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Understanding engagement with health-apps: An evaluation of user experiences with the long-term usage of health-apps and wearables

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Abstract

Nowadays, combining health-apps with wearables is a popular way to monitor and adjust the own behavior, in order to lead a healthy lifestyle. Hereby, the concept of engagement is important to address, because engagement is related to an effective usage of those devices.

In order to find out which factors make people feel engaged with health-apps, and whether wearables can offer an additional value to the long-term usage of those apps, an interview study was done. Therefore five participants were interviewed. A semi-structured interview scheme was used about factors that were perceived to have an influence on the engagement with those devices. The age of the participants ranged between 24 and 53 years, who used the combination of the devices between five months and three years. The results showed that there were personal factors that made people feel engaged, e.g. intrinsic motivation, but also technological factors, e.g. reminders. There were also factors found, which were perceived as disengaging, e.g. a lack of trustworthiness. Furthermore, it was found that during the usage over a longer period a bond between user and device was created, which made it less likely that people stop using the intervention. Finally, it was found that wearables can help to feel more engaged with a health app, as they help to make the usage more accurate and effortless.

These findings are in line with Fogg's Behavior Model for Persuasive Design (Fogg, 2009), which describes that the desired behavior is performed when the motivation, the ability and the trigger to change are present. But also several stages of engagement (O'Brien & Toms, 2008) are found back in the results, which imply specific factors that make the user feel engaged, e.g. the ubiquity of the devices to avoid disengagement. So, the concept of engagement is important to consider in order to enhance the effectiveness of an health intervention. But literature still lacks on finding a clear definition of engagement, which should be focused in future research.

Samenvatting

Tegenwoordig wordt het gebruik van gezondheidsapps en fitnesstrackers (wearables) populairder, waarbij mensen door het observeren van hun gedrag proberen hun leefstijl te verbeteren. Hierbij is een niet adherent gedrag een groot probleem, wat vaak veroorzaakt wordt door een gebrek aan engagement. Om te weten te komen, wat mensen engageert maakt met een gezondheidsapp, en of een wearable hierbij een toevoegende waarde heeft, werd een interview studie gedaan. Vijf respondenten tussen 24 en 53 jaar werden verzameld, die de combinatie van app en wearable tussen vijf maanden en drie jaren gebruikten. De resultaten lieten zien, dat er zowel persoonlijke factoren en rol speelden, zoals een intrinsieke motivatie, als ook technologische factoren, zoals herinneringen vanuit de app en de wearable. Verder werden er factoren gevonden, die mensen demotiveren om een app over een langer tijdstip te gebruiken, zoals een gebrek aan vertrouwen. Daarnaast werd gevonden, dat er tussen de toestellen en de gebruiker een bond kan ontstaan, die ervoor zorgt dat mensen een interventie langer gebruiken omdat ze zich hiermee verbonden voelen. Bovendien kan gezegd worden, dat mensen zich motiveert voelen een app langer te gebruiken, wanneer deze met een wearable gecombineerd wordt.

De resultaten kunnen gekoppeld worden aan theoretische bevindingen van Fogg (2009), die in zijn ‘Behavior Model for Persuasive Design’ beschrijft dat het gewenste gedrag uitgevoerd wordt, als mensen motiveert zijn, de mogelijkheid tot verandering hebben en een soort ‘trigger’ ervaren. Daarnaast kon ook gevonden worden, dat mensen na een tijd de houding tegenover een app veranderen en dat op verschillende tijdstippen verschillende factoren belangrijk voor engagement zijn. Dit kan gekoppeld worden aan de ‘stages of engagement’ van O’Brien and Toms (2008). Dus het concept van engagement is belangrijk om de effectiviteit van mHealth interventies te vergroten. Echter bestaat er nog geen duidelijke definitie van engagement, wat verder onderzoek nodig maakt.

Introduction

Supporting patient autonomy recently has become a popular topic within the healthcare sector. Whereas in earlier years the health professionals decided the best possible outcome for health issues, people nowadays take a more active role (Doherty & Doherty, 2005). People do not longer see themselves as passive patients but want to be informed about their health status independently from a medical institution. This leads to a higher demand of sources that can bring practical health support in daily life. Hereby, eHealth plays an important role. eHealth is defined as *'(...) referring to health services, and information delivered or enhanced through the Internet and related technology'* (Eysenbach, 2001). As a part of eHealth, mobile Health (mHealth) has expanded widely for the last decade (Fiordelli, Diviani & Schulz, 2013). mHealth can thereby be described *'as medical and public health practice supported by mobile devices (...)'* (Kay, Santos & Takane, 2011). Especially, smartphones that function as mobile computerized systems offer a simple, efficient and low- cost option to get access to multiple health services (Zhao, Freeman & Li, 2016). Those health services can be delivered through applications (apps), but also additional devices like bracelets, watches or other trackers (wearables). Thereby, they offer advantages over other interventions, e.g. website or face-to-face interventions, because they offer functions like feedback, praise, self-monitoring or social support in real-time. By that people can be addressed in real life situations where decisions about health are actually made (Schoeppe et al., 2016).

Digital health devices became increasingly popular, so that in 2017 approximately 325.000 mHealth-apps were available on the app market, which is an increase of 50% among Android apps compared to 2016 (research2guidance, 2017). Those mHealth-apps are mostly lifestyle apps like 'health and fitness apps', but also 'medical apps', whereby one of the leading target groups for mHealth interventions are users with obesity. In July 2017 the Fitbit app has been the most frequent used 'health and fitness' app with 23.6 million monthly users. This is followed by S Health (for Samsung) with 13.2 million monthly users and MyFitnessPal with 11.7 monthly users. Also wearables, such as the Fitbit trackers, Apple Watch, Samsung Gear Fit, Polar or Jawbone are used frequently, with 19 million connected wearables in 2014 (Berginsight, 2018). All of these apps and wearables offer similar features, as they monitor daily activities like sleep behavior and water consumption, or measuring the activity by counting steps and calories.

