HOW BEHAVIOR CHANGE SUPPORT SYSTEMS INFLUENCE SELF-EFFICACY: A QUALITATIVE STUDY USING WEARABLES

Research paper

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Abstract

Although Behavior Change Support Systems (BCSS) are gaining ground in the field of health interventions, we lack an empirically grounded understanding of how the behavior change techniques (BCTs) that are implemented in BCSS influence behavioral outcomes. Based on the self-efficacy theory, we conduct narrative interviews to investigate the process along which BCTs applied in wearable activity trackers (WATs) influence users' perceived self-efficacy and behaviors. We find three patterns that show how WATs' BCTs feed certain information sources on which users build their self-efficacy beliefs. We identify a positive path (i.e., high self-efficacy, leading to compliant behavior) and a negative path (i.e., low self-efficacy, leading to non-compliant behavior) for each of these patterns. Our findings indicate that, under certain circumstances and/or at a certain level of task difficulty, BCTs inflict adverse effects on users' perceptions of their self-efficacy and their subsequent behavioral responses. Our results provide insights for theory and practice into how BCSS affect perceptions of self-efficacy and behavior changes.

Keywords: Behavior Change Support Systems, Self-Efficacy, Behavior Change, Wearable, Process

1 Introduction

Behavior change support systems (BCSS) are gaining ground as sensor-based technologies spread. BCSS refer to technologies that use persuasive elements to induce changes in behavior and generate cognitive and behavioral outcomes in their users (Oinas-Kukkonen, 2013). They typically use behavior change techniques (BCTs), which refer to components of the intervention content that shape user behavior (Michie et al., 2013). BCSS are widespread in the field of health interventions; by emphasizing offline behaviors that are to be reinforced, altered, or newly formed they address health risks and behaviors that could have negative impacts on personal health (Oinas-Kukkonen, 2013). With 312 million users worldwide and global revenues of 26.4 billion USD in 2018, wearables are a prominent form of BCSS that focus on health outcomes (Statista, 2019a, 2019b). The most popular devices are wristbands and smartwatches from producers like Apple, Xiaomi, Fitbit, and Garmin (Statista, 2019c).

Research in psychology has shown that the confidence, effort, and perseverance with which individuals pursue a change in behavior depends heavily on their belief in their ability to perform the new behavior, giving rise to the self-efficacy theory on cognitive processes in humans' behavior changes (Bandura, 1977). The self-efficacy theory is one of the key theoretical foundations for BCSS, as one's perceived self-efficacy is thought to mediate the link between the intervention and the behavioral response the BCSS drive (Oinas-Kukkonen, 2013).

Information systems (IS) scholars have taken up the self-efficacy construct to investigate BCSS (e.g., Kuonanoja et al., 2015; Ronen and Te'eni, 2013) and have suggested that BCSS positively influences individuals' beliefs in their own self-efficacy (e.g., Kuonanoja et al., 2015; Langrial and Lappalainen, 2016; Mohamed et al., 2017). Research has also assigned self-efficacy a central role in supporting BCSS-induced changes in behavior (e.g., Myneni et al., 2016). While these findings help to explain the links between IT and self-efficacy and between self-efficacy and behavioral outcomes, we lack insight into the process as a whole, starting from BCSS and their components, how they influence users' self-efficacy, and subsequently shape changes in behavior. Against this background, we ask: *How do BCSS's BCTs influence users' beliefs about their self-efficacy in performing an offline behavior?*

To address this question, we conducted qualitative interviews with twenty-five users of wearable activity trackers (WATs). We used WATs as a research context because they are a prominent and widespread category of BCSS that incorporate a wide variety of BCTs. Applying the narrative interview technique allowed us to gain longitudinal insight into their use history and the sequence of events in using the BCSS. Informed by Bandura's (1977) self-efficacy theory, we investigated which of the technology's features shape cognitive outcomes and the relationship to self-efficacy beliefs and behavioral responses.

The present research makes several contributions to theory and practice. First, we contribute to BCSS-specific research by presenting one of the first studies to investigate wearable technology as BCSS in relation to self-efficacy. Second, we offer a process-oriented explanation of how the various BCTs present in WATs influence users' perceived self-efficacy and their subsequent behavioral responses. Thus, our research provides valuable insights into the cognitive and behavioral processes that are active in users who participate in some form of behavior change intervention. Third, we contribute to practice by offering WAT providers valuable design implications for effective interventions.

The paper proceeds as follows. First, we present the theoretical background on BCSS, the self-efficacy theory, and its role in IS and BCSS research. Then we present our methodology and the results of our analysis, before concluding with a discussion of our results, limitations, and proposals for further research.

2 Theoretical Background

2.1 Wearables as Behavior Change Support Systems

BCSS, a term coined by Oinas-Kukkonen (2013, p. 1225), can be defined as "socio-technical information systems with psychological and behavioral outcomes designed to form, alter or reinforce attitudes, behaviors or an act of complying without using coercion or deception." BCSS are persuasive systems or applications that aim to alter behavior using software designed to shape judgment in a predefined way (Oinas-Kukkonen and Harjumaa, 2009). The persuasive elements used to shape behavior can entail simple user interface design elements like digital nudges (cf., Mirsch et al., 2017), system features (cf., Forget et al., 2008), or entire applications, as in the sports app Runtastic. According to Michie et al. (2013), central to all BCSS is the use of BCTs, the intervention content that is designed to induce changes in behavior, which Michie et al. defined as "observable, replicable, and irreducible component[s] of an intervention designed to alter or redirect causal processes that regulate behavior" (p. 82). The authors provide a comprehensive collection of BCTs with their 2013 taxonomy of ninety-three BCTs. Prominent examples of BCTs are self-monitoring, rewards and threats, goal-setting, and social comparison.

By changing users' behaviors, BCSS aim to accomplish certain outcomes, including reinforcing existing behavioral patterns or taking up entirely new ones (Oinas-Kukkonen, 2010), so the magnitude of the change the system aims to encourage can vary. Besides a classical behavior change, which includes an intermediate- to long-term change in behavioral patterns, a change in attitudes or a simple act of compliance also fall under the term (Oinas-Kukkonen, 2013).

BCSS are gaining importance in the context of health care and health risks (Lehto and Oinas-Kukkonen, 2015). This development can be traced back to the emergence of mobile and sensor-based technologies. An increasing number of health BCSS are delivered through mobile apps or wearable technology that addresses health parameters (e.g., tracking and analysis of daily activity, sports, nutrition, or sleep) (Oinas-Kukkonen, 2013). A specialty of health BCSS is the targeting of offline behaviors that lead to changes in health outcomes (Lehto and Oinas-Kukkonen, 2015; Oinas-Kukkonen, 2013) by, for example, supporting users in abandoning unhealthy behaviors like smoking or adopting health-improving ones like regular exercise.

