be used for and what will happen with that data in case data collecting companies (be that Fitbit, Jawbone, etc.) are sold or merged with companies with different privacy standards [4]. These questions become even more important as activity data is correlated with other available data sets and as such data assemblages begin to find their way into courtrooms [6]. Yet little is known about workplace implementations of activity tracker use and the kinds of experiences and concerns employees might have when engaging with these technologies in practice [14,18].

In this paper we report on a study of a workplace health promotion campaign that relies on the use of step counting technologies and individual daily reporting of steps over the course of three weeks. We explore the kinds of concerns employees express about disclosure of step counts, and how they change over time. We find that there is little in the way of concern with data disclosure to institutional actors such as the organization behind the health promotion campaign, the workplace itself and the technology companies that provide the devices and applications for counting. Concerns over data disclosure to interpersonal connections such as fellow employees, bosses or friends, however, change over time.

BACKGROUND

Concerns about health information disclosure have been voiced in many ways. Within HCI, these are concerns about data ownership and use, leading to research focusing on personal privacy [9]. Whereas data security is protected by laws, personal privacy denotes the “more fluid notion of privacy around a person, such as one’s right to control personal information flow” [2]. Much HCI research has focused on how users manage information sharing, as this has influence on uptake of current technologies, and the development of future technologies [1,10].

Outside of HCI, privacy advocates argue that there is the possibility that when some people are encouraged to disclose health information, it might force everyone to do so down the line, in which case those refusing to disclose could become stigmatized or even penalized [16]. However, a recent survey conducted by Healthline showed that just 25% out of 3,679 participants were concerned about data collected by health tracking technologies and apps [15].

Perhaps something like steps does not in fact qualify as health data? Researchers have argued that people who share personal information online may fail to understand how it is possible to aggregate information from different online sources, for example identifying high confidence patients [12]. For example, Facebook likes can reveal a person's sexual orientation, ethnicity, religious and political views, amongst other personal attributes regardless of how much the person themselves wants to reveal directly [11]. Steps are an indicator of activity levels, which could potentially be used to infer sensitive information about individual users. In a study of experimental integrated wellness application Cardea, Lingg et al. have shown how data from a wearable device can be synced with data from Human Capital Management databases to compare sleep quality across employees working on different projects. Lingg et al. do admit that "a subset of our users felt that privacy is a significant concern" [13] but do not clarify what these concerns are and how they might be addressed.

In research on tracking technologies, the notion of privacy concern is often used as an umbrella term that conflates worries about data disclosure to institutional actors such as health insurers, employers or tech companies and concerns with the impact of data disclosure on interpersonal relationships [10]. Research on privacy attitudes however tends to focus on either interpersonal or institutional concerns separately [19,20]. Despite a frequent focus on privacy concerns few studies consider how these emerge and are negotiated in practice [2].

RESEARCH CONTEXT AND METHOD

In spring of 2015 the first author conducted observations at a workplace participating in the bi-annual step-counting campaign "Tæl Skridt" (Count Steps). This campaign targets workplaces with sedentary work practices and is initiated by the Danish Company Sports association. Colleagues sign up in teams with a goal to walk 10,000 steps for at least 11 out of the 21 campaign days, and teams reaching the set goal enter a lottery for a cash prize of 50,000 DKK. There is a small fee for participation and participants are free to choose the device or tracker they want to use. Some companies waive the fee and even provide participants with trackers. Participants in this study used a variety of trackers, including pedometers, and various smartphone apps. Employees use the campaign web site to log their steps and to convert other activities, such as cycling, golfing or swimming, to steps. For a more detailed description of the campaign and our methodology please see [7].

The department under study is part of a 2000 employee-sized company. The department is a communications department in charge of generating text for digital communication with company customers and supporting optimization of digital tools, and had 28 employees (20 females and 8 males) at the time of the study. Employees ranged in age between 20 and 65 with two employees aged over 50 and approximately a third aged 30 or younger. 17 participated in

the campaign (hereafter called "participants"). The first author spent 12 workdays at the workplace in March 2015, and conducted 9 interviews with both participants and non-participants at the end of the study. Field notes and interview transcripts were iteratively coded following [5].

FINDINGS

The fact that just under two thirds of the department under study participated in the Count Steps campaign gave us an opportunity to study both users and non-users in situ as they negotiated the use of the device and campaign participation in the workplace. Considerations of non-participation have previously been detailed in early studies of active badges in the workplace [8], but are limited in current research on wearable health technologies. In the following we consider the range of concerns people expressed in the course of the step-counting campaign addressing both participants and non-participants and then describe how attitudes towards the campaign changed over time.

Interns and external consultants were not able to join the employee association, which meant they could not sign up for the campaign. Participation required addressing several practical issues such as finding a team, signing up, and selecting a step-counting device if one was not already owned. The hassle of signing up, paired with the expectation that one might not have the time to put in the effort to get to 10,000 steps a day was a hindrance to several employees who were eligible for participation. A few, however, explained other reasons for non-participation.

Over the course of the campaign we observed that some non-participants were unhappy with the time participants spent on campaign participation (checking steps online, walking longer to get coffee, etc.). Kirsten explained that the competition element brought out not-so-nice sides in some of her colleagues: "*So that's where I see a flipside, to some people this is not good. Not to say that you shouldn't do it, but some take it too literally. Use it more as a thing, to down prioritize tasks*" (Kirsten, non-participant, interview). To others the focus of the campaign just did not fit with their idea of health. Kirsten was wary of signing up because her friend had become obsessed with tracking and she feared a slippery slope to a problematic obsession for herself as well. However, very few chose not to participate because they were explicitly unwilling to disclose information they saw as private. At the start of the campaign none of the employees seemed to think that disclosing the number of steps walked per day was anything to be worried about. Frederik, for example, said that steps were "*innocent*", but also noted that "*it is in some ways a blurring of the line between work and private life*" (non-participant, interview).

Overall, the reasons for choosing not to participate were quite personal. Non-participants considered campaign participation in relation to their own expectations, views of health and time they were willing to put aside for this, and found that these did not align. The concerns thus were pri-

marily about time commitment and none gave much thought to potential disclosure of data and its outcomes.

Initial reasons for participation

The majority of employees chose to participate in the campaign thus agreeing to reveal personal step-counting data to their coworkers, to the organization behind the campaign and potentially to any other campaign participants across Denmark. To understand why people were not particularly concerned with such broad disclosure of health data we first consider the reasons for participation. As we have previously described [7], employees in Danish workplaces participate in a range of city and countrywide health-promotion campaigns that are designed to encourage cycling to work or promoting sugar-free workplaces. Thus the Count Steps campaign was quite familiar and easily understood, with the use of the tracking device as the only new element.

Tæl Skridt marketed itself as a “*campaign focusing on activity, socializing, and competition in the workday*”¹. To some participants the stated purpose of activity intersected with their personal goals. To Elizabeth, the social element was of primary importance: “*I’m also quite new in this workplace, and then I thought that was a good opportunity to get more integrated and be a part of the community*” (participant, interview). For Rachel, a long-term employee this was also important: “*I feel like it gives an extra incentive to keep an eye out on whether you walk enough, but if there hadn’t been colleagues who said, we want to join, then I wouldn’t have joined*” (Participant, interview).

So while participation was helped along when there was a fit between stated campaign goals and personal motivations from prior to the campaign, the social aspect was crucial. This was also linked to the competition element, which was important to many of the participants, turning the campaign into a game. In short, reasons for participation match the rhetoric of the campaign. In addition, the length of just three weeks seemed reasonable at the outset of the campaign, which made participation a temporary commitment and thus less daunting.

The reasons for participation also framed some of the initial ways that campaign participants explained their willingness to disclose step data. The voluntary nature of the campaign and the fact that it focused on steps was considered harmless: “*I mean you walk steps anyway*” as Rachel explained (participant, interview). It was clear that participants did not expect their data to be used in any other setting, or combined with other datasets to infer any information about them. In general, there was a strong feeling of control. For example, Jonas used several apps on his iPhone, for tracking different kinds of sport activities. He explained his relationship to the companies behind his trackers: “*Well, I mean, I have just said no, no, no, to everything, so there’s*

nothing, I mean, I think they can see my data... But they are not allowed to use it for anything” (Participant, interview).

Arguably, in the case of the Tæl Skridt campaign, the information is not used for anything other than knowing how many people signed up², but that only accounts for the website. Even so, the participants raised no concern of sharing their data with other institutional players such as the companies behind the devices and apps they used. Only in interviews, when participants were directly asked towards the end of the interview, of their opinion of US style health insurance premium discount programs for participation in step counting, a participant said; “*The problem is then if you deselect someone, if you can’t get insured if you are too inactive*” (Jakob, participant, interview). Jonas explained in an interview why for him it is not a problem to share health data with the workplace: “*Well there’s no challenge, the problem is only if they have information the other way, if you are defective in some way, if you are sick or something. But they would know that anyway*” (Participant, interview). This reveals how this participant clearly expects that the data or information about his steps in this case, but information about him also more broadly, is not used to infer anything about him that he already does not know himself, and that he has not explicitly revealed to his workplace. Despite this certainty in the safety of their data with respect to institutional involvement, the implementation of the trackers in the work life did not go without incident.

Experiences of use

Wearable health technologies make a particular set of information about past activity, such as the number of steps taken, available in an easily reportable manner. Even though the campaign had similarities to other health initiatives, participants had not previously experienced this sort of specificity in disclosure of information about them to others in the workplace. This, combined with the competitive elements of the campaign, necessitated negotiations of what had to be revealed, and when it was acceptable not to share one’s step counts. Participants therefore experienced that the implementation of the tracker demanded a renegotiation of boundaries of disclosure. We observed how participants collectively negotiated that some events in their private life could excuse them from registering steps while others clearly did not.

In the office Dorit asks Jonas whether Hans is sick. Jonas replied: “No, Hans just hasn’t registered any steps yet”. Rachel and Dorit discuss that they haven’t walked 10,000 steps all days, and they think they might also have dragged the team average down because of it. (Observations, week 2)

In this case, it was well known in the office that Hans was under a lot of stress at that moment. Dorit realized that ask-

¹ <http://www.taelskridt.dk/>

² Interview with campaign manager

ing about it might seem insensitive. She then offered her own experience of not having walked that much.

The use of the step counter and the necessity of registering steps daily on the campaign website troubled the tensions between what people felt they were comfortable disclosing and what was perhaps less appropriate in a work context. In principle the campaign demanded that all participants reach the same goal and reveal the same amount of information, yet in practice we observed how employees negotiated when and how one can appropriately demand teammates to “pull themselves together”, or when one should look the other way. By using the device, participants discovered that disclosing steps was more than merely disclosing a number. Step-counts as indicators of activity level, became objects of scrutiny. Participants would often ask each other how many steps they had walked which led to inquiries of how and why.

One morning in the office Rachel and Kathy are discussing their steps as Rachel says: “Kathy walked more than a half-marathon!” Charlotte interrupts: “Now I have to ask, what did you do this weekend?” Rachel explains that she and her boyfriend went hiking in Sweden. (Observations, week 2)

At lunch participants are discussing their weekend activities and how many steps they counted. Vibeke explains that she didn’t get many steps on Sunday because she was at her mom’s place. (Observations, week 2)

Here we note that teammates required of each other explanations of very high and low step-counts, such as visiting an elderly mother or going for a long hike. Just as steps could be a sign of very high activity levels, low numbers revealed that perhaps things were not going so well.

Over time we observed that the amount of social pressure became quite significant. As the weeks wore on, the length of the campaign (just three weeks) became increasingly important: “The last week I was thinking, good this thing ends soon. To me this thing about being bound up to a step counter everyday, I had enough of it” (Rachel, participant, interview). This attitude was shared across all participants, and in fact when the campaign ended, no one chose to continue counting steps in the same way. We see the on-going management of the social expectations and feelings of step-counting as a burden as practical manifestations of how people address privacy concerns. During the three weeks of the campaign, it became acceptable to question other participants about their private life outside of the workplace, explicitly based on the step-counts they reported. These step-counts, after all had to correspond, at least somewhat, to what they were actually doing, which in turn had an impact on the choices they began to make in their private lives (we observed people discussing their decisions to go for an extra walk or staying on the couch over the weekend). Participants had to negotiate the realities of private life that intervened with their step-counts, such as being sick, with the

pressures of teams and competition through increased disclosure of personal matters. Over time, the teasing and discussions of steps began to subside, disappearing almost entirely together with the wearable step-counters in the days after the campaign. Through the pressures and demands of participation, concerns about what information was revealed changed over time. Initially attitudes toward the campaign and information disclosure were largely framed by the rhetoric of the campaign, but over time these changed to accommodate the lived experience with the technology. Thus from a design point of view, if we are going to worry about privacy, we need to consider what it is that people might be worried about and what might be the sources of comfort or discomfort. Thus design should consider initial concerns as well as concerns that evolve over time when we talk about privacy in the context of the workplace.

