Understanding mobile app engagement

An interview study investigating user experiences with health apps.

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ABSTRACT

Researchers in the field of health promotion assume that adhering to health-related apps may significantly improve app effectiveness, which, in turn, may reduce expenditure in healthcare services. As adherence has frequently been associated with mobile app engagement, examining this ambiguous concept may result in a better understanding of adherence to health apps. Therefore, the present study examined mobile app engagement by exploring how users experience health-related apps. More specifically, it was investigated how health app users evaluate their apps, which emotions they experience, what health app usage means to them and whether they experience flow, an experience believed to be identical to mobile app engagement. Five semi-structured face-to-face interviews were conducted with individuals making use of health apps on a regular basis. Data analysis revealed that even though users complained about some app characteristics, they were generally satisfied with their apps and considered them to be important for achieving health-related goals, indicating that a health app does not have to be "perfect" to be engaging. Participants mentioned positive as well as negative emotions related to app usage but asserted that their intensity may decrease over time. This finding suggests that mobile app engagement may also decline, holding important implications for future health app design. Moreover, it was found that particular app characteristics prevent users from experiencing flow when using health apps, indicating that mobile app engagement is not identical to flow experience. However, future research is needed to improve the understanding of mobile app engagement.

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INTRODUCTION

The changing face of healthcare

Mobile phone ownership rapidly proliferates. By the end of 2018, an estimated 65 percent of the Western European population will be using a smartphone, a handheld personal computer possessing high-speed Internet access (Statista, 2018). Researchers in the field of health promotion have been quick to take advantage of this trend. They assumed that expenditure in healthcare services could be significantly reduced by making health resources accessible via the Internet (Mosa, Yoo, & Sheets, 2012). Mobile health applications (apps) have been designed to enable users to take active control of their physical and mental well-being (Agarwal, Gao, des Roches, & Jha, 2010). Such apps may promote self-care by assisting the public to achieve a variety of health objectives (e.g. weight loss, smoking cessation and stress reduction), thereby contributing to the prevention and treatment of physical and mental health problems (Carroll et al., 2017). Today, there are more than 318.000 apps focusing on health promotion available, with more than 200 health apps being added each day (IQVIA, 2017). Among smartphone users, however, only 21 percent use their phone for health-related issues (Ernsting et al., 2017) and nearly 80 percent of health apps is abandoned within the first two weeks of usage (Baldwin, Singh, Sittig, & Giardina, 2017). This implies that mobile health apps continue to present an untapped opportunity to reduce expenditure in healthcare services. As outlined in the following sections, investigating and improving user experiences with mobile health apps may help realizing the full potential of these apps.

Adherence as a factor fostering app effectiveness

A growing body of research has investigated the effectiveness of health-related apps. Comprehensive literature reviews found that participants are more successful in changing maladaptive health behaviours such as drinking alcohol (Quanbeck, Chih, Isham, & Gustafson, 2014) and engaging in sedentary behaviour (e.g. Bort-Roig, Gilson, Puig-Ribera, Contreras, & Trost, 2014; Stephens, & Allen, 2013) when supported by an app. Other researchers, however, found a gap between the postulated and empirically demonstrated benefits of health-related apps. For example, Laing et al. (2014) demonstrated that MyFitnessPal, one of the most popular apps for tracking calorie intake, was not effective in assisting overweight individuals to lose weight over a six-month period. As is commonly done in eHealth evaluations, the authors discussed the issue of non-adherence as a factor negatively affecting app effectiveness. Adherence refers to the degree to which a user experiences the content of an app as intended by

its creators (Donkin et al., 2011). The concept of intended use, which describes the extent to which users should experience the content of an app to derive maximum benefit from it, is an essential part of mobile app adherence (Kelders, Kok, Ossebaard, & van Gemert-Pijnen, 2012). In their systematic review on how adherence has been conceptualized in previous eHealth evaluations, however, Sieverink, Kelders and van Gemert-Pijnen (2017) concluded that most reports did not provide the intended usage but operationalized adherence in terms of "the more usage, the better", indicating that health apps might be more effective the more they are used. Individuals may also stop using a health app because they already have achieved their personal goals though, suggesting that the time of dropout is not necessarily an indicator of app effectiveness and thus no adequate operationalization of intended usage (Christensen & Mackinnon, 2006). Properly defining the intended use of a health app is problematic since users might pursue different goals or vary with regard to the amount of use that is needed to achieve their desired outcome (Hekler et al., 2016). Investigating individual usage behaviour and personal experiences with a mobile health app is thus inevitable to usefully define the intended use which, in turn, may enable researchers to draw distinct conclusions about user adherence and app effectiveness. The concept of adherence has frequently been associated with mobile app engagement, even though these terms do not refer to the same construct (Sieverink et al., 2017). However, as mobile app engagement is assumed to be closely related to an individual's personal experiences with health apps (Perski, Blandford, West, & Michie, 2016), examining this concept might provide an insight on how to usefully operationalize the intended use, allowing inferences to be made about adherence to mobile health apps.

