Health Self-Management Applications in the Workplace

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General Introduction

Health Self-management Applications (HSMAs) are sensor and intervention technologies that provide individual users with key metrics about their bodily functioning and personal health-related behaviours. Examples are activity trackers or heartrate monitors. Since the introduction of HSMAs to the consumer market, the use of such tools has rapidly grown (Kalantari, 2017). This growth is also seen in the work environment, where employers include options to use HSMAs in their health programs to stimulate and facilitate their workers to become relatively more healthy and to remain healthy (Jacobs et al., 2019). HSMAs are often welcomed enthusiastically by both employers and employees. For employers it seems like a simple and relatively low-cost way to contribute to a more healthy work environment and to support healthy behaviour in the work place (Huang, Benford, & Blake, 2019). Besides, workers often see it as a nice gadget that is easy to use which increases the acceptance of the HSMA (Jacobs et al., 2019). The responsible development and use of HSMAs in the work environment however is a niche that has not received the scientific attention it should, given the societal relevance.

The increased use of HSMAs, both in the work environment and in the consumer market (Kalantari, 2017), has reinforced that the workings and effectiveness of HSMAs are popular subjects of study. Research into the effectiveness of HSMAs in non-work settings, such as in healthcare and the consumer market, shows reason to be optimistic. For example, HSMAs improve disease management (Lorig, Sobel, Ritter, Laurent, & Hobbs, 2001; Lorig et al., 1999) and reduce health risks (de Vries, Kooiman, van Ittersum, van Brussel, & de Groot, 2016; Jakicic et al., 2016). Consumers using HSMAs show an increased physical activity (de Vries et al., 2016) and lower BMIs (Jakicic et al., 2016). These positive outcomes are encouraging, and triggered employers to include the use of HSMAs in their health enhancement programs (Kalantari, 2017). Yet, the effectiveness of HSMAs in the workplace seems lower. Previous research shows that the use of technologies such as HSMAs in the workplace is subject to high dropout rates (Eysenbach, 2005) and seems not effective in reducing sick leave (Linden, Muschalla, Hansmeier, & Sandner, 2014).

It seems that an effective use of HSMAs requires more than just wearing a sensor, it also implies that feedback information should be adequately reacted upon and workers should change their health-related behaviour. Even though there is much known about the effectiveness of feedback on all sorts of worker behaviour (Kluger & DeNisi, 1996), little research attention was given to the ways to influence the effectiveness of feedback information on health-related behaviour of workers provided by HSMAs in the work environment.

While the addition of 'self-management' in the name of these sensor technologies suggests that their use enlarge the users' autonomy in regulating their own health behaviour, recent research has questioned this and argues that the use of sensor technologies in the workplace might decline the perceived autonomy of employees (Leclercq-Vandelannoitte, 2017). This is a very unfavourable effect, because a loss of general job autonomy is at the root of many issues such as decline of job satisfaction (Thompson & Prottas, 2006) and productivity (Parker & Ohly, 2008), but when the autonomy is specifically related to the health domain, a loss of autonomy may negatively impact workers' health both inside and outside the work environment. This loss of autonomy might be enlarged due to the experienced pressure to comply with built-in norms of HSMAs, such as the 10.000 steps per day and inclusion of HSMAs in employers' health promotion programs, which might diffuse the division of responsibilities for employee health in the workplace between employer and worker. Employees might appreciate receiving HSMAs from their employer to monitor their healthy behaviour, but continuation of monitoring during off-work time might feel as an intrusion of the employer in their personal life (Leclercq-Vandelannoitte, 2017; Martin & Freeman, 2003).

The lack of knowledge on the effective use of HSMAs in the workplace, as well as the questions regarding impact on worker autonomy, show that despite the societal relevance and increasing use, HSMAs in the workplace have not sufficiently been studied from a multidisciplinary perspective. We therefore aim to answer questions about how HSMAs

can responsibly and effectively be developed and used to stimulate workers to engage in more healthy work behaviours. This is the central theme of this research.