DISCUSSION AND CONCLUSION

Our findings show that there is a difference in concerns relating to disclosure of health data in the workplace between people who do and do not choose to use wearable technologies and participate in health promotion campaigns. Non-participants raised concerns of obsessions with tracking, the amount of time spent on it, and the potential blurring of lines between work and private life, whereas the initial lack of concern of participants was framed by the strong rhetoric of the campaign. Secondly, we are able to show how the concerns of the employees who choose to participate change over time. Initially concerns about step count disclosures were dismissed as harmless. Over time however, participants discovered how revealing these types of disclosures could potentially be and thus they were forced to renegotiate boundaries of disclosure in situ.

A recent report from PricewaterhouseCoopers states that “for all the concern, consumer appetite for revealing personal information is changing – they are now growing more comfortable with the risks as the rewards become more appealing” [17]. Our findings caution against such an assertion. As the rewards of using wearable technologies, such as pedometers, become more appealing, consumers are attracted by the *rhetoric* and the imaginaries of their use. The resulting necessary negotiations of boundaries of disclosure, and experienced discomforts, are unexpected because they do not fit with the rhetoric, and must be dealt with alongside the use of the technology. At the point where these concerns surface however, it may be too late to change the conditions of disclosure set up as they are based on the rhetoric of health, wellness and better life. Thus we observe users putting effort into collectively redrawing boundaries of disclosure to accommodate the devices.

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Paper 3

Chung C, Gorm N, Shklovski I, & Munson, S. (2017). Finding the Right Fit: Understanding Health Tracking in Workplace Wellness Programs. *CHI'17*. *Honorable Mention Award*.

Finding the Right Fit: Understanding Health Tracking in Workplace Wellness Programs

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ABSTRACT

Workplace health and wellness programs are increasingly integrating personal health tracking technologies, such as Fitbit and Apple Watch. Many question whether these technologies truly support employees in their pursuit of better wellness levels, raising objections about workplace surveillance and further blurring of boundaries between work and personal life. We conducted a study to understand how tracking tools are adopted in wellness programs and employees' opinions about these programs. We find that employees are generally positive about incentivized health tracking in the workplace, as it helps raise awareness of activity levels. However, there is a gap between the intentions of the programs and individual experiences and health goals. This sometimes results in confusion and creates barriers to participation. Even if this gap can be addressed, health tracking in the workplace will not be for everyone; this has implications for the design of both workplace wellness programs and tracking technologies.

Author Keywords

Self-Tracking; Health and Wellness Program; Workplace

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous

INTRODUCTION

Personal health tracking devices such as Fitbit, Jawbone UP, or the Apple Watch, are rapidly becoming common fixtures in workplace health and wellness programs [7,22,29]. One industry report estimates that more than 27.5 million wearable devices will be ordered by enterprise customers in 2020, compared to just 166,000 units in 2013 [29]. In some cases, companies are incentivizing the use of these devices by offering financial benefits to employees who are physically active and share their personal health

data, such as steps, heart rate, and sleep patterns with workplace or insurance health and wellness programs. Employees may be rewarded for their activities with virtual points that can be exchanged for company swag or gifts, or companies may offer a discount on health insurance premiums or deductibles. The popularity of such programs that capitalize on the easily available health tracking data often hinges on an argument that a healthy workforce is a more productive workforce with the resultant declines in healthcare expenditures.

As participants in health and wellness programs begin to share health tracking data with their employers and insurance providers, there is a need to understand perceived benefits and concerns about the sharing, and how these experiences might evolve over time [28]. Knowing how employees value (or do not value) the use of health trackers can inform the design and development of wellness programs. Well-designed programs can lead to greater uptake and sustained engagement with healthy behaviors.

To illustrate the range of experiences employees have with integration of tracking into workplace wellness programs, we present findings from an empirical study conducted in three phases. First, we interviewed employees and wellness program administrators across seven US companies to understand their experiences with health tracking in a workplace wellness program. Analysis of these interviews informed a survey of over 500 employees and 45 wellness program administrators. Finally, we conducted follow-up interviews with selected survey respondents.

Our findings reveal many positive and negative attitudes among employees toward workplace activity tracking and frustrations among program administrators in the limitations of current technologies. On the positive side, many employees felt that the wellness programs demonstrated that their employers care about their health and working conditions beyond mere measures of productivity. Some also acknowledged that their use of health tracking improved their own awareness of activity levels. At the same time, many criticized the health tracking programs for failing to support individual health goals in favor of easily defined and measurable one-size-fits-all metrics. Some found health tracking stressful and a few were concerned about personal data disclosure, privacy and an enforced blurring between work and personal life. Many program administrators hoped to support more holistic

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views of health, yet current programs so far tended to incentivize mostly what is easily measured and tracked: steps. In the following sections, we review current literature about workplace health and wellness programs and the recent movement of bringing health tracking into these programs. We then provide an in-depth discussion of employee challenges, goals and expectations when participating in such program, as well as reasons for deciding not to participate. We consider the tension between the design and the practice of these programs as well as implications for implementation.

BACKGROUND

Workplace health programs are not a new development. The first workplace health programs emerged in response to government oversight of workplace safety conditions in factories and mills going back as far as the Industrial Revolution. These programs primarily consisted of physicians investigating safety conditions through in-person visits [2]. Workplace safety is now regulated in most developed countries and health programs now encompass not only safety but also health more broadly. Today, employee health promotion in the workplace is an “international trend” [6], and investments in these programs are rising [5].

The most common components of workplace health and wellness programs include screening activities, preventive interventions of health risks, and health promotion activities for healthy lifestyles [2,24]. With increasing healthcare costs, organizations explore options that might motivate their employees to pursue healthier lifestyles, such as being more physically active. Wellness programs are often coupled with incentives for participation or competition, and encourage employees to use fitness centers [10], maintain physical activities during winter [4], and increase physical activity levels toward a pre-set goal [19,25]. With the advent of digital health tracking, integration of these technologies into wellness programs is an obvious step for many companies.

Health Tracking in Workplace Wellness Programs

In this study, we define health tracking as using a means to keep track of any aspect of health. That is, in addition to automatic sensing, we also include health and wellness programs that implement manual tracking or self-report of health data as part of the investigation. As organizations currently implement health tracking in various ways, this allows us to explore employee perceptions and experiences broadly.

In this section, we present three types of health tracking implementation and their incentive models derived from the literature as well as our interview and survey data. These implementations are not exclusive – one company might implement multiple options simultaneously. We also do not claim this to be an exhaustive list. Our goal is to provide an overview of the health and wellness programs we studied to help situate our findings.

Subsidizing activity trackers or gym memberships

Many companies provide their employees with discounts for fitness trackers or reimbursement for gym membership to encourage employees to exercise on their own [16,24,33]. One recent US nation-wide survey reported that around 18% of companies also provide onsite exercise facilities [30]. These programs usually do not require employees to report their use or participation but also do not provide incentives for maintaining or improving healthy behavior. Some research shows that free gym membership supplemented with educational resources, coaching or incentives for participation time can better improve employee physical activities than when these measures are implemented alone [16].

Short-term events or challenges

Some companies organize events or challenges to promote awareness of healthy behavior and to encourage employees to increase levels of physical activity [4,17,19]. These events or challenges usually range from one to three months in length with incentives such as gift cards or cash rewards. In some cases, companies offer employees free tracking devices, while in others employees must purchase their own devices to participate. Sometimes such events are designed as competitions, during which employees might compete as individuals or in teams for prizes. Others have predefined goals, such as average steps/miles per day or number of days biking to work, and any employee who reaches the goal can receive incentives.

Long-term programs

In long-term programs, employees receive incentives based on their health tracking data [25]. For example, employees might receive virtual points according to their accumulated physical activity levels (e.g., 1 step = 1 point) or when reaching certain activity goals in a given time (e.g., averaging 7,000 steps per day). These virtual points can then be exchanged for cash rewards, gift cards, or insurance discounts. Some of these programs are scheduled based on calendar year during which the virtual points might expire at the end of each year, and employees have to opt-in or opt-out at the start of each calendar year. This is particularly common when the program is sponsored by an insurance provider. Other programs are operated on an on-going basis, which means that employees can ‘save’ their virtual points for longer periods of time.

Criticisms of workplace health tracking programs

The integration of health tracking technologies in workplace health and wellness programs has not gone unnoticed by media, who has largely reported critically on the subject. Concerns of a blurring of work and private life spheres have been put forward, and questions of whether employees actually have a choice to participate or a coerced into participation have been raised [22].

These concerns are echoed and elaborated in research taking a more theoretical approach to the development. The increasing quantification of employees is worrisome

because all other things that make up well-being, but that are not easily measured, can be undermined [27]. Researchers highlight how incentivized health tracking, when connected to the workplace, risks disciplining employees with implications for those who cannot afford to say no, that there is a risk of reducing health to numbers, and voice concerns that data can be de-anonymized and used for other ends than expected by the employee [7].

Nissenbaum and Patterson have applied the lens of contextual integrity to the area of health tracking in the workplace [28]. They suggest that health tracking technologies challenge informational norms due to the close monitoring and gathering of personal information, and the ability of these data to be used by third parties without the knowledge of the user. Nissenbaum and Patterson argue how this area is “*sorely lacking fundamental factual details*” [28]. Responding to this call for research, we focus on whether and how these potential challenges are experienced in practice.

Even though researchers call for more empirical research in the area [7,27], only a few studies have investigated the use of health tracking devices in the workplace from the perspective of the employees. For example, one empirical study of Danish employees participating in a three-week step-counting campaign found that while steps may seem like an obvious entity, participants in the campaign put effort into figuring out what counted as a step [17]. Different devices count steps differently, as participants found out, and they then had to negotiate this to be able to fairly compare to each other. This demanded time and effort. The same study also points out that the campaign influenced the workday of both participants and non-participants, because non-participants could not easily join conversations or activities revolving around step-counting [17]. Masson et al. gave 13 participants from within their own company activity tracking devices. They found that all participants ceased using their device within 3 months, and that all participants were concerned about the privacy of the collected data [23]. While these studies focus on the experiences of employees, both studies involve short-term health tracking and include relatively small groups of participants. In the study at hand, we consider short-term tracking (such as event based tracking) as well as long-term tracking.

STUDY DESIGN

To understand the design and practice of health tracking in workplace health and wellness programs, we conducted exploratory interviews, a survey, and follow-up interviews with survey respondents. The study was conducted with employees and wellness program administrators from North American companies from March to August in 2016.

Exploratory Interviews

To get insight into various options and implementations of health tracking in the workplace, we initially conducted semi-structured interviews with three wellness program administrators and seven employee participants from seven

different companies. We recruited participants using snowball sampling through mailing lists and authors’ social networks. Interviews with wellness program administrators focused on their goals, design process, and the implementation details of their programs, as well as their roles in implementing and maintaining the program. Interviews with employees explored prior experiences with health tracking in general as well as experiences with the health and wellness program offered by the workplaces.

Three interviews were conducted in person, and all other interviews were conducted via phone or video conferencing and lasted from 30 to 90 minutes. Each interview participant was compensated with a USD\$10 gift card. All interviews were audio recorded and transcribed for analysis. Two researchers read through the transcripts and discussed emergent themes iteratively. We then used these themes as a basis for designing survey questions intended to reach out to a broader set of participants.

Survey

We sent out the survey through wellness program administrators who agreed to help distribute it during the exploratory interviews. We also recruited participants using authors’ social networks. We received 606 complete responses. After excluding 25 respondents who were unaware of any health and wellness programs offered in their workplace, we had 581 valid responses with 45 from wellness program administrators and 536 from employees. We sought to reach a broad audience, but one particular wellness administrator shared the survey particularly broadly and enthusiastically. As a result, most survey responses (539 out of 581 responses) came from one particular company (hereafter ‘Company X’) since our survey was distributed through their internal mailing list. This provides us an opportunity to gain an in-depth understanding of perception and experience of a large (over 5000 employees) company (Table 1) while also analyzing responses from at least 13 other companies (Table 2) for comparison.