Such a leading and growing popularity with using health devices can be interpreted positively, as it is an important way to react on the growing numbers of obesity. Especially, in America and Europe 40% of the population over 18 years is overweight or obese (Eurostat,

2018). People thereby report to find it increasingly difficult to maintain a normal weight. Also the activity level is an important factor for health issues, as a lack of activity can influence the emergence of chronic diseases like metabolic diseases (WHO, 2016). In order to react to this development, several studies have found that mHealth interventions have a positive effect on physical activity and dieting (Schoeppe et al., 2016; Zhao, Freeman & Li, 2016; Bort-Roig, Gilson, Puig- Ribera, Contreras & Trost, 2014). Additionally, Schoeppe et al. (2016) have found that multi-component interventions, where apps are combined with other tools, e.g. SMS, telephone coaching's or emails, show more improvements than 'stand-alone' apps. Whether the combination of wearable and app has a similar effect is not known. However, wearables alone are found to significantly increase physical activity and decrease body mass index and blood pressure (Bravata et al., 2009). Besides that, Bravata et al. (2007) describe that wearables are '*always on and always ready and accessible'* which is an advantage over mobile devices. They are small, light and unobtrusive, have access to every situation with a maximum of flexibility and can thereby directly measure the current state of the user, whereupon the user can react immediately (Bliem-Ritz, 2014). Such flexible right-in-time functions cannot be offered by smartphone apps. So, it can be expected that wearables offer an important additional value to the usage of health-apps.

Engagement

Even though mHealth interventions offer opportunities to change behavior and support a healthier lifestyle, it is important to consider that interventions can only be effective when they are used in the desired way, which often implies a long-term usage. Especially, when it comes to interventions that require a change of behavior, e.g. for weight loss, the adherence with an app is necessary in order to be effective (Carter, Burley, Nykajaer, Cade, 2013). Factors that have a negative effect on the adherence can be based on the attitude, e.g. the usage is perceived as too burdensome, or on technological features, e.g. the device is not working properly (Taki, et al., 2017). But also a lack of engagement was found to lead to non-adherence. With regard to wearables, Harrison, Marshall, Bianchi-Berthouze and Bird (2015) describe that an effective usage of these devices is linked to engagement. So, the concept of engagement is often considered as important, when it comes to enhancing the effectiveness of health interventions for different people (Perski, 2016).

Until now, there are several approaches to define engagement which all differ from each other, but a clear definition is lacking. First, there are approaches to find factors that make people feel engaged. Second, there are approaches to define what engagement is. And

third, there are approaches that describe characteristics of engagement which show how engagement is expressed (see figure 1).

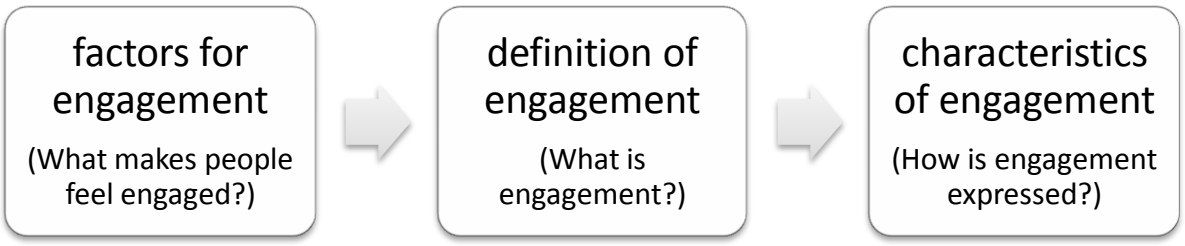

Figure 1. Concepts of engagement.

With regard to the first approach of conceptualizing engagement, Perski (2016) explains that engagement is influenced by the intervention itself. By that, the author mentions content (e.g. feedback, reminders, self-monitoring) and delivery (e.g. ease of use, personalization, interactivity) as important factors to make users feel engaged. Another explanation comes from O'Brien and Toms (2008), who have analyzed user perceptions of applications within the field of video games, online shopping, etc. and found a continuum of four stages of engagement. Each stage implies different factors that make people feel engaged. The first stage 'point of engagement' describes the point where the user starts being engaged with an app, which can be achieved through e.g. an aesthetic and novel interface of the app. The second stage 'period of engagement' describes important factors that make users keep their engagement within a certain period, e.g. interactivity, challenge and feedback. After a time of engagement people often tend to 'disengage', e.g. through interruption, a lack of the perceived time, or the usage of the device was experienced as too challenging. This stage can result in either positive or negative affect, which influences whether 'reengagement', the fourth stage, occurs or not. Positive experiences lead more often to reengagement and are also in other studies described to be factors that make people feel engaged (e.g. Dennison, Morrison, Conway & Yardley, 2013). The authors state that positive experiences can be gained through e.g. flexible apps with automatic tracking, well-documented features and an ease of use, which make it more likely that an adherent behavior is showed. Also the social support is interpreted positively with engagement. In contrast, a lack of faith in the accuracy of the given data and mistrust with regard to privacy concerns are described as negative experiences with an app and therefore potential risks of non-adherence.

The second approach to conceptualize engagement by finding a definition for engagement, can be found in the study of Kim, Kim and Wachter (2013). The authors define engagement as motivation which they specify in sub-elements: the utilitarian motivation (completing a task), the hedonic motivation (feeling entertained) and the social motivation (connecting with others). Also, Perski (2016) is defining engagement and has two different definitions for the concept. On the one hand, the author describes engagement as a subjective experience of flow with an app and on the other hand, she describes engagement as usage. So, it seems that engagement is a multidimensional concept, but a clear and consistent definition is lacking.

With regard to the third approach of conceptualizing engagement, characteristics of engagement are taken into account. Kim et al. (2013) describes that engagement is expressed by the user through satisfaction, intention and a perceived value. Perski (2016) explains that the subjective experience of engagement is expressed by attention, interest and affect. When it comes to the concept of engagement defined as usage, the author describes frequency and duration as important characteristics. Those characteristics make the presence of engagement more measurable, so a predication about whether the user is engaged or not can be made.

Current study

The current study aims to get a deeper insight in the perceptions of people about engagement with apps. Thereby, factors that make people feel engaged with health-apps are focused, as this is the most relevant topic to make mHealth interventions more effective. A broader knowledge about this topic can be used and integrated in the process of developing these interventions in order to increase adherence and effect. Besides that, the focus also lies on wearables, as they are expected to add an important value to mHealth interventions. Especially, fitness trackers offer functions that are described as motivating the user, e.g. through their perceived flexibility (Bliem-Ritz, 2014). This is expected to influence the engagement with health-apps and thereby enhance the adherence when both devices are combined. However, literature about user engagement with apps and wearables in combination is not provided until now.