The working of HSMAs is based on the well-known principle that feedback about current health-relevant behaviour in the work setting can stimulate employees to self-regulate and adjust their behaviour (Ryan & Deci, 2000, 2006) and to meet desired standards. HSMAs such as activity trackers show users how many steps they took, how many stairs they climbed, and what their heart rate was while walking and climbing stairs. This feedback information enables the user to reflect on their current behaviour and to decide to alter their behaviour or not. For example, the norm of 10.000 steps per day is widely known (Johnman, Mackie, & Sim, 2017), the activity tracker (HSMA) registers and displays this information, and this insight in the actual amount of steps allows users to reflect on their current performance, and to change behaviours to reach this norm.

Feedback on health-related behaviour can be designed in many ways, altering characteristics such as timing, actionability, and the focus of feedback. Previous studies have investigated the impact of real-time (that is, administered at the time the behaviour occurs) (Roossien et al., 2017) or actionable feedback (that is, timely, individualized, non-punitive, and customizable) (Larouche et al., 2018), but not the joint effect. The effectiveness of this actionable feedback could probably be improved by giving this type of feedback real-time (Kluger & DeNisi, 1996; Kulik & Kulik, 1988; Luke & Alavosius, 2011), because a shorter time between the occurrence of behaviour and feedback on the behaviour improves the motivation of users to improve (Luke & Alavosius, 2011). Therefore, the first aim of this research is to examine the effects of HSMAs that provide both real-time and actionable feedback on worker's health-related behaviour.

An important assumption of HSMAs is that they provide users with feedback information, which subsequently can be used to decide autonomously how to respond to this feedback. Following self-

determination theory (SDT) (Ryan & Deci, 2000, 2006), it is assumed that HSMAs promote a sense of autonomy through which workers become intrinsically motivated to self-regulate their health-related behaviour. Yet, the use of HSMAs may also undermine the perceived autonomy of workers because they subject users to norms and values that are unlike their own (Owens & Cribb, 2017)). The second aim of this study therefore is to examine how using an HSMA in the workplace impacts the perceived autonomy to self-regulate the health-related behaviour of workers.

In order to protect the perceived autonomy of users as well as the privacy of data, it is important to know that sensor technologies are never value neutral (Martin & Freeman, 2003). The introduction of HSMAs in the workplace may affect worker privacy (Damman, van der Beek, & Timmermans, 2015) and autonomy (Damman et al., 2015; Leclercq-Vandelannoitte, 2017), and the responsible use of technologies such as HSMAs is subject for debate (van Berkel et al., 2014). To improve and facilitate responsible use, guidelines for responsible research and innovation (RRI) have been developed (Stahl, 2013; Stilgoe, Owen, & Macnaghten, 2013). Multiple concerns remain about how responsible design and use can be integrated in the development of technologies such as HSMAs for the work environment (Leclercq-Vandelannoitte, 2017). Further, knowledge on the practical execution of responsible research and innovation is lacking (Jakobsen, Fløysand, & Overton, 2019).Therefore, our third research goal is to explore how sensor and intervention technologies such as HSMAs for the work environment can be responsibly developed and implemented.

Serving the main aim of this research to enhance insights how HSMAs can responsibly and effectively be developed and used to stimulate workers to show more healthy behaviours, first HSMAs will be introduced: what are HSMAs, what do they aim to achieve, and what is their working? Second, the scientific background of this research is provided through describing the main underlying mechanisms of HSMA: the provision of feedback, autonomous decision making and

self-regulation. Third, the theoretical and practical motivation for this study is presented by identifying the main contributions of this research. Finally, the outline of this thesis is presented by shortly introducing the main chapters.