The survey consisted of open- and close-ended questions. Employees were asked what type of health tracking programs were offered in their workplace health and wellness program, and what factors they have considered when deciding whether to participate. If they had participated or were participating in such programs, we asked about their experience of participation, whether they considered that the program supported their health goal, and their overall perception of the program. Wellness program administrators were asked about their goals, experience, and challenges of developing and deploying health tracking in the health and wellness program. Survey respondents were enrolled into a raffle with one of six gift cards (one USD\$50 and five USD\$20) if they provided an email address at the end of the survey.

Follow-up Interviews

We conducted follow-up interviews with 11 survey respondents to gain a more in-depth understanding of their

perceptions and experiences. We recruited participants with different roles (wellness program administrators vs. employees), experiences (participation vs. non-participation), and attitudes toward the programs (positive, ambivalent, or unenthusiastic). We also strove for diversity in program type and features. We conducted all follow-up interviews via phone or video conferencing. Interviews lasted from 30 to 45 minutes. Each interviewee was compensated with a USD\$10 gift card. All interviews were audio recorded and transcribed for analysis.

Interview transcripts and open-ended survey responses were coded using open and iterative coding. Two authors coded separate sections, and then discussed these codes and emergent themes, identifying tensions or overlaps. All authors then engaged in an iterative process of identifying main themes in the analysis and writing.

Participant company and program information

In our data set, we have most responses from employees from Company X. Due to the anonymization process of the survey we could not always determine which company respondents were affiliated with. However, some provided links to the health and wellness program used in their company, and we were thus able to determine that we have responses from at least 13 companies besides Company X. As we analyzed interviews and survey responses we paid special attention to potential discrepancies between attitudes and experiences expressed by employees of Company X and all other companies. We found, however, the determining factor of experience and attitudes was in the nuance of what was offered at their local office or company, not whether they were employees in Company X. Across all survey questions, most responses between employees from Company X and other companies are within 5% of each other. We hereafter present the results of responses as split percentages (X: x%, O: o%) for Company X and other companies, respectively. We discuss nuance in differences. In the following we first present some background information to show the various tracking options available to employees in Company X.

Company X is a US-based technology company with 5,000-10,000 employees located in more than ten North American cities. Its employees have mostly desk jobs but with flexible working hours. The health and wellness program is a point-based system, where employees can earn virtual points

Company X	
Employees (N=504)	
Age	Mean = 30
Gender	Female (282), Male (222), Unstated (1)
Education level	High school (7), College (271), Graduate (227), Unstated (1)
Wellness program administrators (N=35)	
Age	Mean = 30
Gender	Female (28), Male (6), Unstated (1)
Education level	High school (1), College (16), Graduate (18)

Table 1 Survey participants from Company X

from various health and wellness activities. This includes, for example, filling out wellness surveys or participating in educational seminars. Employees can then use these virtual points to purchase company swag or fitness products from an internal online wellness store. The company provides a wide range of options to encourage healthy behavior and relevant tracking. These include:

- *On-going health tracking program.* Employees can connect their trackers or apps to or manually input their data into the program app or website. These data are then converted into virtual points.
- *Onsite gym/class participation.* The company provides an onsite gym in most office sites and a wide range of fitness classes during lunch and afternoon break. Participation is automatically tracked when they swipe their employee ID card upon entering and converted to the virtual points.
- *Short-term events.* Company X also works with third-party companies to provide various short-term health and wellness events, such as stress or food tracking activities, which can also be converted to the virtual points.
- *Gym membership reimbursement.* For employees who wish to use their preferred gym or activities outside of the company, the program will reimburse the membership or class fees up to a fixed allowance. However, this participation is not tracked in the virtual point system.

In analysis of our findings we have noted which company participants were from for clarity, and we recognize that most quotes we provide are from Company X due to the majority of responses. However, this dataset of both Company X and all other responses provides a broad variety of experiences on which we base our findings.

Other companies	
Industries and company size	
Technology	0-50 (2), >5000 (4)
Health	201-1000 (2), 1001-5000 (1), >5000 (1)
Finance	0-50 (1), 1000-5000 (1)
Education	> 5000 (1)
Employees (N=32)	
Age	Mean = 34
Gender	Female (21), Male (11)
Education level	High school (1), College (5), Graduate (15), Unstated (1)
Company size	0-50 (4), 51-200 (1), 201-1000 (5), 1000-5000(6), 5000+ (16)
Program sponsors	My own company (24), An insurance company (9), A third-party company (8)
Wellness program administrators (N=10)	
Age	Mean = 39
Gender	Female (8), Male (2)
Education level	College (1), Graduate (9)
Company size	0-50 (1), 51-200 (1), 201-1000 (5), 1000-5000(1), 5000+ (2)
Program sponsors	My own company (10), An insurance company (7), A third-party company (5)

Table 2 Survey participants from other companies

In this study, we also interviewed and surveyed people who played a role in implementing and/or maintaining workplace health and wellness programs, and refer to these as “wellness program administrators.” Some of these administrators had development, implementation, and maintenance of workplace wellness programs as their main job responsibilities. These employees were usually in human resources departments. Others had management and development of the programs as an added role in their job.

FINDINGS

In the following sections, we first present and discuss participant perception of health tracking in health and wellness programs. Most (X: 81%, O: 66%) survey participants perceived health tracking programs useful to support their health goals. Variations in different programs could cause people to have different experiences. Also, Company X, as described in the previous section, has a particularly comprehensive program, which may contribute to the higher perceived usefulness. Other participants expressed some reservations. Second, we found that time commitment was a main concern for those employees who had chosen not to participate in health tracking in the workplace health and wellness program. However, aspects such as different personal health goals, a disinterest in tracking overall, and technological challenges also surfaced. A small group of non-participating employees voiced privacy concerns, to which we pay special attention.

Prior tracking experience affected employee opinions

Some participants noted that they already used a tracker outside of their workplace health and wellness program. This aligns with research from 2013 showing that 69% American adults already track some health indicators, and one in five do so supported by technology [15]. Previous experience with activity tracking devices plays a role in the reactions towards workplace health and wellness programs. For example, employees who already tracked some aspects of health, but in a looser or paper based manner, appreciated how the health tracking system setup in their workplace made it easier for them: “As a reminder and single source tracker (as opposed to losing journals, etc.)” (E113, Company X, survey). Another respondent explained: “It was able to save me some manual work” (E498, Company X, survey). These employees had some experience with tracking prior to entering the health and wellness program, and were positively tuned towards health tracking.

Other survey respondents were more negative. For example, one respondent explained: “I have had previous negative experiences with tracking (obsessive/disordered behavior) so I choose not to track anymore” (E288, Company X, survey). This respondent, and others who voiced similar concerns, feared that health tracking could end up being an obsession, and potentially lead to lower health levels: “Tracking using apps ends up causing me stress” (E361, Company X, survey). Concerns of overuse and obsession with tracking technologies have also been

voiced by participants in studies of short-term activity tracking workplace wellness campaigns [17].

Still other participants were engaged in health tracking as part of their own practices but did not find it useful to connect their trackers to the workplace health and wellness program: “as part of the wellness program not at all. The health tracker was useful to me though personally” (E236, Company X, survey). In these cases, incorporating existing health tracking practices with the workplace programs could be perceived as burdensome: “[I wish the workplace program has] better integration with the health/fitness app I already use so I don't have to track my activity in multiple apps” (E383, Company X, survey).

Health tracking in the workplace wellness programs

In this section, we present attitudes and expectations from employees and wellness program administrators to provide an overall understanding of health tracking implementation in the workplace wellness program.

It's nice the company cares

Most (X: 75%, O: 75%) employees who participated in health tracking programs expressed positive attitudes. Employees liked how their companies made health and activity a subject to be taken up at work, and in turn it made them feel that the company cared for them.

A majority of all participants (X: 83%, O: 78%) said they would recommend health tracking programs to new colleagues. They felt that providing financial incentives to encourage physical activity delivered a positive message regarding how the company cared about employee health: “Companies that invest their time and effort into keeping their employees healthy and active make their employees feel valued beyond just their work contribution, and make the office a happier, more fulfilling place” (E160, Company X, survey). One respondent said: “It's a fun way to be motivated and reach your goals, to talk about it with your colleagues. And I appreciate that the company motivates me to stay fit!” (E253, Company X, survey). Knowing that the company wanted employees to be active made it easier to prioritize physical activities throughout the day.

We asked participants about their overall opinions on workplaces that offer health tracking. Responses to this open-ended question were overwhelmingly positive. For example, a respondent said: “I would prefer to work for a company that offers health tracking over a company that does not. I find health tracking to be a good way to get employees engaged in the program and with each other” (E110, Company X, survey).

Diversity in physical activity is problematic

Some employees thought health tracking programs might be more useful for people who are new to health tracking and who are not active: “I think the program offers great solutions for those who are entry level health/wellness users” (E111, Company X, survey). As a result, employees who are more active wanted the health tracking program to

provide more flexibility to adapt to their personal goals: *“There should be an option to customize the program to fit your personal needs, like set your own goals or small team goals etc. and not just a global company goal”* (E33, Company X, survey).

For example, some employees wanted the programs to accommodate different routines: *“I wish it was more customizable since different people practice different workouts that require different tools”* (E94, Company X, survey). Some (X: 14%, O: 14%) voiced reservations about recommending the program to others: *“Depends on their fitness levels, for people who need to get a boost to start doing some exercise sure but for sports enthusiasts not really”* (E33, Company X, survey).

Even though Company X provides incentives to encourage other activities, employees still felt step counts were the most emphasized because they were better integrated in the system employees used. For example, one participant expressed his frustration when he first logged into the web application: *“You had to select one of those before you moved forward and you had to select what you're good at what you do frequently and the options are only running, cycling, walking, and one more thing. You couldn't say okay, I do martial arts or I do weight lifting or I do cross training”* (E404, Company X, follow-up interview). In this case, the concept of what constitutes physical activity for the program failed to account for the diversity of employee practices: *“There was no personalized fitness plan or outcome, the goal was to log miles but my personal goal is a combination of running, crossfit, weight training. Goals were misaligned and no other personal incentives to provide the data”* (E33, Company X, survey).

Program administrators: holistic views not supported

In contrast with some employee perceptions, wellness program administrators emphasized their goal of supporting a more holistic view of health and wellness. For example, one administrator said: *“Wellness to you could be gardening and yoga, wellness to me could be eating really healthy, and running marathons”* (IP09, other companies, exploratory interview), and explained how they tried to account for that in their programs. In most cases, these wellness program administrators promoted other activities by providing subsidies for gym membership or class fees as well as incentives for participation.

These wellness program administrators were also aware that their programs favored some physical activities, especially step counts, over others, due to the prevalence of devices and apps that track these activities: *“Right now, steps are emphasized all the time. It's all about movement. That's cool, but you can smoke a cigarette and go for a walk.”* (IP10, Company X, exploratory interview). They noted the difficulty of changing these programs and realized that there is more work to do: *“it is a system set up to acknowledge what you track. We can't change the whole program right now. We're looking to improve the program*

and make it easier, and we're trying to ask questions of people and listen, but no formal change at this moment. We're just in the process” (P12, other companies, follow-up interview).

On the one hand, many employees are positive about health tracking technologies in workplace health and wellness programs and consider it useful for increasing physical activity levels. However, even though program administrators tried to encourage a range of activities related to health and wellness, both employees and program administrators recognized that activities that can be easily tracked shape the programs.

Awareness, incentives and accountabilities

Increasing awareness

Consistent with prior research on why people adopt fitness trackers [13,20], many survey respondents (X: 54%, O: 50%) said in an open-ended question (*“Describe your health goals before signing up for the wellness program with the health tracking option”*) that they wanted to develop awareness of and increase their physical activity level. These participants found their wellness program's health tracking option helpful for supporting these goals: *“...tracking helped me realize I was not as active as previously thought and allowed me to continuously track and improve towards my goals”* (E114, Company X, survey). Several respondents enjoyed the awareness health tracking gave them of their habits and activity levels, and how it enabled them *“to monitor my fitness, even when it wasn't top of mind”* (E475, Company X, survey). In this way, health tracking supported participants by reminding them to focus on walking more steps or sleep more hours in a busy day, when many other priorities competed for their attention. Participants felt it was motivating to see how they progressed: *“I enjoy keeping track of my improvements”* (E291, Company X, survey).

