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Why Users Comply with Wearables: The Role of Contextual Self-Efficacy in Behavioral Change

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ABSTRACT

Wearables provide great opportunities for improving personal health, but research challenges their capacity to evoke behavioral change effectively. Realizing the full potential of wearables requires a better understanding of users' behavior change processes. Based on self-efficacy theory, we investigate how wearables influence users' perceptions of their self-efficacy and subsequent health behavior. Using narrative interviews with twenty-five long-term wearable users, we show that wearables can have both positive and negative effects on users' perceptions of their self-efficacy and that these perceptions are subject to internal and external contexts, which can positively or negatively affect users' compliance. We also find that the internal context may have a compounding or neutralizing effect on self-efficacy, despite an adverse external context. Our study shows the contextual and transient nature of self-efficacy, thus contributing to self-efficacy theory and research on wearables and offering practical design implications.

1. Introduction

Wearables are electronic computing devices worn on the body that use sensor technology so users can track their personal activities and parameters like steps, hours of sleep, activities, and food consumption (Mettler & Wulf, 2019). With the emergence of mobile and sensor-based technologies, the prevalence and popularity of wearables that foster a healthful lifestyle – and, generally, systems and applications designed to alter human behavior (Fogg, 2003; Oinas-Kukkonen & Harjumaa, 2009) – have increased rapidly (Khalil & Abdallah, 2013). Wearables, which have become ubiquitous, provide new ways to collect and analyze personal health data and to manage one's personal health through their self-tracking features.

Wearables, which are usually advertised as facilitators of change in health-related behavior, incorporate various behavior change techniques (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 walking into their days or reverse unhealthful eating behaviors. Wearables can also reinforce existing behavioral patterns by providing users with workout histories and statistics, making regular exercise more fun. The health sector places considerable hope in wearables' potential, as 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).

Accenture Research (2018) reported that 75% of consumers surveyed emphasize the importance of technology in managing their health and 48% of healthcare consumers use mobile health applications. Accenture Research (2018) also reported that the use of wearable technologies more than tripled between 2014 and 2018, jumping from 9% to 33%. While more people appear to be using wearables, there is little evidence on which aspects of wearables motivate them to engage and comply with the wearables to change their health-related behaviors (Asimakopoulos et al., 2017). Despite their ascribed potential, wearables' capacity to evoke behavior change has been questioned. In the context of wearables and health apps, contrasting study results (Brickwood et al., 2019; West et al., 2016) and reasonable doubts concerning the long-term effects (Jakicic et al., 2016) have led to skepticism regarding the technologies' capacity for user adoption and positive behavioral outcomes, especially given reports of high levels of attrition after short periods of use (Ledger & McCaffrey, 2014). Ogbanufe and Gerhart's (2018) research on smartwatches found that the haptic feedback, proximity, and convenience of smartwatches increase users' satisfaction with these wearables and promote their continued use. Our investigation adds to this line of research by investigating the behavioral and contextual factors that influence users' compliance with wearables as the first step in long-term behavioral change. Our literature search for the strongest predictor of behavior pointed us to perceptions of self-efficacy as an important antecedent to behavior (Spagnolli et al., 2016). We focus on this factor, as

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there is little evidence on what contributes to self-efficacy with respect to wearables (Asimakopoulos et al., 2017).

Self-efficacy is defined as the person's belief in his or her ability to perform a particular behavior (Bandura, 1977). Self-efficacy is key predictor of the ability to change and maintain a health-related behavior (Strecher et al., 1986). When an individual believes * he or she can perform a certain behavior, such as walking ten thousand steps a day, * his or her self-efficacy determines whether * he or she has the confidence, physical ability, and perseverance with which to change * his or her old behaviors (e.g., being sedentary) (Bandura, 1977). Research on the use of wearables for health care has identified self-efficacy as central to users' engagement with health-related applications and devices (Asimakopoulos et al., 2017; Shih et al., 2015) and has suggested that self-efficacy mediates the relationship between technology use and behavioral outcomes (e.g., Liang & Xue, 2009; Myneni et al., 2016). In particular, studies on the influence of behavior-changing technology on users' perceptions of their self-efficacy in the health context have found that technology can strengthen self-efficacy related to the treatment of depression (Kuonanoja et al., 2015; Langrial & Lappalainen, 2016), food consumption (Ronen & Te'eni, 2013), meditation (Laurie & Blandford, 2016), and physical activity (Lim & Noh, 2017). Moreover, scholars have investigated the role of computer-related self-efficacy (Compeau & Higgins, 1995) in performing a variety of technology-related behaviors, such as technology acceptance (e.g., Pavlou & Fygenson, 2006) and coping with malicious information technology (Liang & Xue, 2009).

Despite these research efforts, in-depth insights into wearables' potential to shape users' perceptions of their self-efficacy and their behavior are lacking. Distinguishing among the various forms of self-efficacy is necessary to arrive at such insights. If individuals believe they are able to (with or without prior training) use a wearable device easily, then they have *computer (wearable) self-efficacy*. If individuals believe they are capable of performing a task that a wearable device prompts them to do, such as walking, exercising at a particular pace, or sleeping, then they have *general self-efficacy* with respect to the task that the wearable prompts them to perform. Rieder and Rhyn (2020) mentioned different self-efficacy types than the two types just mentioned. Other authors have identified and measured *relapse self-efficacy* (cf. Sallis et al., 1988), referring to a person's belief in * his or her ability not to relapse, and *scheduling self-efficacy* (cf. Maddison & Prapavessis, 2016; Sallis et al., 1988; Scholz et al., 2016), referring to a person's belief in * his or her ability to make time to engage in a task. The terms used for self-efficacy also show the situationally changing nature of self-efficacy: While a person may be capable of doing a certain behavior, he may relapse under certain conditions or may not be able to make time in a certain context or under certain conditions. Therefore, we adopt a contextual lens to identify the factors that contribute to self-efficacy in the use of wearables and to determine whether there are types of self-efficacy other than those mentioned above.

To determine how context influences self-efficacy, thus enabling compliance with a wearable, we adopt the broad definition of context given by the philosopher Scharfstein: "that which environs the object of our interest and helps by its relevance to explain it. The environing may be temporal, geographical, cultural, cognitive, emotional – of any sort at all. Synonyms for context, each with its own associations, are words such as environment, milieu, setting, and background" (Scharfstein, 1989, p. 1). We consider context as an enabler of or a barrier to self-efficacy and compliance with the wearable. In line with these arguments, we pose the following research question:

> *How does context influence wearable users' perceptions of self-efficacy and compliance with wearables?*

The following sections present the theoretical background on wearables and self-efficacy theory (generally, and within the IS field). Then we present our method and the results of our analysis. Next, the discussion section provide our contributions to theory, presents the limitations of the study, and proposes further research in the area. Finally, we present how our findings contribute to human-computer interaction (HCI) decisions related to wearable design and use.