Health Self-Management Applications: a description

HSMAs monitor the behaviour of users, and provide the users with feedback information on their bodily functioning and health-related behaviour. Popular examples are activity trackers such as Fitbit and Jawbone, that keep track of the number of steps and other activities during the day, and smartphone apps such as Strava and Runkeeper that keep track of performance during running or cycling using GPS. The most important aspects of these HSMAs are that they use sensor technology to monitor certain aspects of daily life, and they return the data as feedback to the user, in order for the user to be able to alter the behaviour. Feedback given by HSMAs differs from general feedback in the sense that it only aims at behaviour that is associated with health, i.e. amount and intensity of exercise, heart rate, estimated calories burned, hours of sleep, et cetera. Often, there are general norms for these behaviours (i.e. walk 10.000 steps per day (Johnman et al., 2017), sleep 7-9 hours per night (Hirshkowitz et al., 2015)).

When providing feedback, HSMAs allow individuals to self-manage and regulate their health-related behaviour and health (Schermer, 2009). This makes it possible for individuals to alter their behaviour in order to reach personal goals, such as losing weight, running a marathon, or prevent disease. In the last decade, the focus of HSMAs has been shifting from curative to preventive approaches (Fjeldsoe, Marshall, & Miller, 2009), and the use of HSMAs has shifted from the field of medicine to lifestyle. This makes that HSMAs are relevant for a larger crowd, because many people could use some support in improving their lifestyle in order to prevent diseases such as cardiovascular disease, obesity, or diabetes (Miller, Balady, & Fletcher, 1997; Netz, Wu, Becker, & Tenenbaum, 2005). Moreover, usage has been extended to the work environment (Linden et al., 2014). A

growing number of organizations equip their employees with HSMAs for health purposes (Linden et al., 2014; Ruitenburg, Plat, Fringsdresen, & Sluiter, 2015). The implicit assumption underlying the usage of HSMAs is that the feedback provided by HSMAs will be utilized by employees to self-manage and adapt their health-related behaviour, as these HSMAs in the work environment are also aimed at the prevention of disease (Jacobs et al., 2019). This makes that the effect of these HSMAs stretch into the private life of the worker. Prevention of disease is, after all, a lifestyle change, and such a change affects all parts of the user's life (Grady & Gough, 2014).

In recent years many employers have started to facilitate the use of HSMAs in the workplace (Kalantari, 2017). Often, HSMAs are part of the Workplace Health Promotion Program of the employer, in which other interventions such as health checks and a healthy cafeteria are also included. Employers started with the inclusion of relatively simple technologies in their health promotion programs, such as RSI prevention tools These HSMAs were simple, because they did not measure the behaviour of the user but used time-based breaks, and they did not provide feedback, but they demanded a certain action (i.e. users had to quit typing, or the computer would shut down). Currently, HSMAs that are used in the workplace have extended options on how and when to provide feedback and what kind of feedback. Especially in the last decade HSMAs have more advanced options, allowing real-time feedback, but also feedback that is adjusted to personal goals or norms instead of general guidelines (Bravata et al., 2007; Luke & Alavosius, 2011; Schermer, 2009). The advanced options of HSMAs facilitate the self-regulation of behaviour more than earlier HSMAs, because users have more autonomy in how and when they want to act on given feedback. In the workplace however, the norms regarding healthy behaviour are not only set by the user, but also by the employer and the work environment (Linden et al., 2014).

Theoretical background

The goal of this study is to answer questions about how HSMAs can responsibly and effectively be developed and used to stimulate

workers to show more healthy behaviours. Therefore, we focus on the most relevant themes for this research in this theoretical background. First, we look into the research on feedback, more specifically feedback in the work environment, how feedback characteristics can improve behavioural alterations, and how this can be applied in HSMAs. Secondly, we focus on what is known about autonomy, how this relates to the use of HSMAs in the work environment, and how this affects the self-management capacities of individuals.

Feedback

Feedback refers to evaluative information about self-relevant attributes (i.e., abilities, performance) that aim to improve the self-managing capabilities of individuals by stimulating a process of reflection (Anseel, Lievens, & Schollaert, 2009; Sargeant, Mann, Van Der Vleuten, & Metsemakers, 2009). Feedback makes individuals reflect on the desired and actual behaviour and helps these individuals in planning to alter their behaviour (London & Smither, 1995; Steelman, Rutkowski, Steelman, & Rutkowski, 2004). The characteristics of feedback can differ extensively (Kluger & DeNisi, 1996). In this research, we focus on differences in type (i.e., performance versus developmental), timing, actionability, and frequency of feedback.

