The use of digital nudges on wearable devices for improving physical activity

Master Thesis

MSc. Communication Science

Student:	Ann-Sophie Zey
Student number:	s2644479
E-Mail:	ann-sophie.zey@student.utwente.nl
University:	University of Twente
Faculty:	Behavioural, Management and Social Sciences
Master:	Communication Science
First Supervisor:	Dr. Joris J. van Hoof
Second Supervisor:	Dr. Ruud S. Jacobs

Date: Sunday, April 24, 2022

UNIVERSITY OF TWENTE.

Abstract

Background: Wearable devices, especially smart watches and fitness trackers, are becoming more common and are advertised as effective tools to improve physical activity. The devices are used to motivate users to be more physically active. The question is how these devices can have such a profound impact on the users to achieve behavior change. For this purpose, the theory of nudging is referred to. Nudges are used to persuade users towards certain decisions. This research focuses on five different nudging mechanisms and how they are used on wearable devices.

Objective: This study aims to identify how the perception of nudges impacts the users of wearable devices to motivate them towards more active behavior and what kind of nudge seems to be the most promising one.

Methods: An online survey among wearable device users was conducted to obtain a realistic assessment of the perceived effects that nudges might have on users in their daily lives. The participants were asked about the perceived effectiveness of and frustration with the nudges and reported how their physical activity changed after they started using their wearable device. A total of 204 German speaking participants ranging from 17 to 66 years participated in the study.

Results: In the study the users of wearable devices reported that only one of the five nudges was perceived as effective in positively influencing physical activity. The only nudge that showed significant results was the scarcity nudge. It was also analyzed if perceived frustration with the nudges could influence the perceived effectiveness. Although the perceived effectiveness of the nudges decreased to some degree as the level of frustration increased, the effects were not significant.

Conclusion: Scarcity nudges were perceived as persuasive and encouraging activity. Their proximity to gamification elements offers further research opportunities to improve the use of digital nudges on wearable devices.

Keywords: digital nudging, choice architecture, wearable devices, physical activity, behavior change

List of content

1 Introduction

Physical activity is important for everyone's health. It is of such importance that official recommendations are made by the World Health Organization (WHO). Advice for different age groups and people with physical disabilities is given. The guidelines for adults recommend 150-300 minutes of moderate intensity or 75-150 minutes of vigorous intensity of physical activity per week and it is also advised to reduce sedentary behavior (Bull et al., 2020). Moderate intensity can be walking, housework, gardening or any kind of activity that is integrated within the day, whereas vigorous intensity is exercise, any kind of sports or body fitness (WHO, 2020). However, these recommendations are not met by a high number of people and physical inactivity is leading towards greater health risks (Pinto et al., 2020).

Many people try to counteract this inactivity and stimulate activity by keeping track of their behavior via their mobile devices, fitness trackers, or wearable devices. The devices are normally wrist-worn and record physical activity, based on data relating to fitness or health, such as the number of calories burned, the heart rate, a step count, or distance (Merriam-Webster, n.d.-b). Wearable devices are becoming a greater part in people's life and their techniques are continuously developed. They are advertised as effective tools to improve physical activity and a healthier lifestyle (Fitbit, n.d.; Garmin, n.d.). According to the International Data Corporation (IDC, 2021) the demand for wearable devices, to track health and physical activity, increased by as much as 28.4% during the year 2020. One reason for the rising demand for wearable devices may be that there is more forthcoming evidence that these devices can encourage people to increase physical activity (Sullivan & Lachman, 2017; Yen & Huang, 2021) but further research is needed to identify what kind of techniques are used within

wearable devices and what effect these techniques can have on the user's motivation for physical activity.

A promising approach could be to identify different digital nudges that are used on wearable devices. Digital nudges are based on the concept of nudges which was defined by Thaler and Sunstein (2008). In their words a nudge is "any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives. To count as a mere nudge, the intervention must be easy and cheap to avoid." (Thaler & Sunstein, 2008, p. 6). The choice architecture is the environment that is adapted to influence people's behavior. The researchers highlight that nudges are not meant to pressure or limit people in their decision making but help them to make certain decisions more easily than alternatives. Nudges were already used in offline contexts, for example, in the arrangements of products or the placements of advertising. The idea was to help humans in decision making by adapting the environment. One example for nudges in the offline context is the rearrangement of food products in supermarkets to influence purchase behavior. For example, changing the order and the position of healthy food choices to be closer to the customer, was found to increase the purchase of healthy food (Bucher et al., 2016).

After nudges were found to be effective, they soon moved to the online context, now called digital nudges. Digital nudges are prominent on e-commerce websites but also on organizational or governmental websites. They are used to facilitate the interaction between user and website. Prominent nudges are for example the default nudge, where one option is already selected for the user, or the middle option bias, where one option is highlighted in the middle and persuades the user to choose this option (Schneider et al., 2018; Weinmann et al.,

2016). Other nudges support the user by giving feedback, structuring complex choices, or providing incentives (Thaler et al., 2013).

Wearable devices do now open many more possibilities to nudge the user due to their close proximity and the possibility to provide haptic feedback to the user (Ogbanufe & Gerhart, 2018). Few studies have focused on the use of digital nudges on wearable devices. Although the researchers found promising results of the nudges influence on the user's habit formation and behavior change (Nakamura & Matsuda, 2021; Weßel et al., 2019), none of the studies has focused on the different kind of nudges that are used on wearable devices. Therefore, this study will analyze the impact of different nudges that are used on wearable devices on the user's physical activity. Leading to the following research question:

> What is the perceived or anticipated effectiveness of different nudges presented on wearable devices to increase physical activity?

To identify the different nudges on wearable devices the framework of Caraban and colleagues (2019) was used as a groundwork. The researchers defined 23 different types of nudges that were presented in different studies using a systematic literature review. The combination of this framework and additional studies on nudges has helped to classify the nudges used on wearable devices into five types. These types are confronting nudges, social nudges, scarcity nudges, prompting nudges, and feedback nudges. These nudges trigger different emotions and can lead to different outcomes. The feedback nudge offers positive feedback to the user, whereas the confronting nudge confronts the user with their inactivity. The social nudge enables social comparison because it shows when other users were physically active, when they are connected to each other. The prompting nudge delivers reminders just in

the right moment to keep people active and motivate them. While the scarcity nudge offers users medals, points, banners, or similar, to gain when they complete a certain activity withing a limited timeframe. The different directions of the nudges could possibly lead to a varying perceived effectiveness. To investigate this, a second question was formulated as follows:

> Which of the five nudges presented is perceived as the most promising one to increase users' physical activity?

2 Theoretical framework

In this chapter the theoretical background related to this research will be elaborated. In the first step research on wearable devices is presented. Additionally, a deeper look is taken into different mechanisms that are used on wearable devices to influence user behavior. Second, the theory of nudges will be explained, as well as the theoretical and practical implications. Afterwards, the use of nudges on wearable devices is described. Last, there are some ethical concerns in research presented, that relate to the functioning of wearable devices and digital nudges.

2.1 Wearable devices

Wearable devices have received more attention in research in recent years. The rapidly changing technologies demand great attention from researchers as there are many possibilities, from communication to personal health monitoring, requiring benefits, drawbacks, and data security to be carefully assessed (e.g., Kim, 2021; Ogbanufe & Gerhart, 2018). Researchers are not only concerned with the question of why wearable devices are so popular, but also with profound questions about which mechanisms and techniques actually function and which do not (e.g., Laranjo et al., 2021; Sullivan & Lachman, 2017).

Kim (2021) proposes that there is a need to further evaluate the effectiveness of different technologies, such as wearable devices, and their influence on user behavior. Therefore, Kim (2021) examined how positive and negative emotions impact user behavior. Important insights the study delivered are that messages from a wearable device can trigger emotional reactions that lead to certain behaviors to avoid negative emotions and maintain positive emotions (Kim, 2021). Drawing from this, it can be expected that experiencing negative emotions while using the wearable device might have an impact on user behavior.

The researchers Ogbanufe and Gerhart (2018) identified three different characteristics on why wearable devices have gained such popularity and are continuously used. In comparison to other technical devices, the activity trackers or smartwatches offer a direct proximity, this way, haptic feedback can be given to the user, as well as it offers high convenience as the device does not need to be carried but is directly on the user's wrist. Furthermore, they determined two distinct uses of the device: One is for communication and the other for tracking activity.

Besides having different kinds of usage, it was also found that the interaction and expectations towards the wearable device change over time (Laranjo et al., 2021; Randriambelonoro et al., 2017) and might also lead to a discontinuance of using the wearable device if certain expectations are not fulfilled anymore (Karahanoğlu et al., 2018). Therefore, different researchers call for a higher possibility to personalize and adapt the wearable devices to the own needs (Laranjo et al., 2021; Randriambelonoro et al., 2017).

In general, studies report that wearable devices have a positive impact on the user's physical activity (Randriambelonoro et al., 2017; Sullivan & Lachman, 2017; Yen & Huang, 2021). Recent evidence shows that this is because users become more aware of their physical behavior and are likely to take control of their own activity and health (Chong et al., 2020). Randriambelonoro and colleagues (2017) conducted a longitudinal study with 16 diabetic and/or obese participants. Each participant received a Fitbit at the beginning and was accompanied over 7 months by the researchers. Interviews with the participants revealed that the devices had the ability to motivate them to higher physical activity. Yen and Huang (2021) found that users of wearable devices formed more stable habits for including physical activity

in their lifestyle, the users of their online survey reported higher times of physical activity and lower sedentary behavior. The sedentary time of users and non-users of wearable devices differed on average by as much as half an hour, vigorous activity was as much as two and a half hours more when a wearable device was used (Yen & Huang, 2021). Since habits are quite difficult to form and people need repetition and reminders to form a habit (Psychology Today, n.d.), the question is raised how wearable devices are so effective in promoting habit formation.

2.1.1 Mechanisms on wearable devices

Different studies were conducted to identify the mechanisms that wearable devices apply to motivate its users towards a greater physical activity. One reason wearable devices are so successful could be the haptic feedback they provide (Ogbanufe & Gerhart, 2018). Smartwatches draw attention to new notifications with only a slight vibration and thus reduce the information overload that people are nowadays exposed to. The researchers state that "haptics feedback is viewed as a complement to verbal and visual communication" (Ogbanufe & Gerhart, 2018, p. 1008). It is also stated that the proximity of the wearable device provides high convenience and ensures that users can keep track of their active behavior and communication.

Techniques for decision-making and behavior change are often used in wearable devices and connected fitness apps. In a study conducted by Sullivan and Lachman (2017) the researchers found different behavior change techniques like goal setting, social support, feedback, or rewards. However, the researchers point out that it is not clear to what extent these techniques affect the user and if they have the ability to implement long-term change (Sullivan & Lachman, 2017). Later, Laranjo and colleagues (2021) reviewed 28 different studies measuring the effects of fitness trackers or mobile apps on physical activity of adults aged 18

to 65 years without chronical illnesses. Within their research they also identified the different techniques for behavior change, such as goals and planning, feedback and monitoring, or social support. Depending on the type of technique that was used a small to moderate positive effect on the people's physical activity could be seen.

Looking at the level of entertainment that fitness trackers provide, gamification plays a significant role. Gamification elements such as goal setting, rewards, and social engagement can be found in wearable devices (Windasari & Lin, 2021). Researchers report that gamifying the activities with rewards, competition, and collaboration is very valuable to improve user experience and combine active behavior with positive emotions, making it more enjoyable (Benner et al., 2021; Kelders et al., 2012). Several studies report that goal setting is one of the most common used features used on wearable devices (Chong et al., 2020; Fritz et al., 2014; Laranjo et al., 2021; Peng et al., 2021). It motivates the users to reach for their goal and strive for higher goals as they can adjust them to their needs. The researchers around Peng (2021) found that goal setting is a very important feature that can lead users more effectively towards the formation of habits, resulting in a more active lifestyle. Especially the numerical feedback (setting a numeric step goal or a specific number for burned calories) that is connected to artificial rewards, goals, and prices was found to be very effective in motivating users (Fritz et al., 2014). Another way users are kept active is by receiving feedback and reminders on their wearable device. The survey conducted by the researchers Yen and Huang (2021) revealed that users of wearable devices have lower sedentary time than non-users because they receive reminders on their sedentary behavior. Text messages and alerts that are sent to the participants are most effective when they are personalized to their actions and when they focus on positive effects, rather than negative consequences (Sullivan & Lachman, 2017). Next to goal setting and feedback, social support plays a big role in the gamification of wearable devices. The way

that users can connect to each other and share activity information with one another is a key feature that keeps people motivated (Chong et al., 2020; Kelders et al., 2012; Sullivan & Lachman, 2017). Another reason for the power of social support results from the psychological herd instinct bias, this means that people tend to mimic what others do or what they say they do (Caraban et al., 2019). Now looking at this in the wearable device context, it means that when users share their information, they are more likely to engage in physical activity if the other users were also engaged in sports (Weßel et al., 2019).

2.2 Nudges

Nudging is a concept that was initially coined by Thaler and Sunstein (2008). They built this theory on three pillars derived from psychology and the social sciences, choice architecture, the dual-process theory, and the thought of libertarian paternalism. These three theories provide the explanation on why nudges can be so effectful.

The term choice architecture was coined by Thaler and Sunstein (2008) and further developed with their colleague Balz (Thaler et al., 2013). They explain that every human is surrounded by a choice architecture, it is created by the individual itself or by the people around them. This environment influences the individual's decision making. In their theory, Thaler, Sunstein, and Balz outline a choice architect who can rearrange or adjust this environment to influence the people within it in a predictable way. Any adaption in the presentation of choices is thus based on this idea and lies the initial ground to the creation of different nudges.

The dual-process theory by Kahneman and Tversky (1979) highlights the psychological reasons why adjustments in the choice architecture and different nudges have an influence on people's decision making. The reason why people are susceptible to choice architecture is

because humans own two systems of thinking. The first system is based on instincts and leads the individual towards quick decisions, whereas the second system is one of conscious thoughts (Thaler et al., 2013). The researchers explain that people mainly make decisions based on heuristics and emotions, meaning that the individual decides based on what they know from their own experiences, however, these judgements are therefore often biased. The second phase of thinking is more complex and slower because it makes goal-oriented and conscious decisions involving judgments and rational thinking (Kahneman, 2003). Building on this concept of a two-system thinking, choice architecture uses heuristics and instincts to design the environment to make it more accessible for the automatic system and help individuals to make decisions faster (Thaler et al., 2013).