With the development of wearable devices, a new category of health-related BCSS has emerged. "Wearables" refers to any electronic computing device worn on the body and that uses sensor technology so users can track their personal activities and vital parameters like steps, sleep, sports activities, and food consumption (Gimpel et al., 2013; Sjöklint et al., 2015; Trickler, 2013). Even though a wide range of devices (e.g., wristbands, glasses, clothing) fall under the umbrella term of wearables, we focus on wearable devices that track physical activity: WATs. Wearable devices that are designed only to track other health-related parameters, such as fertility, blood pressure, or blood glucose levels, do not fall into the category that we investigate in this study. WATs, which usually take the form of bracelets and watches, are the most popular category of the wearables market (IDC, 2018). These devices provide users with insights into their physical performance through self-tracking. Users can usually interact with WATs directly over the devices' screens or via mobile applications, which are typically accessible using a smartphone. WATs are usually advertised as facilitators of changes in health behavior and incorporate various BCTs (Lyons et al., 2014; Mercer et al., 2016) to target a variety of health-related behaviors and outcomes (Oinas-Kukkonen, 2013). For example, behavioral patterns can be formed or altered when users build walks into their days or reverse unhealthful eating behaviors. WATs can also reinforce existing behavioral patterns by providing users with workout histories and statistics, making regular exercise more fun and appealing. Not surprisingly, the health sector places great hope in the potential of WATs. The intended behavioral outcomes of wearable use, such as increased activity levels and conscious nutrition, are keys to improving public health and reducing pressure on healthcare providers and insurers (Gimpel et al., 2013). To date, research on wearables has predominantly taken a quantitative approach to examining the effectiveness of using WATs in health behavior interventions (e.g., Jakicic et al., 2016), but only a small fraction of studies has focused on the experiential side of WATs and the qualitative analysis of the user's perspective (e.g., Becker et al., 2017; Kari et al., 2016; Miyamoto et al., 2016; Rieder et al., 2019).

2.2 Self-Efficacy Theory

Bandura's (1977) self-efficacy theory is one of the dominant behavior-change theories. Originally stemming from cognitive psychology—specifically, the treatment of phobias—the self-efficacy theory has been transferred to various research fields and contexts, including education, nutritional science, psychotherapy, management science, and IS. Bandura (1977) postulated that behavior is heavily affected by a person's own beliefs about his or her capacity to perform a behavior that is necessary to produce particular outcomes. When forming such beliefs, individuals use a variety of inputs, such as feedback, circumstantial factors, patterns of action, and resulting consequences, which they synthesize over long periods of time. The resulting perception of self-efficacy can be defined as beliefs in or judgment of one's ability to execute the courses of action required to produce desired outcomes (Bandura, 1977, 1982). However, the focus of the theory does not lie on outcome expectations (Eastman and Marzillier, 1984; Marzillier and Eastman, 1984). An individual's self-efficacy substantially affects his or her initiation of the behavior in question as well as the effort and persistence with which it is pursued, even in the face of obstacles and negative experiences (Bandura, 1977, 1982; Stajkovic and Luthans, 1998). Consequently, the greater an individual's perceived self-efficacy, the more likely the desired outcome or performance is to be reached (Bandura, 1982; Stajkovic and Luthans, 1998). Interventions which intend to strengthen self-efficacy expectations in a targeted way are more likely to successfully induce behavioral change, because individuals perceive themselves as equipped with the resources required to perform a behavior and can therefore more easily maintain the level of effort (Bandura, 1997). Individuals' confidence in their self-efficacy can vary based on the difficulty of the task (Stajkovic and Luthans, 1998) and can vary from specific to general, affecting whether expectations are transferable to other activities or circumstances (Bandura, 1977). The strength of the belief in one's self-efficacy can also vary based on the ease with which that belief can be weakened by disconfirming experiences (See also Stajkovic and Sommer, 2000).

When building their belief in their self-efficacy, individuals rely on sources that provide them with information related to their ability to deal with a situation or task: *performance accomplishments*, *vicarious experience*, *verbal persuasion*, and *emotional arousal*. Information about *performance accomplishments* is based on previous positive experience and is directly affected by the successes of those experiences that strengthen the efficacy information derived from this source. Experience-based levels of self-efficacy can generalize across a variety of situational circumstances, leading to improved behavioral responses in diverse contexts and activities. Judgments about one's self-efficacy can also be based on *vicarious experience*—that is, on observing others perform a behavior that results in desired or undesirable outcomes, building on mechanisms of social comparison. However, the informative value of vicarious experience is lower than the information from personal experience, and judgments made based on it are less stable. Information from *verbal persuasion* can convince individuals of their ability to deal successfully with a particular situation through the power of suggestion. The impact of verbal persuasion on self-efficacy is lower than of performance accomplishments and vicarious experience, but Bandura (1977) emphasized that verbal persuasion combined with other aids and techniques can help to increase one's sense of self-efficacy. Finally, *emotional arousal* provides information that serves as an interpretive basis of personal competency. The interpretation of physiological arousal (e.g., anxiety, stress reactions) in response to certain cues differs from individual to individual, helping to explain differences in individuals' motivation to undertake a behavior.

The degree to which efficacy information affects perceived self-efficacy depends not only on source-related factors but also on external factors like the situation in which the action is performed or the difficulty level of the task, as well as personal factors like the degree to which one credits an achievement to one's own capabilities, the effort undertaken to accomplish a task, and the individual's ability to cope with setbacks (Stajkovic and Sommer, 2000; Bandura, 1977, 1997).

2.3 Self-efficacy in IS and BCSS research

The self-efficacy theory has been applied in IS research for more than three decades, but two streams of the literature on self-efficacy in IS stand out. One covers the link between information technology and perceived self-efficacy, clarifying how IS can influence individual self-efficacy judgments, and another focuses on the link between perceived self-efficacy and the subsequent IS-use-related behaviors.

Traditionally, IS and especially BCSS-specific research have treated self-efficacy as a cognitive outcome following (behavioral) interventions (cf., Figure 1). Studies in this comparatively small research stream have investigated the effects of behavioral interventions on multiple outcome measures, one of which has usually included perceived self-efficacy. General IS studies have looked into the effects of technology-mediated interventions on chronic pain in terms of patients' movement-related self-efficacy (Olugblade et al., 2018) or students' academic self-efficacy (Alrushiedat and Olfman, 2014), while behavioral interventions in BCSS-specific studies have focused on using BCSS in treating depression (Kuonanoja et al., 2015; Langrial and Lappalainen, 2016) and sleeplessness (Langrial and Lappalainen, 2016), improving general mental well-being (Laurie and Blandford, 2016), reducing sedentary behavior (Mohamed et al., 2017), and complying with health-care-related prescriptions (Ronen and Te'eni, 2013). Among other effectiveness-related measures (e.g., alleviation of symptoms), studies have also surveyed users' perceived self-efficacy in undertaking the tasks and behaviors that support treatment. All of the studies have described positive effects of BCSS on participants' perceived self-efficacy.