2. Theoretical background

2.1. Wearables

Wearables are electronic computing devices worn on the body and that use sensor technology so users can track parameters like steps, sleep, activities, and food consumption (Mettler & Wulf, 2019). Wearables are composed of physical and digital artifacts (Benbunan-Fich, 2019) and are built into objects like wristbands and clothing that are worn on the body. The proximity to the body allows body functions like heart rate, acceleration, and sleep to be measured (Mettler & Wulf, 2019). The data the sensors collect is paired with data analytics and machine learning applications, which create aggregations that are then displayed either directly via wearable interfaces or via accompanying software programs on smartphones or computers (Benbunan-Fich, 2019). Given wearables' pervasiveness and their proximity to the human body, they are an ideal means by which to deliver persuasive content that can help users improve their health, such as by increasing physical activity or eating a healthful diet (De Moya & Pallud, 2020). Wearable devices that are designed only to track other health-related parameters, such as fertility, blood pressure, or blood glucose, do not fall into the category that we investigate in this study.

Wearables usually incorporate a variety of behavior change techniques that are designed to induce changes in behavior. Michie et al. (2013) defined these techniques as "observable, replicable, and irreducible component[s] of an intervention designed to alter or redirect causal processes that regulate behavior" (p. 82). The persuasive elements of a wearable that shape behavior can be simple user-interface design elements like digital nudges (cf. Mirsch et al., 2017) and system features (cf. Forget et al., 2008). Michie et al. (2013) provided a comprehensive collection of behavior-change techniques with their 2013 taxonomy of ninety-three behavior change techniques, prominent examples of which include self-monitoring, rewards and threats, goal-setting, and social comparison. Such behavior change techniques can target various outcomes. Oinas-Kukkonen (2013) distinguished among three types of behavioral and cognitive outcomes of behavior-changing technology: compliance change, behavior change, and attitude change. Compliance change refers to simple acts of compliance with an external (i.e., technological) cue provided by the wearable and is the first step of behavioral change. In contrast, behavior change refers to a more fundamental, intermediate- to long-term change in behavioral patterns or routines. Attitude change, the third type of change, is in the cognitive category and is both an enhancement and a catalyst of behavior change. Oinas-Kukkonen (2013) indicated that behavior change is more likely and more stable if the individual has also changed * his or her attitude. Since compliance change is the first step to behavioral and attitudinal change, and is the most observable change, we focus on explaining what brings about compliance with the wearable.

2.2. Self-efficacy theory

Self-efficacy theory is one of the dominant behavior-change theories (Oinas-Kukkonen, 2013), so it is a key theoretical underpinning of wearables. Self-efficacy is a key predictor of a change in health-related behavior and maintenance of that change (Strecher et al., 1986). Originating from cognitive psychology, self-efficacy relates to an individual's belief in * his or her ability to perform a behavior and determines the confidence, effort, and perseverance with which * he or she pursues a change in behavior (Bandura, 1977). We use the self-efficacy theory to explain how wearables evoke users' behavior compliance. Next, we determine whether (and how) context affects behavioral compliance.

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; 1982) postulated that human behavior is heavily affected by self-efficacy – that is, a person's own beliefs about his or her capacity to perform a behavior – which is necessary to produce desired outcomes.

Individuals' self-efficacy substantially affects whether they initiate a behavior, as well as the effort and persistence with which they pursue it in the face of obstacles and negative experiences (Bandura, 1977; 1982; Stajkovic & Luthans, 1998). Individuals with strong perceptions of self-efficacy see themselves as being equipped with the resources required to perform a behavior, so they can maintain the required level of effort more easily than those whose perceptions of self-efficacy are weak (Bandura, 1997).The stronger (weaker) an individual's perceived self-efficacy, the more (less) likely it is that the desired outcome will result (Bandura, 1982; Stajkovic & Luthans, 1998). Therefore, interventions that promote physical activity must address perceptions of self-efficacy.

When people form their perceptions of self-efficacy, they rely on sources that provide them with information related to their ability to deal with the situation or task at hand: personal accomplishments, vicarious experience, verbal persuasion, and emotional arousal (Bandura, 1977; 1982). Information about personal accomplishments is based on experience and is directly affected by the successes or failures of those experiences. Experience-based self-efficacy can generalize across a variety of situations and circumstances, leading to improved behavioral outcomes and compliance with wearables in diverse contexts and activities. Judgments about one's self-efficacy in performing a behavior can also be based on observing others perform the behavior that results in desirable or undesirable outcomes, which builds on the mechanism 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, although the impact of verbal persuasion on self-efficacy is lower than that of personal accomplishments and vicarious experience. However, 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. Emotional arousal refers to such physical responses as sweating from anxiety and stress. The level of emotional arousal in response to a given cue differs from individual to individual, which helps explain differences in individuals' motivation to undertake or avoid a behavior.

2.3. Self-efficacy and information technology

Self-efficacy theory has been applied in technology-related research for more than three decades, but two streams of the literature on self-efficacy stand out. The first research stream investigates the effect of information technology on individuals' perceptions of self-efficacy, while the second stream focuses on the relationship between perceptions of self-efficacy and the subsequent intentions or behaviors. The extant research presented here can be summarized as suggesting that technology-induced outcome behaviors are mediated by self-efficacy (e.g., Liang & Xue, 2009; Myneni et al., 2016). Therefore, we expect that self-efficacy as it relates to wearable use and to the tasks the wearable suggests affects users' compliance with the wearable's cues.

2.3.1. The effect of information technology on self-efficacy

This comparatively small research stream has treated self-efficacy as a cognitive outcome following technology-mediated interventions. Scholars have examined the effects of interventions like peer-to-peer online communities on students' academic self-efficacy (Alrushiedat & Olfman, 2014). Phua (2013) showed that participation in social networking sites geared to health-related issues significantly influenced people's self-efficacy regarding smoking cessation, mediated by social factors like social support.

While no wearable-specific studies have had this focus, several studies have emphasized other behavior-changing technologies. They have investigated the effectiveness of systems that apply certain kinds of behavior change techniques (e.g., reminders, rehearsal, feedback) on the self-efficacy of people who are suffering from depression (Kuonanoja et al., 2015; Langrial & Lappalainen, 2016) and those who want to change their food consumption (Ronen & Te'eni, 2013). In these contexts, self-efficacy describes individuals' confidence in their ability to self-manage their health conditions. Using a laboratory experiment, Lim and Noh (2017) found that gain-framed performance feedback in a fitness app was more effective in boosting users' exercise self-efficacy than loss-framed performance feedback was. Laurie and Blandford (2016) examined the impact of meditation apps on individuals' self-efficacy regarding their ability to set aside time in their daily schedule to mediate. Their self-efficacy was identified in terms of context (i.e., the ability to manage the task's temporal aspect), not in relation to the task (i.e., meditation) or the computer technology (i.e., the use of meditation app).