The third concept Thaler and Sunstein were led by is the idea of libertarian paternalism. This concept states that people can be influenced and directed in their decision-making without a limitation of their choices (Thaler & Sunstein, 2003). The different mechanisms that choice architectures use to design and rearrange the environment are called nudges (Thaler et al., 2013). First nudges were developed within an offline context but some of the techniques are also applicable to the online world, these are then called digital nudges (Schneider et al., 2018). The first technique Thaler and his colleagues (2013) describe is, for example, the default setting, this means that of many options that are provided, one is already selected. Derived from the principle of least effort (Zipf, 1949), users are tempted to choose the pre-selected option because they favor the present state and people do not tend to put much effort into a task if it can be avoided. Another example is called ‘understanding mappings’, this means that difficult information should be made comprehensible by the choice architect so when it comes to decision-making people can rely on a rule-of-thumb, a color-coded scheme, or easily accessible labels for complex information to decide what is best for them (Thaler et al., 2013). These two

examples show how nudges help users in their decision making by drawing from psychological processes. They also show how the users are led to one certain decision without limiting them in their decision making.

2.3 Digital nudges

More details on digital nudging, a term introduced by the researchers Weinmann, Schneider and vom Brocke in 2016, will be given in this section. Digital nudging includes several ways of persuading consumers towards certain decisions within the online context and their application can be found in many different areas. Within e-commerce, nudges are used for product placement by highlighting certain products with colors, generating attention with badges, or evoking a feeling of scarcity by showing limited numbers. On web pages of finance or insurance companies, government websites, or within the health care sector, nudges like the default choice are mainly applied to guide the users' choices and facilitate the use of the website (Weinmann et al., 2016).

Other studies focus on how digital nudges can help to facilitate human and machine interaction (Weßel et al., 2019) or how nudges can be used for behavior change (Benner et al., 2021). The core of the nudge mechanisms is helping the users of technological devices to make the right decision (Weßel et al., 2019).

The use of digital nudges is relatively new, yet one can already examine new directions and new areas where and how nudges will be used in the future. Nudges will be further optimized to fit the consumer's needs and fulfill the demands of companies. With the further development of the online world, the use of big data and artificial intelligence will also change the way nudges are used. With different algorithms based on personal preferences, nudges can be

adapted to the customer, and the impact of nudges will be even more effective. Yeung (2017) presents the idea of using Big Data in connection with nudges. Using an "algorithmic analysis of data patterns" (Yeung, 2017, p. 130) nudges can be adapted and personalized to the individual and help to make faster and more effective decisions.

2.3.1 Nudges on wearable devices

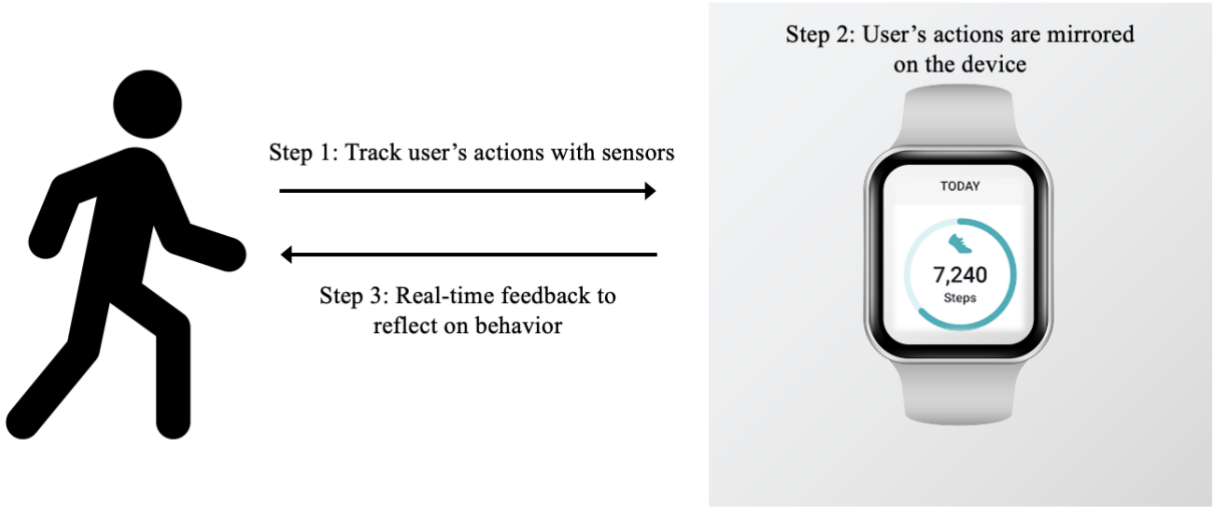
Within wearable devices digital nudges are frequently used in forms of pop-up reminders, visual information, or textual messages. Regarding physical activity, nudges can help the users to stay motivated to reach their activity goals, keep track of what they have done, and be aware of their activity process (Pogue, 2013). The wearable devices use coaching, awards, sharing and competition (Apple, n.d.) or let you set activity goals, send reminders, offer challenges, and social interaction (Fitbit, n.d.). By offering these different techniques the user's commitment and consistency is asked for and adds to motivation and activity (Amirbayat, 2018). Especially the sharing of activity data is appealing to many users because not only seeing other user's activities but also sharing the own activity data can help to generate feelings of social support which in turn helps to motivate for physical activity (Ehrlén, 2021).

A good overview about the use of digital nudges on technological devices is given by the researchers Nakamura and Matsuda (2021). They identify three key functionalities about nudges connected to technological devices. First, the technology is able to track the user's actions with sensors. Second, the user's actions are mirrored on the technological device, with pictures, numbers, bars, etc. Third, the device delivers real-time feedback to the user to reflect on their behavior. The researchers confirm that this self-reflection raises self-awareness, which can promote long-term habit formation (Nakamura & Matsuda, 2021). Even though the users might already know how their behavior needs to change, the continuous reminder nudges help

to maintain the changes. There is also evidence, that the information the nudges provide may be something the user already knows. The simple nudge on their wrist makes them aware to change their behavior (Weßel et al., 2019).

Figure 1

Illustration of digital nudges on wearable devices



2.3.2 Ethical concerns

The use of nudges, however, can not only be considered from a positive side, in fact, there are also critics. Blumenthal-Barby (2013), for example, raises ethical concerns because if choice architects decide what might be the best for the individual, using defaults or bias, the individual is not free in their choice anymore. The nudge mechanisms "might interfere with her autonomy" (Blumenthal-Barby, 2013, p. 190). Likewise, Mele and Spena (2020) express ethical reservations if nudges use algorithms and personal data because this could cause problems between the different parties involved. This negative aspect is also discussed by Lanzing (2019), the researcher fears that companies could exploit users' data to influence users to make profitable decisions. She adds that the use of personal data can violate the users' privacy. The researchers call for scholars and policymakers to provide information about

nudges and the dangers or dark sides of technology driven nudging (Mele & Spena, 2020). Meske and Amojo (2020) highlight that more research regarding the ethical design of digital nudges is necessary. They call for new instruments and guidelines for the practitioners but also for the researchers themselves to find a clear path between nudging and practices that go too far and can be considered as manipulation.

Although ethical concerns certainly have their place in the application of nudges, these concerns are to be limited in terms of the use of nudges for physical activity on wearable devices. In this case, users are aware that they are nudged to change their behavior and are willing to adjust their behavior accordingly. The nudges are intended by the user and activity data is willingly shared, for their own benefit.

2.4 Five types of nudges on wearable devices

In order to formulate research hypotheses, the nudges on wearable devices needed to be identified. Therefore, the framework created by Caraban and colleagues (2019) was used as a groundwork. The nudging techniques on wearable devices can be compared and connected with the different ways of nudges the researchers identified. Using a systematic review of research articles, the researchers identified 23 different nudges based on six categories including facilitate, confront, deceive, social influence, fear, and reinforce. The authors draw attention towards the cognitive processes in connection with the mechanisms of nudging, they identify different heuristics and cognitive biases that explain why nudges are effective.

When looking at the use of wearable devices for activity improvement five different types of nudges were identified. They are defined as confronting nudges, social nudges, scarcity nudges, prompting nudges, and feedback nudges.

2.4.1 Confronting nudge

Confronting nudges are helping to encourage the individual towards certain decisions (Caraban et al., 2019). A nudge like this makes the user rethink their behavior and reflect on their own actions. This nudge can help to change and influence the user's behavior. In the wearable device context, a confronting nudge is often used to end the user's sedentary behavior when they are inactive for too long (Yen & Huang, 2021) and to help users build habits or plan their actions (Peng et al., 2021).

Hypothesis 1: Higher perceived and expected effectiveness of confronting nudges presented on wearable devices increases the users' physical activity.

2.4.2 Social nudge

Social nudges use the tendency of people to do what others expect them to do and to compare own actions with those of others (Caraban et al., 2019). Sunstein (2014) described these nudges as one of the most important and effective ones. Within the digital context these nudges are often used in applications to motivate users. On wearable devices the use of social nudges can encourage activity and engagement in competitions (Sullivan & Lachman, 2017). Social nudges on wearable devices present other user's active behavior, for example if they reach an activity goal, complete a workout, or make great progress towards their goals, the activity is directly shared on the user's device.

Hypothesis 2: Higher perceived and expected effectiveness of social nudges presented on wearable devices increases the users' physical activity.

2.4.3 Scarcity nudges

Another nudge that can be found on wearable devices is the scarcity nudge. The scarcity effect functions as follows: Resources are presented with limited availability in order to urge people to behave in a certain way to receive this resource (Caraban et al., 2019). This works because people tend to desire scarce goods more urgently (Schneider et al., 2018). The scarcity effect is mainly used in consumer marketing to urge users to buy products. Aggarwal and colleagues (2011) differentiated between two different types of scarcity messages, limited quantity, and limited time. The researchers found that when it comes to purchase intention of a product, both messages appear to be effective, however the announcement of limited quantity had a higher impact (Aggarwal et al., 2011). In the context of wearable devices, scarcity nudges are used in such a way that users are offered to win medals, banners, or points, in exchange for completing a certain physical activity within a limited period of time.

Hypothesis 3: Higher perceived and expected effectiveness of scarcity nudges presented on wearable devices increases the users' physical activity.

2.4.4 Prompting nudges

These nudges try to change the behavior by catching the individual's attention through pop-ups, notices, or feedback (Caraban et al., 2019). The distinctive aspect of this nudge is, that the prompt reaches the user at appropriate times, therefore, active behavior is reinforced with this kind of nudge. Especially, the right time and the concrete advice to continue the current activity characterize this nudge (Hirano et al., 2013). An example would be a user who engages in active behavior and then receives a direct message from their device to inform them of their current activity status and the distance to their goal. These nudges are based on data like heartbeat, step count, or workout intensity and are thought to motivate the user to continue

active behavior to reach their set goal. Enabling the right timing of nudges was the focus of Purohit and Holzer's (2019) research. They argue that the right timing of the nudge has a significant effect on its effectiveness and persuasion because digital nudges that are deployed too early may be overlooked and nudges that are deployed too late may reduce the amount of time available for action (Purohit & Holzer, 2019). Furthermore, the researchers around Randriambelonoro (2017) found that a "timely notification in the right context can help users remember the device, application, or health goals they have set" (p. 28). The longitudinal research showed that these timely nudges can be effective in motivating users to physical activity, as users reported they changed their activity behavior over the long-term because constant reminders pushed them to higher activity, e.g., taking the stairs instead of the elevator (Randriambelonoro et al., 2017).

Hypothesis 4: Higher perceived and expected effectiveness of prompting nudges presented on wearable devices increases the users' physical activity.

2.4.5 Feedback nudges

Positive feedback nudges are received after the user completes a workout, reaches a goal, or wins a challenge. In comparison to the nudges before, this one is the only one that actively praises the user for their behavior. In previous research positive messages were found to be more encouraging for the users than negatively framed messages (Sullivan & Lachman, 2017). Additionally, personalized feedback, based on current activity and goals, is reported to be valuable for behavior change (Lanzing, 2019).

Hypothesis 5: Higher perceived and expected effectiveness of feedback nudges presented on wearable devices increases the users' physical activity.

2.4.6 Frustration in the wearable device context

To be frustrated is defined as “feeling discouragement, anger, and annoyance because of unresolved problems or unfulfilled goals, desires, or needs” (Merriam-Webster, n.d.-a). Some studies report about participants that experience frustration when using a wearable device (Lupton & Maslen, 2019; Rieder et al., 2021). In a study conducted by Lupton and Maslen (2019) female participants reported that when they were pregnant and unable to meet their initial activity goals, they still felt guilty and frustrated with the constant reminders of their wearable device. The feeling of being frustrated and pressured through the constant reminders lead them to discontinue using their wearable device.

To explore the background of the usage of wearable devices Rieder and colleagues (2021) conducted interviews with long-term users of wearable devices. In these interviews they found that users experience feelings of frustration, anger, and stress which is in line with the findings from Lupton and Maslen (2019). However, Rieder and colleagues extended this knowledge because they found that users react differently to these feelings. Depending on the individual’s personality, some participants reacted by discontinuing to use the wearable device and others felt even more motivated and persistent in keeping up with their goals when experiencing frustration. Another study conducted by Ryan, Edney, and Maher (2019) also confirms that there are various user types that react differently to the aspects of a wearable device. They found that people with low conscientiousness feel higher anxiety to comply with their goals and that they experience negative feelings because the feedback is always success and failure based.