The second stream of literature, which addresses the link between self-efficacy and behavior change, has been examined by many IS studies. In general IS research, self-efficacy has predominantly been modeled as a predictor of IS-use-related behaviors (i.e., technology acceptance), with many studies having offered extensions to established theories, such as the Technology Acceptance Model or Theory of Planned Behavior (e.g., Pavlou and Fygenson, 2006; Rahman et al., 2016; Yi and Hwang, 2003). Only a few general IS studies have covered other types of behavior change that are supported by self-efficacy, such as coping with malicious information technology (Liang and Xue, 2009) or information and purchasing behaviors in online commerce (Pavlou and Fygenson, 2006). Of the BCSS-specific studies, only two have addressed the role of perceived self-efficacy in changing behavior (cf., Figure 1): Oinas-Kukkonen's (2013) conceptual paper proposed the self-efficacy theory as one of the key theoretical foundations for BCSS, suggesting that perceived self-efficacy mediates the link between the intervention component and the (offline) behavior change induced by the system, while Myneni et al. (2016) analyzed the communication content of a community-based BCSS supporting smoking cessation and found evidence from various behavior change theories, including the self-efficacy theory.

The general self-efficacy concept used in this study is not to be confused with the IS-specific self-efficacy construct of computer self-efficacy (cf. Compeau and Higgins, 1995), an additional literature stream that has focused on perceptions of one's ability to use a computing system.

In summary, the link between perceived self-efficacy and behavior change is underrepresented apart from its coverage in the IS acceptance literature, as is the entire logic described by the self-efficacy theory, including the perceived self-efficacy's link with information technology and behavior change. Moreover, neither general IS studies nor BCSS-specific studies have specifically addressed the sources and factors that influence self-efficacy judgments. To describe and explain this logic in the context of BCSS, we need of a process view of how BCSS's technology features influence individual self-efficacy beliefs and unfolding their effect on the individual's offline behavioral response.

Figure 1 provides an overview of prior research on self-efficacy in the IS and BCSS-specific literature and highlights the scope of the present research, which encompasses process from BCSS to behavior change.

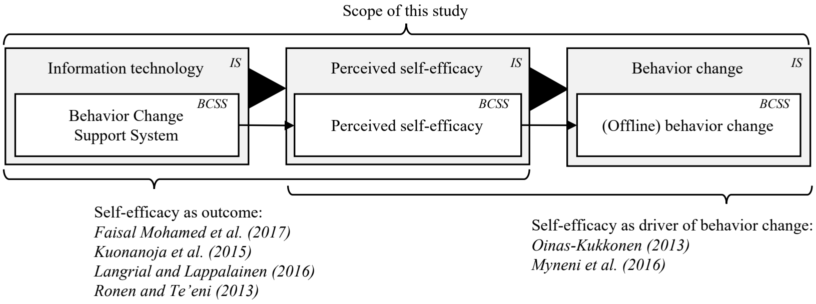

Figure 1. Current IS self-efficacy research and scope of the study

3 Method

Since empirical evidence of the effect of BCSS on users' self-efficacy beliefs regarding the performance of offline behaviors is scarce, we sought to obtain full and rich personal accounts using a qualitative approach. We followed established principles (Chatman, 1978; Küsters, 2009) in conducting narrative interviews with users of WATs, a specific and widespread type of BCSS, to capture individual user experiences and to obtain a longitudinal picture of the individuals' use history. In this interview technique, the interviewee gives an account of a past event (Küsters, 2009), the organization and structuring of which are left to the interviewee. Since the interviewer does not interrupt the narrative, the interview technique helps to avoid common biases, such as social desirability, patterns of interaction in the interview, issues related to wording and placement of questions, and topics and terminology brought in by the interviewer (Küsters, 2009). We considered the narrative interview a suitable technique with which to address our research question for two reasons: First, since we sought to obtain information on the process through which features of the BCSS influence users' perceived self-efficacy and behavioral responses, the longitudinal, process-like nature of data generated through narrative interviews was preferable to more structured interview techniques that would likely put less emphasis on the chronology of the individual interviewee's use history. Second, as the technique involves minimal interference with an individual's narrative, it helps to ensure that only what is relevant to the individual and responsible for shaping his or her perceived self-efficacy and behavioral responses is addressed in the interview. Using techniques that would require that we bring in our own subjects could jeopardize the individual's coloring and weighting of aspects of the narrative.

3.1 Data Collection

We interviewed twenty-five WAT users who were based in Switzerland, one of the most advanced markets for wearables in Europe, with a market penetration of 7.6 percent in 2018 (Statista, 2018). All interviews were conducted between September 2017 and March 2018. Using purposive sampling, we sampled interviewees that met the following inclusion criterion (Miles and Huberman, 1994): all interviewees were intermediate to long-term WAT users (i.e., past the trial phase). All of our twenty-five interviewees had used their WATs for more than four months, and some had done so for several years. Within this inclusion criterion, we aimed to capture maximum variation in demographics (i.e. gender, age, profession) allowing us to identify shared patterns across diverse individuals. The first interviewees were recruited through the authors' personal networks, and snowball sampling was applied to recruit additional interviewees (cf. Miles and Huberman, 1994).

In line with the narrative interview technique, no interview guideline was used (Küsters, 2009). Instead, we used a pre-formulated initial stimulus to ignite interviewees' narratives: *"Please tell me the story of your activity tracker, from the moment you got it until today."* After the interviewees had recognizably finished their narratives without interruption, we took up topics mentioned by the interviewees in their initial narratives to trigger additional accounts. Twenty-two of the interviews were held in person, and three were held via Skype video call. Interviewees were ensured anonymity and confidentiality of the statements they made over the course of the interview. The duration and elaborateness of the narratives varied widely across the interviews, which is reflected in the variance in the depth and length of the interviews, which ranged from nineteen to eighty-seven minutes, excluding preliminary talk and instructions. We recorded and transcribed the interviews verbatim to rigorously and transparently analyze the resulting data. Interviews and transcriptions were done in the participants' native language, whether German, Swiss German dialect, or English, and were processed by native German and fluent English speakers. The quotations presented in this paper were either given in English or translated into English from German or Swiss German dialect.