2.3.2. Self-efficacy as an antecedent of behavioral outcomes

Self-efficacy as an antecedent of behavioral outcomes has been the subject of many academic investigations. In IS research, self-efficacy has been modeled predominantly as a predictor of technology acceptance. Many studies have applied the self-efficacy construct as an extension to established theories, such as the Technology Acceptance Model and the Theory of Planned Behavior (e.g., Pavlou & Fygenson, 2006; Rahman et al., 2016; Yi & Hwang, 2003). Only a few IS studies have covered other types of behavioral outcomes that are influenced by self-efficacy, such as coping with malicious information technology (Liang & Xue, 2009). These studies conceptualized self-efficacy as computer self-efficacy, which refers to individuals' beliefs about their ability to use computers competently (Compeau & Higgins, 1995) or to use specific types of technology or applications, such as health-related technology (Rahman et al., 2016; Reychav et al., 2019), e-commerce websites (Pavlou & Fygenson, 2006), or class-management systems (Yi & Hwang, 2003). In contrast, Yilmaz (2016) investigated the effect of students' academic self-efficacy on their knowledge-sharing behaviors in an online learning community.

Only two studies have focused on behavior-changing technologies and addressed the role of self-efficacy in changing one's behavior: Oinas-Kukkonen's (2013) conceptual paper proposed the self-efficacy theory as one of the key theoretical foundations for wearables and suggested that perceived self-efficacy mediates the link between the intervention component and the (offline) behavior change induced by the system. Myneni et al. (2016) analyzed the communication content of a community-based wearable that supports smoking cessation and found evidence from various behavior-change theories, including the self-efficacy theory.

In summary, research has provided valuable insights into the effect of behavior-changing technologies and certain behavior-change techniques on self-efficacy and subsequent behavioral change. In accordance with the most of these studies' quantitative nature, they shed light on the statistical relationship between the variables under investigation. However, to clarify wearables' role in shaping individuals' behavior and perceptions of self-efficacy, we must find the underlying mechanisms of this relationship, so we delve into how wearables affect self-efficacy and behavior over time and in varying circumstances.

2.4. The influence of context on perceptions of self-efficacy during technology use

When forming their perceptions of self-efficacy, individuals rely on the three sources of self-efficacy, but the context substantially influences their perceptions as well. Bandura (1977; 1982)) indicated that perceptions of self-efficacy may be undermined by factors related to the context in which a behavior will be performed. Such factors may reside with the task, the situation, or the individual. Research in the IS field has not focused on the context or its influence on the perceptions of self-efficacy that influence behavioral outcomes.

Bamberger (2008) suggested that qualitative research should take context into consideration to build situational and/or temporal conditions into theory. Avgerou's (2019) recent article on contextual explanation argued that context is significant to IS research and suggested that, since research cannot accomplish everything at once, it can do one of two things: (1) Provide the conditions of an IS phenomenon's environment that are factored in IS theory, or (2) identify the mechanisms through which contextual conditions affect the occurrence of a phenomenon. This study seeks to clarify the relationship between context and perceptions of self-efficacy – specifically, to determine which contexts affect high or low self-efficacy and whether and how these perceptions influence the behavioral outcome of complying with the wearable's suggestions for meeting health-related goals.

According to Bandura (1977), task-related factors encompass aspects of the task, including a task's level of difficulty. Studies on barriers to self-efficacy related to physical exercise have incorporated expectations about the affordability and enjoyability of the activity as being potentially restricting if they are not met (Blanchard et al., 2002). Bandura (1977) identified restricting factors that arise from context as including the external and social circumstances under which an action is undertaken (Bandura, 1977). Turning now to health education research, a restrictive context may include external factors (e.g., weather) or a period of stressful life changes (Sallis et al., 1988). As personal factors with a potentially attenuating effect, Bandura (1982) named effort, attribution (see also Stajkovic & Sommer, 2000), and coping capabilities. Studies on exercise-related self-efficacy have also specified personal factors as health issues, the tendency to succumb to temptation, and negative emotions about an activity (Blanchard et al., 2007). Rieder and Rhyn (2020) mentioned two types of self-efficacy based on the context: relapse self-efficacy (cf. Sallis et al., 1988), which refers to a person's belief in * his or her ability not to relapse and scheduling self-efficacy (cf. Maddison & Prapavessis, 2016; Sallis et al., 1988; Scholz et al., 2016), which refers to a person's belief in * his or her ability to make time to engage in a task. The terms used for self-efficacy illustrate the situationally changing nature of self-efficacy; for example, a person may be capable of doing a certain behavior but then may relapse under certain conditions or may not be able to make time under other conditions.

3. Method

3.1. Data collection

We focus our analysis on devices that take the form of wristbands and watches and that track physical activity (IDC, 2018), which are also called wearable activity trackers. Leading providers include Apple, Xiaomi, Fitbit, and Garmin (Statista, 2019b).

In emerging fields, where the relationships among concepts are still not fully understood, qualitative research is a better fit than quantitative research (van Aken et al., 2007). Since wearables constitute a new and emerging field, extant research on how wearable use relates to offline behaviors is limited, so we used a qualitative approach to obtain full and rich personal accounts. We followed established principles (Myers, 1997; Küsters, 2009) in conducting narrative interviews with users of wearables to capture individual users' experiences and to obtain a longitudinal picture of the individuals' use history. We used a narrative interview technique (Küsters, 2009), in which the interviewee gives an account of a past event, and determines the organization and structuring of the event. Since the interviewer does not interrupt the narrative, the interview technique avoids 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.

We considered the narrative interview to be a suitable technique with which to address our research question. Since we sought to obtain information on the process through which the wearables' features influence users' perceived self-efficacy and compliance with the wearable as behavioral outcomes, the sequential, process-like nature of data generated through narrative interviews was preferable to more structured interview techniques, which would likely put less emphasis on the chronology of the individual interviewee's use history. In addition, as the narrative interview 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 compliance and perception of self-efficacy is addressed in the interview without incorporating the bias of the interviewer. Using techniques that require that we bring in our own subjects could jeopardize the individual's coloring and weighting of aspects of the narrative.

We interviewed twenty-five users of wearables who were based in Switzerland, one of the most advanced markets for wearables in Europe, with a market penetration of 7.8% in 2019 (Statista, 2019a). Using purposive sampling (Miles & Huberman, 1994), we sampled interviewees who were intermediate to long-term wearable users (i.e., past the trial phase). All of our interviewees had used their wearables for more than four months, and some had used them for several years. With this criterion, we sought to capture maximum variation in demographics (i.e., gender, age, profession) so we could identify shared patterns across diverse individuals. 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 finished their narratives (without interruption), we took up topics they mentioned 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. The duration of the narratives varied widely, ranging from nineteen to eighty-seven minutes, with an average of fifty minutes, excluding preliminary chat, the introduction (i.e., regarding the process of the interview, assurance of anonymity and confidentiality), and concluding talk (e.g., thanking the interviewees, small talk, and responding to questions about the research). We recorded the 1,242 minutes of interviews and transcribed them verbatim into roughly 190 pages of text to ensure rigorous and transparent analysis of 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 made in English or translated into English from German or Swiss German dialect.