The importance of supporting health through technological devices, as well as the chance of improving effectiveness of health interventions through the achievement of a higher engagement, lead to the following research questions: What makes people feel engaged with health-apps? And can wearables offer an additional value to the engagement with health-apps?

Method

Design

A qualitative interview design was used with a semi structured interview scheme.

Participants

In this study five participants were recruited by convenience sampling, four women and one man (see table 1). Their age ranged from 24 to 52, with a mean age of 31.6 years (SD= 11.7). The sampling procedure was based on the following inclusion criteria: the participants had to be older than 18 years, had to describe themselves as engaged with a health app and an eHealth wearable, and had to use a health app in combination with a wearable for at least three months when the interview was conducted. An exclusion criterion was an infrequent usage of a health app.

Tabel 1. *Demographic information (n=5).*

Participant	Gender	Age	Job
#1	Female	24	Nursery school teacher
#2	Male	52	Bricklayer
#3	Female	31	Nurse
#4	Female	26	Office administrator
#5	Female	25	Student

Procedure

Ethical approval was obtained at the Ethics Committee of the Faculty of Behavioral Sciences at the University of Twente (requestnumber: 18223). Before the interviews took place, the participants were invited personally via telephone and provided with information about the purpose and procedure of the interview. The participants got informed about the length and the topic of the interview and they were asked to take their app and wearable with them for demonstration. Then, a time and place for the face-to-face interview was scheduled. At the beginning of the interview an informed consent (see Appendix A) was handed to the participants and signed by both parties in order to participate in the study.

All interviews were conducted by the same researcher and took between 24 and 33 minutes (mean= 29 minutes). At the end of the interview, the participants had the chance to ask questions.

Interview scheme

The interview scheme was semi- structured and in German (see Appendix B). It was used by three researchers and therefore created to address several different topics. This study only concentrates on content that is relevant for the current research questions. Questions with regard to this were based on literature about the usage of health-apps and wearables (e.g. Bravata et al., 2009; Schoeppe et al., 2016).

The interview scheme was structured in five different topics (see table 2). First, four demographic questions about name, gender, age and job of the participants were asked. Second, questions to gain general information's about the devices were asked in seven main questions, whereby some of them were followed by follow-up questions, to get more details if necessary. This part asked for information's about the name of the specific app and wearable, for how long app and wearable were used and whether it was used in a combination. Also the motivations and goals with regard to the usage were addressed, e.g. 'What was your motivation to start using the app?'. Third, the functions of the app and the wearable were addressed in four main questions and several follow-up questions. Those questions asked for the daily usage of the devices, like the functions the participants used and experienced as motivating, e.g. 'Which functions do you find explicitly motivating for using the app and the wearable over a long time?'. Fourth, the importance of the devices for the users was elaborated. Eight main questions and two follow-up questions asked which personal meaning the devices had gained during the usage, e.g. 'Do you think the usage of the app and the wearable is like a hobby to you?' or 'Has it become a part of your life?'. Fifth, three main questions were asked about further suggestions for improving the app, e.g. 'Are there any aspects that you dislike?´ or 'Which functions may interrupt a long-term usage in the future?'. Afterwards, the participants had the opportunity to ask questions or add important aspects that were not added during the interview.

Tabel 2. *Organization of the interview scheme.*

	Topic	Number of main questions	Number of follow-up questions	Examples
1.	Demographic information	4	-	'What is your name?'
2.	General information about the devices	7	10	'What was your motivation to start using the app?'
3.	Getting to know the functions	4	9	'Which functions do you find explicitly motivating for using the app and the wearable over a long time?'
4.	Importance of the devices	7	3	'Do you think the usage of the app and the wearable is like a hobby to you?'
5.	Further suggestions	3	-	'Are there any aspects that you dislike?'

Analysis

The interviews were transcribed verbatim and translated into English. Then, the data was imported to ATLAS.ti (1993). At the beginning of the coding procedure the first interview was read. On the one hand the structure of the interview scheme was used to identify the codes of the first interview. On the other hand other specific themes with regard to the research question were filtered out and labeled with a code describing the content. Afterwards a code scheme was produced by structuring the different codes with regard to the topic they describe. Then the second interview was read and coded, whereby the code scheme was adjusted in order to clarify the meaning of the codes, avoid codes that appear double or add codes that were missing in the first interview. As an example the codes 'ease of use' and 'complex task' appeared to select similar quotes, and therefore could be used as one code. With the help of the adjusted code scheme (see Appendix C) the first interview was coded again. Then the other three interviews were coded identical to the first ones. Hereby, short phrases, whole sentences and paragraphs with more than one sentence were coded. Thereby,

the data was analyzed sensitive to the given context. This made the coding procedure an inductive approach.

After the coding procedure, the number of quotes per code was counted in order to get an idea which codes were described the most frequent and thereby perceived as important by the participants. Then, the codes were arranged to the research question they answer.

Results

During the coding process, a similar amount of quotes (between 78 and 85, see table 3) were coded per interview. All of the five respondents reported to use a combination of an app and a wearable. The overall usage of the certain combinations ranged between five months and three years. Two participants started with the usage of an app in order to enhance their physical activity and later combined it with a wearable, e.g. to get more accurate results. One participant reported to get the wearable as a present and therefore used it. The other two participants bought the wearable to use it as a watch at first and later tried out the fitness functions of it. So here, the wearable itself inspired people to install a fitness app in addition. All of the apps and wearables had similar functions: they counted steps, active minutes, calories, and monitored sleep and different activities like walking or swimming, also with the help of GPS. Four of the five respondents used the app two or three times every day and took a look on the wearable between 20 and 40 times a day. The other respondent used the app only once a day for four days in a week. Furthermore, participant #1 used two wearables and two apps at the same time, because of their different looks. Participant #3 combined two apps with one wearable and participant #5 used three apps with one wearable. They described to gain more information through the use of more than one app, e.g. adding ‘MyFitnessPal’ to the ‘Fitbit’ app in order to monitor eating behavior.

