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RESEARCH PAPER

Behavior change through wearables: the interplay between self-leadership and IT-based leadership

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Abstract

Physical inactivity is a global public health problem that poses health risks to individuals and imposes financial burdens on already strained healthcare systems. Wearables that promote regular physical activity and a healthy diet bear great potential to meet these challenges and are increasingly integrated into the healthcare system. However, extant research shows ambivalent results regarding the effectiveness of wearables in improving users' health behavior. Specifically important is understanding users' systematic behavior change through wearables. Constructive digitalization of the healthcare system requires a deeper understanding of why some users change their behavior and others do not. Based on self-leadership theory and our analysis of narrative interviews with 50 long-term wearable users, we identify four wearable use patterns that bring about different behavioral outcomes: following, ignoring, combining, and self-leading. Our study contributes to self-leadership theory and research on individual health information systems and has practical implications for wearable and healthcare providers.

Keywords Health information systems · Health · Self-leadership · Technology-based leadership · Wearable · Behavior change

JEL classification I120

Introduction

Physical inactivity is a global public health problem. Insufficient physical activity is a major risk factor for non-communicable diseases such as cardiovascular disease, cancer and diabetes. Inactivity is one of the leading causes of premature death worldwide (World Health Organization 2018). Globally, in 2016, 23% of men and 32% of women aged 18+ years were physically inactive (World Health Organization 2016). These figures have steadily increased over the last two decades (World Health Organization 2018) and are significantly higher in high income countries compared to low income countries. Non-communicable diseases impose a significant and growing financial burden on already strained healthcare systems. In the European Union, public expenditure on health is one of the largest and fastest growing items of government expenditure (European Commission 2020). Non-communicable diseases take up a significant share of the total health budget (at least 25%) and cause significant economic losses (Vandenberghe and Albrecht 2019).

Against this background, wearables that promote regular physical activity such as walking and a healthy diet bear great potential to meet these challenges. Wearables are ascribed the

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potential to empower individuals to better manage their health (De Moya and Pallud 2020). Several large technology companies and start-ups including Apple, Xiaomi, Fitbit, and Garmin (Statista 2019a) have entered the healthcare market with the introduction of wearable devices that allow users to track their personal activities (e.g., daily steps, and sports activity) and various vital parameters (e.g., sleep patterns, and heart rate). The notion is that by recording activity levels and prompting users to improve their behavior, these devices support individuals' efforts to improve their physical activity, sleep, and nutrition. Given the intriguing opportunities offered by wearables to improve health behavior, there have been initial attempts to integrate these devices into the healthcare system. For instance, healthcare providers such as medical doctors and physical therapists integrate wearables into their therapy plans (Hiremath et al. 2014) and health insurance plans offer premium discounts to those customers who use wearables (Wiegard and Breitner 2019). In the private sector, employers see promise in using these devices to encourage their workforce to engage in healthy behavior (Mettler and Wulf 2019). These examples provide anecdotal evidence of the enormous innovation potential of wearables in the healthcare and private sector, promising positive effects on personal health, the healthcare sector, and on society as a whole (Gimpel et al. 2013).

However, for wearables to be part of the solution to the individual and societal burden of physical inactivity, the devices must effectively bring about sustained behavior change. Yet, there is thus far little evidence that wearables actually do so in a reliable manner. In fact, extant research has had ambivalent results regarding the effectiveness of wearables in improving health outcomes among users, and questionable long-term effects, corroborating the position that wearables are lagging behind their potential (Brickwood et al. 2019; Stephenson et al. 2017). These findings suggest that behavior change is not influenced by the technology alone; rather, whether it is beneficial depends on the individual's ability to apply appropriate strategies to foster behavior change (Patel et al. 2015). Given the increasing popularity of wearables and the pressing need for effective solutions in the healthcare system, we require a better understanding of the underlying wearable use patterns explaining why some users end up changing their behavior and others do not. Such an understanding will complement and contribute to previous scholarly work on individual health information systems (IS) and will provide valuable insights for device manufacturers as well as healthcare organizations that seek to innovate their business models or care delivery through the introduction of wearables. Therefore, our research question is: *Which wearable use patterns bring about behavioral change?*

To investigate our research question, we conducted narrative interviews with 50 long-term users of wearables. Our theoretical perspective is based on self-leadership theory, which provided a valuable lens through which to view the self-influence processes employed by individuals in achieving performance outcomes (Manz 1986). Drawing on established behavior change theories, self-leadership theory provides an integrated and comprehensive view of individuals' control of their behavior (Neck and Houghton 2006).

The paper is structured as follows: After outlining the theoretical foundations of our research in the next section, we describe our research approach. We then present our results, and discuss implications for theory and practice.

Theoretical background

Wearables as facilitators of health behavior change

Wearables are designed to support users in improving their general health. The specificity of wearables lies in their characteristic of being composed of physical and digital artifacts (Benbunan-Fich 2019). In the physical sphere, sensors are interwoven into objects (e.g., wristbands, clothing) that are worn on the body—as opposed to being carried around—thereby allowing for the measurement of body functions (e.g., heart rate, acceleration, sleep) (Mettler and Wulf 2019). In the digital sphere, the sensor data are paired with data analytics and machine learning applications, which aggregate data and display the obtained information to the user, either directly via wearable interfaces or by using accompanying software programs on smartphones or computers (Benbunan-Fich 2019). Given wearables' pervasiveness and their proximity to the human body, they represent ideal means to deliver persuasive content aiming to improve users' health outcomes, such as by motivating the user to increase physical activity or fostering a healthy diet (De Moya and Pallud 2020).

Based on the collection and analysis of health-related parameters, wearables provide users with feedback on their past and current performance, which allows individuals to identify and adjust potentially unhealthy behaviors (Mercer et al. 2016). Going beyond self-monitoring, wearables come equipped with built-in behavior change strategies that aim to actively trigger and motivate desired behaviors. Strategies that are most common in commercially available wearables include goal setting, prompts and cues, rewards, and social support (Lyons et al. 2014; Mercer et al. 2016). Thus, wearables are in line with Oinas-Kukkonen's concept of behavior change support systems, 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" (Oinas-Kukkonen 2013, p.1225). The behavioral outcomes of such systems can take different forms. With wearables, users might, for example, use step counting to help form new behavioral patterns such as introducing daily walks. To reverse existing unwanted behaviors, such as unhealthy eating habits, users might use nutrition tracking. Moreover, wearables can also reinforce existing behaviors, for example, by providing workout histories and statistics, and making regular exercise more appealing.

With the growing proliferation of wearables, recent years have witnessed increasing IS research on wearable design (e.g., Chatterjee et al. 2018; Ulmer et al. 2020) and adoption (e.g., Fox and Connolly 2018), and use of persuasive health technologies (e.g., James et al. 2019a, 2019b). However, little attention was paid to the cognitive and behavioral outcomes of wearable use. In terms of cognitive outcomes, James et al. (2019b) investigated how the use of fitness technology feature sets moderates the relationships between users' motivation to exercise and subjective vitality (i.e., positive feeling of aliveness and energy). De Moya and Pallud (2020) found that due to the self-imposed constant surveillance, wearables caused both empowerment and disempowerment among users at once. While the studies mentioned here examine use behaviors and some of them touch upon users' cognitive outcomes, how wearables bring about behavioral change has not been a focus of their investigation. A notable exception is Rieder et al. (2021), who focus specifically on compliance change, and investigate the contextual factors that influence users' self-efficacy and compliance with wearables.