Financial incentives

Some participants enjoyed the financial incentives provided by health and wellness program: *“It's been an added motivator - the rewards for gaining points from running races and gaining step milestones are a great incentive to be active”* (E496, Company X, survey). Others were quite honest about participating only to get the bonuses or points offered in the program. As one respondent bluntly put it: *“I don't care about exercise or eating super foods, I did it for the money, and I'm glad to be done with the most recent challenge so I can go back to being my lazy self”* (E376, other companies, survey). In this way, the incentive becomes an “added motivator”. However, the financial incentive was the only reason E376 tracked, and so here the incentive is more coercive, matching concerns by researchers and media [7,26]. Financial incentives can be that final nudge to employees because they appreciate their efforts are rewarded. However, the financial incentives could also force participants more than just a gentle nudge, in a manner we suspect is unlikely to be sustainable.

Developing internal and external accountability

Some survey respondents (X: 15%, O: 19%) felt that workplace health tracking keeps them accountable to their health goals, but preferred different sources of accountability. Some respondents (X: 8%, O: 9%) found that health tracking helped them be accountable to themselves: *“Helps for personal accountability. Looking at data makes it hard to lie to yourself”* (E76, Company X, survey), or as another respondent put it: *“it created a degree of self-accountability”* (E370, Company X, survey). Others (X: 6%, O: 9%) found it useful to see their health data compared to others: *“It makes me want to be more active as I can see how many steps others are taking and if I am falling behind.”* Another participant responded: *“Seeing what my peers are doing push myself harder.”* Being able to interact or compete with colleagues also encouraged people to move more: *“By making the program company-wide available and promoting it and inspiring people to participate which led me to pay extra attention on how active I was compared to others”* (E5, other companies, survey).

Some participants could socialize with other people with whom they did or did not have direct working relationships and develop “workout buddy” relationships with them: *“Sharing daily and weekly goals and providing a buddy system which creates a support system and also accountability system which worked really well for me”* (E169, Company X, survey). The social nature of the workplace health and wellness programs provided externally driven accountability to help employees make progress toward their goals.

Overall, we found that many participants did appreciate feeling accountable, whether internally or externally. This is in conflict with prior research that has shown how being held accountable for physical activity at work can be straining [17]. We recognize that in a survey and interview study such as ours, the negative aspects of accountability were less likely to surface as clearly as in long-term ethnographic studies. However, our findings suggest that there may be instances when accountabilities can work positively in workplace health and wellness program.

Why some chose not to track

To get an overall view of opinions on health tracking in the workplace, this study also included participants who had not taken up this opportunity. Out of our 536 responses, 107 respondents from Company X (20%) and 4 from other companies (13%) replied that they had chosen not to use health tracking in their workplace health and wellness program. The lower percentage of non-participation in other companies might result from self-selection bias for our study. These participants were then asked to comment on their choice in a follow-up, open-ended question (*“In the previous question you said you chose not to use health tracking in the health or wellness program offered in your workplace. Why is that?”*). Participants often mentioned more than one concern in these responses.

16% of responses from Company X (0 from other companies) mentioned either technical problems or uncertainties that hindered participation. For example, the app or device offered by their companies worked only with certain types of smartphones. Others explained that they were uncertain of the sign-up process. For some programs, participants had to purchase a tracker without reimbursement. This deterred them from participation: *“You had to purchase the product and it was not something I thought I would use after the program.”* (E67, Company X, survey). As such, financial and technical problems did play a role when employees decided not to use health tracking. However, other themes also emerged and will be discussed more in-depth in the following sections.

Concerns with tracking as additional workplace demands

Consistent with prior work [31], 51% of the responses from Company X and 2 responses from other companies mentioned concerns about time commitment. These concerns pertained to time spent uploading and interpreting data as well as to long-term use. Some participants felt that they just did not have time, and that wearing a tracking device and understanding its data would be *“one more thing to do in a busy day”* (E34, Company X, survey). Thus, some felt that health tracking would be one more workplace demand difficult to accomplish in an already hectic schedule. One participant explained: *“requires too much work / effort on my end and I don’t necessarily have the time to follow through on a daily basis”* (E246, Company X, survey). These participants saw the potential of tracking to offer insights, but objected specifically to the long-term, daily use the program encouraged: *“Why do I have to track ALL THE TIME? it’s sickening to having to do that. I only need maybe once a quarter at MOST”* (E73, Company X, survey). Previously, we highlighted how some participants appreciated that physical activity was connected to the workplace, however, here we see others interpreted this same intervention as yet another workplace responsibility.

Already active and/or different health goals

In previous sections, we noted that participants felt tracking technologies did not support or fit well with their preferred physical activities. Responses from non-participants show that this deterred them from starting using health tracking in the health and wellness program in the first place.

28% of responses from Company X and 2 responses from other companies noted that they were already active, and did not feel they needed to use a tracking device to stay active: *“I have my own personal tracking system.”* (E528, Company X, survey). Previously we discussed how participants who already kept track of one or several health indicators in their minds or by pen and paper were generally positive towards switching to technology supported tracking. However, for participants who already used technology supported tracking, switching to the technology used in the health and wellness program was a hurdle.

Moreover, not everyone had goals that can be easily tracked using fitness trackers and apps and therefore are not easily awarded points or credit in the health and wellness programs. For example, although it might be possible to manually journal weight training, employees often cannot input these data into the system. Similarly, some participants had healthy eating goals, but these data were also not part of the incentivized activities: *"It's not so much about getting in shape anymore, but more about paying attention to how I treat my body. What I eat and working out go hand in hand"* (E96, Company X, survey). Others just did not see how tracking would help overall health levels: *"While I completely agree that health is important, I don't see how tracking these features day-to-day is important"* (E399, Company X, survey).

The discrepancy between individual health goals and what fitness trackers and apps can track created tensions. While some respondents were potentially interested in switching from their own tracking routine to using a tracking device in connection to their wellness program, they felt it did not fit their overall wellness goals, or did not feel tracking could support them in reaching their goals.

Tracking uninteresting

In responses about why employees had chosen not to track as part of their workplace health and wellness program, 18% from Company X (0 from other companies) mentioned that health tracking and wearable devices were just not interesting to them. For example, one respondent noted: *"Generally not interested in wearable technology"* (E173, Company X, survey). We were not, however, able to follow up with survey respondents who had noted disinterest as a reason for non-participation. We also recognize that non-use is complex and fluid, and not necessarily a problem to be solved [32]. Although prior research has informed why people abandon their trackers after use [9,20], future research should look into refusing to use from the start to understand non-use in general.

Concerns of privacy

Three participants (3%) from Company X and two participants from other companies voiced privacy concerns. While many respondents in our study felt that their employers' interest in their health was a good thing, some felt it was invasive and thus chose not to participate.

To some respondents this concern related to the boundary between personal life and workplace: *"I feel my stats are personal. I don't need work involved in my personal wellness tracking because it goes beyond my work day. I don't want to feel like my every move is being monitored by work. It just feels uncomfortable"* (E534, Company X, survey). People have different tolerances for how they prefer work and private life to merge, and this diversity is likely to always be present to some degree. However, if financial incentives become great enough, some people might choose to utilize health tracking, even if it overrules their personal preferences. While we did not see many

participants express these concerns, it is still important to acknowledge them, and to realize that this can lead to feelings of coercion regardless of financial compensation.

For others, concerns revolved more around data disclosure at large: *"I don't want a 3rd party to have any more data about me than necessary so I choose against any wearables. I don't like the idea of being monitored"* (E444, Company X, survey). Current systems do not give the user control of their own data, and people are usually confused about how their data are used by these systems [1]. Finally, while we do not have data to support this, it is not unreasonable to think that employees might have fewer privacy concerns because they trust their companies to choose tracking devices that protect their data.

DISCUSSION

Overall, employees who participated in our survey had many positive things to say about health tracking in workplace health and wellness programs. Yet they also expressed a diversity of concerns. The sources of these concerns ranged from the design limitations of current activity tracking technologies to significant individual differences in attitudes towards personal health, the need for separation between work and personal life and financial limitations. In the space below we first discuss the issues that emerged most prominently in our data. This is what Ackerman has called "the socio-technical gap" [1] between the diversity of what people conceptualize as health and wellness, the more holistic goals of the administrators of health and wellness programs and the limits of technologies to support health tracking. We then consider why, despite much criticism about privacy issues, so few of our participants expressed this concern.

The social-technical gap

Ackerman described the social-technical gap as *"the divide between what we know we must support socially and what we can support technically"* [1]. Health tracking, in its current form, has largely been limited by what technology can reliably sense, such as step counts and distance. Despite recent efforts to include functionality to algorithmically recognize other activities from sensor data, most such technologies rely on heart rate and movement measures to estimate effort, resulting in relatively unreliable and limited feedback to the user. Thus, there is often a gap between the diversity of forms that health and wellness activities can take and the activities that could be technologically tracked in workplace health and wellness programs. This gap frustrates both employees and program administrators.

Overall, the program administrators of Company X and the other companies expressed in the survey that the most important goal of the health and wellness programs was to help employees maintain a healthy lifestyle and learn about healthy lifestyle choices, and to support a better working environment. For example, in Company X, the health and wellness program was designed based on a particular

conception of wellbeing, which focused on nutrition, hydration, breathing, movement, thoughts, and rest.

To motivate employees, Company X offered a variety of health and wellness activities, and the incentives were designed to include more than just step counting or distance tracking. For example, employees could also participate in meditation classes, join an ironman race, or go to the gym more than three times a week. However, many of these activities required manual self-report whereas step counting was integrated directly into the tracking systems, and thus more easily reported. This led to most attention being paid to step-counting and leaderboards favored walking and running more than other activities, even though the website and app allowed employees to manually log and convert some of their other activities into miles. Because of this, some employees interpreted step counting as a company-wide goal (one million miles). In addition, simply presenting the number of times an employee engaged in an activity does not provide enough information to help employees pursue or maintain more sophisticated health goals. For example, number of gym visits may not be helpful to support goals such as improving strength level.

As a result, many employees considered health tracking technologies more useful for people who were new to tracking and exercise. People who already were active often did not see the value of counting steps and therefore did not participate in the program or only participated to get the financial incentives. Program designers put effort into encouraging a diversity of activities, supporting individual variation in health goals. However, the ease and prevalence of fitness tracking technologies, combined with leaderboards that clearly acknowledged only steps and distances, caused employees to focus on activities that could be tracked with wearables.

Most employees who completed our survey and interviews perceived their incentivized workplace health and wellness program as a sign that their employer cares about employee health and happiness. This is consistent with findings from another recent workplace survey where the implementation of a workplace program helped to increase employee identification with their company [11]. However, the potential discrepancy between health tracking technologies and the overall goals of the wellness program might affect employee relationship with the company. Future research should consider implementations of health tracking and the influence on employee-employer relationship in detail. The disconnect between the limits imposed by technologies on what can qualify as health and wellness in workplace programs and employee health goals and health practices could result in employees feeling coerced to use health tracking technologies especially in long-term programs where financial incentives are involved. Furthermore, where many appreciated employer interest in employee health and wellness activities outside the workplace, some quite legitimately felt this sort of attention was intrusive.

Therefore, employers should think about how to better design and promote a diversity of components for their wellness programs that can help support individual health goals without overstepping boundaries.

Privacy is not a primary concern, yet

In our study, we strove to understand overall concerns about health tracking in health and wellness programs. Therefore, we included open-ended questions, such as “Overall, what is your opinion on workplaces that offer health tracking as part of their health and wellness programs?” We chose open-ended questions, rather than specific privacy questions, as research suggests that directly asking about privacy may result in biased responses [3]. Most of our survey and interview participants did not voice concerns about privacy in regards to sharing their health tracking data with their employers. This stands in contrast with recent concerns of both researchers and the media [7,27,29]. However, this does not mean that privacy is not an issue. In this section, we discuss several possible explanations. We also note that as other concerns are addressed, privacy concerns may become more important.