Table 1 presents an overview of the study's participants. Our sample consists of nine women and sixteen men from eighteen to sixty-two years of age, all of whom were students and professionals with the exception of one retired individual. The frequency of the wearable's use varied across interviewees and largely depended on the individual's motivation for using it. Most interviewees used the device every day (20 of the 25 interviewees), some also used it at night (7 of the 25 interviewees), and some wore it only when they engaged in sports (5 interviewees). Most used their wearables to track their daily activity, support their sports performance, and improve their health (15 interviewees), although some reported using them to explore the novel technology out of curiosity (10 interviewees). As our research approach relied predominantly on applying pre-identified themes from self-efficacy theory, gaining rich, in-depth narratives from the 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). Therefore, we stopped coding interviews on this topic after twenty-five interviews.

3.2. Data analysis

Two of the authors coded the data independently, with regular discussions between them to consolidate findings and avoid subjective interpretations, a step we considered to be central to the credibility of our findings (Wallendorf & Belk, 1989). The results from this analysis and the coding decisions were discussed with other coauthors, who contributed to the synthesis and conceptualization of findings.

Our two-phased data analysis followed Miles and Huberman (1994) in having three types of codes: self-efficacy codes, behavioral outcome codes, and context-related codes. Appendix A shows the coding schema.

In the first phase of the analysis, we conducted deductive coding, where we coded self-efficacy perceptions using categories from self-efficacy theory. We coded for task-related self-efficacy and sought to identify accounts of self-efficacy and the information sources these perceptions were built on (i.e., personal accomplishment, vicarious experience, verbal persuasion, emotional arousal) (cf. Bandura, 1977). We found several sections in which the interviewees referred to their self-efficacy to perform a behavior cued by the wearable. We found accounts of both high and low levels of self-efficacy. With regard to the information sources that the wearable nurtured, we identified examples in the data of all but emotional arousal. We marked where behavioral outcomes and contexts were in the interviewees' accounts.

Table 1. Interviewee characteristics, the wearables used, and their features.

					Main features used						
Interviewee	Age	Gender	Occupation	Wearable devices used	Activity-tracking and goals	Sports-tracking and performance history	Heart-rate tracking	Competitions	Nutrition-tracking	Sleep-tracking	Use duration in months (at time of interview)
INT1	25	F	Student	2 × Fitbit	X			X			> 24
INT2	24	F	Student	Jawbone	X		X	X	X		6–12
INT3	62	M	Retired	Polar		X					6–12
INT4	27	F	Legal secretary	2 × Fitbit	X	X		X		X	12–24
INT5	63	M	Medical doctor	2 × Polar, Garmin		X					> 24
INT6	57	F	Project manager	Polar, Misfit	X	X			X		12–24
INT7	41	M	Project manager	Polar		X					> 24
INT8	35	M	Financial analyst	Garmin	X				X	X	6–12
INT9	58	M	Consultant	Garmin, Jawbone, Suunto		X					> 24
INT10	41	M	Entrepreneur	Garmin, Apple	X	X	X				12–24
INT11	41	M	Entrepreneur	Misfit	X			X			6–12
INT12	24	F	Student	Fitbit, Garmin	X	X		X			> 24
INT13	40	M	Computer scientist	Jawbone, Apple	X						12–24
INT14	26	M	Ph.D. student	Xiaomi, Fitbit	X		X	X			6–12
INT15	33	F	Nurse	3 × Garmin		X	X		X	X	> 24
INT16	24	F	Student	2 × Misfit, Garmin, Apple	X	X	X		X		> 24
INT17	25	M	Student	Fitbit	X			X			6–12
INT18	57	M	Managing director	2 × Fitbit	X						12–24
INT19	20	F	Student	Garmin	X	X	X	X			6–12
INT20	18	M	Student	2 × Fitbit	X			X			12–24
INT21	26	M	Bartender	Fitbit		X	X				6–12
INT22	22	M	Student	Garmin	X	X	X				6–12
INT23	40	M	Controller	Fitbit, Apple	X	X					> 24
INT24	39	M	Entrepreneur	Garmin, Fitbit, Misfit, Jawbone, Apple	X						> 24
INT25	57	F	Legal secretary	Fitbit	X	X	X		X		3–6

In the second phase of the analysis, we enriched the existing codes on behavioral outcomes and context with descriptive coding. For behavioral outcomes we used descriptive coding (Myers, 2009) to compare and contrast descriptions of behavioral outcomes and grouped similar sets of behaviors into two categories, compliance and noncompliance. Compliance encompassed behaviors that were in line with the behaviors prompted by the wearable, such as changing food consumption or physical activity, and noncompliance included behaviors that disregarded the prompted behaviors or showed negative reactions, such as defiance or strategies to avoid the cue. Similarly, we applied descriptive coding to contexts to identify the contextual and situational issues that affected the interviewees' self-efficacy and grouped them into internal and external context.

4. Results

4.1. How wearables contribute to individuals' perceptions of self-efficacy

Our empirical data revealed that wearables can influence users' perceptions of self-efficacy regarding performing an activity. In providing information to users, wearables strengthened users' perceptions of their self-efficacy in ways that led to compliance behavior. We found numerous instantiations of wearables providing users with information related to personal accomplishment, verbal persuasion, and vicarious experience – but no examples of emotional arousal – which increased their self-efficacy.

4.1.1. Personal accomplishment

Our participants reported that wearables provided information on the extent to which they accomplished their goals. This information provided a sense of achievement, increasing their task self-efficacy. Feeling better about their ability to contribute to their health, they increased their compliance with their wearables' cues to engage in healthful behavior. Thirteen of the twenty-five interviewees indicated that seeing their personal accomplishments motivated them to continue using their wearables and/or to comply with their wearables' suggestions. Commonly associated with information about their personal accomplishments were such features as activity goals and the status of their pursuit of those goals, their activity and training histories, trend statistics that showed their performance over time, and badges and rewards.

For example, one interviewee who used the step counter mentioned how the reference values acquired over time acted as self-efficacy information based on personal accomplishment.