In contrast, medical and nutritional research has paid more attention to behavioral outcomes (Brickwood et al. 2019; Stephenson et al. 2017). Brickwood et al. (2019) provided a recent meta-analysis that, in line with our research interest, focused on the effectiveness of commercially available wearable activity trackers (thus excluding laboratory-based or research-specific devices) in promoting physical activity. Based on the analysis of 26 studies, the authors concluded that there was an overall positive effect of wearables on physical activity (e.g., daily steps), especially when combined with additional support, such as telephone counselling or group-based education. However, the meta-analysis indicated both positive and negative effects of wearables on physical activity, thereby creating a necessity for investigations that unearth which wearable use patterns effectively promote behavior change, and which impede behavior change. Moreover, many of the existing studies constituted short-term trials based on small sample sizes. Thus, Brickwood et al. (2019) called for further research on the long-term usage and effectiveness of consumer wearables. Another shortcoming of extant research is that most of these studies do not build on behavior-change theories that would allow the authors to explain why the observed effects occur.

Self-leadership theory and self-leadership strategies

Self-leadership (Manz 1986) is a process through which individuals control their own behavior, leading themselves to achieve goals by using certain behavioral and cognitive strategies. Self-leadership theory builds upon established behavior change theories and provides an integrated and comprehensive view of individuals' control of their behavior (Neck and Houghton 2006). The underlying theories include goal-setting theory (Locke and Latham 1990; Latham and Locke 1991), cognitive evaluation theory (Deci and Ryan 1985), and self-efficacy theory (Bandura 1986, 1991). A thorough discussion of the underlying theories is provided by Neck and Houghton (2006).

Self-leadership theory expands on established behavior change theories by specifying concrete behavioral and cognitive strategies that individuals may use to enhance their self-regulatory effectiveness (Manz and Neck 1991). This makes self-leadership theory particularly valuable for investigating our research question, as the theory specifies a broad set of empirically identifiable strategies that individuals can use to reach certain outcomes such as changing a behavior. According to this theory, self-leadership strategies can be grouped into behavior-focused strategies, natural reward strategies, and thought pattern strategies. Table 1 provides an overview of self-leadership strategies that users may apply to achieve desired behaviors.

Table 1 Self-leadership strategies (adapted from Neck and Houghton 2006)

Category	Description	Self-leadership strategies
Behavioral strategies focused on preparation	Facilitate behavior management by preparing to initiate behavior	Self-goal setting Self-cueing
Behavioral strategies focused on evaluation	Facilitate behavior management by assessing own behavior	Self-observation Self-reward Self-punishment
Natural reward strategies	Shape perceptions and build enjoyable aspects into activities	Making activity more appealing
Thought pattern strategies	Construction and maintenance of positive thinking patterns	Replacing dysfunctional beliefs and assumptions Mental imagery Positive self-talk

Behavioral strategies focused on preparation *Self-goal setting* is a way to prepare oneself to behave in a certain way, such as reducing calorie intake or exercising more. Individuals who set specific goals that are challenging but reasonable given one's abilities are more likely to achieve their goals because they increase the effort necessary for goal attainment (Locke and Latham 1990; Neck et al. 2020). In contrast, individuals who do not set quantifiable goals such as "losing ten pounds in two months," and instead set vague goals such as "losing weight" are less likely to achieve their goals. Goal-setting is particularly effective if individuals set short-term and long-term goals, and inform others about their goals (Neck et al. 2020). When applying *self-cueing*, individuals create cues in their immediate environment that remind them to initiate a certain behavior. For example, leaving running shoes by one's bedside and going for a run as soon as one sees the running shoes upon waking up would be an example of self-cueing behavior. Self-cueing is also very effective for forming long-term habits (Duhigg 2014).

Behavioral strategies focused on evaluation *Self-observation* involves the monitoring and evaluation of one's current behavior and performance levels. It allows individuals to determine when, why, and under what conditions they engage in certain behaviors (Neck et al. 2020). Self-observation is particularly powerful when the observations are physically recorded (e.g., on paper or with a smartphone application) (Neck et al. 2020). Self-observation can heighten one's self-awareness and lead to the identification of certain behaviors that should be changed, improved, or eliminated in order to achieve desired goals (Neck and Houghton 2006). The other two strategies build on self-observation and involve self-applied consequences for behavior. *Self-reward* is a method of leading oneself toward achievement of goals by rewarding oneself for the desirable behavior (Brown et al. 2018). Self-reward may take the form of mental self-reward, such as self-congratulation, or may be in physical form, such as buying something one wants or taking time off. These rewards increase the value of goal attainment and thus lead to more effort and perseverance in achieving the goals (Neck and Houghton 2006). *Self-punishment* involves punishing oneself for unwanted behavior. Neck et al. (2020) find that self-punishment is often overused and is not as effective as self-reward, since habitual guilt and self-criticism can impair motivation and creativity.

Natural reward strategies Natural reward strategies are about *making an activity more appealing* by emphasizing its inherently enjoyable aspects, rather than focusing on extrinsic rewards (Manz and Neck 2004). This can be achieved by building pleasant and enjoyable features into a given activity to make it more rewarding. For example, listening to one's favorite music while exercising can make a workout more enjoyable. Moreover, individuals can divert their attention away from the unpleasant aspects of the activity and refocus on its inherently rewarding aspects. For example, focusing on the beauty of nature while running, rather than on the physical discomfort of running, can motivate individuals to run more often.

Thought pattern strategies These strategies facilitate the formation of constructive cognitive patterns, which have a positive effect on the desired behavioral outcome (Neck and Manz 1992). Self-efficacy research has shown that high levels of task-specific self-efficacy—an individual's belief in their ability to perform a certain behavior (e.g., exercising, losing weight)—determines the confidence, effort, and perseverance with which individuals pursue a change in behavior (Bandura 1986, 1991). There are three thought pattern strategies: The first thought pattern strategy involves identifying and *replacing dysfunctional beliefs and assumptions* with constructive ones. For example, individuals who would like to lose weight may realize that they have a belief that they can never lose weight. Replacing that with the belief "Many overweight individuals have lost weight. Why shouldn't I?" would affect their behavior and help them find ways (such as working out and exercising) to attempt losing weight. The second thought pattern strategy, *mental imagery,* is about visualizing the successful performance of a behavior before actually conducting it. Alternatively, it can be envisioning a desired version of oneself. For example, imagining oneself to be thinner and enjoying healthy foods and a healthy lifestyle would constitute mental imagery. This strategy can increase the individual's self-efficacy and thus promote an increase in performance (Driskell et al. 1994). *Positive self-talk* refers to positive internal dialogues which can boost self-efficacy. This, in turn, can motivate the necessary effort toward goal attainment and make individuals more resilient in the face of challenges and difficulties. For example, when one gets very tired during exercise, telling oneself "You can do it!" helps one stay motivated to continue their efforts.

Over the last four decades, the concept of self-leadership has enjoyed great popularity, as evidenced by a large number of publications, especially in the fields of management and organizational behavior (Furtner et al. 2018; Marques-Quinteiro et al. 2019; Müller and Niessen 2018; Stewart et al. 2019). In the IS field, however, self-leadership theory has received little attention, even though the connection between self-leadership theory and information technology (IT) was mentioned briefly by Manz (1992). Our search in the EBSCO database and the AIS Library identified only five articles that used self-leadership theory for IS-related research. Eseryel et al. (2014, 2017) first used the term IT self-leadership and found a connection between IT self-leadership and process and product innovation. Yong-Kwan Lim (2018) found that IT-enabled disclosure awareness is key to inducing several leadership behaviors: directive leadership, supportive leadership and interpersonal helping. Xu and Shen (2015) proposed a study connecting self-leadership to project performance.