Our sample consists of nine women and sixteen men from eighteen to sixty-two years of age who were students and professionals, with the exception of one retired individual. The use frequency of the WAT varied across interviewees and largely depended on the individual's motivation for use. Most interviewees used the device every day (20/25), some even used it at night (7/25), and others wore it only when they engaged in sports (5/25). Most used their WATs to track their daily activity, support their sports performance, and improve their health (15/25), although some reported using them to explore the novel technology out of curiosity (10/25). As our research approach relied predominantly on applying pre-identified themes from self-efficacy theory, gaining rich, in-depth narratives from twenty-five participants allowed us to achieve saturation in terms of the extent to which the data instantiated previously determined conceptual categories (Saunders et al., 2018). Based on the interviews, we identified a large number of instantiations of self-efficacy and the associated behavioral responses and information sources. Table 1 presents an overview of the study participants.

alias	age	sex	occupation	months used	devices used	alias	age	sex	occupation	months used	devices used
INT1	25	F	student	> 24	2 x Fitbit	INT14	26	M	Ph.D. student	6-12	Xiaomi, Fitbit
INT2	24	F	student	6-12	Jawbone	INT15	33	F	nurse	> 24	3 x Garmin
INT3	62	M	retired lawyer	6-12	Polar	INT16	24	F	student	> 24	2 x Misfit, Garmin, Apple
INT4	27	F	legal secretary	12-24	2 x Fitbit	INT17	25	M	student	6-12	Fitbit
INT5	63	M	medical doctor	> 24	2 x Polar, Garmin	INT18	57	M	managing director	12-24	2 x Fitbit
INT6	57	F	project manager	12-24	Polar, Misfit	INT19	20	F	student	6-12	Garmin
INT7	41	M	project manager	> 24	Polar	INT20	18	M	student	12-24	2 x Fitbit
INT8	35	M	financial analyst	6-12	Garmin	INT21	26	M	bartender	6-12	Fitbit
INT9	58	M	consultant	> 24	Garmin, Jawbone, Suunto	INT22	22	M	student	6-12	Garmin
INT10	41	M	entrepreneur	12-24	Garmin, Apple	INT23	40	M	controller	> 24	Fitbit, Apple
INT11	41	M	entrepreneur	6-12	Misfit	INT24	39	M	entrepreneur	> 24	Garmin, Fitbit, Misfit, Jawbone, Apple
INT12	24	F	student	> 24	Fitbit, Garmin	INT25	57	F	legal secretary	3-6	Fitbit
INT13	40	M	computer scientist	12-24	Jawbone, Apple						

Table 1. Sample characteristics

3.2 Data Analysis

Our data analysis consisted of two parts, with the first and second author first coding the data to identify accounts of self-efficacy, related behavioral responses, and information sources for self-efficacy and the underlying BCTs. Then we linked the BCTs, self-efficacy beliefs, and behavioral responses to develop a comprehensive framework and identified influencing factors (Figure 2).

The first part of the data analysis was informed by the concepts related to self-efficacy theory (Bandura, 1977). We began by searching for accounts of perceived self-efficacy in the data and found several sections in which the interviewees referred to their perceptions of their capacity to perform a behavior cued by the WAT. We found accounts of both high self-efficacy *("It provides you with a weekly review and how many steps you've taken. And there were weeks in which I took 15,000 to 18,000 steps, so of course 10,000 are not that hard to achieve."* INT19) and low self-efficacy (*"What I found astonishing was that people who are working sitting at a desk won't achieve 10,000 steps, not in one hundred years."* INT6). We also identified the specific behavioral responses related to these self-efficacy beliefs and used descriptive coding (Myers, 2009) to compare and contrast descriptions of behavioral responses and group similar sets of behaviors into categories. Aggregating the behavioral responses revealed that they could be categorized into two general categories, compliance and non-compliance, where compliance encompassed behaviors that were in line with the behaviors prompted by the WAT, such as changing food consumption or physical activity, while non-compliance included behaviors that disregarded the prompted behaviors or showed negative reactions, such as defiance or even strategies to avoid the cue. Subsequently, we analyzed the sources from which the interviewees took the information they used to assess their self-efficacy, based on the four information sources Bandura (1977) suggested: personal accomplishment, vicarious experience, verbal persuasion, and emotional arousal. We found accounts in the data of all but emotional arousal. Next, we identified the technologies' features (i.e., the BCTs) the interviewees described to determine how they were related to the information sources of self-efficacy beliefs. To describe and group the BCTs, we drew on the Taxonomy of Behavior Change Techniques from Michie et al. (2013) and found evidence for target-performance comparison, prompts and cues, feedback, self-monitoring, commitment, and social comparison. We also found the BCT performance history, which the interviewees mention frequently but which was not covered by the taxonomy used.

In the second part of the analysis, we focused on the relationships among the BCTs, the information sources for self-efficacy judgment, and the behavioral responses. For this purpose, we identified the sequences of events observable in our data for each individual and then across individuals. We observed that some interviewees responded to the same BCTs sometimes with high levels of self-efficacy and behavior compliance and sometimes with low levels of self-efficacy and behavior non-compliance. After digging more deeply into the data, we identified two superordinate factors that influenced how the information sources affected individuals' self-efficacy judgments: external circumstances (e.g., a knee injury or semester break) and the difficulty of the cued task based on the situation (e.g., a strong opponent). These two influencing are in large part in line with the theoretical concepts Bandura (1977) proposed.

4 Results

Our analysis reveals that the influence that the WAT's features has on users' perceptions of their self-efficacy evolves through the process illustrated in Figure 2. The technology features—more specifically, the BCTs used by WATs—feed three sources of information individuals use to build their self-efficacy beliefs: personal accomplishment, vicarious experience, and verbal persuasion, but not emotional arousal. External circumstances and task difficulty are found to influence the informational value the sources have on forming judgments of self-efficacy. Whether circumstances are restrictive or non-restrictive and whether the task difficulty is adequate or inadequate are subject to the interviewees' evaluation. While non-restrictive circumstances and reasonable level of task difficulty have positive effects on perceived self-efficacy and leads users to comply with the behaviors the WATs instigate, restrictive circumstances and excessive task difficulty dampen users' self-efficacy beliefs and lead to non-compliance. Both high and low self-efficacy are observed in the same users for the same target behaviors based on the circumstances. The following subsections present our results in detail based on the three sources of information.