Program fit is a more immediate concern than privacy

Health tracking programs, in their current forms, impose other more concerning challenges on employees than their privacy expectations. For example, some employees struggled with the balance between busy work schedule and fitting workout into their routine. Although employees appreciated employer interest in physical activities, long-term, everyday health tracking can become burdensome for some. Positive health and wellness promotion rhetoric in the workplace influences employee choices to participate, and they expect positive outcomes. However, such efforts can also force an unwelcome renegotiation of boundaries between work and private life for some [18].

On-going, continuous health tracking program can be useful in some cases and employees in our study disagreed with each other. Where some were in agreement with prior research [17,23] and appreciated the limited length of health promotion efforts, others wanted more. Some survey participants and interviewees whose companies offered short-term health tracking events expressed a preference for continuous health tracking options: “health is not for three months”. However, we urge companies to consider the goals and appropriate use cases for each option and to explicitly communicate these goals to their employees when implementing health tracking programs. While continuous health tracking might help people who want to develop consistent, regular routines of working out, it may not be useful for everyone. In this case, the incentives should be designed to encourage consistency rather than fixed, step-count goals [8]. Short-term events are effective to increase employee attention and to boost activity level in a short period of time [4]. People also might be able to continue the habit and apply the knowledge obtained from participating in short-term events and use it independently

[12]. However, companies should also consider how to help sustain the behavior if employees wish to. These short-term events should also account for a diversity of health goals, activities, and work routines. In this way companies need to understand which challenges the individual employees are facing, and find the right fit to respond to that need, rather than forcing one-size-fits-all wellness programs.

Transparent policy about how data is handled

Most of the companies in our study were very transparent about their data collection process and access policies. These companies usually adopted third-party platforms to implement health tracking programs. As part of the system design, employers often do not have individual health tracking data but receive aggregated, anonymous reports at the end of each program period. Wellness program administrators also strove to openly address the potential privacy concerns by explaining the data use policy in newsletters (P7, P10) and by having an open, standard FAQ in response to employee concerns (P9). There remains, however, an issue in the fact that a third-party is introduced into the process of intimate disclosure of health data between the employees and the workplace.

Minimal use of health tracking data

The most common outcome variable measured by wellness program administrators we surveyed and interviewed is engagement (i.e., participation rate) in the health tracking program. As health tracking is relatively new, most wellness program administrators are preoccupied with increasing employee interest in tracking their health and in motivating them to shift from a sedentary lifestyle to a more active level.

This transparent and minimal use of health tracking data might have eased current employee concerns. On the other hand, some employees felt their data were underused and wished their programs would provide in-depth analysis of their data, creating more opportunities to help achieve their health goals. As more and more employees have experience with health tracking data, employers might need to put thought into how to provide personalized information to support individual health goals while assuaging privacy concerns. Building on the citizen science movement, individual-lead collective health data analysis has drawn attention from research [14]. As employees see the need to derive better value from the tracked data shared with wellness programs, there is potential in employees participating in the decision of how these data can be used. Future research should investigate employee expectations and concerns with regard to employee-driven data analysis.

Limitations

Our survey respondents and interviewees are relatively young (*median* = 35 vs. 42 of the labor force in USA [21]) and largely from tech-savvy companies. Because incentives for the health tracking program in our case study site, Company X, were implemented as a virtual point system, our data better describe programs that offer monetary discounts or virtual point systems than those offering

insurance discounts. Therefore, employees participating in insurance sponsored health tracking program might have substantially different experiences or concerns and their attitudes about sharing data might differ. However, analysis of data from the small sample of participants in insurance sponsored program indicated that the social-technical gap between health tracking technologies and health and wellness goals is just as relevant. We also found similar needs to support various health goals and routines from participants of both types of programs. Future studies should investigate how employee experiences and concerns might differ in other types of programs.

CONCLUSION

Companies increasingly include health tracking as an element in their workplace health and wellness programs. This may include manual tracking or self-report, but also increasingly includes the use of tracking technologies such as the Fitbit, the AppleWatch and other devices that can automatically sync data with the health and wellness program. Companies incentivize sharing of health data from these devices in various ways. For example, some employees may receive virtual points in a gift shop, while other employees receive discounts on insurance premiums. Among researchers and media, this has caused privacy concerns, discussions of datafication of health and disciplining of the employees.

This paper makes two primary contributions. First, it uses empirical data to provide an understanding of employee experiences and attitudes towards health tracking in workplace health and wellness programs. We found that program fit turned out to be a more immediate concern than privacy. Second, we found that program administrators in our study were already aware of the gap between a holistic view of health and what is incentivized because it is easy to reliably track (often this is steps). We encourage the program administrators to continue their work to develop and promote programs with holistic views of health that incentivize and support more than what is easily tracked. We call for research to help administrators in this quest, which will lead to a better fit between what employees want from their workplace wellness program and what they get.

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Paper 4

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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

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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 awkwardness in the interview situation by providing an object of focus. Third, the process of discussing photos can allow the participant 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 between 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

Participant	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.

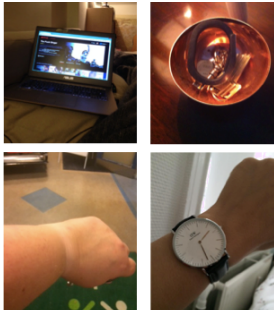


Figure 1: Examples of photos of non-use. Clockwise from top-left P6F, P14M, P20F, P12F

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 one's 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 your 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).

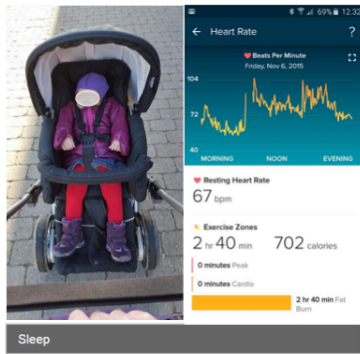


Figure 2: Example of photos sent by P21M. “It was nice that even someone like me, who doesn’t use the tracker for training purposes could tell about it, and what you can use it for besides focusing on exercise, exercise, exercise” (P21M).

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:



Figure 5: P9F depicting an evening walk.

“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).

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.

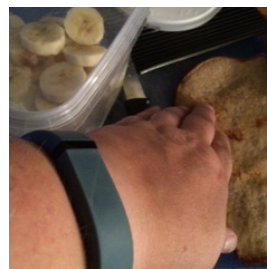
4. Expect discontinuity & technical difficulties

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 lose 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 explore 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.

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Paper 5

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Episodic Use: Practices of Care in Self-Tracking

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Abstract

The development of self-tracking technologies has resulted in a burst of research considering how self-tracking practices manifest themselves in everyday life. Based on a 5-month long photo elicitation study of Danish self-trackers we argue that no matter how committed people might be to tracking their activities, their use of self-tracking technologies can be best described as episodic rather than continuous. Using Mol's theoretical framework for understanding care practices (Mol, 2008) as a lens, we show how episodic use can be interpreted through the logic of care. By using self-tracking devices episodically users employ strategies of care in a way that can be productive and useful. These strategies often come in conflict with the logics of choice that underlie the design of self-tracking technologies. We argue that this has consequences for the way self-tracking devices need to be imagined, designed and introduced as part of workplace and insurance type tracking programs.

Introduction

Activity tracking technologies have gained increasing attention within the last 10 years, with recent numbers showing that 30% of all households in Denmark have at least one activity tracking device (Danmarks Statistik, 2018). This uptake of activity tracking devices is driven by hopes for its potential to improve levels of physical activity (Ledger and McCaffrey, 2014). The basic assumption is that activity tracking can inform the individual about health behaviors and ideally this information will motivate them towards healthier habits. This sort of responsabilization of health has been previously extensively critiqued (Lupton, 2016; Moore and Piwek, 2016), however, the rhetoric remains largely positive. So much so, in fact, that activity tracking devices are increasingly introduced in workplaces as part of health and wellness programs and insurance incentive schemes (Chung et al., 2017; Gorm and Shklovski, 2016).

Despite the rapid expansion of activity tracking technologies, we find that little attention has been paid to the fact that users often leave devices behind sooner than expected. Industry research shows that half of US users leave their devices behind within six months (Ledger and McCaffrey, 2014), which is sometimes referred to as the "dirty secret" of activity tracking (Hammond, 2014). Abandonment is often framed as failure and seen as an opportunity to develop and improve technologies, thereby "fixing" the

problem. Some researchers have critiqued this assumption, suggesting a variety of interpretations for how and why people manage and stop their use of tracking devices. For example, Nafus and Sherman, have suggested that switching between devices and seemingly irregular tracking practices can be interpreted as a form of “soft resistance” (Nafus and Sherman, 2014). Others have argued that long-term use is not necessarily a criteria of success (Gorm and Shklovski, 2016), while notions of “lapsing” show a variety of reasons for leaving devices behind (Epstein et al., 2015). Finally, “happy abandonment” highlights how some users leave devices when they have learned what they set out to learn (Clawson et al., 2015). Taken together, these research efforts show how non-use of activity tracking technologies is more than simply a failure of technology. However, where these research efforts considered implications of device non-use of different kinds for the design or implementation of these devices in institutional practices, most either pointed to opportunities to design in ways that might increase engagement (thus limiting lapsing of various kinds) (Epstein et al., 2015) or argued against institutional adoption of these devices (Moore and Robinson, 2015).

In this paper we add a different interpretation of this stopping of use, that of episodic use. We argue that episodic use is an integral part of on-going self-tracking practices rather than a problematic hitch or an ending. By looking at the practices and concerns surrounding self-tracking technologies, combining prolonged empirical studies with key theoretical concerns from Mol’s work on care, this paper empirically investigates self-tracking practices over time. Foregrounding the idea of episodic use as a practice of care not only challenges the focus on lapsing as a technologically fixable problem, but also augments existing theoretical vocabularies (Epstein et al., 2015; Lomborg et al., 2018).

Considering the importance of non-use

An increasing number of studies have considered the implications of activity tracking practices. On one hand, many researchers adopt a positive rhetoric towards self-tracking, where abandonment of tracking technologies is often discussed by industry (Ledger and McCaffrey, 2014) as well as academic research as a first and foremost a technological problem that could and should be fixed (Literature review forthcoming; Wilde et al., 2015). Improving aesthetics (Shih et al., 2015), creating interesting visualizations (Consolvo et al., 2008), building variation in goal-setting (Munson and Consolvo, 2012) and offering opportunities for reflection rather than prescriptive information (Baumer et al., 2012) are but some of the suggested solutions to the problem of abandonment. Much of this research sees people stopping their tracking as a kind of failure either of internal motivation or of the design of the devices. These researchers then focus on finding ways that current devices might be re-designed thus providing a technological fix to the problem, coming from the idea that best health benefits can be gained from continuous use (Wilde et al., 2015). Improving devices and fixing bugs so that users have better experiences with them is a laudable goal. We suggest, however, that only attending to technological solutions to abandonment overlooks other reasons for leaving trackers behind, and that in fact idiosyncratic user patterns are a way for users to stay in control of the activity tracking devices.

On the other hand, some researchers have expressed growing concerns about the potential negative implications of self-tracking technologies. These typically revolve around the fact that health data is bought and sold, and can be used in unforeseen ways (Neff and Nafus, 2016). The data producers (self-trackers) rarely have full knowledge or access to their own data and, as researchers point out, we do not yet understand the ways in which self-tracked data may disrupt existing information flows (Nissenbaum and Patterson, 2016). Researchers in this space have argued for a “*refusal of data- a refusal to track the body, a refusal to subordinate the qualitative to the quantitative*” (Moore and Robinson, 2015). While there are important, and grave, consequences of the increasing datafication of health, such critique rarely shows ways forward (Mol, 2008). The simplest way to address many of these critiques is not to use these devices at all and abandonment is seen as a form of resistance to the perils of this extension of a control society (Moore and Robinson, 2015).

Yet attending to the overarching societal implications in this way undermines the lived experiences of tracking, which can be fun and personally meaningful (Neff and Nafus, 2016). Kristensen and Ruckenstein demonstrate that self-tracking can be experienced as amplifying some parts of the self, while reducing and restricting others (Kristensen and Ruckenstein, 2018). This draws attention to consequences of tracking at a more detailed level. Recent work by Lomborg et al. show that users are hooked in a different way than those inscribed in the technology, yet the pleasure of building a personal repositories is something some users find important (whether tracking runs or types of wine tasted) (Lomborg et al., 2018). Tracking, thus, is not a straightforward process working towards standard health goals, in fact, researchers have also argued that self-tracking can sometimes be a type of soft resistance, actively working against prescribed norms (Nafus and Sherman, 2014). Devices are also sometimes left behind when the user have reached their goals, leading to “happy abandonment” (Clawson et al., 2015). Rooksby et al. suggests that the use of activity trackers can be characterized as “lived informatics”, showing how self-tracking intertwines with everyday life in a variety of ways and proposing a taxonomy of different styles of tracking (Rooksby et al., 2014).