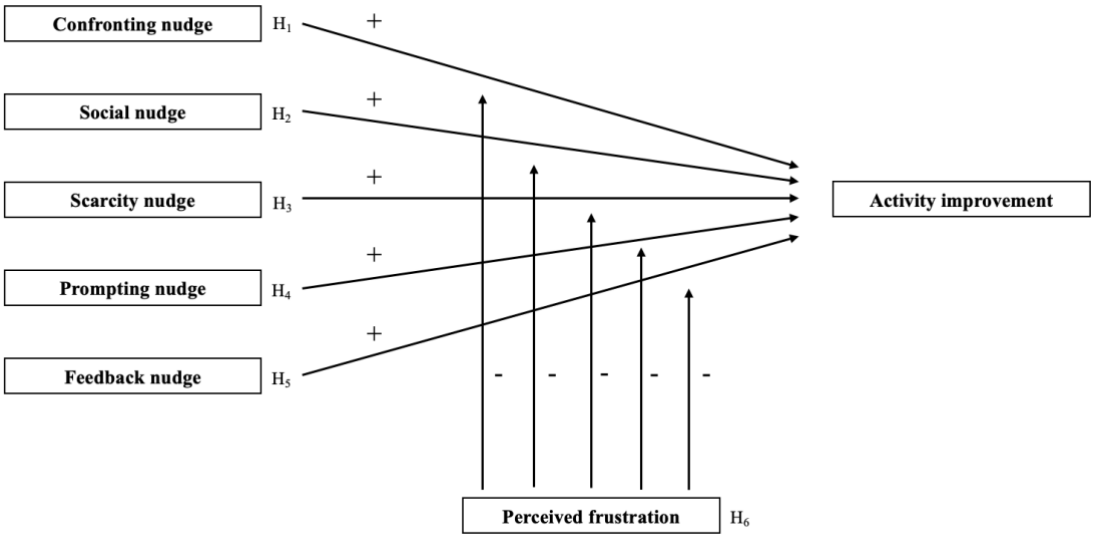
Taking a different approach, Schneider and Graham (2017) looked at nudges in videogames. Their participants were confronted with different nudges, visual and auditory, that either fit

naturally to the game or that are more obtrusive and even kept players from continuing the game. With the different levels of feedback, it was found that nudges that fit more natural to the environment are less likely to arouse negative feelings and players reacted to those nudges. When the nudges were too obtrusive the participants experience higher levels of frustration. Building on these findings the question is raised if the different nudges that are presented on a wearable device regarding physical activity influence the experience of frustration and in turn impact the perceived effectiveness of the nudge. Therefore, the hypothesis is formulated as follows:

Hypothesis 6: The perceived level of frustration decreases the perceived and expected positive effect of the nudges.

Figure 2

Research model with hypotheses



3 Research design and methods

The purpose of this section is to provide insight into how the study was conducted and how the sample was composed. The measures and survey materials are explained to give a better understanding about the research. Additionally, a short description about the structure of the survey is given.

3.1 Method selection

To answer the research questions an online survey was conducted. The survey was set up in the online survey tool Qualtrics and distributed via an online link. Before distributing the survey was pre-tested to avoid misunderstanding and make sure that participants are provided with enough information to respond to the questions. Using an online survey had the advantage that participants could report about their own past behavior in their natural environment. A snowball method via contacts, other students, and social media was used for the distribution. All in all, the data collection had a duration of nearly two months.

3.2 Measures

The survey contained 60 items, including a combination of existing and purposely designed measures. The effect of the different nudges was measured on a self-reported effectiveness scale. A four-item scale was created based on the effectiveness and capability scales of Thomas and colleagues (2019). The level of frustration was considered as it could have a moderating effect on the perceived effectiveness. To identify the perceived frustration with the different nudges a scale including 4 items was built. Participants were also questioned about their use of the wearable device with an existing scale, called level of product use (Lee & Lee, 2020). The dependent variable was the participant's overall perceived activity improvement. Therefore, three different scales taken from Lunney and colleagues (2016). The scales measure the

perceived health improvement, information about an active lifestyle, and about exercise or workouts. Additionally, demographic and background information about the participants and their wearable devices were asked for. Demographic information included age and gender. The length of use, frequency of use and kind of brand were the information that was asked about the wearable device.

3.3 Survey materials

For the survey five different mockup images were created to give the participants an idea about what the different nudges look like. These images were created after reviewing multiple wearable devices and their nudging messages to the users. The results can be seen below and are an aggregate of the different brands of wearable devices.

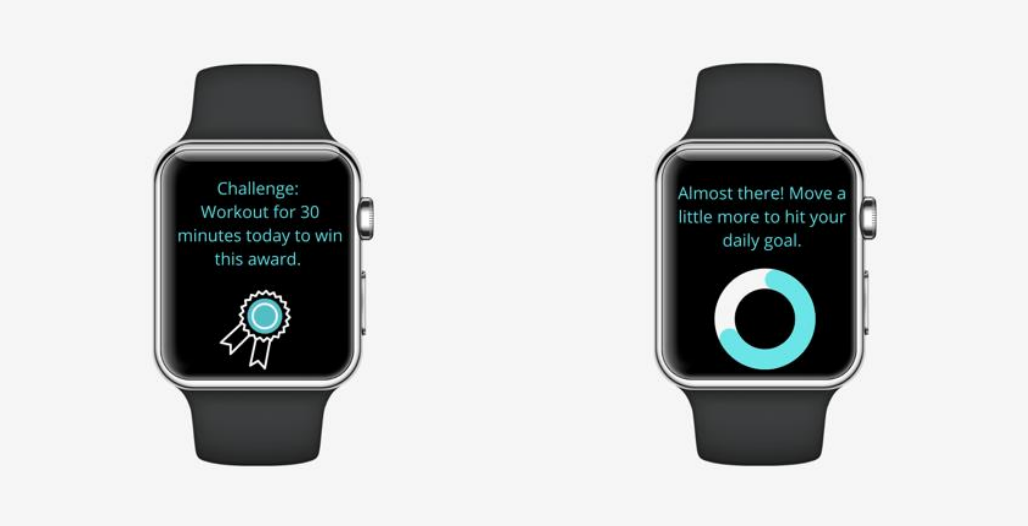
The confronting nudge confronts the user with inactive behavior and reminds them to be more active again. Wearable devices often offer the possibility to share the progress with friends, family, or even strangers. The social nudge then shows other users' activity on the own wearable device, e.g., if they reach a goal, work out, or make great progress. The scarcity nudge offers the user different kind of challenges or goals from time to time to reach in a specific timeframe in order to win medals, banners, or points. The prompting nudge reacts to active behavior and motivates the user to continue this active behavior to reach a goal. Last, the feedback nudge offers positive feedback after the user completes a workout, reaches a goal, or wins a challenge.

Figure 3

Mockup images of the five nudges as used in the survey

Confronting nudge

Social nudge



Scarcity nudge

Prompting nudge

Feedback nudge

3.4 Procedure

The survey started by offering a short explanation about the aim of the research to the participants and they were asked for their consent to record their answers. Next, participants needed to confirm that they have experience with using a wearable device, otherwise they were excluded from the survey. The study used a within-subject design where all participants were shown the five different nudges in a randomized order. During the survey the participants received pictures and textual descriptions of the nudges. It was possible to select whether they recognize this nudge from their wearable device or not. If the answer was ‘yes’, they were led to the questions about how they reacted when the specific nudge was shown to them. If the answer was ‘no’ the participants were only asked to anticipate their behavior and state how they would act. These two routes lead to the formation of two groupings for each nudge. One group of users who have already experienced the nudge themselves (Grouping 1) and one that only anticipates how they will react (Grouping 2). These two groupings are of course different from nudge to nudge, and participants may be in Grouping 1 for one nudge but in Grouping 2 for other nudges, depending on their own experience. Therefore, a participant who might had the confronting nudge lands in Grouping 1 for this nudge, but if their device did not show the social nudge, they are categorized in Grouping 2 for this nudge. This results in the number 183 for Grouping 1 and 168 for Grouping 2. This means that a total of 21 participants reported that they did not receive any of the five nudges and 36 participants reported that they received all the nudges. Afterwards, the participants were asked about their usage of the wearable device and then how the wearable device has changed their activity behavior. Last, the users were asked for their age and gender. They also had the option to provide comments or questions about the research. The whole survey can be found in Appendix B.

3.5 Participants

The sample population was chosen to be only people that had experience with using a wearable device or a fitness tracker. This is to provide real-life experience and information about how they interact with their wearable device. Additionally, the survey was only provided in the German language which resulted in a sample consisting only of German speaking participants.

All in all, 290 participants started the survey, 6 participants did not agree to the consent form and dropped out after the first question. With the inclusion criteria of having a wearable device, another 43 participants dropped out of the survey because they did not have this kind of device. Along the way of the survey, 35 participants stopped answering the questions and did not finish the survey. Those responses will be taken out and will not count towards the analysis. This leaves 204 valid survey answers that were considered for the analysis.

As the survey was mostly distributed among students it is not surprising that the median age lies at 27. With the youngest participant being 17 and the oldest participant being 66 the mean age lies at 30,44. Two of the 204 participants did not fill in their age. Looking at gender the distribution was quite uneven. The majority of the participants were female (150), and the other 54 participants were male. None of the participants chose the answer ‘non-binary’ or were not willing to fill in gender.

Table 1
Characteristics of the participants

Variable		n	%	Mean	Median
Age	Total	204	100.0	30.44	27.0
	17 - 29	145	71.1		
	30 - 39	25	12.3		
	40 - 49	11	5.4		
	50 - 59	16	7.8		
	60 - 69	5	2.5		
	missing	2	1.0		
Gender	Total	204	100.0		
	Female	150	73.5		
	Male	54	26.5		
	Non-binary	0	0		

Some important information the survey delivered was also about the participant's use of the wearable device. Almost 60% of the participants (n = 119) use their wearable device daily. The active use of the device suggests that the participants can report authentically about the perceived effectiveness of and the experienced frustration with the different nudges. Most of the participants have used their wearable device for longer than two years. This also indicates that the participants have enough experience with their device. When looking at the different brands it was found that about 37% were users of an Apple Watch, followed by users of the Fitbit (16%). Other brands that were mentioned in the open question were Amazfit (n = 2), Letsfit (n = 1), Oozoo (n = 1), Niaxues (n = 1), Popglory (n = 1), Yamay (n = 1), or the brand was unknown or not mentioned.

Table 2
Brands of wearable devices

Brand	n	%
Apple Watch	76	37.3
Fitbit	33	16.2
Fossil	2	1.0
Garmin	30	14.7
Huawei	6	2.9
LG	1	0.5
Polar	9	4.4
Samsung	20	9.8
Withings	2	1.0
Xiaomi	8	3.9
Other	17	8.3
Total	204	100.0

3.6 Reliability and validity

Reliability was examined based on Cronbach's Alpha. For a scale to be reliable it needs to be higher than 0.70 (Field, 2013). Taking this as the benchmark all scales were tested reliable (Table 3). The reliability test was conducted for each of the five nudges. The scales were tested for the two groupings that either knew the nudge from their wearable device or the grouping that did not have the nudge on their device. Lastly, the scales that will be used to evaluate the self-reported change in active behavior were also tested reliable.

Table 3
Results of the reliability tests for all scales

Scale	Number of items	*n*	Cronbach's Alpha
Grouping 1 - Users who received specific nudge			
Effectiveness confronting nudge	4	135	.90
Frustration confronting nudge	4	135	.76
Effectiveness social nudge	4	65	.89
Frustration social nudge	4	65	.82
Effectiveness scarcity nudge	4	104	.88
Frustration scarcity nudge	4	104	.76
Effectiveness prompting nudge	4	121	.88
Frustration prompting nudge	4	121	.75
Effectiveness feedback nudge	4	168	.84
Frustration feedback nudge	4	168	.80
Grouping 2 - Users who did not receive specific nudge			
Effectiveness confronting nudge	4	69	.94
Frustration confronting nudge	4	69	.80
Effectiveness social nudge	4	139	.93
Frustration social nudge	4	139	.75
Effectiveness scarcity nudge	4	100	.91
Frustration scarcity nudge	4	100	.82
Effectiveness prompting nudge	4	83	.93
Frustration prompting nudge	4	83	.73
Effectiveness feedback nudge	4	36	.84
Frustration feedback nudge	4	36	.91
Activity improvement			
Health improvement	3	204	.80
Active lifestyle	3	204	.85
Exercise workout	3	204	.83
Additional scale			
Level of use	4	204	.77

To check the scales for their validity a factor analysis was conducted for each of the different groupings and nudges. Most of the scales were found in one component with an acceptable value. The items that scored below the acceptable value were the reversed coded items in the frustration scale. Although these items did not have a satisfactory value they were kept in the scale. On the one hand this was to keep the scales alike for all the five nudges. On the other hand, it is known that reverse coded items are more likely to score lower because of

the participants answering tendencies, namely acquiescence, careless responding, or confirmation bias (Weijters et al., 2013).

Following the reliability check and the validity check the items were computed into scales. Beyond the scales for the nudge's perceived effectiveness and the level of frustration there is a need for a scale that measures overall activity improvement. For the creation of this scale, the items of three different measurements were used: health improvement, active lifestyle, and exercise workout. To combine the right items into one scale that measures the activity improvement, an exploratory factor analysis (EFA) with a Varimax rotation was conducted. Two different factors were found within the 9 items (see Appendix A). As the first factor had a higher factor loading overall, a scale was created out of all items except the two statements that had a lower factor loading than 0.5. These two were statement one and three of the perceived health improvement scale (Since adopting a wearable device I have lost weight, Since adopting a wearable device I have lived a healthier lifestyle).

4 Results

More in-depth analysis is conducted to evaluate the (possible) perceived effectiveness of the nudges on physical activity and the impact that the experience of frustration has on the perceived effectiveness. First, the correlation between the nudges and the activity improvement was assessed. In the next step, the effect that the experience of frustration has on the perceived effectiveness of the nudges was examined using Pearson's correlation.

Ultimately, a multiple linear regression analysis was conducted. Thereby, the perceived effectiveness of the nudges was tested to see if this significantly predicted the participants' self-reported activity improvement. To conduct the analysis, the two groupings were combined because the number of people who experienced the nudge or the number of people who only anticipated their behavior was not sufficient to detect a relationship. The decision to merge these two groupings had to be made because the activity improvement scales were completed by all participants and it was no longer possible to distinguish participants' answers. Now the results show the perceived and anticipated effectiveness and the impact of frustration of all participants on their reported physical activity improvement.

4.1 Descriptive data analysis

Before starting the analysis an overview of the scales for perceived effectiveness and frustration, the level of use, perceived health improvement, active lifestyle, and exercise workout was created. On the one hand, to check how many participants did have which nudge and how many did not. On the other hand, the mean scores of the different scales can give a first impression of the direction of the answers.