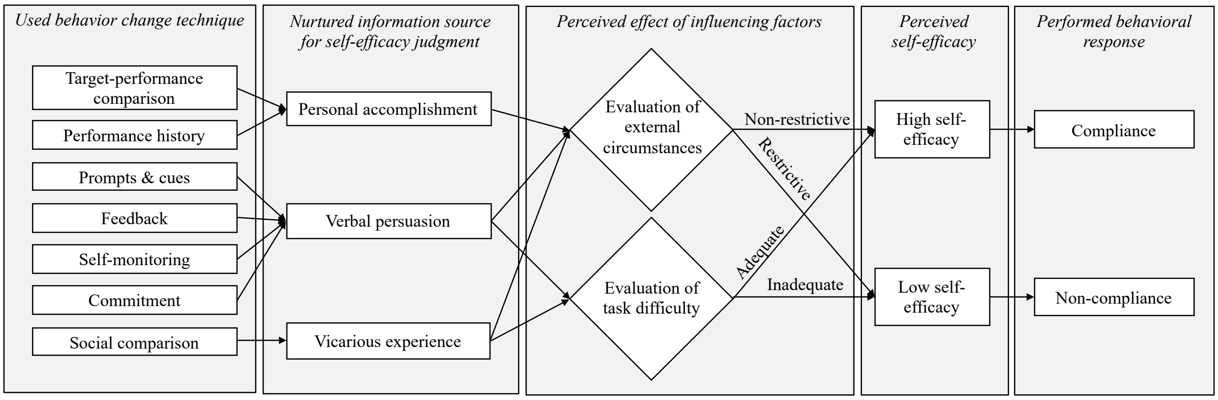

Figure 2. Overview of results

4.1 Self-efficacy judgment informed by personal accomplishment

Several BCTs inform individuals' perceptions of their personal accomplishments. The BCT *target-performance comparison* was mainly in WATs' step-counting function. With many WATs imposing a daily goal of 10,000 steps, the status of the user's goal achievement can be checked either directly over the wearable device's user interface or via the smartphone app. The BCT *performance history* is more global in nature, as it provides users with statistics and aggregations of the data of multiple functionalities, such as step-counting and sports monitoring, thus providing insights into performance development over longer time periods. The information from these BCTs is processed as personal accomplishment, a source for the assessment of personal self-efficacy. For example, one interviewee mentioned how the reference values acquired over the time the interviewee had been using the step-counting functionality helped the interviewee to make sense of the daily step goals and make realistic estimations of whether the goal was achievable or not:

> *[Your use of the WAT] gets better because you eventually have reference values from which you know, "Ah, I can do this much" or "I've already achieved this many steps," and that helps you pin down the number of steps. In the beginning, it is hard to interpret what the number of steps means—steps are an abstract measure—but when you've used it for a couple of weeks, you can see what you can achieve on average, what you do on days on which you're really active, and what makes the difference. (INT17)*

Another interviewee described the confidence gained toward reaching the daily step goals by relying on historical data of what had already been achieved:

> *It provides you with a weekly review and how many steps you've made. And there were weeks in which I made 15,000 to 18,000 steps and then, of course, 10,000 are not that hard to achieve. If I hadn't made them yet, the motivation was high to achieve them somehow because otherwise you were below your average. (INT19)*

However, the effect that information about personal accomplishments have on the interviewees' self-efficacy beliefs is affected by circumstantial factors. If the interviewee evaluates external circumstances as non-restrictive, the sense of personal accomplishment gained from the technology is strong enough to form high self-efficacy beliefs, leading to compliance with the prompted behavior. One interviewee, who was a habitual user of the step-counting functionality and persistently pursued daily step goals, had to stop using the WAT for a time because of a knee injury. Despite these restrictive circumstances, the interviewee described how several aspects of performance history (i.e., badges, accumulated number of steps) convinced the interviewee to continue pursuing daily step goals, which is indicative of high perceived self-efficacy:

> *When I had my knee injury would have been the ideal moment to put it aside. I could have said, "I have a ton of badges … made several hundreds of thousands of steps, and this is it for now," but I thought I had to be able to deal with [this] little rubber band with four lights. (INT18)*

In contrast, if circumstances change in a way that restricts users in their ability or readiness to perform the behavior, even users who usually show high levels of self-efficacy assess their ability to perform the same behavior more poorly and decide not to comply with the technology. The intensity of non-compliance reaches from simply not showing a reaction to the cue to avoidance strategies in the form of taking the device off until the unfavorable circumstances resolve. An interviewee speaks of restrictive circumstances at work that preclude reaching the daily step goal, but on days off, the interviewee has no difficulty complying with the cue:

> *What I found astonishing was that people who are working sitting at a desk won't achieve 10,000 steps, not in one hundred years. That's actually logical: If you don't do anything in addition and only go to the toilet twice and grab some coffee three times per day, you maybe make 4,500 steps. […] On Fridays, when I do not work and even if I do not go for a run, I don't have any difficulty reaching 10,000 steps. Housewives rush around the house, upstairs, downstairs—it's easy. And if it happened when I was at home that I was below 10,000 steps, I thought, "I want to have them." (INT6)*

Another interviewee mentioned the semester break as a factor that undermined usually high self-efficacy about achieving the daily step goal. Not keeping up with previous accomplishments led to frustration and a guilty conscience, so the interviewee decided to take the WAT off to avoid the resulting adverse emotional state:

> *During the semester break, we always took it off when we had to study because then we wouldn't even get 1,000 steps per day. We only moved from the desk to the kitchen and to the toilet, which is practically nothing, and this was so depressing that we just thought "no." […] And to silence my conscience, I just didn't [wear the WAT] at all. (INT1)*

4.2 Self-efficacy judgment informed by verbal persuasion

A variety of BCTs serve as verbal persuasion, differing in terms of the explicitness with which the WATs suggest behavioral responses. With *prompts and cues*, usually in the form of reminders and push-notifications suggesting that users take a specific number of steps, move for some number of minutes, drink water, or go to bed, the technology makes the target behavior clear. WATs also operate the BCT *feedback*, especially related to sports monitoring, which can take any form from real-time data during exercise (e.g., pace) to indications of training effects that persuade users in a subtle way to adjust their training behavior. Some WATs also use *commitment* to get users to stick with their own, self-established goals. Another important BCT WATs use is *self-monitoring*, which lies at the core of the nutrition-tracking function. By having users enter the food and drink they consume and providing them with an analysis of their nutritional intake (e.g., in terms of calories, macro- and micronutrients, against established benchmarks), WATs send gentle, normative messages to users, which can be categorized as verbal persuasion. The interviewees assess their self-efficacy based on the information drawn from these BCTs and largely report such prompts to be helpful in teaching them about and remembering to execute behaviors that are favorable for their personal health. An interviewee who used the Apple Watch as a WAT reported feeling convinced of the ability to meet the prompted goals because the alerts from the WAT were situationally appropriate:

> *Over the course of the day, you get a reminder on the Apple Watch or a message telling you, "Hey, you've almost reached your walking goal, but you still have to stand a little more" or… "you've stood enough but should walk a little more." It informs you interactively and situationally over the course of the day, not only in the evening with "Hey, you've achieved it" or you have not, but rather, "Right now, you should walk for ten minutes in order to reach your goal, why don't you go out real quick?" And you're told this in the afternoon at four o'clock, five o'clock, so you feel like you're being coached, and it's not simply a statistic that is reported afterward. Because if you learn about it retrospectively, it's always "Okay, well, but now it's too late, and I can't do anything about it." (INT24)*

Another interviewee stated that the WAT provided her with information about adjusting nutritional intake to match the level of energy expenditure:

> *You also have your calorie information. During the winter, I don't care, but in summer when it's all about [muscle] definition, I really do rely on these values. Like when it tells me at the end of the day that I have used 3,000 calories, then I know what is within the range in terms of food. And when I'm really watching, you enter everything you have eaten. (INT15)*

Verbal persuasion as an information source for perceived self-efficacy is strong only so long as there is no negative impact of circumstantial factors or difficulty in the prompted task. Under beneficial circumstances that allow the users to execute the target behavior and with a level of task difficulty that does not exceed users' coping skills, BCTs that use verbal persuasion positively affect judgments of self-efficacy. One interviewee mentioned how the WAT's indication of training effects was persuasive in the decision to increase training intensity:

> *But I realized you can become a slave. […] You have training effects that the watch is indicating, and above 3.0 is form-building, and below 3.0 is form-maintaining. You always want to build up form, so when you're at 2.9 and virtually done with your training, you keep doing something so you'll hit 3.0. […] So for me, it's a total motivator that is pushing me and eventually gives me a*

sense of achievement when it says, "Yes, today you've built up your form with this training." (INT15)

However, the same BCTs that have positive effects on perceived self-efficacy can also negatively affect the use's self-efficacy judgments, especially if the user evaluates external circumstances as restrictive or the task difficulty as exceeding his or her coping skills. A situation that provokes negative emotions can lead to non-compliance with the prompt or even evoke defiance. For example, an interviewee reported that the task difficulty of the behavior cued by hourly activity reminders increased with longer sedentary periods, which sometimes led to disregarding the prompt:

It had five red bars that showed you hadn't moved for, like, twenty minutes, so when you were at the table studying, it eventually started beeping, and this is when I usually got up and walked through the apartment to get rid of the red bar. […] But if you hadn't moved for thirty or forty minutes, you got a long bar, and with every ten minutes another small one and in the end you had like five bars that were filled. The more bars you had, the longer it took to get rid of them. So if you had one bar, you could cross your apartment two or three times […] before it eventually disappeared, but when you had five bars, you would have to move for five or ten minutes in a row to get rid of all of them, which I sometimes did […]. The red bar really annoyed me. (INT19)

Another interviewee with a usually high level of self-efficacy in regard to complying with verbal persuasion transmitted through activity prompts indicated that these persuasions can eventually be "terrorizing," especially when circumstances do not allow for compliance. Besides calling WATs "terrorizing," the interviewee mentioned reacting with strong negative emotions like frustration and defiance and ultimately not complying with the prompt:

Sometimes I'm in the bathroom, brushing my teeth shortly before midnight, and then the watch says, "You're missing six activity minutes," and it proposes something you could do to close this ring. So I'm in the bathroom, running in place or doing jumping jacks, or if I am warming a cherry pit pillow in the microwave, I do something to close the ring because it's just nice, it's a great lift with which you can go to bed. […] I am trying not to let it terrorize me anymore. But I realize that I am developing a kind of defiance if the watch wants something, and I know that today I just cannot or don't want to do it. Then I get really defiant. I think, "Oh, you always demand very high standards! Leave me alone! I simply can't comply with it today!" (INT16)

4.3 Self-efficacy judgment informed by vicarious experience

Most WATs offer users the opportunity to compare specific behavioral outcomes to those of other users. For example, employing the BCT *social comparison* allows WATs users to compete against each other in taking more steps per day or provides them with rankings from a larger user base. By making it visible to users how others perform a behavior, social comparison feeds vicarious experience as an information source for perceived self-efficacy. Several interviewees reported using competitions and being motivated by comparing themselves to others:

At first, it primarily was like, "Okay, this person has [this WAT] too, so let's do it." There was a challenge, and after I was defeated once, I had to win. Then I walked an extreme [number of steps]. I came to realize that it could be considered sports too, so I did more, and I won. And then I thought, "Again!" (INT20)

Another interviewee commented on the positive effect this transparency had on the assessment of the capacity to take a certain number of steps:

Soon, more colleagues got one of the same brand, and you have a community where you can see how many steps the others take. Then you have this "if he does this many steps, then I will take more," and if many do that, you were comparing and it was an inducement. (INT1)

While generally social comparison informs users' self-efficacy judgments, they are also influenced by external circumstances and the task's difficulty. When circumstances and task difficulty are assessed as non-restrictive and not too difficult, the resulting judgment of personal efficacy is strong and users comply with the cued behaviors by, for example, taking more steps than their opponents do. An interviewee who was not negatively affected by restrictive circumstances or excessive task difficulty reported being highly motivated to win the competition:

> *It extremely motivated me. I purposely took the stairs or when I knew I had to take the subway for one stop, I walked instead because I desperately wanted to beat my boyfriend. (INT2)*

However, if the task difficulty exceeds a certain level or external circumstances get in the way of performing a behavior, users assess their self-efficacy poorly and do not comply with the behavioral response prompted by the WAT. One interviewee commented that social comparison was motivational and strengthening of self-efficacy as long the competition was with opponents that provided a realistic chance of winning. However, with stronger opponents, task difficulty exceeded the activity level that was achievable considering the circumstances of the interviewee's life, in which case peers' performance (i.e., vicarious experience) dampened the interviewee's confidence and led to deciding against competing against much stronger opponents:

> *You could also engage in competitions over the weekend, and with one colleague I used to do this with, I didn't get a chance even though I felt I had done lots of steps. When I had around 40,000 steps a day, and then he reached 60,000, I dropped it because it [irritated] me, […] so I didn't do any challenges against him anymore. […] You look instead at the ones closer to 10,000 per day, like my friend and her sister. We used to compare every once in a while and eventually I'd say, "Hmm … now they have more than I do, so I should probably see that I have 1,000 more per day than just the 10,000." (INT1)*

5 Discussion

This study investigates the process through which BCSS influence self-efficacy beliefs, thus inducing changes in behavior. Based on narrative interviews with twenty-five WAT users, we identified three patterns in which WATs' BCTs feed the information sources on which users build their self-efficacy beliefs, thus determining whether users comply with the prompted behavior. We show that the BCTs WATs use do inform users' self-efficacy judgments in a positive way and that these increased levels of self-efficacy have a positive effect on the execution of target behaviors. This finding is in accordance with the theoretical foundations of self-efficacy (Bandura, 1977, 1997) and multiple studies from the field of IS that have investigated self-efficacy-related issues (e.g., Kuonanoja et al., 2015; Oinas-Kukkonen, 2013; Ronen and Te'eni, 2013).

Our findings also indicate that the same BCTs that positively influence self-efficacy can also have adverse effects on users' self-efficacy beliefs, a finding that has not been addressed in prior IS research. We observe adverse effects when external circumstances and/or the difficulty level of a task negatively affect the informational value of the sources of self-efficacy. This finding can be explained by the self-efficacy theory, which lists potential attenuating factors to self-efficacy beliefs (Bandura, 1977). The perception of self-efficacy that is informed by verbal persuasion and vicarious experience are found to be potentially affected by both external circumstances and the level of task difficulty, but we find evidence for external circumstances having an effect only on self-efficacy judgments that are informed by personal accomplishment, perhaps because individuals are likely to skip the assessment of a task's difficulty when they have previously performed the behavior.