Interviewee 17 described how the wearable allowed him to see his personal accomplishment:

> In the beginning, it is hard to interpret what the number of steps means – steps are an abstract measure. But my use of the wearable got better because I eventually had reference values from which I knew, "Ah, I can do this much" or "I've already achieved this many steps," and that helped me pin down the number of steps. After using it for a couple of weeks, I knew what I could achieve on average, what I do on days on which I'm really active, and what makes the difference. (INT 17)

Thus, the feature helped this participant to make sense of the daily step goals and make realistic estimations about whether the goal was achievable, fostering his self-efficacy in taking up the behavior. Another interviewee pointed out that displays of her progress on her wearable device helped her stay committed and to comply with its requests:

> It gave me a satisfying feeling–viewing the statistics and the progress I was making. It showed me my progress in the calories I burned during sports, which really motivated me to push myself. It also helped me resist–I don't know–eating a brownie. I didn't want to eat something like that if I had to enter it. (INT 2)

4.1.2. Verbal persuasion

Verbal persuasion refers to how verbal encouragement increases a person's self-efficacy and behavioral compliance. Wearables provided many elements of verbal persuasion for our participants. Most common were activity reminders, such as when the wearables say, "Walk another thousand steps to reach your goal today," or "You're on a five-day streak! Keep it up today." Besides activity reminders, verbal persuasion was also conveyed through real-time training parameters, bedtime reminders, or inactivity alerts.

Fourteen of the twenty-five interviewees indicated that the elements related to verbal persuasion helped them feel more capable, increasing their task self-efficacy, and caused them to continue using the wearable and/or to comply with its suggestions. One interviewee described how reminders empowered him to comply with the wearable:

> Over the course of the day, the Apple Watch sends me a reminder or a message saying, "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 me interactively and situationally over the course of the day, not only in the evening with "Hey, you've achieved it" (or you haven't) but "Right now, you should walk for ten minutes to reach your goal, so why don't you go out real quick?" It tells me this in the afternoon at four o'clock, five o'clock, so I feel like I'm being coached and enabled and it's not simply a statistic that is reported afterward. (INT 24)

Another interviewee spoke about the motivational effect the wearable's persuasive messages had on her. Receiving real-time notifications about the training's impact prompted her to push herself even more:

> To me, the wearable is an extreme motivator that pushes me and gives me a sense of achievement. There is a real-time rating of how effective my training is, and I always want to build up my form. So if I'm actually done with my training, but the effect is at 2.9 and I know it only takes a few minutes to reach a higher training effect, I will do that. (INT 15)

4.1.3. Vicarious experience

Vicarious experience refers to how seeing another person do a task or knowing that another person is able to do a task causes individuals to believe that they can do it too. Vicarious experience is manifested mostly through wearables' social features that connect users to each other and allow them to build a community to follow and track each other's performance. Social features also enabled them either to compete against each other or to work jointly toward the same goals (i.e., challenges). Our interviewees reported that such connections and competition increased their self-efficacy to do as much as or better than the others and to change their behavior to comply with the wearable. Interviewee 4 explained the connection between vicarious experience through competitions and resulting behavior changes:

> It was surprising. We are a group of people who all had a Fitbit, so we can participate in competitions like who does the most steps, the most stairs. This is very encouraging to me, checking the app and seeing the steps the others have been doing. It encourages me to do better, maybe to walk the ten meters home and not take the tram instead. (INT 4)

Five of the twenty-five interviewees indicated that vicarious experience motivated them to continue using the wearable and/or to comply with the wearable.

Clearly, wearables can increase users' perceptions of their self-efficacy and, thus, their behavioral compliance by providing features that visualize their personal accomplishments for them, verbally persuade them, and increase their belief in themselves through vicarious experience.

Next, we discuss how context influences users' perceptions of their self-efficacy and compliance with their wearables' suggestions.

4.2. Effect of internal and external contexts on self-efficacy and behavioral outcomes

We defined context as "that which environs the object of our interest and helps by its relevance to explain it. The environing may be temporal, geographical, cultural, cognitive, emotional – of any sort at all." (Scharfstein, 1989, p. 1).

Two types of context emerged from our study's data: internal and external. Table 2 lists the most frequently observed instances of internal and external context. The internal contexts that emerged from our data referred to the users' internal processes, which are endogenous in the sense that the cognitive, behavioral, and emotional responses that constitute the internal context reside with the users' sphere of action and originate from their personalities, individual characteristics, and experiences. Differences in individuals' internal contexts may be due to motivation and commitment to goals; health issues like injuries, illness, or chronic conditions; and ingrained, routinized patterns of action like habits and addictive or compulsive behavior patterns. The internal contexts that emerged from our data were cognitive (e.g., ambition), behavioral (e.g., positive self-reinforcement), and emotional factors (e.g., negative emotions) that contributed to or detracted from the participants' self-efficacy.

Table 2. Internal and external contexts and their influence on self-efficacy and behavioral outcomes.

Impact on Self-Efficacy and Compliance \ Context Type	Internal Context	External Context
Positive	Awareness Ambition Positive reinforcement Self-punishment Learning effects	Household chores Encouraging competition
Negative	Negative emotions Too much pressure Lack of discipline Temptations Other priorities Other hobbies Negative habits	Work Weather Time of the year Time of the day Discouraging competition

As opposed to internal contexts, external contexts refer to the factors that reside outside the individual and influence their self-efficacy. Examples of external contexts from our participants included schedule-related restrictions (e.g., fixed office hours or an examination period), limiting circumstances (e.g., the weather), and activity patterns (e.g., having a sedentary job versus a physical job). In some cases, but not most, the participant had some control over the external context. A feature of some wearables is creating competition by enabling friends or independent participants to see each other's progress. We categorized such competition as an external context since it is not an internal process.

Our data showed that internal and external contexts can influence individuals' self-efficacy negatively or positively. While interviewees referred to certain internal contexts as contributing positively to their self-efficacy and influencing their compliance with the wearable, they identified other internal contexts as reducing their self-efficacy and compliance with the wearable.

The only external context that the interviewees mentioned as having a positive influence was household chores. Since these chores usually involved physically intense activities, interviewees felt that they facilitated attaining their activity goals. The external context, unlike the internal context, was typically listed as a factor that negatively affected self-efficacy (e.g., bad weather did not allow more steps, their schedule did not allow time to go running). Contexts could be short-term or long-term. Permanent external contexts like chronic medical conditions and permanent internal contexts like strong, ingrained habits imposed special hardship on users in terms of staying committed to the actions the wearable required and led to frequent setbacks.