We argue that self-leadership theory is valuable for investigating socio-technical phenomena, in which the interplay between individuals' self-leadership strategies and IT-based leadership strategies leads to behavioral outcomes. As the design of wearables is informed by behavior change theories such as self-regulation and self-efficacy theories (Mercer et al. 2016), we expect that these devices will offer individuals various features which provide strategies for behavior adoption and change, some or all of which may have been identified by self-leadership theory. Moreover, in cases where wearables do not provide certain features for behavior change, individuals may make up for that by applying personal self-leadership strategies. We argue that the strategies proposed by self-leadership theory can be applied regardless of whether these strategies are applied by individuals or technology. In that sense, self-leadership theory provides us with the flexibility to track the strategies provided both by the wearables and by the individuals themselves. Therefore, self-leadership theory allows us to explicitly incorporate the involvement of both the IT artifact and the user into our analysis and theory building.

Method

Data collection

Answering our research question "Which wearable use patterns bring about behavioral change?" required us to gain an in-depth understanding of individuals' wearable use patterns, in terms of the leadership strategies applied by the users and the wearable, and to analyze the relationship between these use patterns and behavioral change. Rather than testing specific predefined hypotheses, as is common in quantitative research, a qualitative research approach was chosen, as it permitted theory-building through discovering patterns and connections in empirical data (in our case, interview data) (Tesch 1990). Qualitative research especially lends itself to developing knowledge in poorly understood, or complex, areas (Fossey et al. 2002). As both apply to our area of investigation, a qualitative research approach allowed us to gain an in-depth understanding of how individuals interact with wearables in their daily lives. Interviewing individuals gave us the opportunity to obtain full and rich personal accounts of their everyday life experiences and behaviors, and was therefore more suitable for capturing the complex nature of the phenomenon in depth compared to a quantitative approach.

Since we aimed to investigate how the leadership strategies and behavior change unfolded over time, we selected a behavioral approach, rather than a traits or skills approach (Northouse 2019). A behavioral approach focuses on individuals' behaviors, that is, what they actually do and how they act, rather than on their inherent personality traits or abilities (Northouse 2019). For the same reason, we chose the narrative interview technique, which permitted us to obtain a sequential account of the use histories of long-term wearable users. Narrative interviews facilitate the collection of reports on the sequence of past events by leaving the organization and structure of the interview largely up to the respondent (Küsters 2009). In contrast to more structured approaches, this technique helped maintain the individual focus. It further enabled the identification of various themes that appeared in individuals' narratives. Moreover, since the interviewer's influence was reduced to a minimum, narrative interviews were effective in eliminating common biases, such as distortions due to wording and placement of questions, interaction effects, social desirability, and topics and terminology brought up by the interviewer (Küsters 2009).

We interviewed 50 long-term wearable users based in Switzerland, which is one of the most advanced markets for wearables in Europe, with a market penetration of 7.8% in 2019 (Statista 2019b). Using purposive sampling (Miles and Huberman 1994), we only included long-term users of wearables who had used their devices for at least 6 months. Within this criterion, we aimed to reach maximum variation of demographics (i.e., age, gender, occupation), use purposes (e.g., medical conditions, optimizing sports performance, gathering data), and types of devices (i.e., lifestyle vs. sports-oriented). As the participants used wearables from different providers such as Apple, Fitbit, Garmin, and Polar, the devices differed slightly in terms of the range of features offered. However, a basic set of features for goal setting, monitoring and evaluating physical activity, and sending reminders was present in all

Table 2 Sample characteristics

Full sample	#		(%)	**Devices used**[1]	#	(%)
N	50		*(100)*	Apple	14	*(28)*
Gender	#		*(%)*	Fitbit	22	*(44)*
Females	19		*(38)*	Garmin	15	*(30)*
Males	31		*(62)*	Polar	12	*(24)*
Occupation	#		*(%)*	Other[2]	5	*(10)*
Students	9		*(18)*	**Use duration**	#	*(%)*
Professionals	40		*(80)*	6–12 months	11	*(22)*
Retired	1		*(2)*	12–24 months	12	*(24)*
Age				> 24 months	27	*(54)*
Mean	Median	Min	Max			
37.4	35.5	19	64			

[1] Interviewees had used multiple devices by different brands

[2] Other brands included devices by Huawei (2), Misfit (1), Suunto (1), and Xiaomi (1)

devices. All participants used the wearable to record parameters related to their physical activity such as walking or different sports activities (e.g., running, biking), while some also tracked their sleep. Only a few participants used it to improve relaxation (e.g., breathing exercises) or hydration (i.e., reminders to drink regularly). Table 2 presents the characteristics of our sample of 50 interviewees.

Following Küsters' (2009) guidelines, we used a preformulated stimulus to prompt the interviewees' storytelling: "Please tell me the story of your wearable, from the moment you got it until today." Questions were only asked once the interviewees had finished their narratives. In the first (i.e., immanent) stage of inquiry, we only took up topics that had already been mentioned by the interviewees in the initial narrative to impel additional accounts. Only after all narratives were exhausted did we bring up topics and concepts not previously mentioned by the interviewee.

The interviews were held in person or via Skype video call and were recorded. Our data were collected by different interviewers, ensuring that differences in our data actually arise from the interviewees and their individual contexts rather than from potential biases, motivations, and perspectives of the interviewer. The interviewees were assured anonymity and confidentiality of any given information. The average duration of the interviews ranged from 19 to 87 min, excluding preliminary talk and instructions. The interviews were held in the interviewees' native languages, i.e., German, Swiss German dialect, or English. Subsequently, the interviews were transcribed verbatim so we could rigorously and transparently analyze the data. Native German and fluent English speakers processed the interviews and made sure we would always use the original transcripts and quotations for data analysis. The quotations that will be presented later in this paper were either given in English or translated into English from German or Swiss German dialect to enhance the paper's intelligibility.

Including rich, in-depth narratives from 50 interviewees was considered sufficient because we observed use cases and use histories being repeated after some time, indicating thematic saturation (Faulkner and Trotter 2017). Moreover, since our coding involved deductively applying concepts from self-leadership theory to our data, we were able to observe theoretical saturation, as elements kept repeating and we were unable to detect new elements (Saunders et al. 2018).

Data analysis

Our data analysis process was supported by the ATLAS.ti software and comprised three steps, following qualitative data coding procedures (Miles and Huberman 1994). We began our analysis with a theory-informed approach, which was followed by an inductive data-driven approach. A third step involved pattern coding to identify regularities in our data and derive plausible explanations. The coding was conducted by two of the authors independently of each other. They held regular discussions to avoid subjective interpretations and to reach full agreement whenever findings or interpretations were in dispute. The coding decisions and results from this analysis were discussed with the other authors, who contributed to the synthesis and conceptualization of findings.

Before we began coding our data, we developed a codebook based on the self-leadership theory, including leadership strategies applied by the user and the wearable as well as behavioral change as outcome variable (see Appendix). We operationalized behavioral change using the conceptualization proposed by Oinas-Kukkonen (2013), who distinguishes between compliance and behavior change. As an additional outcome option, we added "no behavioral change," for the cases in which users would not react to wearable requests or change their routines. Based on our codebook, we used descriptive coding (Miles and Huberman 1994) to deductively apply the codes to our data.

Second, we inductively extended our codebook with concepts emerging from the data (Miles and Huberman 1994), which may enrich our understanding of the relationship between the leadership strategies and behavior change. For this purpose, we applied open coding and frequently compared the participants' responses in an effort to group quotes that pertained to common codes. The emerging codes were further grouped and integrated in order to derive more abstract concepts. Especially in this step of the data analysis process, we took several measures to corroborate our findings and ensure the trustworthiness of our results (Wallendorf and Belk 1989). We triangulated across interviewees and researchers, who analyzed the data independently. The coding decisions and results from this analysis were regularly discussed with co-authors not involved in the actual coding to ensure plausibility and confirmability. Moreover, we went back and forth between our empirical data and the literature to iteratively refine the identified concepts and derive clear definitions. Using the ATLAS.ti software enabled us to store all our data in a central location, analyze it, and maintain traceability of the coding. The concepts that emerged from our data included use purpose, positive reinforcement, attitude change, motivation to change (i.e., high, low), and external constraints. Moreover, we found the need to add a leadership strategy that was not part of the original self-leadership theory, but mentioned by 19 participants, i.e., social comparison. The Appendix shows an excerpt of the coding schema developed in our study and examples from our empirical data.