Where researchers have considered less than linear patterns of use, we see discussions of lapsing (Epstein et al., 2015). Epstein et al. suggest that there are four different types of lapsing; forgetting, upkeep, skipping and suspending. Users might forget to wear their devices, and devices also demand upkeep such as charging in order to work. Users may skip some occurrences in their tracking practices if it is too cumbersome, while suspending tracking can happen because the user decides tracking is no longer needed or wanted. These categories of lapsing, however, are used as a springboard for considering how to support users to return to their tracking practices by improving technologies. We suggest that considering the limits of tracking, especially when forms of tracking become barriers rather than support practices of care, demands a reconceptualization of what it means to leave trackers behind. The notion of *episodic use* offers a different interpretation of this stopping of use, going beyond seeing abandonment as a technologically fixable problem. Rather, what we call episodic use is integral to using activity tracking in ways that support practices of care.

Understanding how users stay in control is important, not least as the idea of sustained use moves into new settings, such as workplace health insurance schemes and health promotion initiatives (Christophersen et al., 2015; Moore and Robinson, 2015). This development signals a move from “private” self-tracking to “pushed” self-tracking, where the encouragement to initiate tracking is put forward as part of institutional arrangements (Lupton, 2014). For example, employees in some companies in the US earn points for gift-shops or receive lower insurance premiums through the use of self-trackers (Christophersen et al., 2015; Chung et al., 2017; Nissenbaum and Patterson, 2016). This means that in some cases, even if individuals may want to stop using their devices this could have economic consequences. The fact that activity-tracking devices, and the positive rhetoric surrounding them, are moving into areas beyond personal choice merits a closer look at what it actually means for humans to track and to stop tracking their activity levels.

Activity tracking from the perspective of logic of choice and logic of care

In order to expand our knowledge and understanding of self-tracking practices we question the underlying assumptions guiding the developments in the field against actual user practices. Mol provides a language to engage with such assumptions, referring to them as “logics”. Mol works with two main logics, namely “logic of choice” and “logic of care”. We take up her invitation to translate and apply these theoretical concepts (Mol, 2008: 8). While there are differences between the chronically ill patients with diabetes with whom Mol works and the typically healthy, perhaps even fitness minded participants in our study, the same underlying logics are at play. For example, if people are seen as rational individuals then merely providing information about the harms of a certain type of behavior will be enough for them to stop that activity. Mol refers to this way of informing about health as logic of choice. The logic of choice underpins the idea of “patient choice”, which was originally put in place to support patients in dealing with paternalistic doctors. Ideally, this creates a more equal relationship between doctors and patients. As a downside to this, when things go wrong, because bodies and technologies are “unruly”, the blame falls onto the shoulders of the patient (Mol, 2008). This makes individuals responsible for their own health despite the fact that health is greatly impacted by structures beyond individual control (Stokols, 1996). Furthermore, the problem with the logic of choice is that people do not make rational choices, nor are their choices made in a vacuum. For example, patients do not act entirely on their own but have family and friends, who influence their choices (Mol, 2008). The same is true for users of activity tracking devices, whose habits and everyday lives are impacted by and impact others too.

Taking the structures and social circumstances into consideration, rather than seeing people as autonomous individuals, is a part of what drives the logic of care (Mol, 2008). Good care is not the result of well-considered individually made choices. Rather, good care recognizes the complexities of life, trying to strive for improvement but knowing that the process is not linear. This is not an excuse to give up when challenges arise, yet a forgiving and persistent view on improving health. The logics of choice and care are not mutually exclusive, yet occur and interweave at the same time (Mol, 2008). In this paper we show how the logic of choice drives the rhetoric of the marketing of activity tracking

devices. Yet when activity tracking is taken up in everyday life, our participants did substantial work to use technologies in ways that underpin practices of care. We translate Mol's framework to the area of mundane, everyday self-tracking. By doing so we show how the logic of choice guides how participants felt they should use their devices, and how this contrasted with their preferred use patterns.

Research Design and Empirical Data

Studying self-tracking as it develops over weeks and months poses a challenge. Self-tracking and interaction with wearable devices tend to happen idiosyncratically, often alongside other activities. This makes observational studies difficult and is the reason why most studies have relied on surveys or interviews (Epstein et al., 2015, 2016; Fritz et al., 2014; Rooksby et al., 2014). However, engagement with users over time is key. Building on well-known methods of photo-elicitation and projective interviewing (Harper, 2002), we adapted the participant-driven photo-elicitation method (Clark-Ibáñez, 2004; Harper, 2002) to studying self-tracking in order to facilitate recall of self-tracking practices over time in ways that would help participants remember better. Below we present a brief description of the methodology we developed. For a detailed discussion please see (Anonymized).

Study set-up

We recruited 25 participants from Denmark through several Facebook groups (Ladies First (women in start-ups), FitBit Denmark and Fitness.dk (fitness chain)). We used Facebook for our recruitment as Denmark has a very high percentage, 67% of the population using the site (Wijas-Jensen, 2014). We selected these Facebook groups because it gave us access to a variety of users who we assumed would be interested in technologies and/ or fitness. We asked anyone who was interested in participating to also share the post to enable snowball sampling.

We received 64 replies and selected a varied group of participants from this pool. To have as much variety in the study as possible, we conducted initial phone screenings and included participants with varying degrees of previous experience, age and occupation. The study included a total of 25 participants: 15 women and 10 men, ranging in age between 21 and 57, with an average age of 36. Participants covered a variety of occupations, including two students, a music teacher, a carpenter, a nurse, a nursing home employee, a writer, an human resource employee, an IT consultant and others. Apart from the nursing home employee and the carpenter, participants had mostly sedentary occupations. To ensure that we could recruit new users, we offered Fitbit's for the duration of the study. Nine participants had never tracked before and accepted the Fitbit's that we had offered. We included participants from several different parts of Denmark, covering both the two biggest cities of Copenhagen and Aarhus as well as several small town and countryside areas. For more details on recruiting, participants and methods of this study, please refer to (Anonymized).

The study was designed to run for at least five months and all participants committed to engaging with us for this period of time. The study consisted of an initial interview, the photo-elicitation component, which included intermittent engagement via email for several months, and a final interview at the end. Initial interviews took place during August and September 2015 in order to gain a deeper understanding of existing experience participants had with self-tracking, and to give the Fitbits to the group of new users. Participants were given the choice between Fitbit One (Clip-on) and Fitbit Flex (armband), to allow for personal preferences.¹

For the photo-elicitation all participants were asked to take photos of their experiences with activity-tracking devices over the course of five months. We encouraged them to capture any experience, thought or subject that they felt was important in relation to their activity-tracking practices. We gave no instructions or specific tasks, and relied on participants to use their own smartphones to capture photos. Photos were sent to us via e-mail and we encouraged adding a short written description with each photo. If we had not received photos for two weeks, we sent a personalized reminder, sometimes asking to follow up on something they had mentioned in their previous e-mail. Two participants, who had received Fitbits, lost their trackers within a few weeks from the start the study. We followed up with both participants as they left the study, but one was omitted as he had used the device only briefly before losing it. Two participants did not respond to our invitation for follow-up interviews. We received 313 photos in total over the course of the study, ranging from 4 to 125 photos per participant, with a median of 8 photos. We refer to participants by a number, indicating M= Male, F= Female for anonymization purposes.

For the follow-up interview we printed all of photos each participant had sent. At the follow up interview participants were asked to go through each photo and explain what it was and why they had taken it. To facilitate further reflection participants were then asked to look across their photos and discuss whether some photos fit together in categories. Finally, the researcher made sure to follow up on any subjects or questions that had arisen from the previous months. We conducted 21 interviews in Danish and one in English. All interviews were recorded and transcribed. We followed a grounded theory approach when coding the interviews, using the TAMSanalyzer tool (Weinstein, n.d.). The findings presented in this paper are based on photos, e-mails, researcher notes and interviews with the 22 participants who completed a follow-up interview during December 2015 and January 2016.

Self-Tracking in Practice

Throughout the study, participants shared a wide variety of their experiences with us. These included fun and motivation, struggles and guilt when goals were not reached, and a variety of non-use situations. In what follows we detail the mundane nature of self-

¹ We chose to provide new users with Fitbits because at the time, Fitbit had Facebook groups in Danish where participants could potentially seek help.

tracking and the common experiences our participants shared. We then consider episodes of non-use and how this is intertwined in everyday life when using activity trackers.

Self-tracking can be both motivating and fun as many of our participants frequently attested. For example, P21F explained that she found meeting her goals really pleasant and it gave her the confidence and energy to try to reach more steps on other days too. The couple P15M and P16F had participated in a 200 km bike race, and really enjoyed the fact that their relatives were able to follow them in real-time because of their GPS tracking. They had also lent a tracker to their son to teach him about speed: *“We gave it to him to give him an idea about speed, because one thing is when he says: “Look mom, I’m biking 100km/h”. Arh well, not quite, but then he could see for himself how fast he was going.”* P25F liked receiving badges from her Fitbit when she reached certain amounts of steps, and she also enjoyed the visualizations of her heartrate during workout: *“Maybe I’m a visual type of person I guess, I like to see the result, I’m all about that at the moment.”* Such stories are common and have been discussed in much scholarship on self-tracking (Neff & Nafus, 2016). What we soon noticed, however, were the many times in which the experience of self-tracking was more of a let-down for our participants. Consider the following quote from P19F, who was enthusiastically counting her steps because she wanted to increase her fitness levels. Generally she would set high goals and work hard to achieve them. Although high goals motivated her it backfired when she did not meet them, as she would feel disappointed with herself.



“Okay, so in this (photo), I was thinking that it’s late and I’ve only walked 4300 steps, and it’s 10 pm so I will not walk more steps and it’s not even close to my goal. My goal is 12000 a day, so 4300 is incredibly few. I think it’s the first time I’ve been so far from my goal, except if I didn’t wear it at all. So this shows the thing about 10pm and I just realized that I haven’t reached those steps and it really sucks”

(P19F, follow-up interview)

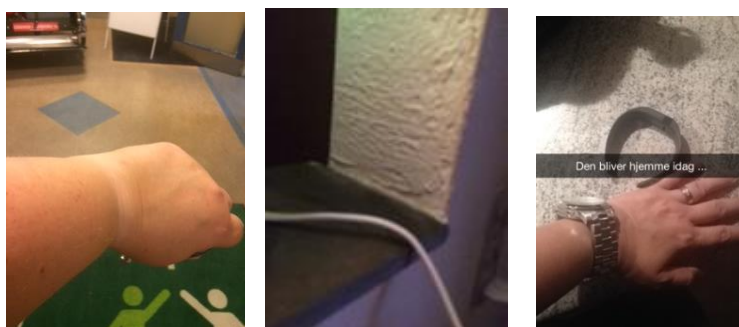
Perhaps this feeling of disappointment is necessary, especially if people are ostensibly trying to be healthier and walk more. Disappointments, after all, may lead to better performance later. Yet in the follow-up interview P19F explained how hard she worked to not let the feeling of disappointment at missing her own goals take up too much emotional space: *“Yes, well I actually find it incredibly difficult, also because I’ve been stressed before, so I know I can’t let this thing control too much, and I have to feel whether I do this because I have to or because I want to. So I’m very aware that I shouldn’t stress too much about walking those steps (...).”* P19F’s concerns about letting the tracker “control too much” is interesting especially because she points to this concern

as a potential source of stress. The same was true for P25F who described being “disappointed” when she did not reach her daily step goal. This disappointment, however, did not lead to her trying to walk more. Instead, she told us that she realized she had to take a step back from her goals and to forgive herself when it was difficult to reach them when other things in life demanded her time (work, travel). P22F explained how frustrated she had been with her low levels of physical activity in the past few months. Her low numbers of steps were due to a temporary work situation, which demanded entirely sedentary work, and due to the long dark Danish winter, she explained. In these conditions, self-tracking to her was “permanently a bad conscience” (P22F, follow-up interview).