The concept of mobile app engagement

In the last decade, two main definitions of mobile app engagement have emerged, conceptualizing engagement as behaviour and engagement as subjective experience respectively (Perski et al., 2016). In behavioural science literature, mobile app engagement has typically been defined as "usage", including temporal patterns such as frequency and duration of app usage (e.g. Pham, Nguyen, Hwang, & Chen, 2016). Authors supporting the concept of engagement as subjective experience assume that it is a psychological process evolving from an ongoing usage of a particular app (e.g. Bowden, 2009; Brodie, Ilic, Juric, & Hollebeek, 2011). It is described as the interactive relationship with an app that helps achieving the intended objectives and satisfies the emotional needs of the user (Brodie et al., 2011). Drawing upon this definition, the mobile user engagement (MoEN) model by Kim, Kim and Wachter

(2013) proposes that mobile app engagement occurs when users interact with an app to satisfy a need state. The resulting satisfaction increases the perceived value of engaging in this activity which, in turn, leads to a more frequent use of the app. O'Brien and Toms (2008), who also believe engagement to be a subjective experience, define engagement as a mental state of flow, characterized by increased attention, positive affect, sensory as well as intellectual satisfaction and mastery. Similarly, Calvo-Porral, Faíña-Medín and Nieto-Mengotti (2017) argue that cognitive concentration – also known as flow experience – is conceptually identical to the concept of engagement. In an attempt to develop an integrative definition, Perski et al. (2016) conceptualized mobile app engagement as a multidimensional construct, incorporating the extent of usage and an individual's subjective experience with mobile apps. This definition suggests that mobile app engagement is partially composed of a user's subjective experiences with an app, indicating that gaining insight into how users experience health apps is inevitable to fully understand engagement with mobile health apps. As multiple researchers suggest that users experience some kind of flow when using apps, it might be of particular interest to examine whether health app users indeed experience flow and how they describe this experience. As little is known about how users experience mobile app engagement, examining user experiences with health apps may help to obtain a better understanding of mobile app engagement, enabling researchers to draw conclusions about the relationship between engagement, adherence rates and app effectiveness.

Flow experience

According to Mihaly Csikszentmihalyi, who introduced flow theory in 1975, flow is an autotelic experience (i.e. an experience that is rewarding on its own), occurring when body or mind undertake a voluntary effort to accomplish something difficult (Csikszentmihalyi, 1997). Flow is induced when an individual believes that he or she has the skills to cope with situational demands being above average for the person (Piotrowski & Meester, 2018). It is described as a short-lasting peak experience characterized by a sense of control, complete immersion in activity, transformation of time and deep satisfaction (e.g. Bakker, 2008; Jackson & Marsh, 1996). Summarizing these ideas, Rheinberg, Vollmeyer and Engeser (2003) identified three core components of flow: perceived fit of skills and demands, absorption by activity and fluency of performance. Most often, flow occurs while engaging in hobbies such as exercising and when learning or working, even though it may appear in other situations as well (e.g. Csikszentmihalyi and LeFevre, 1989; Rheinberg et al., 2003). Researchers in the field of flow

suggest that flow is only induced by activities with clearly defined goals, allowing the individual to know whether he or she is succeeding in the activity (Jackson & Marsh, 1996). As health apps are usually used with the aim of achieving a particular goal (e.g. weight loss or smoking cessation), it might be assumed that health app users also experience some kind of flow when using their apps. Since multiple researchers assume flow experience to be identical to mobile app engagement and understanding mobile app engagement is believed to be important for operationalizing the intended use and assessing adherence to health-related apps, exploring flow experience during health app usage might be essential for improving adherence rates and overall app effectiveness. However, the nature of flow experience during health app usage has not been subject to investigation so far. The present study seeks to fill this gap by examining flow experience during health app usage from a user's perspective.

Present study

　　Researchers in the field of health promotion assume that adhering to health-related apps may significantly improve app effectiveness which, in turn, may result in reduced expenditure in healthcare services (e.g. Laing et al., 2014; Vandelanotte et al., 2016). In eHealth evaluations, however, adherence is often operationalized in a way that does not meet the definition of the concept, making it difficult to draw conclusions about app effectiveness (Sieverink et al., 2017). As adherence has frequently been associated with mobile app engagement, which is assumed to be composed of an individual's subjective experiences with health apps (Perski et al., 2016), examining this concept may provide an insight on how to usefully operationalize adherence to mobile health apps. Therefore, the present study intends to shed more light on mobile app engagement by gaining insight into how users experience health-related apps. More specifically, it is examined how health app users evaluate health apps in terms of negative and positive aspects, which emotions they experience with regard to app usage and what health app usage means to them. Since multiple researchers suggest that users experience flow when using health apps and that flow experience might be even identical to mobile app engagement, it is also explored whether health app users indeed experience flow and how they describe this experience. The research question is formulated as follows: "How do health app users experience mobile health apps in terms of negative and positive aspects, emotions related to app use, meaning and flow experience?" By answering the research question it is tried to develop a better understanding of mobile app engagement, which might result in increased adherence rates and an improvement of health app effectiveness.