Third, we searched for patterns across interviewees aiming to reach an explanatory level in our data analysis. We looked for common threads in participants' accounts and found that they could be grouped according to the applied leadership strategies and the consequent behavioral outcome. This analysis showed that individuals were either primarily self-led, primarily led by the wearable, or a combination of both. In a fourth pattern, users ignored the strategies offered by the wearable, and did not apply self-leadership strategies to steer their behavior. The concepts that we had identified inductively helped us to better understand and further delineate the four patterns. This third step of our data analysis was very iterative, encompassing frequent discussions among the researchers. Moreover, to avoid premature analytic closure, we remained open to our empirical data throughout the analysis and paid particular attention to narratives that challenged previously revealed patterns.

Results

In this section, we present our findings on the self-leadership strategies applied by users and the wearable as well as the associated behavioral outcomes. First, we briefly present the specific leadership strategies identified in our data, and then turn to the abstracted use patterns and explain how they relate to behavioral outcomes.

Leadership strategies applied by users and wearables

Our interviews revealed that seven of the nine self-leadership strategies mentioned in the literature were present in the empirical data, namely goal setting, cueing, observation, reward, punishment, making activity more appealing, and positive talk. In addition, we identified the behavioral strategy of social comparison, which emerged from our empirical data. We found no evidence of two of the strategies mentioned in the literature, namely replacing dysfunctional beliefs and assumptions as well as mental imagery. As expected, our data revealed that leadership strategies were applied by the users themselves, but also by the wearables. The wearables used by our interviewees applied goal setting, cueing, observation, rewards, and positive talk and a sixth strategy that emerged from our data, namely social comparison. Table 3 provides an overview of the leadership strategies applied by users as well as the wearables.

The leadership strategies applied by the wearable can be related to specific technology features. Goal setting is supported by wearable features that automatically set exercise goals, but also allow users to manually adjust them. A typical example is the goal setting feature of the step counter, which sets a predefined goal of ten thousand steps per day. Cueing is assisted by features that prompt the user to perform a certain activity. For example, wearables send users reminders to take more steps, stand, breathe, or drink water. Observation is facilitated by features that enable users to monitor and evaluate their behavior. For example, graphics (e.g., progress bars) provide users with information about their goal attainment, while exercise histories allow users to observe patterns and trends in their behavior over time. Social comparison is similar to observation in that in both cases the wearable user makes a judgement about their own performance. However, unlike in observation, in social comparison there is an external observer effect, which may change the user's behavior in unexpected ways. Moreover, social comparison differs from observation in that it is supported by different features such as those that allow users to connect and interact with other wearable users and compare their own performance to that of others. For example, users can take part in challenges and are ranked relative to other users based on their performance (e.g., number of steps over a certain period of time). The reward strategy is supported by features that reward the user for the successful performance of a behavior. A typical example is badges users obtain when reaching a certain goal (e.g., a certain number of steps). Positive talk is assisted by features that prompt users with motivational messages to overcome motivational issues.

Wearable use patterns and behavioral outcomes

We now turn our attention to the abstracted wearable use patterns. Our empirical data revealed four wearable use patterns showing how the application of self-leadership strategies or IT-based leadership strategies relate to behavioral outcomes: 1) Following (following leadership strategies provided by the wearable) and the outcome of compliance change, 2) Ignoring (ignoring leadership strategies provided by the wearable) and the outcome of no behavior change, 3) Combining (combining leadership strategies provided by the wearable with self-leadership strategies) and the outcome of behavior change, and 4) Self-leading (self-leadership supported by the wearable) and the outcome of no wearable-induced behavior change. In the first two use patterns, leadership strategies applied by the wearable (i.e., IT-based leadership strategies) were most prominent, while in the third pattern they were combined with users' self-leadership strategies as individuals sought to change their patterns of physical activity. The fourth pattern was characterized by users primarily applying self-leadership strategies to control their physical activity. Apart from the leadership strategies, we found that the wearable use patterns differ in users' motivation to change their physical activity pattern, ranging from low to high motivation. Table 4 provides an overview of the four wearable use patterns, including the individuals' level of motivation to change their behavior, the applied leadership strategies and associated behavioral outcomes.

In the following sections, we will present the four wearable use patterns in detail. In our presentation we will focus on the specific leadership strategies (see Table 3) that were most prominent in each pattern (i.e., mentioned by at least one-third of the participants in each pattern). It is important to note that the patterns relate to use cases, not users. A use case represents, for example, increasing personal fitness or

Table 3 Overview of identified leadership strategies applied by users and wearables

Strategies	Description	Applied by …	
		User	Wearable
Behavior-focused strategies			
a) Behavioral strategies focused on preparation			
1. Goal setting	Establishing specific goals to be achieved by performing the behavior.	√	√
2. Cueing	Establishing cues / reminders to initiate the behavior.	√	√
b) Behavioral strategies focused on evaluation			
3. Observation	Assessing how well the behavior is performed.	√	√
4. Social comparison	Comparing own performance to that of others	√	√
5. Reward	Rewarding the individual for the successful performance of a behavior.	√	√
6. Punishment	Criticizing the individual for the unsuccessful performance of a behavior.	√	
Natural reward strategies			
7. Make activity more appealing	Finding rewarding aspects of the activity at hand by building pleasant and enjoyable features into it.	√	
Thought pattern strategies			
8. Positive talk	Talking to the individual to overcome motivational issues.	√	√

improving quality of sleep. Our analysis showed that most users can be assigned to a specific pattern. However, seven out of 50 users showed different patterns depending on the use case. For example, one user meticulously followed the IT-based leadership strategies provided by the wearable in order to increase her physical activity. Simultaneously, with regard to her sleep behavior, she acquired self-leadership strategies and combined them with the wearable's leadership strategies, thereby exhibiting a completely different behavioral pattern.

FOLLOWING: Following leadership strategies provided by wearable and the outcome of compliance change

In this wearable use pattern, users were highly motivated to improve their health behavior, but were not sure how to do so. They willingly followed the leadership strategies deployed by the wearable, which provided clear performance standards and instructions for the behavior to be performed. Users let themselves be guided by the wearable instead of their own bodily feelings. Thus, although users indeed changed their behaviors, their actions remained closely coupled to the device (i.e., compliance) because users were either unable or unwilling to perform activities on their own initiative.

The interviewees usually pursued a general goal in using the wearable, such as improving their fitness or health by being more active in their everyday lives or losing weight. However, the users did not quite know how to achieve their goals and therefore relied on the wearable to guide them. To this end, they used the step counter, and also used the heart rate monitor during exercise.