Our study makes four primary contributions to research on BCSS. First, the study is among the first to present a process view of the influence BCSS have on self-efficacy and behavioral responses. Our research covers the relationship between BCSS, perceptions of self-efficacy, and behavior change, starting from the BCTs the BCSS use, to users' self-efficacy judgments, to the execution of behavior. Most BCSS research has concentrated on investigating self-efficacy as an outcome measure (e.g., Kuonanoja et al, 2014; Laurie and Blandford, 2016; Mohamed, 2017), and a small fraction has described the link between self-efficacy and behavior (Myneni et al., 2015; Oinas-Kukkonen, 2013), but no effort has been made to explain the entire process. Second, prior studies have shown only positive effects of BCSS on users' self-efficacy beliefs (e.g., Kuonanoja et al., 2015; Langrial and Lappalainen, 2016), but we show that wearable interventions also have a negative path and so can also negatively influence perceived self-efficacy, resulting in users' non-compliance. Third, to our knowledge, this study is the first to investigate wearable technology in relation to self-efficacy. Other studies in the field have focused on web-based BCSS (e.g., Kuonanoja et al., 2015; Myneni et al., 2016) or mobile BCSS (Mohamed et al., 2017), although wearables offer new opportunities for BCSS by making new types of data accessible through sensor technology. Fourth, examining commercially available WATs rather than BCSS that are designed for research purposes (e.g., Ronen and Te'eni, 2013) allows us to study BCSS's influence on perceptions of self-efficacy and subsequent behavior in a natural environment.

Our research has three useful implications for research and practice. First, our findings suggest that self-efficacy should be regarded situationally, rather than in a generalized way, because self-efficacy judgments as they relate to the same target behavior can change as situational factors vary. Therefore, studies that model self-efficacy as an outcome measure of behavior-change interventions should also account for situational variations, which requires measuring self-efficacy at frequent intervals, rather than inquiring only at the beginning and the end of the observation period. Moreover, interventions that target behavior change that are related to topics like severe medical conditions and mental health must consider this factor since a situational drop in self-efficacy and the accompanying non-compliance can have severely negative consequences. Second, the difficulty of the tasks BCSS suggest should be based on individual idiosyncrasies rather than on an identical difficulty level for every user. What may be too much for one user can still be motivational for another. The literature has suggested that personal factors and attitudes are determinative in assessing task difficulty (Bandura, 1977). Third, WAT providers can learn from this study the information sources by which BCTs influence self-efficacy and the resulting behavior. Our findings show which BCTs WAT users actually notice and that impact their perceptions and behaviors. WAT providers can also learn that, besides positively influencing self-efficacy, BCSS can also have adverse effects on users' perceptions of their self-efficacy, resulting in non-compliance. These findings have important implications for the design of WATs and inform practitioners' decisions about which BCTs to use and which measures to apply to counteract adverse effects. For example, since the negative effects on behavior that result from restrictive external circumstances must be addressed, WAT providers can consider equipping their systems with a feature that allows users to pause the intervention or lower its intensity.

6 Limitations and Further Research

The present research is subject to some limitations. Since we investigated only one type of BCSS—that is, WATs—our findings' generalizability may be restricted. Even though WATs incorporate a wide variety of BCTs, the systems are typically directed toward changing health outcomes that are related to physical activity and nutrition, which cover only a fraction of the areas of life that BCSS can target. In addition, although the narrative interview technique is especially valuable when it comes to exploring longitudinal, process-like issues with highly individual characteristics, some themes could be over- or under-represented in the data, so there may be a bias in the data toward highly positive or highly negative issues and incidents of WAT use that are vivid in the interviewees' memories and can be recalled more easily than others. These limitations lead to suggestions for future research. For example, researchers could investigate other types of BCSS that apply other kinds of BCTs, thereby extending our findings. In addition, since the study's participants were all based in Switzerland, a follow-up study might take other cultural contexts into account to determine whether the findings can be generalized. A longitudinal study could also investigate the development process of self-efficacy beliefs over time with a particular focus on the logic with which switches from the positive to the negative path occur, investigate the development of the perceived value of self-efficacy information derived from the three information sources, and detail the influencing factors and behavioral responses further. Moreover, it may prove to be fruitful to consider additional criteria, such as personality traits, in the sampling strategy.

References

Alrushiedat, N. and Olfman, L. (2014). “Anchoring for Self-Efficacy and Success: An Anchored Asynchronous Online Discussion Case.” *Journal of Information Systems Education* 25 (2), 107–116.

Bandura, A. (1977). “Self-Efficacy: Toward A Unifying Theory of Behavioral Change.” *Psychological Review* 84, 191–215.

Bandura, A. (1982). “Self-Efficacy Mechanism in Human Agency.” *American Psychologist* 37 (2), 122–147.

Bandura, A. (1997). *Self-Efficacy. The Exercise of Control*. New York: W.H. Freeman and Company.

Becker, M., Kolbeck, A., Matt, C., and Hess, T. (2017). “Understanding the Continuous Use of Fitness Trackers: A Thematic Analysis”. *PACIS 2017 Proceedings.*

Chatman, S. (1978). *Story and Discourse. Narrative Structure in Fiction and Film*. Ithaca: Cornell University Press.

Compeau, D.R. and Higgins, C.A. (1995). “Computer Self-Efficacy: Development of a Measure and Initial Test.” *Management Information Systems Quarterly* 19 (2), 189–211.

Eastman, C. and Marzillier, J.S. (1984). “Theoretical and Methodological Difficulties in Bandura's Self-Efficacy Theory.” *Cognitive Therapy and Research* 8 (3), 213–229.

Faisal Mohamed, N.F., Abdul Rahman, A., and Iahad, N.A. (2017). “Managing Sedentary Behavior with Smartphone” *PACIS 2017 Proceedings*. 253.

Forget, A., Chiasson, S., van Oorschot, P.C., and Biddle, R. (2008). “Persuasion for Stronger Passwords: Motivation and Pilot Study.” In: Oinas-Kukkonen, H., Hasle, P., Harjumaa, M., Segerståhl, K., and Øhrstrøm, P. (Eds.) (2008). *PERSUASIVE 2008* (vol. 5033), 140–150. Heidelberg: Springer.

Gimpel, H., Nissen, M., and Görlitz, R.A. (2013). “Quantifying the Quantified Self: A Study on the Motivation of Patients to Track Their Own Health.” *ICIS 2013 Proceedings*.

IDC (2018). *Global Wearable Market Grows 7.7% in 4Q17 and 10.3% in 2017 as Apple Seizes the Leader Position, Says IDC*. URL: https://www.idc.com/getdoc.jsp?containerId=prUS43598218 (visited on 10/11/2018)

Jakicic, J.M., Davis, K.K., Rogers, R.J., King, W.C., Marcus, M.D., Helsel, D., …, Belle, S.H. (2016). “Effect of Wearable Technology Combined With a Lifestyle Intervention on Long-term Weight Loss: The IDEA Randomized Clinical Trial.” *Journal of the American Medical Association* 316 (11), 1161–1171.

Kari, T., Koivunen, S., Frank, L., Makkonen, M., and Moilanen, P. (2016). “Critical Experiences During the Implementation of a Self-Tracking Technology.” *PACIS 2016 Proceedings*.