Changing behaviors, such as engaging in more physical activity, is difficult. Predictably wearing a tracker made obvious to our participants that they were not as active as they wanted to be. This, in part, is the very point of self-tracking devices – to make people aware of their situation and to provide them with the impetus for change. The trackers then are designed to remind, to push, to constantly update and some of our participants responded by working hard to not be “stressed” by this onslaught, and to forgive themselves when they did not reach their goals. Many had to acknowledge that other things in life took priority and the devices took no notice, making people feel increasingly guilty. This guilt and bad conscience could eventually lead to people no longer using their devices, either for shorter periods of time or for good.

Lapsing in use

Situations of non-use of self-tracking devices have been documented by many scholars with Epstein et al. developing a taxonomy of lapsing, and in our study we observed all four types (Epstein et al., 2015). These were stories of batteries needing charging, broken armbands, lost devices, and skipping of use because device did not fit with a certain outfit or because detailed logging was too cumbersome (See photos below). For example, P20F explained her skipping when she had not logged all foods over Christmas; “Yes, well, I haven’t done it (tracked food) much over Christmas, because I just couldn’t be bothered about writing up every little fish fillet, I just didn’t bother, or if we’ve been out eating, then it’s too much” (Follow-up interview).



Photos: A) Forgetting to wear, B) Photo where the charger used to be (causing lapsing due to challenges with upkeep), C) Skipping use when the tracker didn’t go with the outfit.

In paying attention to various ways our participants did not use their devices we noted interesting patterns that lead us to consider that perhaps some forms of lapsing are quite purposeful and may even be necessary for self-tracking to be possible for many of our participants at all. For example, P22F had had days of forgetting to wear the tracker, but also days when she *decided* not to wear it. It wasn't planned, she explained, but something "emotional" and "impulsive". She said: *"I've been aware that it should not control my life, it should be part of my life. It depends on how you use it. It's not a thing that has been controlling me, it's something I've used to check how I've moved"* (P22F, follow-up interview). This particular participant was also going through exhausting medical procedures at the time of our study. Using the tracker motivated her to be more active. However, she knew she may not be able to live up to her activity goals, not because she was lazy, but because she had real physical limitations to deal with. Still, she emphasized, that she did not want to just abandon the tracker. Rather, she used it episodically, allowing herself a way to control her use of the device.

During our 5-month long study, participants would leave trackers for periods of time, usually for very specific reasons. P20F and P11F both explained how it was important to have *"lazy days"*, where they would either not wear the tracker or not look at the numbers at all. Some participants even mentioned that reaching their goals every single day may be actually harmful for them. To P20F it was extremely important to have *"lazy days"*. She had tried a range of diets and would inevitably lose her motivation if she did not sometimes relax, she explained. In the same way P11F said: *"I have special weekend rules, but I think Sunday is sort of sacred, it's okay to lie on the couch and watch movies all day"* (follow-up interview). In order to do this she would mute the reminders her tracker usually gave her every hour to remind her to stand up. She explained that this was a difficult battle with her competitive nature. For example, even though she had surpassed her step goals for an entire week, the fact that there was a big fat zero after a Sunday on the couch bothered her. Yet Sunday on the couch gave her a feeling of a better balance between focusing on activity, while also giving the body time to rest.



Photo showing tracker with no steps taken and the view from her couch. *"Actually no steps today. Hard weekend with work = relaxing on the couch today"*. (E-mail description, P20F).

Lazy days and other such efforts are a form of what some researchers have termed skipping or suspending (Epstein et al., 2015) – where people may not need or want to track certain things or times of day. The feelings participants described when explaining about special weekend rules or leaving the tracker to stay in control, were forceful and

clearly very important to them. There was more at play than simply skipping or suspending tracking for a while. Leaving the tracker on, and considering each and every number on the screen, left some people feeling powerless. The failing may or may not have been theirs alone, but they were always left to contend with the structural constraints of their lives leading them to make trade-offs in order to manage competing obligations. Lazy days were a way to manage the tensions that arose from tracking and reaching for specific goals. If the self-tracking devices were to be domesticated they needed to accommodate the pleasure of staying on the couch as well.

Conceptualizing Episodic Use

Typically, the reason participants in our study had obtained a tracking device or was curious to try it out was because they decided that they wanted to “do something” about their activity level. Some had received trackers as gifts or were just generally gadget-happy and curious to see what the fuss was all about. No matter the initial reason for tracking participants soon had to come to terms with the numbers on the screen. When the trackers showed how many steps have been walked, participants in our study would often compare this to the pre-set goal (almost always 10.000 steps). Most of our participants struggled to reach this goal but were adamant to stay positive. However, staying positive when day after day the goals are not met, and there is little to be done about it because of busy workdays, was a challenge.

As a consequence of this P12F explained how she had decided to “*use the tracker the other way around*”. She chose deliberately to only look at the good days where she did have a chance to walk. In fact, by the end of the study she only wore the device when she knew she was going for a run or a long walk. P12F had found a use pattern that worked for her: “*I think that when I go travel or something where you walk a lot, I think I’ll wear it all of the time, because it’s fun to see how much you walk, but when I’m at work and I walk 2000 then I don’t want to wear it, it doesn’t make a difference if I wear it or not*” (P12F, follow-up interview). In the quote above “*it doesn’t make a difference if I wear it or not*” is a statement that was echoed by many. No matter the personal goals, P12F had many obligations that needed to be fulfilled and often these came in conflict, arranging her days in ways that did not allow a lot of walking. The self-tracking device could only reinforce what she already knew was the case; it could not change the situation.

P20F had a lot of motivation to improve her activity levels, but at work the tracker only served as a constant reminder of how little she walked. P20F did not dwell on her not so active days: “*(...) I use the positive in this and say: I’ve actually been doing something, and maybe I haven’t been as active as I would want, but I did do something. Because that’s actually my philosophy that you have to look on the positive side when you have something like this [a tracker], ‘cause if you start looking at the negative aspects then you’ll quickly turn it into something negative*” (P20F, follow-up interview).

In the stories we related earlier in the paper and in these two examples above we see how participants struggled with the implications of the data that the trackers made visible. No

matter their aspirations, they needed to devise new ways of encountering the data in order to feel good about the trackers. Similar to Lomborg et al. (2018), our participants often had ambiguous relationships with their devices and data, sometimes re-interpreting the step numbers in unexpected ways that would lead to more positive feedback, allowing them to stay in control. For example, P22F at times felt that tracking steps annoyed her and took up too much energy. She had then discovered that playing the piano would make her wrist-worn tracker count steps, and was quite happy about it:

Interviewer: *But that's not physical activity?*

P22F: *No, but then you get to 10.000 [steps]*

Interviewer: *You could just sit and shake it?*

P22F: *No, that would be sad*

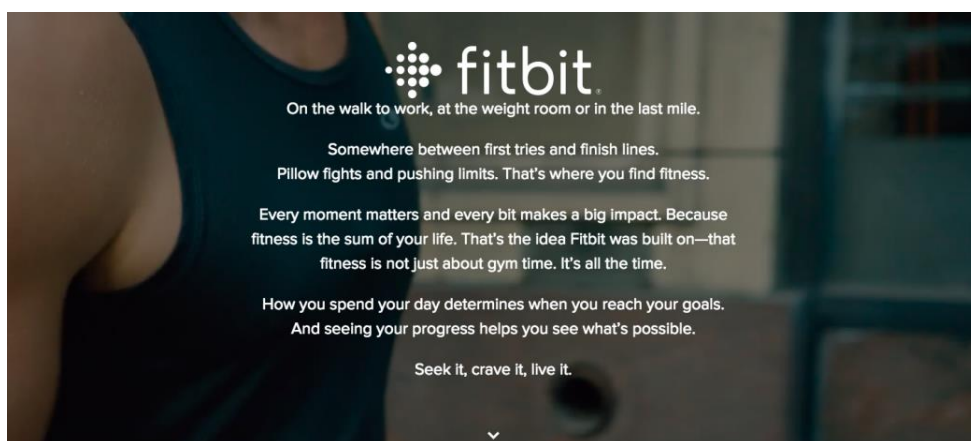
She fully acknowledged that the final step count was misleading if it were to be interpreted only from the point of view of walking, but it meant much more to her. Since she wanted to play more piano and walk more steps, she had no problems with this. We find that what these participants are saying about their tracking experiences is that the decision to *not* use their device for a while, or to use it in ways that result in faulty data of steps from playing the piano, is more complex than merely the problems described in prior research as forms of lapsing (Epstein et al., 2015). Most of our participants did not engage in the sort of data manipulation described by Lomborg et al (Lomborg et al., 2018). Rather, they engaged in what we have termed *episodic use*. The effort here is oriented in trying to stay positive towards the numbers that appear on the screen. Choosing to wear the device only when one knows that there will be a “good” or “interesting” number, one that supports the feeling of “doing something about physical activity”, is one form of episodic use. This, as Mol points out, is a way to be kind to one self. Instead of feeling guilty about not living up to the demands set by the device our participants worked to acknowledge the falling short, moving on and trying again. The approach here is similar to that of Mol’s diabetes patients: caring for oneself is a process. There are bound to be bumps along the way. But rather than diving into feelings of shame for not living up to expectations or blaming oneself for weakness, one must try, adjust expectations and processes if unsuccessful, and then try again (Mol, 2008: 20).

Episodic use as a logic of care

Activity-tracking devices are designed around the assumption that continuous tracking is how the user needs to use the device in order to benefit from it. Examples of these assumptions are clear in industry reports that equate success with long-term engagement: “*The success of a wearable depends on its adoption by the market and how well it inspires long-term engagement*” (Ledger and McCaffrey, 2014). The strings of reminders, vibrations and visualizations are all oriented around daily goal completion, weekly overviews of daily activity and so on. Lazy days are often starkly marked out and the averages are of course non-sensical if the lazy days are counted in. As Mol would put it, current self-tracking devices are designed with the logic of choice built in – people must choose to become more active (and thus by definition healthier) but when such a choice is made through the purchase of the self-tracking device, the device anoints its user with the responsibility of living up to a particular notion of “more active” and

“healthier” built into the device. The perfect user here is one that wears the device continuously, achieves daily goals and manages to charge the device while conveniently stationary in between bouts of active effort. Episodic use, by this line of thought, is not a success but must be eradicated.

Much like the diabetes measurement technologies studied by Mol, self-tracking devices are marketed following the logic of choice. Advertisements for self-tracking technologies are full of healthy and happy bodies, that with the help of the self-tracking devices are making the right choices to stay fit. On their website, Fitbit state “... *that fitness is not just about gym time. It’s all the time*” (see photo below). To stay fit (which is something to strive for and equaled to staying healthy) one should be active, and every move counts. Following this logic, one should ideally be active as much as possible. Activity-tracking ads, such as the one below, do not mention the everyday struggles and realities of trying to be more active.



(Screenshot from Fitbit website, (Why Fitbit, n.d.))

Here we find a main difference between Mol’s diabetes patients and the participants of this study. Mol’s diabetes patients were in contact with doctors and diabetes nurses. These healthcare professionals support diabetes patients following a logic of care. While the logic of choice points to continuous use as a gold standard, logic of care is different. With logic of care, the health professionals realize that not everyone can do the diabetes measurements all of the time, and keep blood sugar levels low at all times. A caring health professional will translate generalities into what is suitable for the specific patient (Mol, 2008: 67). In the case of self-tracking there are no caring professionals, so our participants would turn to friends or online forums and then work out what was “right” for them. Even with these more personalized goals, however, participants would struggle to keep them and would deviate from their plans.

For example, P11F had a goal of how many calories she wanted to burn every day: “*I think, actually, in general it’s only acceptable [to herself] to reach 600 [burned calories], but realistically speaking there are just many days where it’s just, that’s not going to happen (...)*” (P11F, follow-up interview). This was the participant who explained to us her special Sunday rules. She would set high goals and make plans, knowing that many

days these would motivate her, and on other days she would deviate from this plan. Episodes of non-use were obviously deviations and participants readily acknowledged this, but these moments also gave participants a space to breathe and make room for other things in life.