Table 5
Descriptive statistics

Scale	*n*	min.	max.	*M*	*SD*
Grouping 1 - Users who received specific nudge					
Effectiveness confronting nudge	135	1.00	5.00	3.49	0.99
Frustration confronting nudge	135	1.00	4.25	2.45	0.82
Effectiveness social nudge	65	1.00	5.00	3.29	0.96
Frustration social nudge	65	1.00	4.25	2.21	0.77
Effectiveness scarcity nudge	104	1.00	5.00	3.53	0.95
Frustration scarcity nudge	104	1.00	4.25	2.06	0.78
Effectiveness prompting nudge	121	1.00	5.00	3.63	0.87
Frustration prompting nudge	121	1.00	4.25	2.17	0.71
Effectiveness feedback nudge	168	1.00	5.00	3.56	0.81
Frustration feedback nudge	168	1.00	3.50	1.53	0.61
Grouping 2 - Users who did not receive specific nudge					
Effectiveness confronting nudge	69	1.00	5.00	3.14	0.99
Frustration confronting nudge	69	1.00	4.25	2.64	0.88
Effectiveness social nudge	139	1.00	5.00	3.06	0.99
Frustration social nudge	139	1.25	5.00	2.87	0.87
Effectiveness scarcity nudge	100	1.00	5.00	3.24	0.98
Frustration scarcity nudge	100	1.00	4.75	2.34	0.81
Effectiveness prompting nudge	83	1.00	5.00	3.21	0.96
Frustration prompting nudge	83	1.00	4.75	2.53	0.76
Effectiveness feedback nudge	36	1.50	4.75	3.16	0.74
Frustration feedback nudge	36	1.00	4.00	1.78	0.78
Activity improvement					
Health improvement	204	1.00	5.00	3.11	0.88
Active lifestyle	204	1.67	5.00	3.76	0.66
Exercise workout	204	1.00	5.00	3.65	0.68
Additional scale					
Level of use	204	1.67	5.00	4.00	0.74

It can be seen that the most prominent nudge on wearable devices was the feedback nudge, as 168 out of the 204 participants indicated that this nudge is shown on their wearable device. This nudge was followed by the confronting nudge, that 135 participants recognized from their device. The nudge indicated by the fewest participants was the social nudge (n = 65).

Looking at the scale of the level of use of the wearable device there is strong evidence that most people enjoy using their device because of the high reported mean score (M = 4.00, max.: 5.00). The high mean scores in the three activity improvement scales, health improvement (M

= 3.11, max.: 5.00), active lifestyle (M = 3.76, max.: 5.00), and exercise workout (M = 3.65, max.: 5.00), also suggest that the participants report higher physical activity.

4.2 Correlation between perceived effectiveness and activity improvement

A Pearson's correlation coefficient was computed to assess the linear relationship between the reported effectiveness of the nudges and the self-reported activity improvement, for the grouping with nudges and the grouping without nudges. The correlation can give insights on a possible connection between the perception of the nudges and how this has reportedly impacted the users' activity behavior. A significant positive correlation was reported for both groupings. The correlation factors revealed that the effect for the grouping that experienced the nudges (r (183) = .32, p < .001) was moderate and higher, compared to the grouping without the nudges (r (168) = .21, p = .007) that only showed a weak correlation. The correlation revealed that the participants who perceived the nudges as effective also reported higher active behavior.

Table 6
Correlation of the different nudges and activity improvement

Variable	*n*	Pearson's R
Grouping 1 - Users who received specific nudge	183	.32**
Effectiveness confronting nudge	135	.25**
Effectiveness social nudge	65	.27*
Effectiveness scarcity nudge	104	.33**
Effectiveness prompting nudge	121	.21*
Effectiveness feedback nudge	168	.22**
Grouping 2 - Users who did not receive specific nudge	168	.21**
Effectiveness confronting nudge	69	.21
Effectiveness social nudge	139	.16
Effectiveness scarcity nudge	100	.23*
Effectiveness prompting nudge	83	.09
Effectiveness feedback nudge	36	.05

* p < .05
** p < .01

4.3 Frustration with the nudges

In order to examine how experienced frustration impacts the perceived effectiveness of the nudges a Pearson's correlation was calculated. This analysis can give insights on how frustration impact the relation between perceived effectiveness of the nudges and the reported activity improvement of the users. Looking at Grouping 1 first, the participants who were able to report their past feelings and behavior. They reported the highest impact of frustration on the confronting nudge (r (135) = - .355, p < .001). This shows that the message of the nudge delivers the highest level of negative feelings and therefore hinders the user to change their behavior towards a higher physical activity. The impact on the confronting nudge was closely followed by the scarcity nudge (r (104) = - .326, p < .001). The influence of frustration on the perceived effectiveness of the prompting nudge was found to be lower and not significant. All in all, it can be said that the experience of frustration impacts the perceived effectiveness of the nudges and plays a role in the participants physical activity improvement.

Table 7
Correlation of the different nudges and frustration with the nudge

Variable	*n*	Pearson's R
Grouping 1 - Users who received specific nudge		
Effectiveness confronting nudge	135	- .35**
Effectiveness social nudge	65	- .20*
Effectiveness scarcity nudge	104	- .33**
Effectiveness prompting nudge	121	- .16
Effectiveness feedback nudge	168	.03
Grouping 2 - Users who did not receive specific nudge		
Effectiveness confronting nudge	69	- .19
Effectiveness social nudge	139	- .06
Effectiveness scarcity nudge	100	- .38**
Effectiveness prompting nudge	83	- .38**
Effectiveness feedback nudge	36	.09

* p < .05
** p < .01

Interestingly, the results of Grouping 2, those who did not receive the nudges and only anticipates the feelings of frustration and perceived effectiveness, show slightly different results. The confronting nudge and the social nudge are no longer significant. Instead, the prompting nudge shows a significant result on the experience of frustration and its perceived effectiveness (r (83) = - .380, p < .001), along with the scarcity nudge (r (100) = - .380, p < .001).

4.4 Impact of perceived effectiveness and frustration on physical activity

A regression analysis was used to test if the perceived and anticipated effectiveness of the five different nudges had a significant impact on the participants' self-reported activity improvement. As there is a high variation between the number of users of each nudge and a very low sample number of those users who received all five nudges, it was decided to include both groupings, those who did have the nudge and those who did not have the nudge on their wearable device, in the regression analysis. The variables for the perceived effectiveness of the nudges and the perceived frustration are now a combination of all participants and their effects on the self-reported activity improvement is measured. The variables gender, age, usage, and length of use were also taken into account.

The whole model reported a fit of 24.6%. The test revealed that neither the age group (β = - .03, p = .502), the gender (β = - .10, p = .275), nor how long the participants already used a wearable device (β = .05, p = .115) had a significant impact on the self-reported physical activity improvement. However, when looking at how often people use their wearable device, it can be seen that higher usage has a significant positive impact on their activity (β = - .14, p < .001). Respondents who report using their device on a daily basis also tend to show a greater change in their active behavior compared to those who rarely use their device.

Using the combined score of the perceived effectiveness of the Grouping 1, that received the nudges on their device, and the anticipated effectiveness of Grouping 2, that did not have the specific nudge on their device, a significant impact on the user's physical activity was only found for the scarcity nudge (β = .122, p = .021). The other nudges reported a positive but not significant impact on the users' activity.

Table 8
Combined score for both groups for the effectiveness of the nudges on users' activity improvement

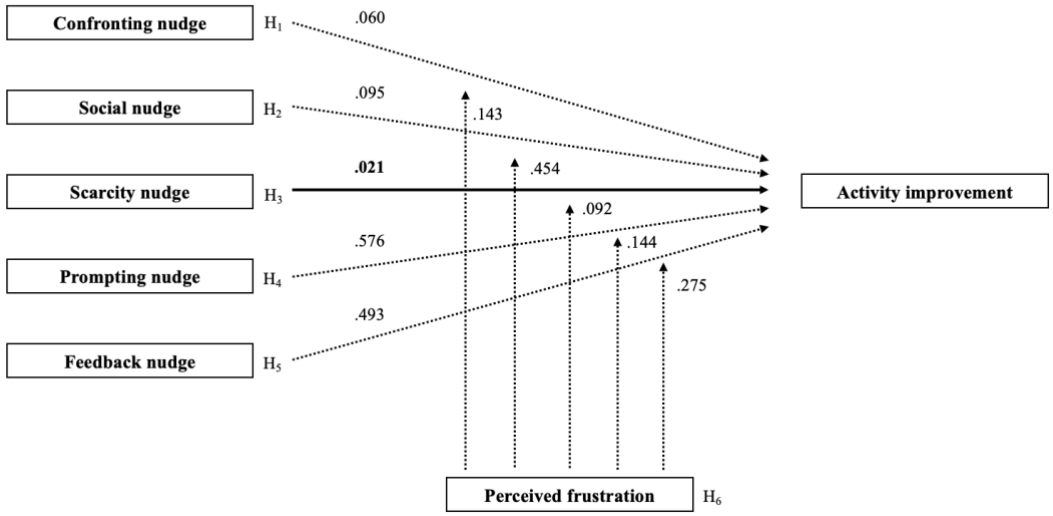
Variable	*B*	*SE*	*β*	*t*	*p*	R^2	*adj.* R^2
Combined score of Grouping 1 and Grouping 2							
Step 1						.08	.07
Constant	3.97	0.24		16.53	< .001		
Gender	- 0.07	0.10	- .05	- 0.70	.487		
Age groups	- 0.05	0.04	- .09	- 1.25	.212		
Length of use	0.04	0.03	.09	1.30	.196		
Usage	- 0.13	0.04	- .24	- 3.34	.001		
Step 2						.22	.18
Constant	3.97	0.23		17.52	< .001		
Gender	- 0.10	0.09	- .07	- 1.07	.286		
Age groups	- 0.03	0.04	- .04	- 0.65	.514		
Length of use	0.05	0.03	.10	1.55	.124		
Usage	- 0.14	0.04	- .25	- 3.68	< .001		
Effectiveness confronting nudge	0.08	0.05	.13	1.67	.096		
Effectiveness social nudge	0.07	0.05	.10	1.43	.155		
Effectiveness scarcity nudge	0.13	0.05	.19	2.43	.016		
Effectiveness prompting nudge	0.01	0.05	.01	0.19	.849		
Effectiveness feedback nudge	0.05	0.06	.06	0.84	.401		
Step 3						.25	.19
Constant	3.94	0.23		17.36	< .001		
Gender	- 0.10	0.09	- .07	- 1.09	.275		
Age groups	- 0.03	0.04	- .05	- 0.67	.502		
Length of use	0.05	0.03	.11	1.58	.115		
Usage	- 0.14	0.04	- .24	- 3.64	< .001		
Effectiveness confronting nudge	0.10	0.05	.16	1.89	.060		
Effectiveness social nudge	0.08	0.05	.12	1.68	.095		
Effectiveness scarcity nudge	0.12	0.05	.18	2.32	.021		
Effectiveness prompting nudge	- 0.03	0.06	- .05	- 0.56	.576		
Effectiveness feedback nudge	0.04	0.06	.05	0.69	.493		
Confronting nudge Interaction of effectiveness and frustration	- 0.07	0.05	- .10	- 1.47	.143		
Social nudge Interaction of effectiveness and frustration	- 0.03	0.04	- .05	- 0.75	.454		
Scarcity nudge Interaction of effectiveness and frustration	- 0.09	0.05	- .12	- 1.69	.092		
Prompting nudge Interaction of effectiveness and frustration	0.08	0.05	.10	1.47	.144		
Feedback nudge Interaction of effectiveness and frustration	0.09	0.09	.08	1.09	.275		

Turning to the interaction of frustration on the perceived effectiveness of the nudges and physical activity improvement. None of the nudges seems to deliver a significant amount of frustration that could impact the effect of the nudges on physical activity. From the regression analysis it can be seen that the confronting (β = - .071, p = .143), the social (β = - .033, p = .454), and the scarcity nudge (β = - .087, p = .092) have a negative influence on the users' activity, whereas prompting nudges (β = .081, p = .144) and feedback nudges (β = .095, p = .275) have a slight positive impact.

The results of the perceived effectiveness of the nudges and the influence of frustration for both groupings are combined in Figure 5. Only for the scarcity nudges significant results on the self-reported activity improvement are shown.

Figure 5

Regression effects of the effectiveness of the nudges and the perceived frustration with the nudges on activity improvement



4.5 Comparison of the perceived effectiveness of the five nudges

Two answer the second research question, a repeated measures ANOVA with the combined score of both groupings was conducted. As the assumption of sphericity was met, no correction for the degrees of freedom was needed. The analysis determined that the mean perceived effectiveness differed statically significant for the five different nudges (F (4, 812) = 7.05, $p < .001$). However, the strength of the association between the variables only showed a small effect size ($\eta^2 = .03$). To answer the question, which of the nudges was perceived as the most promising one, a post hoc analysis was conducted (Table 9). The post hoc analysis with a Bonferroni adjustment revealed that the perceived effectiveness of the social nudge was significantly lower than all the other nudges. There was no statistically significant effect between the four other nudges.

Table 9
Pairwise comparison - Perceived effectiveness of the five nudges

Combined perceived effectiveness	Combined perceived effectiveness	Mean Difference	Std. Error	*p*
1. Confronting nudge	2	0.234*	.081	.045
	3	- 0.022	.071	1.000
	4	- 0.089	.070	1.000
	5	- 0.120	.074	1.000
2. Social nudge	1	- 0.234*	.081	.045
	3	- 0.256*	.079	.014
	4	- 0.324*	.072	< .001
	5	- 0.354*	.079	< .001
3. Scarcity nudge	1	0.022	.071	1.000
	2	0.256*	.079	.014
	4	- 0.067	.071	1.000
	5	- 0.098	.072	1.000
4. Prompting nudge	1	0.089	.070	1.000
	2	0.324*	.072	< .001
	3	0.067	.071	1.000
	5	- 0.031	.071	1.000
5. Feedback nudge	1	0.120	.074	1.000
	2	0.354*	.079	< .001
	3	0.098	.072	1.000
	4	0.031	.071	1.000

4.6 Comparison of the perceived frustration with the five nudges

In order to determine which of the five nudges reported the highest perceived frustration another repeated measures ANOVA with the combined score for frustration for both groupings was conducted. This time the assumption of sphericity was violated. Consequently, a correction of the degrees of freedom is needed and the Huynh-Feldt correction was chosen ($\varepsilon > .75$). The repeated measures ANOVA with the Huynh-Feldt correction determined that the perceived frustration differed statistically significantly between the five nudges (F (3.81, 772.83) = 80.09, $p < .001$). The strength of the association between the variables showed a large effect size ($\eta^2 = .28$). Post hoc analysis with a Bonferroni adjustment revealed that the lowest statistically significant frustration was perceived with the feedback nudge, which is not surprising as this is the only nudge the offered positive feedback to the users. The highest level of frustration was perceived with the social nudge, compared to the scarcity, prompting, and feedback nudge, this difference was significant.