Tabel 3. *Overview of app and wearable usage.*

Participant	Quotes per participant	App	Wearable	Duration
#1	85	Samsung Health	Samsung Gear S2	2 years
		Google Fit	Michael Kors Smartwatch	1 year
#2	85	Garmin Connect	Garmin Forerunner 305	5 months
#3	78	MyFitnessPal	-	2 years
		Fitbit	Fitbit alta	7 months
#4	82	Fitbit	Fitbit charge	6 months
#5	80	Apple Health	Apple watch	3 years
		Lifesum		3 years
		Runtastic		3 years

Engagement with health-apps

In order to answer the first research question 'What makes people feel engaged with health-apps?' a distinction was made between factors for 'engagement' and 'disengagement'. Elements that motivate people to a consistent and frequent long-term usage were interpreted as factors of engagement. Related to engagement nine topics were coded (see table 4). People reported that there were personal and technological factors that motivate them. Hereby, the following four codes were personal factors: 'intrinsic motivation', 'bond', 'personal fit' and 'availability'. The following five codes were more technological factors but still perceived as motivating for a long-term usage of health devices: 'monitoring', 'reminders', 'praise', 'goals' and 'social support'.

Tabel 4. *Code overview with regard to the first research question: 'What makes people feel engaged with health-apps?'.*

Topic level 1	Topic level 2	Code	Number of interviews (N=5)	Number of codes (N=174), n (%)
Engagement	Personal factors	Intrinsic motivation	5	19 (11)
		Bond	5	15 (9)
		Personal fit	5	13 (7)
		Availability	4	16 (9)
	Technological factors	Monitoring	5	32 (18)
		Reminders	5	19 (11)
		Praise	5	10 (6)
		Goals	4	16 (9)
		Social support	3	13 (7)
Disengagement		Insight	5	13 (7)
		Trustworthiness	4	8 (5)

Personal factors of engagement

All of the respondents agreed, that the '**intrinsic motivation**' is the most important factor for a long-term usage of those digital devices. They reported that using the app started with an intrinsic motivation to achieve a goal or behavior change, like losing weight, increase the activity level or get an overview of the health status. The app and the wearable were described

as supporting devices to achieve these goals, but without the intrinsic motivation their behavior would not change at all. *'When I am forced to use [the health intervention] but I don't want to, the app won't be able to change my behavior.' (#2). 'If I don't want to change, there can be thousands of apps but that does not make me eat less.' (#3).*

The second personal element was the '**bond**' that was created with the app and the wearable. Thereby people explained to feel related to the certain device and did not want to change to another app or wearable. Also, there was a sort of identification with the usage described: *'When other people talk about it, I think 'I am a Fitbit user, too', so I somehow identify myself with the usage.' (#3).* Furthermore it was reported, that devices were integrated in daily life and also seen as a hobby that people do not want to give up. But at the same time, when people were asked whether the devices were perceived as important, the respondents disagreed. *'It's of course not the elixir of life!' (#2). 'When someone wants me to decide between for example my car and my smartwatch, I would always choose the car.' (#4*). So, on a technical level people choose 'their' device above other apps and wearables, but compared to other important elements in life, the devices were valued less.

The third personal element was the **'personal fit**' The technological functions as well as the outer appearance of the wearable needed to fit to the user. People described to only use the devices when they liked them, if not the wearable was returned or the app deleted. *'When I don't like it immediately I won't use it.' (#1).* So, it was perceived as a requirement for the engagement with an app or a wearable to fit to the user on a personal level. Interestingly, participant #1 used two wearables at the same time, which was also caused by liking and personal fit. The participant described to use the wearable with a more sporty look in daily life, as it was more comfortable to wear, but used the second wearable for outgoing events, as it was more glamorous. So, on one hand the look and personal fit of the wearables seemed to be important, but on the other hand it also seemed to be important to be able to wear a wearable on any occasion.

Next to that, the '**availability**' of the wearable was perceived as a reason for the usage. In contrast to most of apps, a wearable is a device which can be expensive. People consider carefully if it is necessary to buy a wearable in addition to the app. But when they bought it, they feel forced to use it. *'Now I own the wearable, which has also cost a lot, so now I have to use it and therefore would not discard it.' (#1).* Interestingly, this reasoning was also reported when the wearable was a gift and the participant self did not spend money on it. Furthermore, it is important to notice that none of the respondents reported to have ever made a break during the usage of the certain combination of app and wearable since they started using it.

But respondents who used only an app before they started using the combination of both reported that they made breaks during the usage. Thereby, the addition of the wearable seemed to force people more to actually use it. By only using an app it was easier to stop as people did not invest in it.

Technological factors of engagement

In contrast to the personal factor of the intrinsic motivation, there were digital factors that appear to motivate people. The most frequent described factor was the '**monitoring**' of behavior. By that it was meant that people feel motivated by observing their behavior and progress. Due to the wearable, people were able to see on every time and in every situation how much they had achieved already. Monitoring every activity per day helped users to get an overview over what had been achieved already and what was left to do. This helped to be more conscious about the own health behavior and was described as motivating to adjust the own behavior. *'[otherwise] I think I would lose track over the things I eat or how much I actually exercise' (#3). 'It's like a constant mirror that reflects your behavior. You are less unfaithful to yourself, because the app knows that you did not go for a walk today!' (#5)*

Next to that, the **'reminders**' that both devices could give their users were experienced as motivating. The wearable reminded with vibrations on the wrist that there were activities left to achieve. *'The bracelet never stops reminding me to be active. Because of that it would not happen that I am not active for a whole week.' (#3).* Even the presence of the wearable on the wrist was enough to remind respondents to be more active. Apps could also give reminding hints to the user, but this was described to be less effective, as the reminders are not noticed right-in-time. However, the reminding function appeared to be sensible and was interpret positively when people were willing to be active, but also negatively when the intrinsic motivation was low and people got annoyed by the reminders. *'When I know I was lazy, I perceive the reminders as annoying. (…) It can be motivating, but at the same time, it can also be annoying, that depends on my mood.' (#3).* A function that seemed to motivate respondents in a similar way was the function of '**praise**' that app and wearable can give. When goals were reached the user got feedback in form of a compliment, e.g. 'You did it great!'. This was described as highly motivating. Even a little game to appreciate the achievement appeared at the Fitbit wearable. Respondents thereby described that they expect the device to praise them. *'Somehow, I own the wearable to have a positive approval for my behavior.' (#2).*

Often apps required the user to set small '**goals**', which could be achieved on a daily or weekly basis, e.g. the amount of steps that should be done in one hour or at one day, the amount of calories that are allowed to eat per day, or different activities that should be undertaken within a week. Especially, small goals for example a small amount of steps that had to be accomplished within an hour seemed to constantly motivate people to adjust their behavior. '*[When I am at work and] notice that I have some steps left per hour in order to reach my goal, I often look for reasons to quickly go to the office of my colleague or to the toilet or in the kitchen, just to reach the amount of steps.' (#4).*

The last motivating function was the '**social support**' that could be gained with the help of the app. Most apps offered the opportunity to create a community to compare results. Starting a competition with others was experienced as motivating to be more active. The Fitbit app for example offered a function where friends could give each other a hint when they reached more steps. By that a respondent explained to be highly motivated to beat the achievement of others. Also receiving information about others was perceived as motivating, e.g. offered the Samsung App normative information, whereby the user received the information that he or she was better than the average user. Two of the five participants knew that receiving social support was possible with their devices but did not make use of it.