Type of feedback: performance and developmental feedback

Feedback can differ in focus, i.e. it can focus on past performance and the judgement of that performance, or on future development and strategies to get there. Performance feedback is aimed at only the actual performance, formulated retrospectively and only emphasizing the difference between goal and behaviour, and developmental feedback includes information that facilitates recipients to learn, develop, and make adaptive behavioural changes (Li, Harris, Boswell, & Xie, 2011; Zhou, 2003). Self-Determination Theory (SDT) suggests that developmental feedback may boost autonomy and intrinsic motivation for learning and improvement, whereas performance

feedback may inhibit feelings of autonomy because it is formulated negatively and retrospectively (Ryan & Deci, 2006). Performance feedback on health behaviour is given in a data-only format, in which the user is provided feedback on their current behaviour, supplemented with the general norm ("You have walked 7738 steps today, the norm for daily exercise is 10.000 steps"). Developmental feedback on the other hand builds upon future-oriented goal-related feedback in order to improve users' behaviour ("If you take a lunch walk, you may take 2262 steps and reach your goal!"). The effect of performance vs. developmental feedback is studied in Chapter 3.

Real-time actionable feedback

Feedback Intervention Theory shows that feedback is more effective if there is less time between the behaviour and a feedback signal. This effectiveness of real-time feedback is explained by the increased direct attention to the causes for behaviour, and the motivations to alter this behaviour (Kluger & DeNisi, 1996; Kulik & Kulik, 1988; Luke & Alavosius, 2011). Modern HSMAs mainly give real-time feedback, so the feedback message is sent at the time at which the deviating behaviour is signalled. In order to further optimize feedback outcomes, Hysong et al. (2006) show that actionable feedback (that is, feedback that is timely, individualized, non-punitive, and customizable) is more effective in altering behaviour. Due to the timely and individualized approach, the targeted behaviour can immediately be denominated, thereby increasing chances of direct action, after which the non-punitive and customizable character increase learning capacities of the receiver (Cannon & Witherspoon, 2005). The effect of real-time actionable feedback is studied in chapter 2.

Feedback frequency

Under normal circumstances, increased feedback frequency improves the effectiveness of the feedback (Kluger & DeNisi, 1996), because the receiver of the feedback is reminded more often of the potential improvements and has the opportunity to gradually improve (Lurie &

Swaminathan, 2009). This effect however fades when the feedback frequency is too high (Lam, DeRue, Karam, & Hollenbeck, 2011) because too frequent feedback overwhelms the cognitive capacity of the receivers, thereby invalidating them to improve their behaviour. This suggests an inverse U-shaped relation. This studies that describe this inverse U-shaped effect, however, only use imposed feedback frequencies (Lam et al., 2011). For self-controlled feedback frequencies, studies show that only subjects who are already improving, increase their frequency even more, thereby optimizing the feedback frequency for all individual participants (Chiviacowsky & Wulf, 2002). For HSMAs in the workplace, this self-controlled optimization of the feedback frequency could be very beneficial, because especially in the work environment, externally imposed feedback characteristics could lead to decrease of autonomy (Kukla, 2005) and loss of effectiveness of feedback (Alder, 2007).

Autonomy

In this section, we show what the relevant literature says about self-regulation of behaviour and the link with worker autonomy when using HSMAs or other monitoring technologies. We use the term 'perceived autonomy', because we study the perception of autonomy as experienced by the worker. Our study does not alter the conditions under which persons work, so no alterations in work routines or rules and regulations are put in place. Therefore, no objective changes in worker autonomy are caused. The perceived autonomy, however, can be very different, as is explained in this section.