Users who wanted to be more active followed the specific goals set by the wearable (i.e., IT-goal setting), such as meeting the criterion of a certain number of steps per day. Furthermore, they valued and tended to react to reminders sent by the wearable (i.e., IT-cueing), prompting them to perform a specific activity, either to achieve the goals set by the device

Table 4 Overview of identified wearable use patterns

Wearable Use Patterns	Motivation to change behavior	IT-based leadership strategies	Self-leadership strategies	Behavioral outcomes
1) FOLLOWING: Following leadership strategies provided by the wearable	high	X		Compliance change
2) IGNORING: Ignoring leadership strategies provided by the wearable	low	X		No behavior change
3) COMBINING: Combining leadership strategies provided by the wearable with self-leadership strategies	high	X	X	Behavior change
4) SELF-LEADING: Self-leadership supported by the wearable	medium		X	No behavior change

(e.g., moving, standing), or to improve their overall well-being (e.g., drinking water regularly, doing a breathing exercise). Users appreciated that the wearable reminded them of certain activities and they did not have to think about them themselves. One interviewee described how he complied with the reminders:

> *"I work in the office and the wearable keeps telling me 'Hey now it's time to get up again'. I follow that quite often. This shows me that I've been sitting for two hours. Then I get up and get some water and move around a bit."* (male, 27, auditor)

Users also strongly relied on the wearable's assessment of how well they have performed the desired behavior (i.e., IT-observation). Visual representations (e.g., progress bars), either shown directly on the wearable interfaces or on the accompanying smartphone application, were used as an "objective measure" to assess the extent to which they had achieved the goals set by the device. IT-observation was also facilitated by the device's heart rate function, which guided users during their training. Users highly appreciated the wearable showing them their own activities and progress. Moreover, some users stated that they felt motivated by the badges awarded by the wearable and saw them as a reward (i.e., IT-reward). They gave the users a good feeling when they had achieved a goal. The following statement by a user is representative for the use pattern. It summarizes how the user tried to reach the goals set by the wearable (i.e., IT-goal setting), how she observed her goal achievement (i.e., IT-observation), and how she was motivated by the badges awarded by the wearable (i.e., IT-reward):

> *"I always try to reach the goal that the watch sets. It always calculates the new goal for the next week depending on how many calories I burnt the week before. I think that's quite nice. Sometimes it's also really stressful because the watch demands that I always close these three activity rings: the movement, active calorie, and standing ring. I always get such beautiful, colorful awards when I manage to do that. Humans are so predictable, but it simply works - terrible. I always have to laugh at myself when I'm happy, when such a firework appears on my watch."* (female, 24, student)

The same participant explained how the cues received from the wearable (i.e., IT-cuing) caused her to comply:

> *"Sometimes I stand in the bathroom brushing my teeth just before midnight. Then the watch says: 'Come on, there are still six minutes of activity missing!' and it suggests what to do to close this ring. Then I sometimes stand in the bathroom and walk on the spot or I make jumping jacks. It's such a nice feeling of success that you can go to bed with in the evening."* (female, 24, student)

In this wearable use pattern, users assigned leadership to the wearable and complied with the behavior it suggested. Users delegated leadership to the technology and used it as a way to control their actions, and deliberately pressured themselves to perform the activity and achieve the goal set by the device. Users indeed reported moving more in their everyday life, however, only as much as the wearable demanded of them. Their behavior remained closely coupled to the device, even though they may have been using the device for several years. Users relied on the wearable as a continuous external motivator as well as an "objective measure" because they were unwilling or unable to assess, for example, their own level of activity. Instead, they sought continuous confirmation from the device.

IGNORING: Ignoring leadership strategies provided by wearable and the outcome of no behavior change

Similar to the first wearable use pattern, the wearable offered various leadership strategies. However, these were ignored by the users and sometimes even perceived as disturbing. In this pattern, users were not motivated to change their physical behavior and the wearable can be compared to an ignored instructor.

The primary use purpose for some users was to explore the technical functionalities of the wearable, while others wanted to record and archive their own physical parameters. Although the users did not intend to change their behavior, they regularly interacted with activity-related functionalities such as the step counter and its daily or weekly overview and activity reminders. Some users also recorded their sleep or took part in challenges with other users.

The users in principle accepted the goals set by the wearable and considered them to be desirable (i.e., IT-goal setting). However, when the wearable sent them requests for action (i.e., IT-cueing) throughout the day, the users did not respond to them with compliance. They argued that they could not or did not want to comply with the wearable's request due to external constraints (e.g., time limitations, local environment). Rather, they were annoyed and clicked the message away, as stated by one interviewee:

> *"The watch tells me once an hour that I should sit down and breathe consciously. I always deactivate this message when it appears the first time. It annoys me. And when I sit too long, it tells me to get up. That annoys me, too. I can't just get up in a meeting and say, 'My watch just said I have to get up and move for a minute'."* (male, 31, account manager)

Furthermore, when the wearable informed the users about the discrepancy from the behavioral goal (i.e., IT-observation), users tended to take notice of this information or even actively look at it on a regular basis. However, they did this more out of interest or self-confirmation, as was the case for physically active users, rather than with the intention of adapting their behavior. Thus, the users remained unaffected when the goals set by the wearable were not achieved. One interviewee stated:

> *"I still have the initial settings with ten thousand steps, which I do not reach on a normal working day. When I'm in the app anyway, I check how many steps I've made recently. But don't go outside to do the remaining steps when I see that I am not there yet. I don't do that."* (female, 32, administrative employee)

Another participant explained how he frequently reviewed his activity and sleep data, but without changing his behavior:

> *"The greatest benefit is to record data so that I can look at it every evening. So far, I didn't have a specific goal that I wanted to achieve... I just liked sports and wanted to record it and analyze my data. [...] I also find it exciting to observe how I feel in the morning and compare it to the sleep patterns recorded by my watch. I want to know if that correlates. [...] It didn't change my behavior much, I would say. [...] I'm always happy when I reach my goals, when the wearable vibrates and the fireworks are displayed. But I never check and think to myself: 'Oh, there are still five thousand steps missing' and walk around."* (male, 27, student)

Many participants mentioned that they took part in challenges through the wearable (i.e., IT-social comparison). Most of them stopped using these features as they lost interest in the rankings over time. Those that continuously used social comparison features did so mainly for self-presentation, rather than for achieving behavior change:

> *"I'm using Strava, too. It's cool when complete strangers say 'well done!' That's motivating. It's a bit of 'fishing for compliments', it's self-confirmation."* (male, 40, product manager)

All in all, in this wearable use pattern, users showed no change in behavior resulting from using the wearable. Some of the users stated that they achieved the goals set by the wearable in their daily lives anyway, and thus perceived a further change in their behavior as unnecessary. At the same time, they showed no motivation to set higher, more ambitious goals that would require a behavioral change. Further reasons for the absence of behavioral change were (perceived) external constraints such as private or professional circumstances.

COMBINING: Combining leadership strategies provided by wearable with self-leadership strategies and the outcome of behavior change

This wearable use pattern is characterized by a high motivation for behavior change and a stronger reliance on the wearable in the initial use phase compared to later phases. Compared to the previously described patterns (i.e., following and ignoring), users developed a sensitivity to their own behaviors over time and acquired self-leadership strategies to complement those provided by the wearable. After that, the wearable did not become obsolete, but continued to accompany the user as an external motivator. Thus, the users combined IT-based and self-leadership strategies. This is the only wearable use pattern in which we observed substantial behavior change, i.e., shifts in behavioral patterns and routines that go beyond the wearable's requests.

Most users who fit this pattern had a goal, which they wanted to achieve with the wearable, for example, to lose weight, overcome a disease (e.g., Type 2 diabetes), or resolve a sleep problem. Some users were made aware of a health deficit (e.g., low activity levels) by the wearable and were shocked at this insight, therefore criticizing themselves (i.e., self-punishment). One participant reported that the wearable originally made him aware of how little he moved:

> *"As I often drive to work and have a job where I don't move much, I watch my physical activity. In the beginning, it was shocking when I saw that I only walk two kilometers a day. That is really pathetic!"* (male, 24, computer scientist)

To achieve their goals, users tracked their physical activity, in terms of daily steps and sports activities (e.g., speed, distance and pulse while running or cycling), or monitored their sleeping patterns. At the beginning of the use, the users employed the wearable to observe themselves and to gain "objective" information about their own behavior and body functioning.