Disengagement with health-apps

All of the previous mentioned factors were experienced as motivating to change behavior. But there were also topics described which increased feelings of disengaging with a mobile health intervention. Especially, the lack of '**insight**' and '**trustworthiness**' were described negatively. A lack of insight means that there were functions mainly on the app that were unclear, not well explained or not working. For example was a reason to not use an app frequently that it was unclear where the collected numbers came from as the app counted active minutes, while the user was not moving at all. Also single functions like monitoring the sleep behavior were poorly used, because respondents explained to not know how to interpret the results and what that meant for their daily life. *'I want to download the app, open it and understand everything intuitively. If it is not working or complicated, I delete it.' (#3).* Interestingly, a lack of insight in form of not plausible functions or measurements were noticed at the very beginning of the usage of an intervention, so the app or wearable was deleted or returned directly. Different from that, people reacted on a lack of trustworthiness. The code trustworthiness described the insecurity and mistrust whether the recorded numbers were right. *'We walked five kilometers but the app just showed me two kilometers' (#2).* There

was also uncertainty about the use of the data. Therefore it was perceived as a risk to track every activity, as this is can be used with wrong intentions when the provider of the app gives it to third parties. Next to that, annoying functions as advertisements or too many reminders were perceived as demotivating. But in contrast to a lack of insight, people did not stop with an intervention when they noticed a lack of trustworthiness. Most people continued using the intervention even when they were dissatisfied and uncertain at some point about the correctness of the given numbers. As a reason they described to feel connected to the devices and used to it, so they did not want to stop the usage, even when they were dissatisfied with some functions.

The additional values of wearables

To answer the second research question: 'Can wearables offer an additional value to the engagement with health-apps?' the following five topics were coded: 'effort', 'variety', 'overview', 'precision' and 'ubiquity' (see table 5).

Table 5. *Code overview with regard to the second research question: 'Can wearables offer an additional value to the engagement with health-apps?'.*

Code	Number of interviews (N=5)	Number of codes (N=99), n (%)
Effort	5	34 (34)
Variety	5	22 (22)
Overview	5	17 (17)
Precision	5	17 (17)
Ubiquity	5	9 (9)

The first und most frequent mentioned topic was coded with '**effort**'. Respondents reported that adding a wearable to the usage of an app made the use easier. The wearables in form of bracelets were worn by every respondent on a daily basis and some worn it even at night, which made it easy for the system to gain data. Through an automatic and frequent process of synchronization the apps were updated later, without the user to have any effort. This brings also an advantage over apps where information had to be typed in personally. *'I use [the combination of app and wearable] because it works automatically. If I had to do it on my own I would not use it' (#5).*

Next to this a combination of both devices brought the advantage of '**variety**'. Through different measurements people had the opportunity to use more functions, e.g. measuring the heart rate which was only possible with the wearable or getting background information or GPS tracking which could only be obtained through the app. Thereby respondents described to interpret both devices as one unit and did not want to use only one of it, as only the combination of both could offer a complete picture of an overall activity and health status. *'[The first wearable] did not have enough functions therefore I returned it. (#2).*

When people were ask whether they think a combination motivates them more, people felt ambivalent at first. Some answered the wearable itself was enough and that they did not need an app; others answered the app was enough. But during the interview all of the respondents came to the conclusion that the combination of both made the use more complete, which was experienced as motivating. *'The interaction [of both devices] motivates me.' (#1), 'At first, the wearable on its own was sufficient, but since I have both [devices] my motivation is enhanced.' (#2).* It was perceived as important that there was a combination of wearable and smartphone app in order to have a complete intervention. The wearable itself could help to make an intervention easier, more accurate and accessible to every situation, still the app is needed for a concrete '**overview**'. Respondents reported that it discomforted them to see their results on the small screen of the wearable. They preferred to have an app which presented results in a clear, bright and colorful manner, which made it possible to notice the most important data within seconds. '*You open it and you can see directly a sort dashboard where all your steps, calories […] are showed and then you are quickly done with it.' (#3).*

The frequent use of the wearable brought another advantage, which was coded as '**precision**'. This means that through the placement of the wearable on the body people could wear it the whole day and data could be gained without interruption. Because of that the data, e.g. the calories that were burned, were counted very precisely and in every situation. By using only an app such a precision cannot be obtained as people reported to not have their phone with them the whole day. The accuracy of the gained data was described as important by the respondents and therefore it was criticized when data could not be gained accurate. Also people reported to regret when they forget to wear the bracelet. *'I easily get annoyed when realize I forgot to wear the bracelet in the morning and miss the first steps' (#1).* This advantage was also linked to the last advantage and code '**ubiquity**', which described that the wearable has access to every situation. Especially at work people described not to be able to check their progress or data on the app and therefore used the wearable. Also activities like swimming could be tracked through the wearable as most of them were waterproof and easy

to wear during sport activities. In contrast, smartphones were often not waterproof and could not be taken to every situation in a practical manner. *'During lunch break I want to chat with my colleagues and do not want to take out my phone to type in my calories' (#3).*

Discussion

In this interview study, user- experiences with health-apps and wearables were evaluated. With regard to the first research question, factors that make people feel engaged were explored. On a personal level people's perceptions towards the devices change over time. At the beginning, it seems to be important, that there is intrinsic motivation. This means, that people describe to need the willingness to start with an intervention and to make a change in behavior. This can be linked to previous findings of Kim et al. (2013), who explain that motivation is important for engagement. Furthermore, users are in the beginning very critical with the choice of the certain device and describe to find it important that it fits to the own person. Perfection is thereby expected; otherwise it is not used. Interestingly, on a later point, people are more willing to ignore mistakes and accept failures from the device, e.g. a lack of accuracy. This can be explained with the creation of a bond, as people describe to feel related to the specific app or wearable and do not want to change the device or stop the usage. The creation of a bond between health app or wearable and the user is investigated poorly within literature, however Kang (2014) found in a broader context that emotional bonding is an important dimension of engagement. Similarities can also be found in approaches that implement human support within eHealth interventions: Mohr, Cuijpers and Lehman (2011) explain that an emotional bond is important for adherence in any form of behavioral procedure. Apparently, the creation of a bond is also possible between user and app. In addition, the availability of the devices, especially the availability of the wearable, makes people feel personally engaged in using an intervention over a longer period. People thereby describe to feel forced to make use of the wearable, as it was expensive on the one hand and on the other hand triggers people to continue as it is highly present in everyday life. This is described as an advantage of wearables.