Self-regulated behaviour

SDT (Ryan & Deci, 2000, 2006) is a widely used framework for the study of autonomy as enhancer of the self-regulation of health-related behaviour. SDT states that the motivation for regulating behaviour varies along a continuum from autonomous motivation to externally controlled motivation. Research shows that an increase in perceived autonomy promotes the cognitive, affective, and behavioural self-regulation of health-related behaviour (Chatzisarantis & Hagger,

2009; Fortier, Sweet, O'Sullivan, & Williams, 2007; Rose, Parfitt, & Williams, 2005; Silva et al., 2010; Williams, Gagné, Ryan, & Deci, 2002; Williams, McGregor, Zeldman, Freedman, & Deci, 2004). This self-regulation makes employees responsible for their own health and enables them to independently self-manage their health-related behaviour. Therefore, in order to allow workers to self-regulate their health behaviour, the autonomy of these workers needs to be ensured.

Worker autonomy

Autonomy refers to the say a worker has about their health-related behaviour in the work environment, and it reflects the extent to which a worker can make decisions on whether, how and when to alter behaviour without the involvement of others (Owens & Cribb, 2017). In this way, autonomous actions are those actions that are fully in line with the preferences and values of the individual (Ekstrom, 2005; Ricoeur, 1966). An important assumption of HSMAs is that using HSMAs increases the perceived autonomy of workers. HSMAs provide workers with feedback information that enables workers to decide autonomously whether to adapt or not their health behaviour, such as doing exercises, or change break-taking and sitting behaviour. In the context of HSMAs in the work environment, this means that a worker can for instance self-decide whether or not to take a walk during their break, or can work standing up instead of sitting down. It also enables workers to reach goals they have, for instance walking 10.000 steps per day, or perform moderately intensive exercise for 30 minutes per day. On the other hand, workers can perceive the feedback as pressing (Owens & Cribb, 2017), because they may agree on the values, but do not share the same norms for behaviour (i.e. 10.000 steps per day). They do not internalize these norms, and therefore do not perceive them as their own norms.

Imposed norms for behaviour, that are not internalized by the workers, make that the perceived autonomy to self-regulate health-related behaviour is under pressure. Workers may experience this pressure in the work environment, but also feel obligated to continue

pursuing these goals at home. This therefore not only affects their autonomy at work, but also at home. The experienced pressure may increase when the worker is less healthy or shows less healthy behaviour: HMSAs that are provided in the work environment show that the employer values workers who are healthy and show healthy behaviour. Therefore, when the worker deviates from these values, the perceived pressure to alter behaviour may be higher.

Scientific contributions

This study uses a multidisciplinary approach to study the ways to responsibly develop and use HSMAs aimed at improving health-related behaviour of workers. Doing so, we aim to make two main contributions.

Firstly, this thesis contributes to the field of Workplace Health Promotion by applying insights from Feedback Intervention Theory and Self Determination Theory to the context of HSMAs in the workplace. By doing so, we study if real-time, actionable feedback improves worker health-related behaviour, and how the difference between performance and developmental feedback affects the perceived autonomy of the users of HSMAs. This knowledge adds to the field of Workplace Health Promotion, by showing how the alteration of feedback characteristics can support the improvement of health-related behaviour of workers, and gives insight in boundary conditions (i.e., type of feedback: performance vs developmental; health of users) that moderate the effects of HSMAs on the users' perceived autonomy in self-regulating their health-related behaviour.

Secondly, we aim to add knowledge to the field of Responsible Research and Innovation. We do so by examining how members of a multidisciplinary research team can co-operate in a continuous cycle of reflection on the stakeholders (i.e., developers, employers, users) and their values, in the design and use of sensor and intervention technology for promoting health work behaviour. We show how a context-sensitive ethics approach can identify effects on worker autonomy and privacy that would have gone unidentified in regular

RRI projects. Identifying these issues gives us the opportunity to overcome three issues, namely compartmentalization of development and use of HSMAs, generalization of ethical issues, and defining the responsibilities for responsible use for worker and employer.