Table 10
Pairwise comparison - Perceived frustration with the five nudges

Combined perceived effectiveness	Combined perceived effectiveness	Mean Difference	Std. Error	*p*
1. Confronting nudge	2	- 0.147	.076	.530
	3	0.314*	.065	< .001
	4	0.194*	.060	.016
	5	0.941*	.068	< .001
2. Social nudge	1	0.147	.076	.530
	3	0.461*	.070	< .001
	4	0.341*	.071	< .001
	5	1.088*	.070	< .001
3. Scarcity nudge	1	- 0.314*	.065	< .001
	2	- 0.461*	.070	< .001
	4	- 0.120	.064	.620
	5	0.627*	.056	< .001
4. Prompting nudge	1	- 0.194*	.060	.016
	2	- 0.341*	.072	< .001
	3	0.12	.064	.620
	5	0.748*	.060	< .001
5. Feedback nudge	1	- 0.941*	.068	< .001
	2	- 1.088*	.070	< .001
	3	- 0.627*	.056	< .001
	4	- 0.748*	.060	< .001

5 Discussion

This chapter begins by summarizing the main findings of the study. Next, the theoretical and practical implications are presented. At last, the limitations are discussed and recommendations for future research are given.

5.1 Main findings

As stated in the introduction the main aim of this research was to investigate if nudges on wearable devices can have a positive effect on their users' physical activity. The findings are based on self-reported behavior of wearable device users. Five different nudges were considered to address multiple types of brands and users. The five nudges were categorized as confronting nudges, social nudges, scarcity nudges, prompting nudges, and feedback nudges. Considering that the nudges have different impacts, it was questioned if there was one nudge that is most promising in increasing the users' physical activity. Furthermore, it was discussed if nudges evoke frustration and how much of an impact this has on the perceived effectiveness of the nudges.

Returning to the research questions and hypotheses posed at the beginning of this article, it is now possible to state that only partial confirmation was found regarding the impact of nudges on the self-reported physical activity of the participants. The first research question, about the perceived effectiveness of the nudges on physical activity, cannot be answered completely. As a significant effect on physical activity was found for both groups separately in the correlation. However, this was not confirmed when assessing this relationship in the regression analysis. This indicates that it is a spurious relationship and other factors have a higher influence on the activity improvement than the nudges. Although nudges were found to be efficient in influencing user behavior (e.g., Nakamura & Matsuda, 2021; Pogue, 2013; Weinmann et al.,

2016) and wearable devices are seen as a promising tools in improving the users' physical activity (e.g., Randriambelonoro et al., 2017; Sullivan & Lachman, 2017; Yen & Huang, 2021), in this study the combination of these two factors did not deliver supportive results.

For this research only one of the five hypotheses regarding the nudges' perceived effectiveness on physical activity can be confirmed. Namely, that a significantly positive effect of the scarcity nudge can be found on the user's physical activity. Considering the proximity of the nudge to different gamification elements, namely receiving badges, medals, or points when being physically active, it is not surprising that these nudges have an impact. Studies that are focusing on gamification elements report high perceived effectiveness of motivating to physical activity (Benner et al., 2021; Fritz et al., 2014). It is also considerable that the motivation is higher when a goal is set and reachable (Chong et al., 2020; Fritz et al., 2014; Laranjo et al., 2021; Peng et al., 2021). In their study Benner and colleagues (2021) came to the conclusion that digital nudges and gamification elements address similar internal human need such as "autonomy, relatedness and competence" (p. 319) which are stimulated by psychological factors like "(1) social norms, (2) priming, (3) motivation, (4) choice and (5) representation" (p. 319). Therefore, they explain that the combination of nudges and gamification elements can be very persuasive to a certain degree. This is supported by this study as well, as wearable device users here stated that the scarcity nudges reported to lead to improved physical activity.

The second research question was designed to answer which of the five nudges is the most promising for increasing the users' physical activity. The analysis showed that there were no significant differences between the confronting nudge, the scarcity nudge, the prompting nudge, and the feedback nudge. Only the social nudge showed a significantly lower result than the

other nudges. Consequently, the second research question cannot be sufficiently answered with the results of this study. Since there is no previous study comparing the effects of different nudges, further research is necessary to provide an adequate answer to the question.

Regarding the use of wearable devices, the analysis of the factors usage and length of use delivered following results. There is a satisfactory effect found for a higher activity when participants used their device more often. This is in line with the findings of Peng and colleagues (2021) who stated that a continued engagement with the device leads to a positive behavior change. However, the findings also revealed that there was no substantial influence of the time that the participants used their wearable device on their activity improvement. According to previous research there could be multiple reasons influencing this result. On the one hand, the user interaction changes over time (Laranjo et al., 2021). Since this research had many kinds of users owning the wearable device for different length of time it could be possible that the effects were not consistent enough. It could also be possible that long-term users did not report a high level of change because the nudges they receive are still the same and do not adapt to their changing activity behavior and the expectations they have (Karahanoğlu et al., 2018).

The researcher Kim (2021) stated that it is critical to take positive and negative feelings into account in research when analyzing the interaction of users and their wearable devices. In this study, the factor of frustration was therefore included in the analysis. The findings confirm that frustration has some impact on the perceived effectiveness of the nudges, but this impact is not significant. When comparing the reported frustration with each of the five nudges, it can be seen that the lowest frustration was perceived with the feedback nudge and the highest frustration with the social nudge. Since the social nudge was also the one that reported the least

perceived effectiveness of all five nudges the factor of negative emotions is nevertheless one to consider when analyzing nudges.

5.2 Theoretical implications

Nudges, and especially digital nudges, have been proven efficient in influencing user behavior in the online context before (Caraban et al., 2019; Weßel et al., 2019). There were only limited studies before that focused on nudges on wearable devices (Nakamura & Matsuda, 2021; Yen & Huang, 2021). However, these studies did not fully define different types of nudging and did not analyze how these affected the user. The five different types of nudges that were included in this study delivered varying results about their perceived effectiveness. The scarcity nudge was perceived as effective in motivating towards greater physical activity. Considering the proximity of the nudge to different gamification elements, namely receiving badges, medals, or points when being physically active, it could be beneficial to further pursue the combination of digital nudges and gamification elements (Benner et al., 2021), especially on wearable devices.

Another reason why the nudges might not be effective enough, is the timing of the nudges. Depending on time and place, users might not be able to comply with the nudge. Especially, when users are at work or at social gatherings, one cannot get up right away to be physically active. Therefore, Purohit and Holzer (2019) provide a framework to identify the optimal nudge moment to deliver the nudge at the right time to be effective. This framework could help to improve prompting nudges on wearable devices.

5.3 Practical implications

Although only one of the hypotheses was confirmed, the study can provide some practical implications. Since the scarcity nudge was perceived as effective by users, providers of wearable devices could focus on developing nudges along these lines. As mentioned earlier, scarcity nudges reveal similarities with gamification element. Acknowledging this connection might help to improve nudges to be more appealing and beneficial to the user.

This study is based on the individual perceptions of the participants. Thus, effectiveness is based on whether a participant liked or disliked the specific nudge. Since the nudges participants receive are predetermined on the wearable devices, they offer little opportunity to customize them to the user's own needs. However, this seems to be a promising approach because techniques that can adapt to the users' personal goals and be tailored to their expectations have been proven to be more effective (Randriambelonoro et al., 2017; Sullivan & Lachman, 2017). Consequently, it is important that designers and researchers of wearable devices pay more attention to the different needs of users so that they can create the right nudges for them.

5.4 Limitations and recommendations

It is plausible that a number of limitations might have influenced the results obtained. These limitations could create some opportunities for future research. To begin with, the study relied on a self-reported online survey. Self-reported surveys can be potential sources of bias as it might not reflect real-life situations, but only what the participant reports (Babbie, 2016). It is plausible that the data collected may not accurately represent the reality because people report with a selective memory, remember only positive experiences, or exaggerate about some

circumstances. To overcome this issue, nudges could be tested in an experimental setting to analyze the direct effect of nudges.

Another factor that could influence the data is the sampling method. In this case a convenience sampling method was used which could cause a shift in the population because many university students took part. The data might therefore not accurately represent the population. For further research the sample could be expanded to include several age groups and people of different socioeconomic backgrounds.

As different wearable devices were considered in this research it could also affect the results because not all devices present the same nudges nor are these devices always accurate, some might have more precise sensors than others and data is collected differently (e.g., based on heart rate, blood oxygen, or GPS), which might affect the user experience. Additionally, the survey was only conducted with current users of wearable devices. Had non-users been included in the study, other information might have been obtained that went into more detail about why they stopped using the devices and whether this was related to the nudges. In order to receive a consistent result in the future, only one type of wearable device should be used to make sure that the nudges the users experience are the same.

Participants in this survey were also free to give feedback at the end. One user stated that he solely uses the watch for informative purposes, like looking at the time. In future research this could be questioned and should be considered as a moderating factor because it could have an impact on the results. As Ogbanufe and Gerhart (2018) stated, there are different purposes that users use wearable devices for, either for communication or for tracking activity. Users

that only need the device for communication could be less affected by the nudges for physical activity.

Another possible source of error is the varying number in users that received the nudges. Only 65 participants reported that they experienced the social nudge, compared to 168 participants who received the feedback nudge on their device. The different group sizes could have an impact on the significance and the power of the results. Additionally, the division of male and female participants varied greatly. Only 54 (26.5%) of the participants were male, compared to 150 (73.5%) female participants. Gender did not show a significant effect in this study which may or may not be influenced by these group sizes. Future research should focus on an equal distribution of the nudges and the gender of the participants to eliminate these limitations. As mentioned earlier, it may be appropriate to use only one brand of wearable device in future studies to ensure that the stimuli received are the same for all participants.

5.5 Conclusion

This research has focused on the application of different nudges on wearable devices and can give some insights for future developments in this context. Although most of the hypotheses were rejected, some interesting insights were provided with this study. Results show that the scarcity nudge was perceived to influence user behavior towards higher physical activity. Especially because scarcity nudges draw on gamification elements, they seem to be appealing and successful. The combination of playful elements, such as winning points, medals, or banners, seems to positively influence users and make it easier for them to become active.

The non-significant results for the other hypotheses, open the possibility for further research. On the one hand, it is possible that in the existing research the nudges were not

focused clearly enough to show results. On the other hand, there is the possibility to further develop the nudges to better adapt them to the user. For example, by providing more gamified nudges or by tailoring and personalizing the nudges to potentially improve their perceived effectiveness and influence on physical activity.

All in all, the scarcity nudge seems to offer potential for users of wearable devices. However, other types of nudges need to be explored in more depth, particularly not only based on self-reported results, but also by conducting experiments. Combining different research areas such as gamification with digital nudges could offer the possibility to improve their functionality and help users to improve their physical activity.

References

Aggarwal, P., Jun, S. Y., & Huh, J. H. (2011). Scarcity messages. *Journal of Advertising, 40*(3), 19–30. https://doi.org/10.2753/JOA0091-3367400302

Amirbayat, S. (2018, March 21st). *How Fitbit Ace uses nudges to encourage kids to be healthy.* Keeping TABS. Retrieved May 28th, 2021, from https://medium.com/@canvas8/behavioural-insights-fitbit-nudges-exercise-health-fitness-8cb98f8d5543

Apple (n.d.). *Close your Rings*. Retrieved May 28th, 2021, from https://www.apple.com/watch/close-your-rings/

Babbie, E. R. (2016). *The practice of social research* (Fourteenth). Cengage Learning.

Benner, D., Schöbel, S., & Janson, A. (2021). Exploring the State-of-the-Art of Persuasive Design for Smart Personal Assistants. *WI 2021: Innovation Through Information Systems, 47,* 316-332. https://doi.org/10.1007/978-3-030-86797-3_21

Blumenthal-Barby, J. S. (2013). Choice architecture: improving choice while preserving liberty?. In Coons, C., & Weber, M. (Eds.), *Paternalism: Theory and practice* (pp. 178-196). Cambridge University Press.

Bucher, T., Collins, C., Rollo, M. E., McCaffrey, T. A., De Vlieger, N., Van der Bend, D., ... & Perez-Cueto, F. J. (2016). Nudging consumers towards healthier choices: a systematic review of positional influences on food choice. *British Journal of Nutrition*, *115*(12), 2252-2263. https://doi.org/10.1017/S0007114516001653

Bull, F. C., Al-Ansari, S. S., Biddle, S., Borodulin, K., Buman, M. P., Cardon, G., ... & Willumsen, J. F. (2020). World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *British journal of sports medicine, 54*(24), 1451-1462. https://doi.org/10.1136/bjsports-2020-102955

Caraban, A., Karapanos, E., Gonçalves, D., & Campos, P. (2019). 23 ways to nudge: A review of technology-mediated nudging in human-computer interaction. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (pp.1-15). https://doi.org/10.1145/3290605.3300733

Chong, K. P., Guo, J. Z., Deng, X., & Woo, B. K. (2020). Consumer perceptions of wearable technology devices: retrospective review and analysis. *JMIR mHealth and uHealth*, *8*(4), e17544. https://doi.org/10.2196/17544

Ehrlén, V. (2021). Tracking oneself for others: communal and self-motivational value of sharing exercise data online, *Leisure Studies*, *40*(4), 545-560. https://doi.org/10.1080/02614367.2020.1869289

Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. Sage Publications.