On a technological level, factors that make people feel engaged are present in both app and wearable. Hereby, the most mentioned factor is the function of monitoring the own behavior. This is experienced as motivating, as people feel continuously triggered to reach their goals and thereby adjust their behavior. Fogg (2009) explains that self-monitoring and tracking performances helps people to achieve their goals and change the general attitude about exercising as the provided information about a person's physiological status raises

consciousness and increases people's interest in working out. But also the functions of creating personal goals, getting reminders, receiving praise and social support were perceived as motivating to constantly change the own behavior and thereby use the devices over a long period. Those factors are consistent with factors that are known as persuasive technology, which were found to increase motivation and thereby adherence (Fogg, 2009). Also Oinas-Kukkonen (2009) conducted research about persuasive technology. The author describes that the implementation of persuasive functions helps users to keep moving towards their target behavior. Those functions are also described as related to engagement within the current study, e.g. praise or reminders

Factors, that are perceived as disengaging, which means that they make people feel demotivated to use the devices in long-term, are a lack of insight and trustworthiness. Thereby it is meant, that functions are not working properly, the users do not understand the functions or do not know where the data comes from. There is also mistrust whether technological data is right and how personal data is used. These findings can be linked to a previous study of Dennison et al. (2013), who found that mistrust through a lack of faithful and accurate data is related to negative experiences with an app and therefore a potential risk for non-adherence.

With regard to the second research question, wearables were found to offer an additional value to the engagement with health-apps. Thereby, the most common factor is, that wearables decrease the effort people have with an intervention. Several times a day users can easily monitor their behavior by taking a look at the wearable on their wrist, which tracks the behavior automatically. This is an advantage above mobile apps, as they often require that the data is filled in by oneself. Also the ubiquity of the wearables offers advantages, as the devices can be worn everyday and in situations where mobile phones cannot be used. This was predicted before by Bliem- Ritz (2014), who pointed out the maximum of flexibility as an advantage of wearables. Besides that, the increased precision of numbers through the use of the wearable makes people feel more engaged. Through the presence of the wearable in any situation data can be gathered more precisely and every move can be tracked, which is often difficult by using only a mobile app. Also the variety of possible actions is increased by the use of wearables, as it has different characteristics that cannot be offered by an app, e.g. measuring the heart rate. These findings can be linked to statements of Fogg (2009), who described that technology which makes the usage easier and devices that are always available and nearby the user, are more likely to persuade to a long-term usage.

So, the wearable itself offers advantages above the use of only mobile apps, but participants also explain that the combination of wearable and app is important for them for

engaging in the long-term usage of health interventions. Only the combination of both can give an overall and complete overview about the health behavior. This is used on the one hand in form of small monitoring behavior during the day with the help of the wearable, but on the other hand also through the broader overview with the help of statistics, which can only be showed on the app. Fritz, Huang, Murphy and Zimmermann (2014) state that the visualization of achieved results helped participants to maintain their activity levels, as it provides positive feedback.

The findings of this study can be linked to the Fogg Behavior Model for Persuasive Design (FBM), which intends to explain how persuasive products need to be designed in order to influence people's behavior (Fogg, 2009). The model defines three elements that control whether a desired behavior is performed: motivation, ability and triggers. So, a person needs to be sufficiently motivated, have the ability to perform the desired behavior and needs to receive triggers for behavior change. If all these elements are present in a sufficient amount it is likely that a person performs the desired behavior. This can be transferred to the current findings. With regard to the element motivation, participants of the current study agree and describe to find it important to have intrinsic motivation. The second element ability can also be found back in the results, as it is a requirement for the users to be able in a sufficient amount to use the devices in the desired way in order to change behavior. By that factors like availability (devices need to be available), precision and insight (results should be accurate and understandable), and overview (results need to be replicable) can be linked to the element ability as devices need to work properly to make the user perform the desired behavior. The third element trigger can also be found within the current results, as functions like monitoring behavior, reminders, praise and social support give continuously hints to the user and thereby triggers to change behavior. So, all of these factors need to come together in order to make people change their behavior. By using the combination of health app and wearable, those factors can be present and provide requirements to change the behavior into a healthier lifestyle.

However, a change in behavior can only be effective if it lasts over a longer period. This requires the long-term usage of the devices and therefore engagement with the intervention. The factors that were found in this study to make people feel engaged with mhealth interventions can be linked to the stages of engagement of O'Brien and Toms (2008). During the point of engagement, they describe that an aesthetic and novel interface is important. This can be found back in several factors of the current study, like the personal fit of the devices to the user, which means that the user likes for example the interface of the

device. Also other factors like having broader possibilities in usage, thus variety, getting a clear overview and accurate results seem to be important in the first stage of engagement. People want the devices to be perfect in the beginning; otherwise the point of engagement leads immediately to disengagement. Additionally, negative factors like a lack of insight and trustworthiness shall not be present at the first stage. Within the period of engagement factors like interactivity, challenge and feedback are perceived as important, according to O'Brien and Toms (2008). These factors can be linked to the functions of reminders, praise, social support, monitoring, and creating personal goals. Reasons for the third stage of disengagement were e.g. interruption or a lack of the perceived time. These factors were described to be avoided through the help of the wearables, which are ubiquitous in nearly every situation and therefore the chance of interruption is low. Also the risk of a lack of time is reduced, as the use of wearables decreases the effort and therefore the time that needs to be spend with an intervention. Therefore wearables offer an important additional value to the usage of health-apps.