Research questions and outline of this thesis

This thesis aims to examine how HSMAs can responsibly and effectively be developed and used to stimulate workers to show more healthy behaviours. These effects are examined in three chapters, for which the main research questions are:

How do HSMAs that provide both real-time and actionable feedback impact worker's health-related work behaviour? (Chapter 2)

Does the use of HSMAs in the workplace promote employees' perceptions of autonomy in self-regulating their health-related behaviour? (Chapter 3)

How can HSMAs for the work environment be responsibly developed, with attention for inherent values in and responsibilities for both design and implementation? (Chapter 4)

In Chapter 2, we report on our first experimental study. In this study we examine the effect of real-time actionable feedback on the behavioural change of office workers who use a set of sensor technologies (HSMAs) in the workplace. The behavioural health-related change is aimed at reducing prolonged sitting and preventing mental fatigue, which both are common issues for office workers, and in the long term may cause a range of health problems. To prevent office workers from sitting too long or becoming fatigued is a huge challenge, because workers are often unaware of their sitting behaviour and mental fatigue. The first goal of this chapter is to examine whether sending real-time actionable feedback messages to workers that sit for a long period of time, or who show signs of mental fatigue, improves their health behaviour. So, do workers stand up and/or take a break when they receive actionable real-time feedback

about their behaviours. All workers had the opportunity to autonomously self-control the frequency at which the feedback was provided, and could choose and continuously alter their feedback frequency. This leads to the second goal of this chapter: to examine whether an increased self-controlled feedback frequency would strengthen the effects of real-time, actionable feedback on workers' health behaviour.

In Chapter 3, we describe the results from the second experimental study. In this chapter, we explain how the use of an HSMA (a Fitbit One activity tracker) in the work environment affects the perceived autonomy of workers. All workers received feedback on their daily activity, using the activity tracker and receiving feedback e-mails. This chapter investigates what the effect is of performance vs. developmental feedback on the changes in perceived autonomy of employees. Additionally, we investigate the differences between workers with a high BMI and workers with a medium or low BMI. The purpose of this investigation is to provide more insight in how the pre-experiment health condition of workers influences their perceived autonomy when using an HSMA. We use the data collected in the second field study to explore the actual effects on perceived autonomy of both healthy and less healthy workers, and have deepened our understanding of this phenomenon by conducting a series of interviews.

In Chapter 4, ethical issues are explored in relation to the use of HSMAs in the workplace. The project SPRINT@Work is used as a case study. SPRINT@Work aimed at developing and evaluating sensor and intervention technologies that contribute to keeping the aging worker healthy and effectively employable. In this project, 4 PhD candidates and their supervisors collaborated, and there was a continuous process of intervision with the 4 PhDs and an ethicist, in order to identify the ethical issues that occurred while developing and implementing these technologies for the workplace. Using SPRINT@Work as a case study, we show how the three main problems of Responsible Research and Innovation, mentioned above,

materialize in practice. These problems centre around privacy and autonomy as ethical values. In this chapter we describe first the problem of compartmentalization: how current RRI studies often focus only on either the development of new technologies, or on the implementation of these technologies. At the same time, many of the issues that are relevant for these innovations, such as the values that are inherent to the design, are not bound to just one of these phases. Second, the problem of generalization is described: the work environment has a number of specific characteristics, that make general reflections on these values insufficient. Third, the responsibility problem is illustrated: the responsibilities of different stakeholders should be acknowledged by each stakeholder. To overcome these issues in the SPRINT@Work project, we have deepened our understanding of the relevant values using an approach of context-sensitive ethics. We have shown how a context-sensitive ethics can improve worker autonomy, how the balance between privacy and health can be improved, and how focusing on values in their context can improve the responsible use of technologies.

Lastly, in Chapter 5 we highlight the main findings from each study. Next, we sketch the most important implications for science and society. After outlining the limitations of the work and areas for future research, we finish with some final remarks underlining the scientific and societal relevance of this research.