Users reported that they initially pursued the goals set by the wearable (i.e., IT-goal setting). After a certain period of time, they internalized these goals and defined them as their own personal goals towards which they voluntarily worked (e.g., a daily goal of ten thousand steps) (i.e., self-goal setting). Some users reported that they initially pursued the goals set by the wearable and then increased them gradually on their own initiative and according to their own aspiration, as the following quote illustrates:

> *"I realized that actually it was not that many steps to the coffee machine and started to move more. I started taking the stairs instead of the elevator and walked to the station instead of taking the bus. At some point I*

> *regularly exceeded the standard goal of five thousand steps and then I raised my goal to ten thousand."* (male, 64, computer scientist)

Users also reported that at the beginning of their wearable use, they often looked at the graphics (e.g., progress bars) to check the status of goal achievement (i.e., IT-observation). They always wanted to know exactly where they stood with respect to their goals. Over time, however, users developed an inner feeling for how much or how little they moved (i.e., self-observation). While some users developed a general body sensation allowing them to assess their physical activity, others with a very stable daily routine knew after a while how many steps they were taking on an average day. In both cases, after a certain period of time, users were no longer dependent on the wearable providing them with this information. One interviewee stated:

> *"In the beginning I often looked at the status of my goals, but today I look at it less, because I can tell for myself whether I have done too little or too much. Today, I notice that myself and that's the good thing about it."* (male, 60, bank employee)

Similarly, users described how they initially responded to their wearable's reminders and prompts with compliance (i.e., IT-cueing). Over time, however, they developed a sense of when it was time to move again or drink water, for example. As a result, they moved on their own initiative after a certain amount of time (i.e., self-cueing), even before the wearable prompted them to do so. Thus, they internalized the cues of the technology, as indicated in the following statement:

> *"I no longer have to receive a warning every time saying 'Hey you have to move,' but I notice it myself. When I just sit at my desk and don't move, the Apple Watch automatically tells me after fifty minutes 'Hey you should get up again.' However, inside myself I already notice that it is time to move again. I find that impressive."* (male, 60, bank employee)

Positive reinforcement played an important role in this wearable use pattern. Many users reported that they had noticed an improvement in their overall health and fitness as a result of more exercise in their everyday life. This encouraged them to adopt the IT-based strategies and turn them into self-leadership strategies as illustrated by the following quote:

> *"Last year I had a heart attack. In rehab, I learned that the only thing you can do to not get a second one is to move even more. Based on the wearable's measurements, I noticed that because I had already moved more, my heart was better than the average. Then, I set my daily goal to fifteen thousand steps, of which I always reached ten thousand. But at one point my way to work became too short and now I'm still taking a detour along the river. Then I am on the move for 1.5 hours. I do that three times a week."* (male, 64, computer scientist)

Interestingly, despite the internalization of the IT-based strategies, none of the users discontinued the use of particular features (e.g., switched off reminders or ignored progress bars). Instead, they continued to receive reminders and to observe their daily activities, goal achievement and overall progress on the wearable. However, their behavior became more and more decoupled from the information provided by the device.

In this wearable use pattern, we could observe a fundamental change in behavior. Users reported moving more in their everyday life, for example, by always taking the stairs instead of the elevator or walking instead of taking the bus. Over time, users learned about their behavioral patterns through the wearable and internalized its leadership strategies. This allowed them to decouple their behavior from the immediate feedback of the device, giving way to voluntary exercise out of intrinsic motivation. However, the wearable still played an important role as "objective proof" and "confirmation" that the users had done "enough" and acted as an additional incentive.

SELF-LEADING: Applying self-leadership strategies supported by the wearable and the outcome of no wearable-induced behavior change

In this wearable use pattern, the wearable serves as a tracker that merely supports self-led users. Users were able to direct their own behavior independently of the wearable and apply appropriate self-leadership strategies. Users indicated that they set their own goals independently of the device (i.e., self-goal setting) and were able to assess their own performance (i.e., self-observation). Interestingly, the application of these strategies led to no behavioral change, at least not any induced by the wearable. If users changed their behavior, it was not triggered by the device, but happened by their own choice.

The self-defined goals were often related to the optimization of the users' athletic performance. Some users had concrete goals such as preparing for a marathon. The wearable served the purpose of documenting and providing an overview of the training as well as insights into how their body reacted during the exercise. For this purpose, the users recorded vital parameters during sports activities (e.g., heart rate, distance and pace) or their sleep (e.g., resting heart rate), and counted their steps.

The wearable served merely as a tool for monitoring the achievement of self-imposed goals (i.e., self-goal setting). While some users set their own goals only mentally, others used the device's goal management features to enter them manually (e.g., step goal) as mentioned by one participant:

> *"Garmin used to adjust my step target automatically at the beginning. But I switched that off. Now I have it set at fixed ten thousand steps. As I said before, I move a lot and it would stress me if the number of steps was even higher. I can also choose how many workouts I want to do per week. That's between three and five for me, otherwise I'm training too much."* (male, 31, personal trainer)

Users recorded their activities according to their own needs and the wearable served as a digital logbook. Depending on their own preferences, some users recorded their activity continuously, while others selectively recorded specific activities. Moreover, users selectively looked at particular information provided by the wearable and were also able to interpret it and draw conclusions for their own behavior (i.e., self-observation). Recording and looking at one's own performance and possible progress alone was motivating.

Despite observing their own physical activity regularly, some users underlined that they would attend to how their body felt rather than to the device during training. One interviewee stated:

> *"It is very exciting to see that I have a much lower pulse when swimming than when jogging, for example. In tennis, of course, it makes a difference whether I play singles or doubles. […] But these values are one thing; the subjective feeling is actually much more important. When you feel good, they don't matter."* (male, 62, retired lawyer)

In addition, one participant stated that despite using the heart rate monitor during training and competitions, he relied primarily on his body:

> *"I have been training for ten years and I base my training exclusively on how my body feels. I want my body to say when something is wrong. I have quit races from time to time when I had the feeling that something was wrong or I felt short of breath in places where it should actually be easy."* (male, 58, consultant)

In this wearable use pattern, leadership resided predominantly with the user. However, we did not observe any wearable-induced behavioral change in this pattern. Most users stated that they kept an already high level of physical activity constant or increased it based on their own initiative. The self-led and intrinsically motivated users regarded the wearable as a useful tool to optimize their everyday life and their sports activities in particular. The wearable provided them with valuable information allowing them to assess their performance more precisely and to make more informed decisions about their future behavior (e.g., to exercise more or less). Thus, the wearable played more of a supporting rather than a persuasive role, as the users performed their physical activities anyway out of intrinsic motivation and did not have to be driven by the wearable. In this pattern, the use of wearables seemed to be a self-leadership strategy in itself, in the sense of a natural reward strategy that was applied in addition to self-goal setting and self-observation. Some users incorporated the wearable into their activity as a kind of natural reward for their performance and thus made the activity even more pleasant and enjoyable (i.e., leadership strategy of making activity more appealing).

Discussion

The goal of this study was to investigate how individuals use wearables to achieve health-related behavioral outcomes. More specifically, we investigated how users apply cognitive and behavioral leadership strategies to direct their physical activity, and how this relates to behavior change. Based on our analysis of narrative interviews with 50 long-term wearable users, we identified four wearable use patterns and the associated behavioral outcomes: 1) Following and compliance change, 2) Ignoring and no behavior change, 3) Combining and behavior change, and 4) Self-leading and no wearable-induced behavior change. Our research makes important contributions to the self-leadership theory and research on individual health IS and wearables.