Limitations & Strengths

A first limitation of this study has regard to the process. This research was conducted by only one researcher, which means that the coding and analyzing procedure can be biased as the results depend on the assessment of only one person. This shall be avoided in further research through the implementation of more than one researcher and the charge of inter-rater reliability. A second limitation is related to the idea of using health-apps and wearables in order to increase physical activity. Piwek, Ellis, Andrews and Joinson (2016) describe that wearables are more likely to be used by people who already lead a healthy lifestyle. This means, that interventions with wearables are less likely to reach people who lead an unhealthy lifestyle. Therefore the right target group for many health interventions may not be addressed. So, for the practical implementation of wearables in mHealth interventions, it is necessary to take the personal motivation of the target group into account. Through increasing the intrinsic motivation to lead a healthy lifestyle before using the wearable, chances are higher that people feel engaged with such an intervention.

However, strength of this study was the variety of wearables and apps, as well as the long-term usage of the devices. Through the variety of the devices, more general conclusions can be drawn, as the results are more applicable for different apps and wearables. As the functions of the different wearables were similar, it could be seen what people find most important in order to feel engaged with these devices. Next to that, through the long-term

usage of the participants concrete conclusions can be drawn. Every participant reported to use the mobile app and wearable several times a day for at least a half year. This helps to make the results more concrete, as the participants knew their devices and their behavior with it very well and thereby experienced to feel engaged with it. Still, it has to be mentioned that this could also be caused by the selection of the study.

Further research

Even though this study concentrates on factors that make people feel engaged with health-apps, the concept of engagement is still poor defined. Literature provides several approaches to define engagement (Perski, 2016; Kim et al., 2013), which are incongruent. In order to get a clear picture about the importance and advantages of engagement to make health-apps in eHealth interventions more effective, a clear definition of engagement is absolutely necessary and should be focused in further research. This study showed that engagement is related to subjective experiences, as for example people described to feel engaged when a bond was created. This is in line with other studies (e.g. Perski, 2016), therefore more research should be investigated that focus on the subjective experience with regard to engagement.

Furthermore, the usage of wearables within health interventions should be investigated more, as this study found them to offer an additional value to the use of apps. Especially, the time span of implementing wearables in daily life should be investigated more, because until now it is unclear how long such an intervention needs to be used in order to be effective. This study showed that people tend to use wearables over a long period up to three years. At this point, it is on the one hand questionable whether it is the right intention to create an intervention that makes people use devices for such a long time span. On the other hand, it is unclear whether people would still perform the desired behavior after the end of the intervention. This would mean that daily triggers to perform the desired behavior would disappear, which have a great impact on the performance of the behavior. So, with regard to the implementation of more wearables in eHealth interventions, more research is necessary in order to develop a clear concept how interventions can benefit from the additional values of wearables.

Conclusion

As a conclusion it can be said, that there are several factors that help people to feel engaged with a health app and therefore support the usage of an app for a longer period, which makes it more likely, that these interventions can be effective. Those factors can be technological

ones, which are basically based on persuasive designs for technology, but also personal ones. Next to that, the use of wearables was found to be a helpful component in order to make people feel engaged with an app over a longer period of time. All in all, mHealth interventions can bring advantages to the user in order to enhance a more active and healthy lifestyle. Thereby research should focus more on the implementation of factors that lead to engagement, as well as on the implementation of wearables within those interventions, as they offer important additional values to the long-term usage of health-apps and thereby support a change to a healthier lifestyle.

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Appendix A

Informed consent form

Titel der Studie: Warum nutzen Menschen Gesundheits-Apps?

Verantwortlicher Untersucher: Dr. Saskia Kelders

Ausführender Student: Meike Keseberg (B.Sc.)

Informationen

In der heutigen Zeit besitzt nahezu jeder ein Smartphone und immer mehr Menschen integrieren auch Tablets oder Smartwatches in ihren Alltag. Geräte, die vieles im Alltag einfacher gestalten, durch Apps die uns täglich unterstützen. Auch die Gesundheitsbranche hat die effizienten Möglichkeiten von Smartphone und Co. längst erkannt, weshalb es nicht überraschend ist, dass der aktuelle Markt tausende verschiedene Gesundheits- Apps anbietet. Apps und Smartwatches- oder Armbänder, die helfen sollen den Kalorienverbrauch zu ermitteln, Schritte zu zählen oder den Schlaf zu überwachen. Dies sind nur einige Beispiele von Funktionen, die Apps heutzutage bieten. Doch was muss eine App anbieten, um regelmäßig genutzt zu werden? Was motiviert Nutzer einer App länger als wenige Tage oder Wochen treu zu bleiben und was führt dazu, dass Menschen vorzeitig den Gebrauch der App einstellen? Was braucht eine App um den Nutzer erfolgreich an sein gesundheitliches Ziel zu bringen?

Studien können hierauf zum jetzigen keine ausreichenden Antworten liefern. Jedoch ist es wichtig zu erfahren was Menschen motiviert eine App langfristig zu nutzen, um dieses Wissen im Entwicklungsprozess einzusetzen, sodass zukünftige Apps benutzerfreundlicher gestaltet werden und gesundheitliche Ziele langfristig erreicht werden können.

Im folgenden Interview werde ich Ihnen diesbezüglich ungefähr 30 Minuten Fragen stellen. Wichtig ist, dass es hierbei keine falschen Antworten gibt. Die Teilnahme an dieser Studie ist vollkommen freiwillig und das Interview selbst kann jederzeit abgebrochen werden. Das Gespräch wird aufgenommen um es im Nachhinein zu verschriftlichen. Dabei werden alle persönlichen Daten anonymisiert, sodass keine Rückschlüsse mehr auf Ihre Person gezogen werden können. Die Daten werden nur zu wissenschaftlichen Zwecken verwendet und nicht an Unbeteiligte weitergegeben.

Durch den Teilnehmer auszufüllen

Ich erkläre hiermit, dass ich auf eine für mich verständliche Art und Weise über die Art, Methoden und das Ziel der Studie informiert worden bin. Ich weiß, dass die Ergebnisse der Studie nur anonym und vertraulich an Dritte weitergegeben werden. Meine Fragen sind zur Zufriedenheit beantwortet worden. Ich akzeptiere, dass der Inhalt des Gesprächs aufgenommen wird und für eine wissenschaftliche Analyse verwendet wird. Ich nehme absolut freiwillig an dieser Studie teil. Dabei behalte ich mir das Recht vor zu jedem Moment und ohne Angabe von Gründen die Teilnahme an dieser Studie zu beenden.