The assumption of sustained use as a criteria of success, as seen in activity tracking advertisements, stands in contrast with how our participants engaged with their trackers. P11F was very curious about tracking, and tracked steps, runs, bike rides, calories burned, and active minutes eagerly. At other times, however, she would abandon tracking: *“Yes, then it was in the drawer for I think almost a year, and then all of a sudden I thought it might be fun, because I had such a sedentary job, but then I also walked because I worked in [Copenhagen suburb], so I would walk to the train and the coffee machine was actually in the other end of the building, but when I went to [university] I biked and walked a lot”* (P11F, first interview). To her, the use (or non-use) of her tracking device was dictated by the circumstances in her life. New life situations awakened her interest to measure her steps and to check in about her activity. It appears that the information she gained from tracking was only useful for so long and when routines got established the tracker was no longer of interest. This kind of use of activity trackers has been observed and discussed previously as happy abandonment when users either have learned what they set out to learn, or they upgrade their tracking device to a different one (Clawson et al., 2015). In our longterm study we observed that many participants would learn what they wanted from their trackers but then return to tracking after a while, revealing an episodic pattern. Nafus and Sherman argued that although people would often shift what they tracked, resulting in incomplete data records in a traditional sense, this personally meaningful use of tracking practices could be seen as a form of “soft resistance” (Nafus and Sherman, 2014). Yet it is hard to see P11F’s decisions as forms of resistance in as much as these are merely examples of how self-tracking technologies become what P22F called a “part of life” rather than “controlling life”. Episodic activity tracking in this way is just one of the many little tools to help manage the big and small changes in life.

P17M had used various trackers over the course of the previous 6 years, and was one of the most persistent users in our study. However, even in this case of several years of concerted and effortful tracking, for P17M the role his activity tracking device played changed depending on circumstances: *“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). To P17M self-tracking was an ingrained part of his everyday routine. However, some periods of time, such as Christmas, became a break in this routine. During the time of Christmas lunches and get togethers he did not focus on pulse, steps and so on. When “the weight scale comes out” this is when the tracker comes in handy, and he was better able to understand his needs and activity levels when this again was a priority to him. Such a break in the routine gave him time to focus on other things in life. By using activity tracking he focused on staying active, yet by letting the focus go for some periods of time he cared

for himself in a way that would give him energy to focus on activity again at a later point. The “everyday like” existence he described was likely not at all “everyday” but rather it reflected a change in priorities with attention given over to things other than pulse, steps and calories. As Maitland has pointed out previously “life is not a behavior change program” and this example demonstrates the necessity of changing priorities.

Looking across our data we find that we could categorize our participants according to Rooksby’s five styles of tracking, also we find moments of flow and “hookedness”, as suggested by Lomborg. Epstein et al’s model, with its attention to lapsing, goes a long way in portraying a suitable model for the types of use we saw amongst our participants. All of the theories above could be utilized to allow for better device design and user experiences. However, “lapsing”, and, categorization of users and flow, we suggest, does not cover the full range of non-use of self-tracking devices. Staying in control of self-tracking can be achieved beyond manipulating data (Lomborg et al.), that is, by using devices episodically. Participants who had found a balanced – episodic- approach to their devices were often the happiest with it. Where expectations of continuous use are shaped by a logic of choice, episodic use can be productively interpreted as a form of attention to personal health through the logic of care (Mol, 2008). In this way, participants were able to learn from their devices and to be motivated when it fit with other priorities in their lives. Whereas lapsing can happen due to technological glitches, and therefore can be fixed, episodic use cannot and should not be fixed.

Concluding remarks: Episodic Use as a Feature, Not a Bug

The uses of activity tracking technologies can help people learn something about themselves and their physical activity levels. Yet, tracking can at times be both challenging and tedious, and people often must negotiate feelings of disappointment and guilt when dealing with the constant and unforgiving reminders and nudges of their trackers. In response, we find that people engage in substantial amounts of work to use their devices in ways that truly help them care for themselves. Often, this use was episodic in nature, as priorities in life change over time. Putting forward the notion of *episodic use* has two main implications. First, identifying and taking episodic use seriously challenges the all too pervasive assumption that abandonment is a mainly technological problem. Rather, leaving an activity tracking devices behind for a while is a way for users to deal with complex social situations and life changes. While most research dealing with design and improvement of devices work towards how to make users track more, we suggest for future research to consider *how little* is actually needed for users to benefit from their tracking devices. This is no easy task, and goes against the data-driven business models of the companies developing tracking devices. Yet, questioning the logic of choice that underpins much of the development is pivotal in order to develop truly caring technologies.

Second, we suggest that *episodic use* is crucial to consider when activity-tracking technologies are introduced as part of institutional arrangements, such as in workplace health and wellness programs. Introducing activity tracking in ways that allow employees

to stay in control entail deep considerations of how to allow participants space to focus on activity and tracking when they want to, realizing that this process will not be continuous and linear.

Finally, activity tracking technologies are easily criticized for running the errand of an extended form of a control society. This makes it seem as if activity tracking technologies are inherently different to care, or “other” to care (Mol, 2008). Yet our participants include self-tracking technologies as one element in a process of care by using them episodically. Tracking technologies then, in and of themselves, are not “other” to care, yet the expectations of continuous and linear tracking which is often built into devices *are* other to care. The difference here is easily overlooked, yet truly important. Only by considering how people flourish can we hope to build technologies that in the right ways support- and get out of the way- of life.

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Appendix: Co-author statements

Co-Author Statement

I hereby declare that I am aware that the work in the paper

Gorm N, Chung C, Shklovski I, & Munson, S. (2018) 10 Years of Qualitative Self-Tracking Studies: A Literature Review. *Submitted to TOCHI*.

of which I am a co-author, will form part of the PhD dissertation by

Nanna Gorm Jensen

I, as a corresponding author/co-author have contributed as stated below:

1. Intellectual and analytic contributions:

less than 25% 26-50% 51-75% 76-100%

Comments;

2. Production of empirical data:

less than 25% 26-50% 51-75% 76-100%

Comments:

3. Writing process

less than 25% 26-50% 51-75% 76-100%

Comments:

Signature: _____  _____

Name: Chia-Fang Chung

Date: _____ 09/08/2018 _____

Co-Author Statement

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Comments: _____

3. Writing process

less than 25% 26-50% 51-75% 76-100%

Comments: _____

Signature: _____

Name: Irina Shklovski

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Co-Author Statement

I hereby declare that I am aware that the work in the paper

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3. Writing process

less than 25% 26-50% 51-75% 76-100%

My role in this submission was to provide feedback and suggestions on the content and presentation of that content as Nanna and co-authors prepared the manuscript.

Signature:  _____

Name: Sean A. Munson

Date: 8 September 2018

Co-Author Statement

I hereby declare that I am aware that the work in the paper

Gorm, N., & Shklovski, I. (2016). Steps, Choices, and Moral Accounting: Observations from a Step-Counting Campaign in the Workplace. *CSCW '16*.

of which I am a co-author, will form part of the PhD dissertation by

Nanna Gorm Jensen

I, as a corresponding author/co-author have contributed as stated below:

1. Intellectual and analytic contributions:

less than 25% 26-50% 51-75% 76-100%

Comments: Supported development of ideas only

2. Production of empirical data:

less than 25% 26-50% 51-75% 76-100%

Comments: Nanna conducted all data collection herself

3. Writing process

less than 25% 26-50% 51-75% 76-100%

Comments: As a first paper I helped Nanna learn the style of writing specific to CHI

Signature: _____

Name: Irina Shklovski

Date: _____

8-8-18

Co-Author Statement

I hereby declare that I am aware that the work in the paper

Gorm, N., & Shklovski, I. (2016). Sharing Steps in the Workplace: Changing Privacy Concerns Over Time. *CHI'16*.

of which I am a co-author, will form part of the PhD dissertation by

Nanna Gorm Jensen

I, as a corresponding author/co-author have contributed as stated below:

1. Intellectual and analytic contributions:

less than 25% 26-50% 51-75% 76-100%

Comments;

2. Production of empirical data:

less than 25% 26-50% 51-75% 76-100%

Comments: *Nanna conducted all data collection*

3. Writing process

less than 25% 26-50% 51-75% 76-100%

Comments: *commentary & editing only*

Signature: 

Name: Irina Shklovski

Date: *8-8-18*

Co-Author Statement

I hereby declare that I am aware that the work in the paper

Chung, C., Gorm, N., Shklovski, I., & Munson, S. A. (2017). Finding the Right Fit: Understanding Health Tracking in Workplace Wellness Programs. *CHI 2017*.

of which I am a co-author, will form part of the PhD dissertation by

Nanna Gorm Jensen

I, as a corresponding author/co-author have contributed as stated below:

1. Intellectual and analytic contributions:

less than 25% 26-50% 51-75% 76-100%

Comments: _____

2. Production of empirical data:

less than 25% 26-50% 51-75% 76-100%

Comments: _____

3. Writing process

less than 25% 26-50% 51-75% 76-100%

Comments: _____

Signature: _____  _____

Name: Chia-Fang Chung

Date: _____ 2018/08/16 _____

Co-Author Statement

I hereby declare that I am aware that the work in the paper

Chung, C., Gorm, N., Shklovski, I., & Munson, S. A. (2017). Finding the Right Fit: Understanding Health Tracking in Workplace Wellness Programs. *CHI 2017*.

of which I am a co-author, will form part of the PhD dissertation by

Nanna Gorm Jensen

I, as a corresponding author/co-author have contributed as stated below:

1. Intellectual and analytic contributions:

less than 25% 26-50% 51-75% 76-100%

Comments: Both Sean Munson & I mainly reviewed, commented and discerned conceptual ideas with a minimum of writing

2. Production of empirical data:

less than 25% 26-50% 51-75% 76-100%

Comments: I was not involved in this process aside from initial discussions

3. Writing process

less than 25% 26-50% 51-75% 76-100%

Comments: Mainly commenting, language editing and limited other writing

Signature: 

Name: Irina Shklovski

Date: 8-8-18

Co-Author Statement

I hereby declare that I am aware that the work in the paper

Chung, C., Gorm, N., Shklovski, I., & Munson, S. A. (2017). Finding the Right Fit: Understanding Health Tracking in Workplace Wellness Programs. *CHI 2017*.

of which I am a co-author, will form part of the PhD dissertation by

Nanna Gorm Jensen

I, as a corresponding author/co-author have contributed as stated below:

1. Intellectual and analytic contributions: less than 25%

Comments: Nanna worked with Chia-Fang Chung to conceive of and complete the study. I provided advice and mentorship about research questions, related work, study materials, and recruitment plans. I was a sounding board as they completed the analysis.

2. Production of empirical data: less than 25%

Comments: I produced none of the empirical data.

3. Writing process: less than 25%

Comments: Nanna and Chia-Fang led the entire writing; I only helped edit.

Signature:  _____

Name: Sean A. Munson

Date: 19 July 2018 _____

Co-Author Statement

I hereby declare that I am aware that the work in the paper

Gorm, N., & Shklovski, I. (2017). Participant Driven Photo Elicitation for Understanding Episodic Activity Tracking: Benefits and Limitations. *CSCW2017*.

of which I am a co-author, will form part of the PhD dissertation by

Nanna Gorm Jensen

I, as a corresponding author/co-author have contributed as stated below:

1. Intellectual and analytic contributions:

less than 25% 26-50% 51-75% 76-100%

Comments: this was entirely Nanna's idea, I tried to talk her out of it!

2. Production of empirical data:

less than 25% 26-50% 51-75% 76-100%

Comments: _____

3. Writing process

less than 25% 26-50% 51-75% 76-100%

Comments: comments & minor language editing only

Signature: _____

Name: Irina Shklovski

Date: _____

2018 8-8-18

Co-Author Statement

I hereby declare that I am aware that the work in the paper

Gorm N and Shklovski I (2018) Episodic Use: Practices of Care in Self-Tracking. *Submitted to New Media & Society*.

of which I am a co-author, will form part of the PhD dissertation by

Nanna Gorm Jensen

I, as a corresponding author/co-author have contributed as stated below:

1. Intellectual and analytic contributions:

less than 25% 26-50% 51-75% 76-100%

Comments: _____

2. Production of empirical data:

less than 25% 26-50% 51-75% 76-100%

Comments: _____

3. Writing process

less than 25% 26-50% 51-75% 76-100%

Comments: _____

Signature: _____

Name: Irina Shklovski

Date: 24-09-18