Our study makes three contributions to the self-leadership literature. First, we demonstrate the manifestation of self-leadership as a set of strategies that are deployed not only by humans, but also by technology. In line with extant self-leadership research (Yong-Kwan Lim 2018), we found a wearable use pattern (i.e., "self-leading" pattern) in which users deploy technology to help them lead themselves. However, beyond that, our study demonstrates that technology can itself offer leadership strategies, which we call IT-based leadership strategies, that users may willingly follow to guide and change their behavior. The leadership strategies most prominent in wearables were observation, goal setting, cueing, rewards, and social comparison. While prior research identified some of these strategies for wearables (Lyons et al. 2014; Mercer et al. 2016), we showed how wearables can provide leadership affordances. This knowledge may enable self-leadership theory to be adopted by IS researchers, and especially the subset of researchers in the fields where IS research overlaps with artificial intelligence, human-computer interaction, e-health, and digital health platforms.

Our second contribution to self-leadership theory is the observation that leadership strategies can be transferred from technology to users. As evidenced in the "combining" pattern, some users first follow the leadership strategies provided by the wearable. However, over time, they may internalize some of the strategies, and thus no longer depend on the wearable, but rather devise strategies for more sustainable behavior change. This indicates that, at least for some people, technology can be an effective means to develop self-leadership capabilities.

Third, our analysis revealed a behavioral self-leadership strategy, namely social comparison—applied both by users and technology—that has not received much attention in self-leadership theory. In contrast, social comparison was found to be relevant in wearable literature (James et al. 2019b; Lyons et al. 2014; Mercer et al. 2016). This behavioral strategy creates a different type of observation of oneself, within the context of others, and therefore may motivate one to go above and beyond one's performance limits. For example, observing friends who all run more miles than oneself may motivate a person to increase their mileage. Social comparison also creates an accountability buddy effect (James et al. 2019b), and may help people persist in trying new habits for longer periods of time. Knowing these motivational and accountability factors related to social comparison, one may use them as a successful behavioral strategy towards positive change.

Furthermore, our findings contribute to and extend research on individual health IS in general and wearables in particular, and provide further research opportunities. In the IS field, this study is one of the first studies to explicitly investigate behavioral outcomes of wearable use (e.g., Rieder et al. 2021). Compared to prior short-term experiments in extant medical and nutritional research (Brickwood et al. 2019; Stephenson et al. 2017), our study offers a theory-informed explanation for the inconsistent outcomes of wearable use. Our study demonstrates that, depending on whether leadership resides with the user or is assigned to the wearable or both, different behavioral outcomes emerge. By shedding light on the interplay between leadership strategies applied by humans and technology, our study provides a useful complement to the current understanding of wearable-enabled behavior change. Next, we discuss our findings in more detail and derive three propositions regarding the relationship between leadership strategies and behavioral outcomes, which can guide future research on IT-enabled behavior change.

We show that users may fully assign leadership to the wearable and willingly follow the provided leadership strategies. Especially in the wearable use pattern "following," users accepted the goals, demands and performance evaluation by the device. Users voluntarily and consciously submitted to the "virtual coach" because they perceived the device as an agent with whom they established a fictitious relationship (De Moya and Pallud 2020). By allowing the wearable to guide them, users were enabled to improve their health behavior and achieve their personal goals. This interplay of disempowerment (i.e., subjugation) and empowerment is also discussed by De Moya and Pallud (2020). However, users' physical activity in the "following" pattern always remained closely tied to and dependent on the device.

It is important to note that whether individuals followed the leadership strategies provided by the wearable depended on their motivation to change their behavior. In the pattern "ignoring," users considered the provided leadership strategies to be reasonable, but ignored the device's instructions because they were not in line with their own goals. Rather than changing their behavior to adapt to the wearable, the users sought exploration and self-documentation through wearable use. The important role of motivation for behavior change is in line with Fogg's (2009) behavior model, which suggests that a behavior only takes place when the user is sufficiently motivated, has the ability to perform the behavior and is triggered to do it. This leads to the proposition:

Proposition 1

> *The motivation to change their behavior of individuals who assign leadership to the wearable, influences whether they comply with the device.*

Another novel finding was that IT-based leadership strategies can be transferred from the wearable to the user as was evident in the "combining." pattern. With the transfer, the users could take on self-leadership behaviors from the device and were then able to act independently. Moreover, this transfer of leadership strategies did not make the device obsolete, as it still functioned as a supporting tool. This transfer of IT-based leadership strategies to the users happened when users were sufficiently motivated to learn. Furthermore, users noticed that their actions were beneficial to their health, which motivated them even more. This indicates the influence of positive reinforcement (Reeve 2014) on the internalization of IT-based leadership strategies. If users followed the triggers of the device short-term and noticed an immediate improvement in their well-being, this recognition increased the likelihood that they would follow the requests the next time the wearable prompted them. Together, these short-term reinforcement cycles could lead to long-term behavior change. These findings demonstrate that the interplay between technology and humans yielded the most profound effects in terms of behavior change. Prior researchers have claimed that wearables empower users by providing knowledge about their behavioral patterns and offering behavior change techniques (Lyons et al. 2014; Mercer et al. 2016). Our findings challenge this view as being too simplistic. Our findings indicate that providing knowledge and behavior change techniques is not sufficient to achieve a substantial change of routine. For behavior change to be maintained, that is, decoupled from the device, users must additionally acquire self-leadership strategies. Notably, users with health problems (e.g., diabetes, overweight, sleep problem) were especially likely to exhibit the "self-leading" pattern. They were particularly motivated to get their health problems under control by using wearables and achieved a sustainable change in behavior. These results are positive news for the medical field, as they suggest that wearables can indeed help patients to manage their chronic health conditions (Dimitrov 2016). Based on our findings, we derive the following proposition:

Proposition 2

Individuals who internalize the IT-based leadership strategies and then complement them with self-leadership strategies are likely to exhibit a fundamental and sustained change in behavior.

Scholars have underlined the many challenges to wearables changing individuals' behaviors, from technical shortcomings and adoption barriers to high attrition rates (Patel et al. 2015). Our research adds to this critical view on the effectiveness of wearables by showing that even long-term wearables users who regularly interacted with the device's behavior change features do not always change their behavior due to the wearable. Our results show that behavior change is unlikely to occur if users are not sufficiently motivated. This was the case for two quite different patterns, i.e., ignoring and self-leading. In the first pattern, individuals simply ignored the leadership strategies provided by the device. Interestingly, in the second pattern, self-led individuals took full control over their actions and utilized the device according to their needs, which did not necessarily imply a further change of their physical activities. Thus:

Proposition 3

Self-led individuals are likely to use wearables for support of their physical activities and are not likely to change their behaviors.

Practical implications

Wearables are promising and emerging technologies to deliver preventative care to individuals and support patients in self-managing their diseases. From a practical perspective, our study provides valuable insights for wearable vendors to make their devices even more user-friendly and effective. Our study shows that users differ in their approaches to applying leadership strategies to change their health-related behavior and that not all users are actually motivated to change their behavior. Consequently, wearables should allow for adaptation to the individual use patterns (Hamper 2015). Leveraging artificial intelligence, wearable providers could better tailor the devices' features and content to the individual user if they identified which wearable use pattern(s) he or she follows. For example, some users have effective self-leadership strategies in place, even without the support of the wearable. For such users, a customized user journey and features with fewer persuasion techniques or the possibility to switch off certain features may be appropriate, while others may need even more support from IT-based strategies. For instance, performance goals should be automatically adjusted for users who want to change their behavior and rely heavily on the wearable's guidance to do so, as these users only move as much as the device demands. In addition, wearable providers should innovate approaches that help these users to acquire self-leadership strategies in order to achieve a more profound and sustainable behavior change. Our study showed that wearable providers can do so without having to fear that their device becomes obsolete.