The impact of only one external context, competition, differed depending on the participants. Some participants identified competition as positively influencing their self-efficacy and behavioral compliance when the competition was fun and the competition's performance was similar to their own (i.e., encouraging competition). Others noted that, when competitors performed noticeably better than the participant did, competition had a negative influence on self-efficacy and behavioral compliance (i.e., discouraging competition). Interviewee 1 highlighted the importance of the opponent's performance being similar to her own, as competing with a friend who had similar activity levels was encouraging and motivating:

> With my friend, we were approximately on the same level, as we both had around ten thousand steps every day. We used to compare every once in a while, and eventually I'd say, "Hmm … now she has more than I do, so I should probably see that I do a thousand more per day, rather than just the ten thousand." (INT 1)

However, when the opponent was too strong, the interviewee's self-efficacy and willingness to follow the competition was impaired:

> We were a group of people and we used to do competitions, like who got the most steps over the weekend, but there was this guy against whom I didn't stand a chance. Like when I got forty thousand in only one day and was absolutely certain I would win, he had sixty thousand. And at some point, I ran out of steam and stopped competing against him. (INT 1)

Limitations from the external context often affected the users in such a way that users had little or no faith in their ability to execute the required or planned behaviors. The effect on the individual of the external context's temporal aspect varied quite a bit – anywhere from being momentary or lasting only a few of hours to lasting for three months. For example, some of the participants reported not being able to comply with the wearable during a meeting, which shows the short-term impact of an external context. Others reported being "less inclined to go running during winter" or having "a work schedule that would not allow them to engage in sports on weekdays." In such cases, the participants assessed their ability to engage in the behaviors needed to comply with the wearable as low, so they did not perform them.

4.3. Achieving positive behavioral outcomes in negative external contexts

As Figure 1 shows, positive internal contexts increased individuals' self-efficacy, resulting in compliance with the wearable' suggestions, and negative internal context reduced their self-efficacy, resulting in noncompliance with the wearable. Beyond this basic finding, we developed a more in-depth understanding of the interaction between external and internal context.

4.3.1. Compounded effect

External context that distracted our participants from staying committed to their behavioral goals influenced their internal contexts and led them to doubt their capacity to perform the behaviors the wearables cued. These negative internal contexts ranged from momentary, such as a brief lack of motivation, to much more lasting, such as when users became depressed (internal context) during recovering from an injury (external context), to permanent and deeply impacting users' behavioral patterns. When the external context provided constraints that reduced our participants' self-efficacy, that negative effect was often compounded by negative internal contexts. When they became frustrated or annoyed or felt too pressured, their self-efficacy declined to such low levels that, beyond noncompliance, they stopped using the feature or stopped using the wearable altogether. One interviewee explained how he used the device to increase his walking but was limited by work commitments:

> Polar and Garmin have this function where you can set your daily step goal and then it will remind you to get up and walk around. I find this totally idiotic. If I have meetings on that day, I cannot just go and walk around. And even if I did–I don't know–ten steps, that's just annoying to be honest. It annoys me if a watch is telling me what to do and what not to do. I know that myself. So after some time, I deactivated it. (INT 5)

Another interviewee mentioned low self-efficacy with regard to achieving the daily step goal during the semester break. Not keeping up with previous accomplishments led to frustration and a guilty conscience and ultimately to taking the wearable off to avoid the resulting adverse emotional state:

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

4.3.2. *Neutralizing effect*

Some of our participants were able to overcome the effect of external constraints by means of high levels of self-efficacy. In these cases, wearables offered users the strategies and motivational triggers they needed to pursue the required behaviors, despite constraints.

An interviewee with a knee injury that required him to rest for several months reported struggling to find his way back to his daily walking routine. Looking back at the various achievements that the wearable made transparent, he felt challenged by the device, so he decided to pick the walking routine back up. His response to the challenge of the device activated him to comply with it:

> 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 hundreds of thousands of steps, and this is it for now," but I thought I had to be able to deal with this stupid little rubber band with four lights. (INT 18)

Another interviewee reported how the wearable's giving him the opportunity to commit to annual goals helped him overcome a negative context:

> I set an annual running goal of 2.5 thousand kilometers this year. This goal really makes me go out for a run, even if the weather is bad. That really does have an effect, because my mood or the weather or temperature do not keep me from training, so I easily run sixty kilometers per week. (INT 9)

These examples show how, even when the external context is negative, the internal context determines the self-efficacy and the resulting behavior. When the internal context is also negative, it compounds the impact of the negative external context, even pushing the user to deactivate the wearable's relevant feature, take it off, or stop using it altogether. When the internal context is positive, it neutralizes the impact of a negative external context and pushes the user to face the external context's challenges and continue complying with the wearable. Figure 1 illustrates the neutralizing and compounding effect of the internal context over the external context.

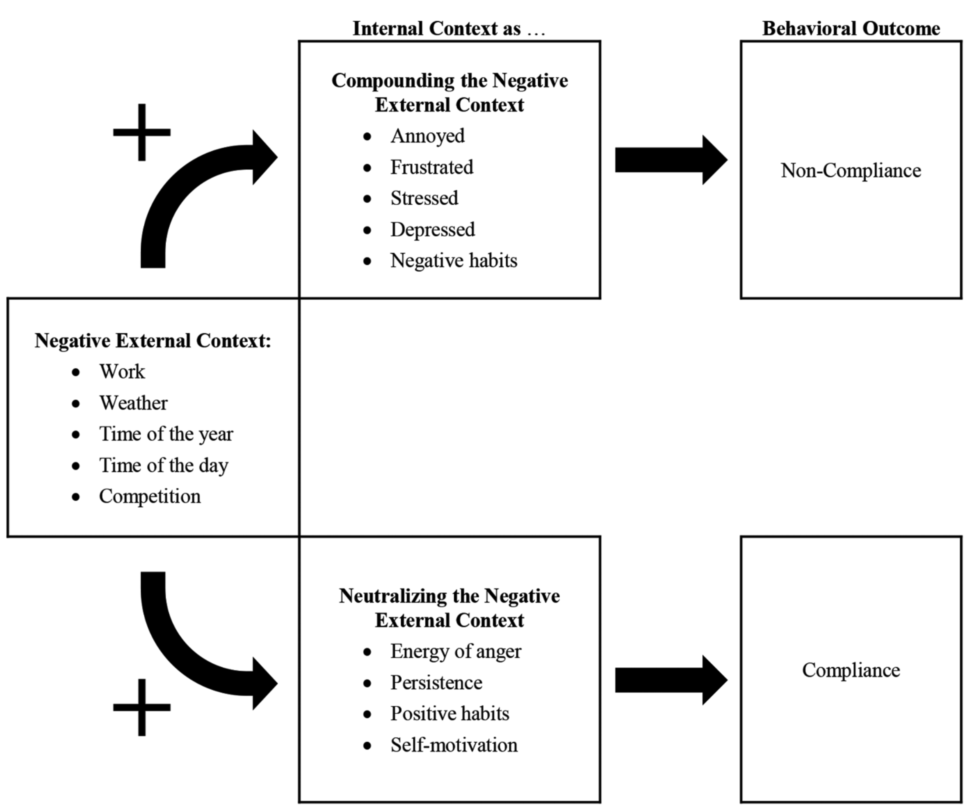

Figure 1. The neutralizing and compounding effect of the internal context over the external context.