Fitbit (n.d.). *Home*. Retrieved March 23rd, 2022, from https://www.fitbit.com/global/us/home

Fritz, T., Huang, E. M., Murphy, G. C., & Zimmermann, T. (2014). Persuasive technology in the real world: a study of long-term use of activity sensing devices for fitness. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 487-496). https://doi.org/10.1145/2556288.2557383

Garmin (n.d.). *Wearables*. Retrieved March 23rd, 2022, from https://www.garmin.com/en-US/c/wearables-smartwatches/

Hirano, S. H., Farrell, R. G., Danis, C. M., & Kellogg, W. A. (2013). WalkMinder: encouraging an active lifestyle using mobile phone interruptions. In *CHI'13 Extended Abstracts on Human Factors in Computing Systems* (pp. 1431-1436). https://doi.org/10.1145/2468356.2468611

IDC (2021, March 15th). *Consumer Enthusiasm for Wearable Devices Drives the Market to 28.4% Growth in 2020, According to IDC.* International Data Corporation. Retrieved May 9th, 2021, from https://www.idc.com/getdoc.jsp?containerId=prUS47534521

Kahneman, D. (2003). A perspective on judgment and choice: Mapping bounded rationality. *American Psychologist, 58*(9), 697–720. https://doi.org/10.1037/0003-066X.58.9.697

Kahneman, D., & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica, 47*(2), 263–291. https://doi.org/10.2307/1914185

Karahanoğlu, A., Van Rompay, T., & Ludden, G. D. (2018). Designing for Lifelong Sports Experience. In *Design Research Society 2018: Catalyst, 5,* 2216. https://doi.org/10.21606/drs.2018.413

Kelders, S. M., Kok, R. N., Ossebaard, H. C., & van Gemert-Pijnen, J. E. W. C. (2012). Persuasive system design does matter: a systematic review of adherence to web-based interventions. *Journal of Medical Internet Research, 14*(6), 2–25. https://doi.org/10.2196/jmir.2104

Kim, M. (2021). Conceptualization of e-servicescapes in the fitness applications and wearable devices context: multi-dimensions, consumer satisfaction, and behavioral intention. *Journal of Retailing and Consumer Services, 61,* 102562–102562. https://doi.org/10.1016/j.jretconser.2021.102562

Lanzing, M. (2019). “Strongly recommended” revisiting decisional privacy to judge hypernudging in self-tracking technologies. *Philosophy & Technology*, *32*(3), 549-568. https://doi.org/10.1007/s13347-018-0316-4

Laranjo, L., Ding, D., Heleno, B., Kocaballi, B., Quiroz, J. C., Tong, H. L., ... & Bates, D. W. (2021). Do smartphone applications and activity trackers increase physical activity in adults? Systematic review, meta-analysis and metaregression. *British journal of sports medicine*, *55*(8), 422-432. http://doi.org/10.1136/bjsports-2020-102892

Lee, S. M., & Lee, D. H. (2020). Healthcare wearable devices: an analysis of key factors for continuous use intention. *Service Business: An International Journal, 14*(4), 503–531. https://doi.org/10.1007/s11628-020-00428-3

Lunney, A., Cunningham, N. R., & Eastin, M. S. (2016). Wearable fitness technology: a structural investigation into acceptance and perceived fitness outcomes. *Computers in Human Behavior, 65*, 114–120. https://doi.org/10.1016/j.chb.2016.08.007

Lupton, D., & Maslen, S. (2019). How women use digital technologies for health: qualitative interview and focus group study. *Journal of Medical Internet Research*, *21*(1), e11481. https://doi.org/10.2196/11481

Mele, C., & Spena T.K. (2020). Smart Nudging: How cognitive technologies enable choice architectures for value co-creation. *Journal of Business Research, 129*, 949-960. https://doi.org/10.1016/j.jbusres.2020.09.004

Merriam-Webster. (n.d.-a). Frustrated. In *Merriam-Webster.com dictionary*. Retrieved March 24, 2022, from https://www.merriam-webster.com/dictionary/frustrated

Merriam-Webster. (n.d.-b). Wearable. In *Merriam-Webster.com dictionary*. Retrieved April 2, 2022, from https://www.merriam-webster.com/dictionary/wearable

Meske, C., & Amojo, I. (2020). Status quo, critical reflection, and the road ahead of digital nudging in information systems research: a discussion with Markus Weinmann and Alexey Voinov. *Communications of the Association for Information Systems*, *46*, 402–420. https://doi.org/10.17705/1CAIS.04617

Nakamura, Y., & Matsuda, Y. (2021). IoT Nudge: IoT Data-driven Nudging for Health Behavior Change. *Adjunct Proceedings of the 2021 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2021 ACM International Symposium on Wearable Computers*, 51-53. https://doi.org/10.1145/3460418.3479280

Ogbanufe, O., & Gerhart, N. (2018). Watch it! Factors driving continued feature use of the smartwatch. *International Journal of Human–Computer Interaction*, *34*(11), 999-1014. https://doi.org/10.1080/10447318.2017.1404779

Peng, W., Li, L., Kononova, A., Cotten, S., Kamp, K., & Bowen, M. (2021). Habit Formation in Wearable Activity Tracker Use Among Older Adults: Qualitative Study. *JMIR mHealth and uHealth*, *9*(1), e22488. https://doi.org/10.2196/22488

Pinto A. J., Dunstan, D. W., Owen, N., Bonfá E., & Gualano, B. (2020). Combating physical inactivity during the covid-19 pandemic. *Nature Reviews Rheumatology*, *16*(7), 347–348. https://doi.org/10.1038/s41584-020-0427-z

Pogue, D. (2013, June 26th). *Wearable Devices Nudge You to Health*. New York Times. Retrieved May 28th, 2021 from https://www.nytimes.com/2013/06/27/technology/personaltech/wearable-devices-nudge-you-to-a-healthier-lifestyle.html

Psychology Today (n.d.). *Habit Formation*. Psychology Today. Retrieved April 15th, 2022, from, https://www.psychologytoday.com/intl/basics/habit-formation

Purohit, A. K., & Holzer, A. (2019). Functional digital nudges: Identifying optimal timing for effective behavior change. In *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems* (pp. 1-6). https://doi.org/10.1145/3290607.3312876

Randriambelonoro, M., Chen, Y., & Pu, P. (2017). Can fitness trackers help diabetic and obese users make and sustain lifestyle changes?. *Computer*, *50*(3), 20-29. https://doi.org/10.1109/MC.2017.92

Rieder, A., Eseryel, U. Y., Lehrer, C., & Jung, R. (2021). Why users comply with Wearables: The role of contextual self-efficacy in behavioral change. *International Journal of Human–Computer Interaction*, *37*(3), 281-294. https://doi.org/10.1080/10447318.2020.1819669

Ryan, J., Edney, S., & Maher, C. (2019). Anxious or empowered? A cross-sectional study exploring how wearable activity trackers make their owners feel. *BMC Psychology*, *7*(1), 1-8. https://doi.org/10.1186/s40359-019-0315-y

Schneider, A. L. J., & Graham, T. N. (2017). Nudging and shoving: Using in-game cues to guide player exertion in exergames. *Entertainment Computing*, *19*, 83-100. https://doi.org/10.1016/j.entcom.2017.01.002

Schneider, C., Weinmann, M., & vom Brocke, J. (2018). Digital nudging: guiding online user choices through interface design. *Communications of the ACM, 61*(7), 67-73. https://doi.org/10.1145/3213765

Sullivan, A. and Lachman, M. (2017). Behavior Change with Fitness Technology in Sedentary Adults: A Review of the Evidence for Increasing Physical Activity. *Frontiers in Public Health, 4*, 289. https://doi.org/10.3389/fpubh.2016.00289

Sunstein, C.R. (2014). Nudging: A Very Short Guide. *Journal of Consumer Policy, 37*(4), 583–588. https://doi.org/10.1007/s10603-014-9273-1

Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness.* Yale University Press.

Thaler, R. H., Sunstein, C. R., and Balz, J. P. (2013). Choice Architecture. In E. Shafir (ed.), *The Behavioral Foundations of Public Policy*, (pp. 428-439), Princeton University Press.

Thomas, R. J., Masthoff, J., & Oren, N. (2019). Can I influence you? Development of a scale to measure perceived persuasiveness and two studies showing the use of the scale. *Frontiers in Artificial Intelligence, 2*, 24. https://doi.org/10.3389/frai.2019.00024

Weijters, B., Baumgartner, H., & Schillewaert, N. (2013). Reversed item bias: an integrative model. *Psychological Methods*, *18*(3), 320–34. https://doi.org/10.1037/a0032121

Weinmann, M., Schneider, C., & vom Brocke, J. (2016). Digital nudging. *Business & Information Systems Engineering: The International Journal of Wirtschafts-informatik*, *58*(6), 433–436. https://doi.org/10.1007/s12599-016-0453-1

Weßel, G., Altendorf, E., Schwalm, M., Canpolat, Y., Burghardt, C., & Flemisch, F. (2019). Self-determined nudging: a system concept for human–machine interaction. *Cognition, Technology & Work*, *21*(4), 621–630. https://doi.org/10.1007/s10111-019-00556-5

WHO (2020, November 26th). *Physical Activity*. World Health Organization. Retrieved May 28th, 2021, from https://www.who.int/news-room/fact-sheets/detail/physical-activity

Windasari, N. A., & Lin, F. (2021). Why Do People Continue Using Fitness Wearables? The Effect of Interactivity and Gamification. *SAGE Open*, *11*(4), 215824402110566–215824402110566. https://doi.org/10.1177/21582440211056606

Yen, H. Y., & Huang, H. Y. (2021). Comparisons of physical activity and sedentary behavior between owners and non-owners of commercial wearable devices. *Perspectives in Public Health, 141*(2), 89–96. https://doi.org/10.1177/1757913921989389

Yeung, K. (2017). ‘Hypernudge’: big data as a mode of regulation by design. *Information, Communication & Society*, *20(1)*, 118–136. https://doi.org/10.1080/1369118X.2016.1186713

Zipf, G. K. (1949). *Human behavior and the principle of least effort*. Addison-Wesley Press.

Appendix

Appendix A – Table 4

Table 4

Varimax rotated component matrix to build health improvement scale

Variable	Component	
	1	2
Health improvement		
Since adopting a wearable device I have lost weight		0.78
Since adopting a wearable device I have increased physical activity	**0.52**	0.64
Since adopting a wearable device I have lived a healthier lifestyle		0.88
Active lifestyle		
Since adopting the wearable device I am ...less active - ...more active	**0.71**	0.46
Since adopting the wearable device I am ...less healthy - ...more healthy	**0.51**	0.62
Since adopting the wearable device I am ...less agile - ...more agile	**0.62**	0.47
Exercise workout		
Since adopting a wearable device I workout ...less frequent - ...more frequent	**0.82**	0.25
Since adopting a wearable device I workout ...less intense - ...more intense	**0.81**	
Since adopting a wearable device I workout …shorter - …longer	**0.79**	

Appendix B – Survey German and English

UNIVERSITY OF TWENTE.

Informed_Consent

Du bist eingeladen, an einer Studie mit dem Titel *The Use of Digital Nudges on Wearable Devices for improving Physical Activity* teilzunehmen. Diese Studie wird von Ann-Sophie Zey von der Fakultät *Behavioural, Management and Social Sciences* an der *University of Twente* durchgeführt.

Ziel dieser Studie ist es, den Zusammenhang zwischen der Verwendung von Aktivitätstrackern und der Auswirkung auf die körperliche Aktivität zu untersuchen. Das Ausfüllen der Studie wird etwa **10 bis 15 Minuten** dauern. Die Daten werden für meine Masterarbeit im Rahmen des Masterstudiengangs Communication Science verwendet.

Deine Teilnahme an dieser Studie ist freiwillig und du kannst jederzeit während des Ausfüllens des Fragebogens aussteigen. Mit der Abgabe deiner Antworten erklärst du dich jedoch damit einverstanden, dass deine Daten für meine Studie verwendet werden. Bitte versuche, die Fragen so ehrlich und korrekt wie möglich auszufüllen.

Das Forschungsprojekt wurde von der BMS-Ethikkommission geprüft und genehmigt. Es sind keine Risiken im Zusammenhang mit dieser Studie bekannt. Nach bestem Wissen und Gewissen werden deine Antworten in dieser Studie vertraulich behandelt. Im Rahmen dieser Studie werden personenbezogene Daten erhoben (z. B. Geschlecht, Alter, Verwendung von Aktivitätstrackern, Verhalten), die jedoch nicht auf den/die Teilnehmer/in zurückgeführt werden können. Die gesammelten Daten werden bis zum Ende der Masterarbeit in Qualtrics gespeichert, was mit der GDPR (General Data Protection Regulation, auf Deutsch: DSGVO) konform ist. Deine Daten werden nur zwischen mir und den an der Studie beteiligten Dozenten weitergegeben.

Bei Fragen kontaktiere bitte:
Ann-Sophie Zey, a.zey@student.utwente.nl

Ich habe die Einwilligungserklärung gelesen.

- ○ Ich bin mit den oben genannten Bedingungen einverstanden und werde die Umfrage wahrheitsgemäß ausfüllen.
- ○ Ich bin mit den oben genannten Bedingungen nicht einverstanden.

Inclusion_Criteria

In dieser Umfrage wird der Begriff „Aktivitätstracker" verwendet. In diesem Fall bedeutet dies jede Art von Gerät, welches deine tägliche körperliche Aktivität zusammen mit anderen Daten in Bezug auf deine Fitness oder Gesundheit aufzeichnet, wie z. B. die Anzahl der verbrannten Kalorien oder die Herzfrequenz, und dir Informationen und Feedback zu deiner Leistung gibt.

UNIVERSITY OF TWENTE.

Informed_Consent

You are being invited to participate in a study titled *The use of digital nudges on wearable devices for improving physical activity*. This study is being conducted by Ann-Sophie Zey from the Faculty of Behavioral, Management and Social Sciences at the University of Twente.

The purpose of this study is to examine the relationship between the use of wearable devices and the effect on physical activity, and will take you approximately **10 to 15 minutes** to complete. The data will be used for my Master Thesis of the Master Communication Science.

Your participation in this study is entirely voluntary and you can withdraw at any time whilst filling out the survey. However, if you submit your answers, you agree that your data will be used for my study. Please try to fill out the questions as sincere and accurate as possible.

The research project has been reviewed and approved by the BMS Ethics Committee. There are no known risks associated with this study. To the best of my ability your answers in this study will remain confidential. This research will collect personal data (e.g. gender, age, use of wearable device, behavior), but it will not be retraceable to the participant. The collected data will be stored in Qualtrics, that is compliant to the GDPR (General Data Protection Regulation, in Dutch: AVG), and will be stored there until the end of the Master Thesis. Your data will only be distributed between the researcher and the teachers involved in the study.