Our study also provides guidance for health providers who want to become part of the ecosystem established around commercial wearables. Health insurance companies that intend to support their customers in achieving a healthier lifestyle through wearables need to clearly identify those customers who really have the motivation to change their behavior. Self-led wearable users may be an attractive target group for health insurance companies due to their often high activity level; however, it may be unprofitable to financially subsidize them, as they would act the same also without the device. A key insight from our study is that insurers as well as physicians should provide offers to educate individuals in self-leadership strategies due to the potential to achieve sustained behavior change.

Limitations and future research

Despite the advantage of the narrative interview technique of leaving the structure of the interview to the interviewee, individuals' memory structures might cause biases in their accounts of their use histories such as, for example, bias towards recall of extreme events that are easier to remember. Future research may triangulate using other research methods and set out to quantitatively assess our findings. When conducting a quantitative study, it may be fruitful to further investigate psycho-social factors such as individuals' personality traits and how they influence the application of leadership strategies and the associated behavioral outcomes. Moreover, given our reliance on a purely Swiss sample, the generalizability of the findings might be limited. A follow-up study may consider other geographical and cultural contexts to examine whether the identified patterns hold in different cultures. Future research may also investigate the extent to which our findings are transferable to other technologies and contexts. In the future, wearables will increasingly be equipped with artificial intelligence, enabling them to provide even more precise and personalized instructions and recommendations. Investigation of how this affects wearable leadership and the interplay with human self-leadership is a promising future research direction.

Appendix: coding schema

Code Category	Code Name	Description	Example
Self-leadership strategies (Neck and Houghton 2006)	Self-goal setting	Establishing specific personal goals for oneself	*"I have set myself an annual target of 2500 km and I also set myself weekly targets depending on the phase of the year."* (male, 58, consultant)
	Self-cueing	Establishing cues independent from the wearable to initiate behavior	*"Whenever I come home at the end of the day, I look how many steps I am missing. Depending on how many are still missing, I know exactly which route I have to walk."* (male, 57, managing director)
	Self-observation	Personal assessment of how well the behavior is performed.	*"I'm an athlete. For me it is very important to record the steps. That motivates me. On holiday we went climbing, hiking and stuff like that. I always want to know how high and how fast I was."* (male, 31, personal trainer)
	Self-reward	Rewarding oneself for the successful performance of a behavior	*"There are many who say 'Hey you're crazy to get up at 5:15 in the morning for your steps'. But it has so many positive side effects. You are out in the fresh air, you see many things in nature that you don't see during the day."* (female, 37, marketing manager)
	Self-punishment	Criticizing oneself for the unsuccessful performance of a behavior	*"At first I was extremely shocked. When I am only in the office and I am not exercising in the evening, it is only 2-3 k steps. That is extremely little!"* (male, 40, product manager)
	Making activity more appealing	Building pleasant and enjoyable features into a given activity	*"I downloaded some audio books to my iPod and then I just walked between 20 to 45 min every night when I got home, depending on how much was missing."* (male, 57, managing director)
	Replacing dysfunctional beliefs and assumptions	Changing one's negative beliefs to positive ones	No instances found
	Mental imagery	Visualizing the successful performance of a behavior	No instances found
	Positive self-talk	Talking to oneself to overcome motivational issues.	*"When I had problems with my knees, it would have been an ideal moment to stop doing sports. But then I said to myself, 'I can do that.'"* (male, 57, managing director)
	Social comparison (emergent code)	Comparing own performance to that of others independent of the wearable	*"I must say that I like to compete with others.* […] *He [my husband] certainly does at least as much sports as I do, but he doesn't think we always have to compare. But I like to do this because it is an incentive for me."* (female, 49, administrative employee)

Leadership strategies applied by the wearable (adapted from Neck and Houghton 2006)	IT-goal setting	Adopting goals set by the wearable	*"At the beginning I received a suggestion of 7.5 k steps. During use, my average was permanently higher than the set targets and the watch then automatically started to increase my target. First 10 k then 15 k and it always adjusts to my current performance."* (male, 22, carpenter)
	IT-cueing	Adopting cues by wearable to initiate behavior	*"It [the Wearable] regularly reminds me to breathe consciously so that I can relax."* (male, 60, bank employee)
	IT-observation	Adopting wearable's assessment of how well the behavior is performed	*"Sometimes I feel like I actually slept well. But the app shows me that I was restless 32 times. It shows me that when I slept badly, I also moved a lot. I find it very good to have an overview."* (female, 29, media planner)
	IT-reward	Receiving reward by the wearable for the successful performance of a behavior	*"When I reach 100% of my daily goal, it provides a notification and I receive an award. That encourages me."* (male, 60, bank employee)
	IT-punishment	Receiving criticism by the wearable for the unsuccessful performance of a behavior	No instances found
	Positive IT-talk	Being talked to by the wearable to overcome motivational issues.	*"It tells me: ′You can do it!′ That motivates me when I wasn't moving so much."* (female, 53, dental assistant)
	IT-social comparison (emergent code)	Comparing own performance to that of others through the wearable	*"Humans are wired in such a way that they want to be better than others. The challenges are great. I do them with friends. When I see that one of them has run more, I want to run more as well."* (male, 32, innovation manager)
Behavioral change (Oinas-Kukkonen 2013)	Compliance	Momentary action taken by users to comply with what is requested by the wearable	*"Sometimes I stand in the bathroom and brush my teeth just before midnight. Then the wearable says 'Come on, only six minutes of activity are missing!', and then it suggests something I can do to close this ring. Then I stand in the bathroom and run on the spot or I do jumping jacks."* (female, 24, student)
	Behavior change	Sustainable and pervasive shift in behavioral patterns and routines	*"Today I always take the time to go out with the dog a little longer or to go for a run. The structure of my everyday life has changed."* (male, 40, product manager)
	No behavioral change	Neither reaction to wearable requests nor change of routines	*"When I'm in the app anyway, I check from time to time how many steps I've done recently. But it's not like I see that I haven't reached the goal yet and then go out and do the remaining steps."* (female, 32, administrative employee)
Emergent codes	Use purpose	Main reason why individual uses the wearable	*"I started using the wearable when I decided that I needed to lose weight. I wanted to get a feel for how much I was moving."* (male, 46, IT employee)
	Positive reinforcement	Sense of improved wellbeing due to wearable use and compliance, increasing the likelihood of future use and compliance	*"Because of my diabetes I go to the doctor regularly. At one point all critical values such as sugar and weight had decreased. So I thought 'in that case it's not so bad." Of course, I had known for a long time: 'Move more, and you'll feel better!'. But the wearable was a perfect way to remind me of that."* (male, 57, managing director)
	Attitude change	Shift in attitude towards health-related behavior	*"It made me aware of how much I move or don't move in my everyday life. This has changed my attitude towards exercise."* (male, 40, product manager)
	High motivation to change	High motivation to comply with the wearable or change behavior	*"This had a strong influence on me because it showed me in a simple way how little I moved. I realized that I had to move more and was motivated to do so, for example, by taking the*

		stairs instead of the lift." (male, 24, computer scientist)
Low motivation to change	Low motivation to comply with the wearable or change behavior	*"I use it to make myself aware of how much I'm moving. It gives me information. But it's not like I need to change anything right now."* (male, 38, product manager)
External constraints	Constraints that reside in the user's external environment	*"I'm time limited because of the kids. If I only have 9000 steps, there's nothing I can do. I can't go outside and exercise."* (female, 37, computer scientist)

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