Name des Teilnehmers.....
Datum……
Unterschrift des Teilnehmers……

Durch den Untersucher auszufüllen

Ich habe sowohl schriftlich als auch mündlich über die Studie informiert. Weitere Fragen über die Studie werde ich bestmöglich klären. Der Teilnehmer wird durch einen vorzeitigen Abbruch der Studie keine negativen Konsequenzen tragen müssen.

Name der ausführenden Studenten.....
Datum…….
Unterschrift der ausführenden Studenten……..……..

Appendix B

Interviewschema

1.) Demografische Informationen
   - Wie ist Ihr Name?
   - Was ist Ihr Geschlecht?
   - Wie alt sind Sie?
   - Welchen Job führen Sie aus?

2.) Allgemeine Fragen bezüglich der Nutzung von App & Armband

   Im Vorfeld hatten Sie bereits angegeben eine Fitnessapp zu nutzen. Im Folgenden werde ich Ihnen nun Fragen stellen bezüglich dieser App und der eventuellen Nutzung eines Armbandes, also zum Beispiel Fitnesstracker oder andere so genannte „wearables“. Für meinen Studienteil ist es wichtig, dass Sie beide Geräte benutzen. Daher meine ich mit meinen folgenden Fragen immer sowohl App als auch Armband.

   - Welche App nutzen Sie?
     - Nutzen Sie ein Armband?
     - Welches Armband benutzen Sie?
     - Kombinieren Sie die App mit dem Armband?
   - Wie lange nutzen Sie die Kombination von App und Armband schon?
     - Haben Sie schon immer die App mit dem Armband kombiniert oder haben Sie die Anwendungen zuvor schon einzeln gebraucht?
     - Was haben Sie zuerst benutzt?
       - Seit wann kombinieren Sie beides?
   - Was war Ihre Motivation um die Nutzung von App, bzw. das Armband zu starten?
     - Warum haben Sie sich dazu entschieden App und Armband zu kombinieren?
     - Denken Sie, dass die zusätzliche Nutzung des Armbandes Einfluss auf Ihre Motivation hat?
   - Welches Ziel wollen Sie mit App und Armband erreichen?
   - Welche Funktionen finden Sie besonders motivierend für eine längere Nutzung?
     - Gibt es eine Funktion die Sie besonders motiviert Ihr genanntes Ziel zu erreichen?
   - Gibt es Funktionen die Sie als demotivierend erfahren?

- Haben Sie schon andere Apps oder Armbänder probiert?
    - Wenn ja, warum haben Sie andere Apps/ Armbänder nicht mehr genutzt?
    - Wenn ja, warum sind Sie bei dieser Kombination geblieben?

3.) Kennenlernen der Funktionen im täglichen Gebrauch

- Können Sie erklären oder zeigen, wie Sie die App bzw. das Armband normalerweise den Tag über nutzen?
    - Was genau machen Sie damit?
    - Wann?
    - Gibt es andere Funktionen die Sie gelegentlich nutzen?
    - Denken Sie, dass Sie alle Funktionen bereits kennen?
    - Ist es Ihnen möglich alle Funktionen zu nutzen?
- Wie oft nutzen Sie die App und das Armband im täglichen Leben? Wie oft schauen Sie zum Beispiel auf die App/ das Armband?
    - Nutzen Sie immer und ausschließlich die Kombination aus beidem?
    - Fall nicht,wann nutzen Sie App und Armband separat?
- In welchem Kontext nutzen Sie App und Armband?
- Haben Sie Pausen gemacht innerhalb der Nutzung?
    - Wenn ja, können Sie erklären warum?
    - Was führte dazu, dass Sie die App erneut nutzen?

4.) Bedeutung der App

- Sie haben angegeben, dass die App eine gewisse Bedeutung für Sie hat im täglichen Leben. Können Sie das erklären?
    - Was bedeutet die App für Sie?
    - Ist es wichtig für Sie, die App zu nutzen?
    - Warum ist es Ihnen wichtig, die App zu nutzen?
- Empfinden Sie die Nutzung als eine Art Hobby?
- Ist es ein Teil Ihres täglichen Lebens geworden?
- Ist es etwas, dass zu Ihnen als Person passt?
- Fühlen Sie sich zur App verbunden?
- Nutzen Sie die App gerne?
- Erzählen Sie anderen von der App?

5.) Verbesserungen
    - Gibt es Aspekte die Sie nicht mögen?
    - Welche Funktionen würden dazu führen, dass Sie die App für längere Zeit nicht mehr nutzen?
    - Haben Sie Verbesserungsvorschläge?

Wir sind nun am Ende des Interviews angelangt. Haben Sie noch weitere Fragen?
Gibt es zusätzliche Anmerkungen, die Sie noch loswerden möchten?
Vielen Dank für die Teilnahme!

Appendix C

Code Scheme

General topic	Level 1	Level 2	Explanation/ Quotes
engagement	personal elements	intrinsic motivations	- the willingness to change behavior - people only do what they want to do
		availability	- 'I have it therefore I use it' - 'It was expensive, so I am forced to use it' - 'I use it when it is free to use'
		bond	- People feel related to the app/ wearable and do not want to change to another app - They think it is important for them to keep up with the usage of this specific app
		personal fit	- 'The devices fit to me as a person' - People identify themselves as a typical 'Fitbit' - user
	technological elements	goals	- People interpret the use as important to reach goals, as a motivator in daily life and a part of the daily life - Reaching goals has impact on behavior and people are more active when they are about to reach these goals
		monitoring	- Seeing actual activity level motivates people to do more and to control behavior - Having an overview afterwards is valued
		reminders	- Feedback 'do more sport' through e.g. vibration

			- Can also be interpret negatively (annoying)
		praise	- 'You do great!' or a sort treat in form of a game, when goals are attained
		social support	- Normative info how own activity is compared to others - Compare results with your own community - Make a battle
disengagement		insight	- No clear insight, where numbers come from and how they are generated
		trustworthiness	- Mistrust whether numbers are right
additional values	wearable	variety	- More options through combination: monitor swimming, monitor sleep, heart rate can be count etc.
		precision	- Possibility to measure every activity on every time, without the need of taking a smartphone with you - Steps are counted more accurate and people feel sorry when they e.g. miss a few steps in the morning
		ubiquity	- Bracelet can be worn everywhere, e.g. on workdays - Possibility for small checks in every situation, - Devices become a part of the daily life
		effort	- Automatic counting motivates to a longer usage – the less people have to do, the longer they stick
	app	overview	- Big, bright, colorful diagraphs make the usage more comfortable