If you have any questions you can contact:
Ann-Sophie Zey, a.zey@student.utwente.nl

I have read the consent form.

- ○ I agree to the above mentioned terms and conditions and will complete the survey truthfully.
- ○ I do not agree to the above mentioned terms and conditions.

Inclusion_Criteria

In this survey the term „wearable device" will be used. In this case this means any kind of device that records your daily physical activity, together with other data relating to your fitness or health, such as the number of calories burned, heart rate, etc., and gives you information and feedback based on your performance.

Do you use a wearable device?

- ○ Yes

Nutzt du einen Aktivitätstracker?

- ○ Ja
- ○ Nein

1.Confront

An Konsequenzen erinnern
Diese Nachricht erinnert dich an dein Ziel und reagiert auf dein bisheriges Verhalten. Wenn dein Aktivitätstracker einen Mangel an Aktivität feststellt, zeigt es dir an, dass du dein Verhalten ändern solltest.

Zeigt dein Aktivitätstracker dir diese Art von Nachrichten an?

- ○ Ja
- ○ Nein
- ○ Ich bin mir nicht sicher

Bitte gib an, inwieweit du den folgenden Aussagen in Bezug auf deine körperliche Aktivität zustimmst oder nicht zustimmst, indem du dich auf das Bild und den Text beziehst.

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Diese Nachricht bewirkte, dass ich mein Verhalten änderte.	○	○	○	○	○
Diese Nachricht bewirkte kleinere Veränderungen in meinem Verhalten.	○	○	○	○	○
Nachdem ich diese Nachricht gesehen habe, habe ich meine Einstellung geändert.	○	○	○	○	○

- ○ No

1.Confront

Reminding of Consequences
This nudge reminds you of your goal and reacts towards your previous behavior. If the wearable device notices a lack of activity this nudge will show you to change your behavior.

Does your wearable device show you these kinds of messages?

- ○ Yes
- ○ No
- ○ I am not sure

Please indicate how much you agree or disagree with the following statement regarding your physical activity by referring to the picture and text.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
This message caused changes in my behavior.	○	○	○	○	○
This message caused me to make some changes in my behavior.	○	○	○	○	○
After viewing this message, I made changes in my attitude.	○	○	○	○	○
This message has the potential to influence user behavior.	○	○	○	○	○

Please indicate how much you agree or disagree with the following statement regarding your physical activity by referring to the picture and text.

Diese Nachricht hatte in der Vergangenheit das Potenzial, mein Verhalten zu beeinflussen.	○	○	○	○	○

Bitte gib an, inwieweit du den folgenden Aussagen zustimmst oder nicht zustimmst, indem du dich auf das Bild und den Text beziehst.

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Ich bin frustriert, wenn ich diese Nachricht bekomme.	○	○	○	○	○
Ich fühle mich durch diese Nachricht irritiert.	○	○	○	○	○
Ich bin verärgert, wenn mir diese Nachricht angezeigt wird.	○	○	○	○	○
Mir gefällt es, wenn mir diese Nachricht angezeigt wird.	○	○	○	○	○

Bitte gib an, inwieweit du den folgenden Aussagen zustimmst oder nicht zustimmst, indem du dich auf das Bild und den Text beziehst.

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Diese Nachricht würde Veränderungen in meinem Aktivitätsverhalten bewirken.	○	○	○	○	○
Diese Nachricht würde bei mir kleinere Verhaltensänderungen auslösen.	○	○	○	○	○
Nachdem ich diese Nachricht bekäme, würde ich meine Einstellung zu meiner körperlichen Aktivität ändern.	○	○	○	○	○
Diese Nachricht hätte das Potenzial, mein Verhalten zu beeinflussen.	○	○	○	○	○

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I feel frustrated when this message is presented.	○	○	○	○	○
I feel irritated when this message is presented.	○	○	○	○	○
I am annoyed when this message is presented.	○	○	○	○	○
I appreciate when this message is presented.	○	○	○	○	○

Please indicate how much you agree or disagree with the following statement regarding your physical activity by referring to the picture and text.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
This message would cause changes in my behavior.	○	○	○	○	○
This message would cause me to make some changes in my behavior.	○	○	○	○	○
After viewing this message, I would make changes in my attitude.	○	○	○	○	○
This message would have the potential to influence my behavior.	○	○	○	○	○

Please indicate how much you agree or disagree with the following statement regarding your physical activity by referring to the picture and text.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I would feel frustrated when this message is presented.	○	○	○	○	○
I would feel irritated when this message is presented.	○	○	○	○	○
I would feel annoyed when this message is presented.	○	○	○	○	○
I would appreciate when this message is presented.	○	○	○	○	○

2.Social_Influence

Bitte gib an, inwieweit du den folgenden Aussagen zustimmst oder nicht zustimmst, indem du dich auf das Bild und den Text beziehst.

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Ich wäre frustriert, wenn ich diese Nachricht bekäme.	○	○	○	○	○
Ich würde mich durch diese Nachricht irritiert fühlen.	○	○	○	○	○
Ich würde verärgert sein, wenn mir diese Nachricht angezeigt wird.	○	○	○	○	○
Mir würde es gefallen, wenn mir diese Nachricht angezeigt wird.	○	○	○	○	○

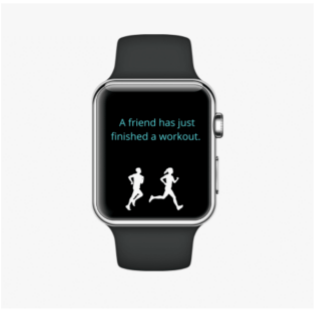
2.Social_Influence

Sozialer Vergleich
Aktivitätstracker bieten oft die Möglichkeit, deine Fortschritte mit Freunden, Familienmitgliedern oder sogar Fremden zu teilen. Gleichzeitig kannst du auch ihre Aktivitäten sehen. Wenn andere Nutzer/innen ein Ziel erreichen, trainieren oder große Fortschritte machen, werden diese Aktivitäten auf deinem Gerät geteilt, sodass du diese sehen kannst.

Zeigt dein Aktivitätstracker dir diese Art von Nachrichten an?

○ Ja
○ Nein
○ Ich bin mir nicht sicher

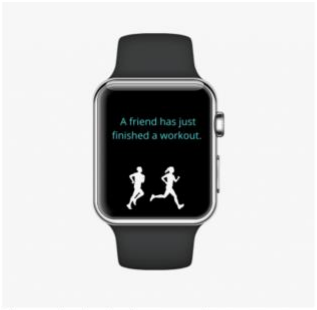
Bitte gib an, inwieweit du den folgenden Aussagen in Bezug auf deine körperliche Aktivität zustimmst oder nicht zustimmst, indem



Social Comparison
Wearable devices often offer the possibility to share your progress with friends, family, or even strangers. On the other hand you can also see their actions. If other users reach a goal, work out, or make great progress, these activities are shared on your device for you to see.

Does your wearable device show you these kinds of messages?

○ Yes
○ No
○ I am not sure



Please indicate how much you agree or disagree with the following statement regarding your physical activity by referring to the picture and text.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
This message caused changes in my behavior.	○	○	○	○	○
This message caused me to make some changes in my behavior.	○	○	○	○	○
After viewing this message, I made changes in my attitude.	○	○	○	○	○
This message has the potential to influence user behavior.	○	○	○	○	○

Please indicate how much you agree or disagree with the following statement regarding your physical activity by referring to the picture and text.

du dich auf das Bild und den Text beziehst.

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Diese Nachricht bewirkte, dass ich mein Verhalten änderte.	○	○	○	○	○
Diese Nachricht bewirkte kleinere Veränderungen in meinem Verhalten.	○	○	○	○	○
Nachdem ich diese Nachricht gesehen habe, habe ich meine Einstellung geändert.	○	○	○	○	○
Diese Nachricht hatte in der Vergangenheit das Potenzial, mein Verhalten zu beeinflussen.	○	○	○	○	○

Bitte gib an, inwieweit du den folgenden Aussagen zustimmst oder nicht zustimmst, indem du dich auf das Bild und den Text beziehst.

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Ich bin frustriert, wenn ich diese Nachricht bekomme.	○	○	○	○	○
Ich fühle mich durch diese Nachricht irritiert.	○	○	○	○	○
Ich bin verärgert, wenn mir diese Nachricht angezeigt wird.	○	○	○	○	○
Mir gefällt es, wenn mir diese Nachricht angezeigt wird.	○	○	○	○	○

Bitte gib an, inwieweit du den folgenden Aussagen zustimmst oder nicht zustimmst, indem du dich auf das Bild und den Text beziehst.

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Diese Nachricht würde Veränderungen in meinem Aktivitätsverhalten bewirken.	○	○	○	○	○
Diese Nachricht würde bei mir kleinere Verhaltensänderungen auslösen.	○	○	○	○	○
Nachdem ich diese Nachricht bekäme, würde ich meine Einstellung zu meiner körperlichen Aktivität ändern.	○	○	○	○	○
Diese Nachricht hätte das Potenzial, mein Verhalten zu beeinflussen.	○	○	○	○	○

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I feel frustrated when this message is presented.	○	○	○	○	○
I feel irritated when this message is presented.	○	○	○	○	○
I am annoyed when this message is presented.	○	○	○	○	○
I appreciate when this message is presented.	○	○	○	○	○

Please indicate how much you agree or disagree with the following statement regarding your physical activity by referring to the picture and text.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
This message would cause changes in my behavior.	○	○	○	○	○
This message would cause me to make some changes in my behavior.	○	○	○	○	○
After viewing this message, I would make changes in my attitude.	○	○	○	○	○
This message would have the potential to influence my behavior.	○	○	○	○	○

Please indicate how much you agree or disagree with the following statement regarding your physical activity by referring to the picture and text.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I would feel frustrated when this message is presented.	○	○	○	○	○
I would feel irritated when this message is presented.	○	○	○	○	○
I would feel annoyed when this message is presented.	○	○	○	○	○
I would appreciate when this message is presented.	○	○	○	○	○

3.Scarcity

Bitte gib an, inwieweit du den folgenden Aussagen zustimmst oder nicht zustimmst, indem du dich auf das Bild und den Text beziehst.

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Ich wäre frustriert, wenn ich diese Nachricht bekäme.	○	○	○	○	○
Ich würde mich durch diese Nachricht irritiert fühlen.	○	○	○	○	○
Ich würde verärgert sein, wenn mir diese Nachricht angezeigt wird.	○	○	○	○	○
Mir würde es gefallen, wenn mir diese Nachricht angezeigt wird.	○	○	○	○	○

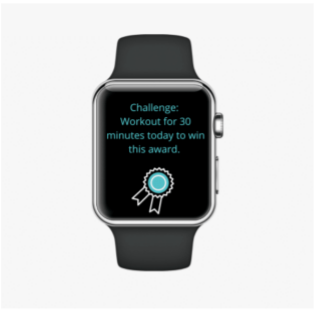
3.Scarcity

Verknappung
Dein Aktivitätstracker bietet dir verschiedene Herausforderungen oder Ziele an, die du innerhalb eines bestimmten Zeitrahmens erreichen musst, um Medaillen, Auszeichnungen oder Punkte zu gewinnen.

Zeigt dein Aktivitätstracker dir diese Art von Nachrichten an?

○ Ja
○ Nein
○ Ich bin mir nicht sicher

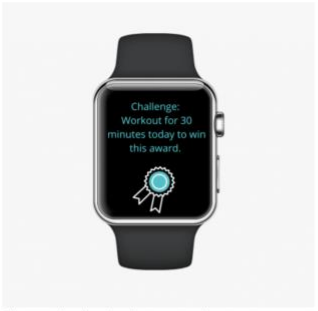
Bitte gib an, inwieweit du den folgenden Aussagen in Bezug auf deine körperliche Aktivität zustimmst oder nicht zustimmst, indem du dich auf das Bild und den Text beziehst.



Scarcity
The wearable device offers you different challenges or goals to reach in specific timeframes to win medals, banners, or points.

Does your wearable device show you these kinds of messages?

○ Yes
○ No
○ I am not sure



Please indicate how much you agree or disagree with the following statement regarding your physical activity by referring to the picture and text.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
This message caused changes in my behavior.	○	○	○	○	○
This message caused me to make some changes in my behavior.	○	○	○	○	○
After viewing this message, I made changes in my attitude.	○	○	○	○	○
This message has the potential to influence user behavior.	○	○	○	○	○

Please indicate how much you agree or disagree with the following statement regarding your physical activity by referring to the picture and text.

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Diese Nachricht bewirkte, dass ich mein Verhalten änderte.	○	○	○	○	○
Diese Nachricht bewirkte kleinere Veränderungen in meinem Verhalten.	○	○	○	○	○
Nachdem ich diese Nachricht gesehen habe, habe ich meine Einstellung geändert.	○	○	○	○	○
Diese Nachricht hatte in der Vergangenheit das Potenzial, mein Verhalten zu beeinflussen.	○	○	○	○	○

Bitte gib an, inwieweit du den folgenden Aussagen zustimmst oder nicht zustimmst, indem du dich auf das Bild und den Text beziehst.

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Ich bin frustriert, wenn ich diese Nachricht bekomme.	○	○	○	○	○
Ich fühle mich durch diese Nachricht irritiert.	○	○	○	○	○
Ich bin verärgert, wenn mir diese Nachricht angezeigt wird.	○	○	○	○	○
Mir gefällt es, wenn mir diese Nachricht angezeigt wird.	○	○	○	○	○

Bitte gib an, inwieweit du den folgenden Aussagen zustimmst oder nicht zustimmst, indem du dich auf das Bild und den Text beziehst.