Kuonanoja, L., Langrial, S., Lappalainen, R., Lappalainen, P., and Oinas-Kukkonen, H. (2015). “Treating Depression with a Behavior Change Support System without Face-to-Face Therapy.” *Transactions on Human Computer Interaction* 7 (3), 192–210.

Küsters, I. (2009). *Narrative Interviews. Grundlagen und Anwendungen*. 2nd Edition. Wiesbaden: VS Verlag für Sozialwissenschaften.

Langrial, S.U. and Lappalainen, P. (2016). “Information Systems for Improving Mental Health: Six Emerging Themes of Research.” *PACIS 2016 Proceedings*, 16.

Laurie, J. and Blandford, A. (2016). “Making Time for Mindfulness.” *International Journal of Medical Informatics*.

Lehto, T. and Oinas-Kukkonen, H. (2015). “Examining the Persuasive Potential of Web-based Health Behavior Change Support Systems.” *Transactions on Human-Computer Interaction* 7 (3), 126–140.

Liang, H. and Xue, Y. (2009). “Avoidance of Information Technology Threats: A Theoretical Perspective.” *Management Information Systems Quarterly* 33 (1), 71–90.

Lyons E.J., Lewis Z.H., Mayrsohn B.G., Rowland J.L. (2014). “Behavior Change Techniques Implemented in Electronic Lifestyle Activity Monitors: A Systematic Content Analysis.” *Journal of Medical Internet Research* 16 (8), 1–15.

Marzillier, J. and Eastman, C. (1984). "Continuing Problems with Self-Efficacy Theory: A Reply to Bandura." *Cognitive Therapy and Research* 8 (3), 257–262.
Mercer, K., Li, M., Giangregorio, L., Burns, C., and Grindrod, K. (2016). "Behavior Change Techniques Present in Wearable Activity Trackers: A Critical Analysis." *JMIR mHealth uHealth* 4 (2), 1–9.
Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., …, Wood, C.E. (2013). "The Behavior Change Technique Taxonomy (v1) of 93 Hierarchically Clustered Techniques: Building an International Consensus for the Reporting of Behavior Change Interventions." *Annals of Behavioral Medicine* 46, 81–95.
Miles, M.B. and Huberman, A.M. (1994). *Qualitative Data Analysis: An Expanded Sourcebook.* 2nd Edition. Thousand Oaks: Sage.
Mirsch, T., Lehrer, C., and Jung, R. (2017). "Digital Nudging: Altering User Behavior in Digital Environments." *13th International Conference on Wirtschaftsinformatik, St. Gallen*, 634–648.
Miyamoto, S.W., Henderson, S., Young, H.M., Pande, A., and Han, J.J. (2016). "Tracking Health Data Is Not Enough: A Qualitative Exploration of the Role of Healthcare Partnerships and mHealth Technology to Promote Physical Activity and to Sustain Behavior Change." *JMIR mHealth uHealth* 4(1), 1–12.
Myers, M.D. (2009). *Qualitative Research in Business & Management*. London: Sage.
Myneni, S., Cobb, N., and Cohen, T. (2016). "In Pursuit of Theoretical Ground in Behavior Change Support Systems: Analysis of Peer-to-Peer Communication in a Health-Related Online Community." *Journal of Medical Internet Research* 18 (2), 1–21.
Oinas-Kukkonen, H. (2010). "Behavior Change Support Systems: A Research Model and Agenda." In Ploug, T., Hasle, P., and Oinas-Kukkonen, H. (Eds.) (2010). *PERSUASIVE*, 4–14. Heidelberg: Springer.
Oinas-Kukkonen, H. (2013). "A Foundation for the Study of Behavior Change Support Systems." *Personal and Ubiquitous Computing* 17, 1223–1235.
Oinas-Kukkonen, H. and Harjumaa, M. (2009). "Persuasive Systems Design: Key Issues, Process Model, and System Features." *Communications of the Association for Information Systems* 24 (28), 485–500.
Olugbade, T., Berthouze, N., Marquardt, N., and Williams, A. (2018). "Human Observer and Automatic Assessment of Movement Related Self-Efficacy in Chronic Pain: from Exercise to Functional Activity." *IEEE Transactions on Affective Computing.*
Pavlou, P.A. and Fygenson, M. (2006). "Understanding and Predicting Electronic Commerce Adoption: An Extension of the Theory of Planned Behavior." *Management Information Systems Quarterly* 30 (1), 115–143.
Rahman, M.S., Ko, M., Warren, J., and Carpenter, D. (2016). "Healthcare Technology Self-Efficacy (HTSE) and Its Influence on Individual Attitude: An Empirical Study." *Computers in Human Behavior* 58, 12–24.
Rieder, A., Lehrer, C., and Jung, R. (2019). "Understanding the Habitual Use of Wearable Activity Trackers." *14th International Conference on Wirtschaftsinformatik, Siegen*, 1002–1016.
Ronen, H. and Te'eni, D. (2013). "The Impact of HCI Design on Health Behavior: The Case for Visual, Interactive, Personalized-content (VIP) Feedback." *ICIS 2013 Proceedings*.
Saunders, B., Sim, J., Kingstone, T., Baker, S., Waterfield, J., Bartlam, B., Burroughs, H. and Jinks, C. (2018). "Saturation in Qualitative Research: Exploring its Conceptualization and Operationalization." *Quality & Quantity* 52 (4), 1893–1907.
Sjöklint, M., Constantiou, I., and Trier, M. (2015). "The Complexities of Self-Tracking - An Inquiry into User Reactions and Goal Attainment." *ECIS 2015 Proceedings*.
Stajkovic, A.D. and Luthans, F. (1998). "Self-Efficacy and Work-Related Performance: A Meta-Analysis." *Psychological Bulletin* 124 (2), 240–261.
Stajkovic, A.D. and Sommer, S.M. (2000). "Self-Efficacy and Causal Attributions: Direct and Reciprocal Links." *Journal of Applied Social Psychology* 30 (4), 707–737.
Statista (2018). *Wearables*. URL: https://de.statista.com/outlook/319/155/wearables/schweiz (visited on 11/06/2018)

Statista (2019a). *Wearables*. URL: https://www.statista.com/outlook/319/100/wearables/worldwide?currency=eur#market-users (visited on 03/01/2019)
Statista (2019b). *Wearable Device Revenue Worldwide*. URL: https://www.statista.com/statistics/ 610447/wearable-device-revenue-worldwide/ (visited on 03/01/2019)
Statista (2019c). *Market Share of Wearables Unit Shipments Worldwide by Vendor from 2014 to 2017*. URL: https://www.statista.com/statistics/ 610447/wearable-device-revenue-worldwide/ (visited on 03/01/2019)
Trickler, C. (2013). "An Overview of Self-Monitoring-Systems." *SAIS 2013 Proceedings*.
Yi, M.Y. and Hwang, Y. (2003). "Predicting the Use of Web-based Information Systems: Self-efficacy, Enjoyment, Learning Goal Orientation, and the Technology Acceptance Model." *International Journal of Human-Computer Studies* 59, 431–449.