4.4. The transient nature of self-efficacy

Compliance behavior is a behavioral outcome from using a wearable, where the users behave in the way intended by the designers of the wearable when the wearable gives cues.

Because of contexts' impact on the participants, those who showed high self-efficacy in positive contexts could show negative self-efficacy when they faced a negative external context and their internal context compounded it. The same interviewee may exhibit different self-efficacy regarding his exercise behavior under different contexts, such as when drinking alcohol or not and the consequent sleep behaviors:

> My goal is to have six hours of sleep every night. I realized that this goal, and especially the quality of sleep, heavily influences my behaviors. If I have six hours, I will be very relaxed the next day and can go to work and do some sports after that. But when I've been drinking, my sleep is so much worse that, the day after, I'll end up going to the bar instead of the gym. (INT 8)

Our data revealed that users' perceptions of their self-efficacy were not stable over time but were subject to contextual changes. In other words, despite having had high (low) self-efficacy regarding a specific behavior in one situation, the same user may show low (high) self-efficacy in another situation with respect to the same behavior. As a consequence, differences in behavioral reactions can be observed.

An interviewee who was working part-time spoke of stark contrasts in her confidence in reaching her daily goal of ten thousand steps depending on whether it was a workday. She mentioned restrictive circumstances at work that precluded reaching her daily step goal, but she had no difficulty complying with the cue on her days off:

> What I found astonishing was that, when I am at work, I won't achieve ten thousand steps, not in a hundred years. That's actually logical: If I am sitting at a desk all the time, don't do anything in addition, and only go to the toilet twice and grab some coffee three times per day, I maybe make forty-five hundred steps. Whereas on Fridays, when I do not work, I don't have any difficulty reaching ten thousand steps, even if I do not go for a run. As a homemaker, I am rushing around the house all the time, upstairs, downstairs – it's easy. (INT 6)

5. Discussion

This study investigates the use of wearables and their influence on the formation of users' perceptions of self-efficacy and the behavioral outcomes of complying with the wearable. Our analysis of qualitative interviews with twenty-five long-term users of wearables revealed findings that contribute to wearable-specific research and self-efficacy research and that have implications for research and practice.

5.1. Main findings and contribution

Our study makes several contributions to research on wearables and on self-efficacy in general. We extend wearable research by shedding light on wearables' influence on the formation of perceptions of self-efficacy and users' behavioral reactions to those perceptions. Our qualitative research approach gave us insights into our participants' interactions and experience with their wearables. By examining the use of commercially available wearables, rather than artifacts that are specifically designed for research purposes, our study allows for investigating the realities of users in a natural setting.

Our first contribution comes from our results that indicate that wearables influence users' perceptions of self-efficacy. As expected, we found that wearables as a source of information strengthened users' perceptions of self-efficacy, which helped them comply with the wearable's suggestions regarding positive health-related behaviors. In self-efficacy theory, Bandura (1977) identified four sources of individual self-efficacy: personal accomplishment, verbal persuasion, vicarious experience, and emotional arousal. We found that three of these applied to wearables and became sources of self-efficacy.

Second, we respond to Avgerou's (2019) call for in-depth research into context by examining how information technologies' impact wearable use for individual heath improvement. Our study revealed that context plays an important role in determining self-efficacy and compliance to the extent that even the self-efficacy of individuals who have task self-efficacy may be reduced significantly by context, such that this reduction causes lack of compliance with the wearable. Therefore, we suggest that the notion of contextual self-efficacy is key to understanding how individuals' task self-efficacy varies across contexts. Contextual self-efficacy is composed of individuals' task self-efficacy, formed based on Bandura's (1977) sources of self-efficacy, as well as the internal and external context. For example, an individual who has a high level of task self-efficacy about running may have a low level of task self-efficacy about running in the rain. Similarly, an individual with a low level of task self-efficacy about running may be have a higher level when he is on vacation.

Third, our findings demonstrate that wearables' effect on users' self-efficacy can be undermined or supported by context. We also underscore individuals' capacity to strengthen their coping skills in the face of constraints to their self-efficacy. In our research we observed two types of contextual variations, external (i.e., arising from the environment) and internal (i.e., residing with the user). The factors that constitute our participants' internal context were described either as positively affecting their self-efficacy and compliance with the wearable or negatively affecting both. Michie et al. (2013) provided various behavior change techniques, among which our study finds that self-monitoring, rewards, goal-setting, and social comparison techniques help with compliance. Compared to the internal factors, all but one of the external factors (household chores) were used in describing barriers to compliance. One external factor, competition, could be either negative or positive, depending on the situation: Encouraging competition could increase self-efficacy and compliance behavior when competitors performed about the same or slightly better than the individual, as this kind of competition created camaraderie, fun, and motivation to do better. On the other hand, when competitors' performance was much better, the individual no longer complied with competition cues, since it was perceived as discouraging. Michie et al. (2013) mentioned social comparison as one of the prominent behavior change techniques. Our findings fine-tune this observation by suggesting that social comparison is helpful only when one compares oneself to those who perform slightly better.

We found that, when the external context provided a constraint, self-efficacy and behavioral compliance declined. However, some participants' self-efficacy and compliance still increased, even in negative external contexts like physical injury. We found that the key to this observation lies in the compounding versus neutralizing role of the internal context: When participants who faced negative external contexts also had negative internal contexts, the internal contexts compounded the external contexts' negative impacts and pushed them beyond lack of compliance to the point of turning off their wearables' feature or taking off their wearables. Under a similarly negative external context, a positive internal context neutralized the negative external context and allowed the participant to continue complying with the wearable.

Finally, we found that perceptions of self-efficacy are not stable over time but vary situationally in either direction depending on a set of internal and external contexts that act as motivators, constraints, compounding constraints, or neutralizers of negative situations. This finding of the transient nature of self-efficacy has significant implications for self-efficacy researchers and contributes to research on self-efficacy by highlighting the contextual aspects of self-efficacy, which is in contrast to the widely used, more generalizable constructs of self-efficacy, such as Bandura's (1977) task self-efficacy or Chen et al.'s (2001) general self-efficacy. We show that the situationally variable construct of contextual self-efficacy may capture and explain momentary shifts and drops in users' self-efficacy and behavioral reactions. We also offer insights into the specificities of constraints to individuals' perceptions of self-efficacy, which the self-efficacy literature has broached only marginally.

Our findings have several implications for research. We suggest that researchers consider measuring contextual self-efficacy when they investigate wearables in general instead of focusing only on computer self-efficacy or task self-efficacy and measuring it under the assumption that the user is operating in ideal conditions. This research would be particularly relevant to changes in health behavior. Studies that use self-efficacy as a dependent variable should also consider measuring self-efficacy at more frequent intervals and in diverse contexts, rather than only at the end of the observation period. This suggestion might be even more useful when applied to interventions that involve serious medical conditions and mental health issues, where a situational drop in self-efficacy and the subsequent noncompliance may have severe consequences.