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Diese Nachricht würde Veränderungen in meinem Aktivitätsverhalten bewirken.	○	○	○	○	○
Diese Nachricht würde bei mir kleinere Verhaltensänderungen auslösen.	○	○	○	○	○
Nachdem ich diese Nachricht bekäme, würde ich meine Einstellung zu meiner körperlichen Aktivität ändern.	○	○	○	○	○
Diese Nachricht hätte das Potenzial, mein Verhalten zu beeinflussen.	○	○	○	○	○

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I feel frustrated when this message is presented.	○	○	○	○	○
I feel irritated when this message is presented.	○	○	○	○	○
I am annoyed when this message is presented.	○	○	○	○	○
I appreciate when this message is presented.	○	○	○	○	○

Please indicate how much you agree or disagree with the following statement regarding your physical activity by referring to the picture and text.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
This message would cause changes in my behavior.	○	○	○	○	○
This message would cause me to make some changes in my behavior.	○	○	○	○	○
After viewing this message, I would make changes in my attitude.	○	○	○	○	○
This message would have the potential to influence my behavior.	○	○	○	○	○

Please indicate how much you agree or disagree with the following statement regarding your physical activity by referring to the picture and text.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I would feel frustrated when this message is presented.	○	○	○	○	○
I would feel irritated when this message is presented.	○	○	○	○	○
I would feel annoyed when this message is presented.	○	○	○	○	○
I would appreciate when this message is presented.	○	○	○	○	○

4.Just-in-Time-Prompts

Bitte gib an, inwieweit du den folgenden Aussagen zustimmst oder nicht zustimmst, indem du dich auf das Bild und den Text beziehst.

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Ich wäre frustriert, wenn ich diese Nachricht bekäme.	○	○	○	○	○
Ich würde mich durch diese Nachricht irritiert fühlen.	○	○	○	○	○
Ich würde verärgert sein, wenn mir diese Nachricht angezeigt wird.	○	○	○	○	○
Mir würde es gefallen, wenn mir diese Nachricht angezeigt wird.	○	○	○	○	○

4.Just-in-Time-Prompts

Rechtzeitige Aufforderungen
Dein Aktivitätstracker zeigt dir während deines aktiven Verhaltens Benachrichtigungen an, um dich zu motivieren, dieses aktive Verhalten fortzusetzen.

Zeigt dein Aktivitätstracker dir diese Art von Nachrichten an?

○ Ja
○ Nein
○ Ich bin mir nicht sicher

Bitte gib an, inwieweit du den folgenden Aussagen in Bezug auf deine körperliche Aktivität zustimmst oder nicht zustimmst, indem du dich auf das Bild und den Text beziehst.

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Diese Nachricht bewirkte, dass ich mein Verhalten änderte.	○	○	○	○	○

Just-in-time prompts
The wearable device offers you notifications during active behavior to motivate you to continue this behavior.

Does your wearable device show you these kinds of messages?

○ Yes
○ No
○ I am not sure

Please indicate how much you agree or disagree with the following statement regarding your physical activity by referring to the picture and text.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
This message caused changes in my behavior.	○	○	○	○	○
This message caused me to make some changes in my behavior.	○	○	○	○	○
After viewing this message, I made changes in my attitude.	○	○	○	○	○
This message has the potential to influence user behavior.	○	○	○	○	○

Please indicate how much you agree or disagree with the following statement regarding your physical activity by referring to the picture and text.

Diese Nachricht bewirkte kleinere Veränderungen in meinem Verhalten.	○	○	○	○	○
Nachdem ich diese Nachricht gesehen habe, habe ich meine Einstellung geändert.	○	○	○	○	○
Diese Nachricht hatte in der Vergangenheit das Potenzial, mein Verhalten zu beeinflussen.	○	○	○	○	○

Bitte gib an, inwieweit du den folgenden Aussagen zustimmst oder nicht zustimmst, indem du dich auf das Bild und den Text beziehst.

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Ich bin frustriert, wenn ich diese Nachricht bekomme.	○	○	○	○	○
Ich fühle mich durch diese Nachricht irritiert.	○	○	○	○	○
Ich bin verärgert, wenn mir diese Nachricht angezeigt wird.	○	○	○	○	○
Mir gefällt es, wenn mir diese Nachricht angezeigt wird.	○	○	○	○	○

Bitte gib an, inwieweit du den folgenden Aussagen zustimmst oder nicht zustimmst, indem du dich auf das Bild und den Text beziehst.

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Diese Nachricht würde Veränderungen in meinem Aktivitätsverhalten bewirken.	○	○	○	○	○
Diese Nachricht würde bei mir kleinere Verhaltensänderungen auslösen.	○	○	○	○	○
Nachdem ich diese Nachricht bekäme, würde ich meine Einstellung zu meiner körperlichen Aktivität ändern.	○	○	○	○	○
Diese Nachricht hätte das Potenzial, mein Verhalten zu beeinflussen.	○	○	○	○	○

Bitte gib an, inwieweit du den folgenden Aussagen zustimmst oder nicht zustimmst, indem du dich auf das Bild und den Text beziehst.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I feel frustrated when this message is presented.	○	○	○	○	○
I feel irritated when this message is presented.	○	○	○	○	○
I am annoyed when this message is presented.	○	○	○	○	○
I appreciate when this message is presented.	○	○	○	○	○

Please indicate how much you agree or disagree with the following statement regarding your physical activity by referring to the picture and text.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
This message would cause changes in my behavior.	○	○	○	○	○
This message would cause me to make some changes in my behavior.	○	○	○	○	○
After viewing this message, I would make changes in my attitude.	○	○	○	○	○
This message would have the potential to influence my behavior.	○	○	○	○	○

Please indicate how much you agree or disagree with the following statement regarding your physical activity by referring to the picture and text.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I would feel frustrated when this message is presented.	○	○	○	○	○
I would feel irritated when this message is presented.	○	○	○	○	○
I would feel annoyed when this message is presented.	○	○	○	○	○
I would appreciate when this message is presented.	○	○	○	○	○

5.Feedback

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Ich wäre frustriert, wenn ich diese Nachricht bekäme.	○	○	○	○	○
Ich würde mich durch diese Nachricht irritiert fühlen.	○	○	○	○	○
Ich würde verärgert sein, wenn mir diese Nachricht angezeigt wird.	○	○	○	○	○
Mir würde es gefallen, wenn mir diese Nachricht angezeigt wird.	○	○	○	○	○

5.Feedback

Feedback
Wenn du ein Training absolviert, ein Ziel erreicht oder eine Herausforderung gewonnen hast, bekommst du von deinem Aktivitätstracker positives Feedback.

Zeigt dein Aktivitätstracker dir diese Art von Nachrichten an?

○ Ja
○ Nein
○ Ich bin mir nicht sicher

Bitte gib an, inwieweit du den folgenden Aussagen in Bezug auf deine körperliche Aktivität zustimmst oder nicht zustimmst, indem du dich auf das Bild und den Text beziehst.

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Diese Nachricht bewirkte, dass ich mein Verhalten änderte.	○	○	○	○	○
Diese Nachricht bewirkte kleinere Veränderungen in meinem Verhalten.	○	○	○	○	○
Nachdem ich diese Nachricht gesehen habe, habe ich meine Einstellung geändert.	○	○	○	○	○

Feedback
After completing a workout, reaching a goal, or winning a challenge the wearable device gives you positive feedback.

Does your wearable device show you these kinds of messages?

○ Yes
○ No
○ I am not sure

Please indicate how much you agree or disagree with the following statement regarding your physical activity by referring to the picture and text.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
This message caused changes in my behavior.	○	○	○	○	○
This message caused me to make some changes in my behavior.	○	○	○	○	○
After viewing this message, I made changes in my attitude.	○	○	○	○	○
This message has the potential to influence user behavior.	○	○	○	○	○

Please indicate how much you agree or disagree with the following statement regarding your physical activity by referring to the picture and text.

Diese Nachricht hatte in der Vergangenheit das Potenzial, mein Verhalten zu beeinflussen.	○	○	○	○	○

Bitte gib an, inwieweit du den folgenden Aussagen zustimmst oder nicht zustimmst, indem du dich auf das Bild und den Text beziehst.

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Ich bin frustriert, wenn ich diese Nachricht bekomme.	○	○	○	○	○
Ich fühle mich durch diese Nachricht irritiert.	○	○	○	○	○
Ich bin verärgert, wenn mir diese Nachricht angezeigt wird.	○	○	○	○	○
Mir gefällt es, wenn mir diese Nachricht angezeigt wird.	○	○	○	○	○

Bitte gib an, inwieweit du den folgenden Aussagen zustimmst oder nicht zustimmst, indem du dich auf das Bild und den Text beziehst.

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Diese Nachricht würde Veränderungen in meinem Aktivitätsverhalten bewirken.	○	○	○	○	○
Diese Nachricht würde bei mir kleinere Verhaltensänderungen auslösen.	○	○	○	○	○
Nachdem ich diese Nachricht bekomme, würde ich meine Einstellung zu meiner körperlichen Aktivität ändern.	○	○	○	○	○
Diese Nachricht hatte das Potenzial, mein Verhalten zu beeinflussen.	○	○	○	○	○

Bitte gib an, inwieweit du den folgenden Aussagen zustimmst oder nicht zustimmst, indem du dich auf das Bild und den Text beziehst.

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Ich wäre frustriert, wenn ich diese Nachricht bekäme.	○	○	○	○	○
Ich würde mich durch diese Nachricht irritiert fühlen.	○	○	○	○	○
Ich würde verärgert sein, wenn mir diese Nachricht angezeigt wird.	○	○	○	○	○
Mir würde es gefallen, wenn mir diese Nachricht angezeigt wird.	○	○	○	○	○

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I feel frustrated when this message is presented.	○	○	○	○	○
I feel irritated when this message is presented.	○	○	○	○	○
I am annoyed when this message is presented.	○	○	○	○	○
I appreciate when this message is presented.	○	○	○	○	○

Please indicate how much you agree or disagree with the following statement regarding your physical activity by referring to the picture and text.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
This message would cause changes in my behavior.	○	○	○	○	○
This message would cause me to make some changes in my behavior.	○	○	○	○	○
After viewing this message, I would make changes in my attitude.	○	○	○	○	○
This message would have the potential to influence my behavior.	○	○	○	○	○

Please indicate how much you agree or disagree with the following statement regarding your physical activity by referring to the picture and text.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I would feel frustrated when this message is presented.	○	○	○	○	○
I would feel irritated when this message is presented.	○	○	○	○	○
I would feel annoyed when this message is presented.	○	○	○	○	○
Mir würde es gefallen, wenn mir diese Nachricht angezeigt wird.	○	○	○	○	○

Usage

What kind of wearable device do you use?

- ○ Apple Watch
- ○ Fitbit
- ○ Fossil

Usage

Welche Art von Aktivitätstracker nutzt du?

- ○ Apple Watch
- ○ Fitbit
- ○ Fossil
- ○ Garmin
- ○ Honor
- ○ Huawei
- ○ LG
- ○ Polar
- ○ Samsung
- ○ Withings
- ○ Xiaomi
- ○ [ ] Andere:

Wie lange nutzt du deinen Aktivitätstracker schon?

- ○ weniger als 3 Monate
- ○ 3 bis 6 Monate
- ○ 6 bis 12 Monate
- ○ 1 bis 2 Jahre
- ○ mehr als 2 Jahre

Wie oft nutzt du deinen Aktivitätstracker?

- ○ Täglich
- ○ Mehrmals pro Woche
- ○ Wöchentlich
- ○ Mehrmals im Monat
- ○ Monatlich
- ○ Seltener

Use of Wearable Devices

Bitte gib an, inwieweit du den folgenden Aussagen zustimmst oder diese ablehnst.

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Ich nutze meinen Aktivitätstracker gerne.	○	○	○	○	○
Ich nutze meinen Aktivitätstracker aktiv.	○	○	○	○	○
Ich empfehle anderen in meiner Umgebung die Verwendung eines Aktivitätstrackers.	○	○	○	○	○
Ich bin sicher im Umgang mit meinem Aktivitätstracker.	○	○	○	○	○

Bitte gebe an, inwieweit du den folgenden Aussagen zustimmst oder diese ablehnst.

	Stimme überhaupt nicht zu	Stimme nicht zu	Neutral	Stimme zu	Stimme voll und ganz zu
Seit ich einen Aktivitätstracker verwende, habe ich abgenommen.	○	○	○	○	○
Seitdem ich einen Aktivitätstracker verwende, bin ich sportlich aktiver.	○	○	○	○	○
Seitdem ich einen Aktivitätstracker verwende, lebe ich gesünder.	○	○	○	○	○

- ○ Garmin
- ○ Honor
- ○ Huawei
- ○ LG
- ○ Polar
- ○ Samsung
- ○ Withings
- ○ Xiaomi
- ○ [ ] Other:

How long have you been using your wearable device?

- ○ less than 3 months
- ○ 3 to 6 months
- ○ 6 to 12 months
- ○ 1 to 2 years
- ○ longer than 2 years

How often do you use your wearable device?

- ○ Daily
- ○ Several times a week
- ○ Weekly
- ○ Several times a month
- ○ Monthly
- ○ Even rarer

Use of Wearable Devices

Please indicate how much you agree or disagree with the following statement.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I enjoy using my wearable device.	○	○	○	○	○
I am actively using my wearable device.	○	○	○	○	○
I recommend using a wearable device to others around me.	○	○	○	○	○
I am confident in using a wearable device.	○	○	○	○	○

Please indicate how much you agree or disagree with the following statement.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Since adopting a wearable device I have lost weight.	○	○	○	○	○
Since adopting a wearable device I have increased physical activity.	○	○	○	○	○
Since adopting a wearable device I have lived a healthier lifestyle.	○	○	○	○	○

Since adopting the wearable device I am...

...less active.				...more active.
○	○	○	○	○
...less healthy.				...more healthy.
○	○	○	○	○

Seitdem ich einen Aktivitätstracker verwende, bin ich...

...weniger aktiv.				...aktiver.
○	○	○	○	○
...weniger gesund.				...gesünder.
○	○	○	○	○
...weniger beweglich.				...beweglicher.
○	○	○	○	○

Seitdem ich den Aktivitätstracker verwende, trainiere ich...

...weniger.				...mehr.
○	○	○	○	○
...weniger intensiv.				...intensiver.
○	○	○	○	○
...kürzer.				...länger.
○	○	○	○	○

Demographics

Wie alt bist du?

Welches Geschlecht hast du?

- ○ Männlich
- ○ Weiblich
- ○ Divers
- ○ Keine Angabe

Hast du noch Anmerkungen oder Fragen zu dieser Umfrage?

Powered by Qualtrics

...less agile.				...more agile.
○	○	○	○	○

Since adopting the wearable device I workout...

...less frequent.				...more frequent.
○	○	○	○	○
...less intense.				...more intense.
○	○	○	○	○
...shorter.				...longer.
○	○	○	○	○

Demographics

What is your age?

What is your gender?

- ○ Male
- ○ Female
- ○ Divers
- ○ Prefer not to say

Do you have any comments or questions about this survey?

Powered by Qualtrics