5.2. Practical implications

To ensure compliance, we recommend that human-computer interaction (HCI) specialists and designers of wearables take into consideration the three sources of information for developing a high level of self-efficacy – personal accomplishment, verbal persuasion, and vicarious experience – in designing additional features or changing existing features. Our findings suggest taking these sources of information into consideration across contexts to eliminate the negative aspects of internal and external context and bolster positive internal and external contexts to increase long-term use of wearables for health purposes. For example, HCI specialists and designers can identify the negative emotions that the wearable causes and provide the option to set up certain times that they can mute the features to avoid this adversity. Gamifying and creating opportunities to make up for muted times to increase self-efficacy may help those who have to mute their wearables to plan how they can make up for lost time, which would increase their use of the device rather than causing them to give up on it. Since internal contexts are within the individual's control, incorporating mindfulness features into the three sources of self-efficacy to help users stay in touch with their emotions and manage them, thus increasing self-efficacy.

When wearables are introduced to groups like the elderly to manage their health, the introduction often includes only technological training and tips. We recommend including tips and training on how to manage the internal context so as to benefit from the wearable. Such training can be provided in simple videos and provided to users of wearables to make them aware of the wearables' neutralizing and compounding effect and how to set one's internal context more toward the neutralizing end. Moreover, designers and HCI specialists should consider incorporating features that provide positive verbal persuasion and reinforcement to improve the internal context in the face of negative external contexts like cold weather so individuals can neutralize them. Options to personalize such settings by inputting the times/days/conditions in which users may need such emotional support could be provided.

Our findings suggest that HCI designers should understand the transient nature of self-efficacy and design moments that add up to high self-efficacy and compliance. Finally, our research warns the providers of wearables and intervention designers to anticipate the possible adverse effects of behavioral cues and to alleviate the detrimental effect of contextual and personal constraints by, for example, incorporating the chance to program pauses and individualized schedules.

5.3. Limitations and further research

As in all qualitative research, its sample and sampling method must be clear to ensure generalization to the right populations. Our study focused on health-focused wearables and used data from individuals who live in Switzerland. We used a narrative interview technique, which is especially valuable in exploring longitudinal, process-like situations. However, the method carries the potential for memory bias. The study's findings could be generalized to similar cultures, but it should be replicated in dissimilar cultures and settings and quantitatively tested to ascertain whether our findings are sensitive to different cultures or can be generalized to all countries.

This study investigated the causes of compliance versus noncompliance, which is the first step in behavioral change. However, studies on long-term behavioral change should go beyond this step and identify what causes individuals to go beyond compliance and to attitude change and behavior change in the form of healthful behaviors that are internalized without being prompted by a wearable. Moreover, the impact that increasing personalization and adaptation of the technology to users' idiosyncrasies may have on perceptions of self-efficacy has to be studied. Finally, future research should look at factors like internal and external contexts to investigate the mechanisms that underlie behavioral change.

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Appendix

Appendix A. Coding Schema

CODE CATEGORY	CODE NAME	DESCRIPTION	REFERENCE	EXAMPLE
Self -Efficacy Perception	High Self-Efficacy	Perception of an individual that they are able to do the task that is their goal with using the wearable.	Bandura 1977, 1982	*"I registered for the Iron Man next summer. It is pretty extreme, after 90 km of cycling, you have to quickly do a half marathon. So I said to myself if I really set goals this high, I need a watch that can support me in this, like giving me all the parameters, analytics, over the past weeks and months so that you can really follow your progress and see what you have to do about it."* (INT 15)
	Low Self-Efficacy	Perception of an individual that they are not able to do the task that is their goal with using the wearable.		*"During the exam period, I only did around 1k steps, which is really bad, and if you are not keeping up for several weeks, it will take forever to catch up. I would have to add around 3k per day for the next few weeks to be able to catch up."* (INT 1)
Information Sources for Self-Efficacy	Personal Accomplish-ment	Personal accomplishment refers to previous experience that shapes individuals' beliefs in their abilities to perform a task.	Bandura 1977, 1982	*"It gives you a weekly review of your activities and steps you've made. There were weeks in which I had 15 to 18k steps on average, so this made me think it couldn't be that hard to reach the 10k. And also, if I hadn't reached the 10k, this motivated me to keep going."*(INT 19)
	Vicarious Experience	Vicarious experience refers to how seeing another person do a task or knowing that another person is able to do a task enables individuals to believe that they can do it too.		*"The effect is really–since in my case, a lot of my workmates were using wearables–that you start comparing to one another. And mostly there was this one person who was super motivated and this had the capacity to drag the others along."*(INT 11)
	Verbal Persuasion	Verbal persuasion refers to how encouraging someone or oneself verbally increases self-efficacy of the person.		*"The bracelet came with five red bars (on the screen) which showed that I had been inactive. When I didn't move for about twenty minutes, like when I was studying at my desk and didn't realize it, it started beeping and blinking, saying that I should move around. "* (INT 19)
Information Sources for Self-Efficacy	Emotional Arousal	An emotional response to cues that are physiological in nature is the basis to form self-efficacy.	Bandura 1977, 1982	E.g.: sweating from anxiety is interpreted as a sign of own incompetence
Behavioral Outcome	Compliance	Indicates a behavior response to the wearable of responding positively to the cue(s) provided by the wearable.	Oinas-Kukkonen, 2013 (cf. Compli-ance Change)	*"It gave me a good overview of the macro- and micronutrients that I consumed over the day, which was very useful. They had these little pie charts indicating, for example, that I had consumed too much sodium or proteins, so I would control that and have less on that day. That helped me to steer my nutrition and fill the nutrients in a more targeted way."* (INT 2)
	Non-compliance	Indicates a behavior response to the wearable of responding negatively to the cue(s) provided by the wearable.		*"Mostly, it's just me and my housemate taunting each other, like, 'You get zero steps in a day?', back and forth. One other guy from the research group also uses it so we can see what each other's been doing on this. There is maybe a tiny competitive element to it, but realistically it is more like we'll talk about it if we see each other but that's all."* (INT 14)
Context	Internal Context	Any setting that constitutes individual's cognitive, emotional, or attitudinal internal environment, which is under the control of the individual.	Adapted from Scharfstein, 1989	*"I try not to let it terrorize me. But I realize that I become very defiant if the watch wants me to do something, but I know that I cannot or don't want to do that today. I become defiant and start thinking 'Oh, you always have such high demands, just leave me alone!'"*(INT 16)
	External Context	Any context that constitutes external environment of the individual, which is not under the control of the individual. This includes temporal, geographical, cultural factors.		*"I used to go for walks before I had the tracker, but now I am more aware of it and it motivates me to do it even if, for example, the weather is bad. "* (INT 25)