METHOD

Sampling procedure and participants

Before participant sampling started, the applied procedure was checked and formally approved by the ethical commission of the University of Twente (request number: 18223). In the present study, in which an interview survey design was employed, participants were recruited by means of convenience sampling. During the month of data collection (June 2018), potential participants from the researcher's social network were approached via social media. Along with a short description of the study purpose and the applied procedure, they were provided with examples of different self-care apps (i.e. apps aiming at improving physical as well as mental health), illustrating which apps might be of interest in the present study. Besides being 18 years or older, regular use of one or more of such health apps was an inclusion criteria, with regularity being subjectively defined by the users. They were asked to respond when they were interested in giving a short audiotaped interview and met the study requirements. The final sample consisted of five individuals aged between 23 and 27 (M_{age} = 23.8), with three participants being female and two being male. All of them were highly educated native German speakers.

Study procedure

In order to ensure that participants feel comfortable, interview times and locations were chosen with regard to individual preferences even though participants were encouraged to opt for a quiet location in order to avoid distraction. When they arrived at the location of their choice, they were informed about the confidential manner in which their data would be stored and processed. Moreover, participants were told that they would not get any rewards from participating but that participation is completely voluntary and that they may choose to discontinue at any point in time. They signed an informed consent to declare that they agree with these terms and conditions. Afterwards, the researcher wrote down demographic characteristics of the participants before audio recorded semi-structured face-to-face interviews were held that lasted between 21 and 30 minutes (M = 25.11). At the end of these interviews, participants were invited to ask questions.

Interview scheme

The interview guide (*see* Appendix A and B) is based on current literature on health apps, mobile app engagement and flow theory. First of all, participants were asked to describe

the functions of their health app and the goals they intended to achieve by using the app. Furthermore, they were asked to elaborate on the importance of the app in achieving their goals as well as on their emotions with regard to app usage. Afterwards, participant's flow experience during app usage was explored. The questions concerning flow were based on the work of Rheinberg et al. (2003). Their Flow Short Scale measures fluency of performance, absorption by activity as well as the perceived fit of demands and skills. For study purposes, some of the original statements were reformulated into questions containing a reference to health apps. For example, the statement "I am totally absorbed in what I am doing" was transformed into "Are you totally absorbed in what you are doing when using your health app?" At the end of the interview, participants were asked to think about suggestions for improving their apps. Situation-bound probes (e.g. "What do you mean by…?" or "Tell me more about…") confirmed and deepened understanding. Short summaries and reflections encouraged participants to further elaborate on a particular topic. When participants did not understand a question, the interviewer reformulated the question without giving suggestions.

Data analysis

In a first step, the interviews were transcribed verbatim and translated into English. For the sake of privacy, all personal information was made anonymous. In a second step, an abbreviated version of grounded theory was utilized to analyze the data. Grounded theory is an inductive approach, indicating that coding categories are derived directly from the data set (Cho & Lee, 2014). For this purpose, each transcript was read several times and fragments relevant for answering the research question were extracted and coded preliminary (i.e. given descriptive labels). Based on these initial labels, a coding scheme was established (*see* Appendix C). Only the codes used to describe a participant's flow experience were developed by means of a deductive approach, indicating that these codes were defined before data analysis commences. They resembled the three core components of flow experience as identified by Rheinberg et al. (2003): fluency of performance, absorption by activity and perceived fit of skills and demands. After developing the coding scheme, the interviews were imported to ATLAS.ti 8, a computer software for the qualitative analysis of large bodies of textual data, and coded according to the coding scheme (ATLAS.ti, 2018). Over the course of the coding process, the applicability of the codes was continuously monitored, resulting in an ongoing adjustment of the coding scheme.

RESULTS

Data analysis resulted in the overarching theme "experience with health apps", comprising the four main categories evaluation, emotions related to app usage, meaning of health apps and flow experience from a user's perspective as well as several subcategories (*see* Table 1). Before each main and subcategory is illustrated by exemplifying quotes, participants' health app usage is shortly described.

Table 1

Frequencies of main and subcodes

Main and subcodes	Code frequencies	Number of interviews in which the code was used (n = 5)
Evaluation	66	5
Recommendation of health app	6	5
Positive aspects	19	5
Simplicity	8	5
Resource-conserving	4	3
Completeness	3	3
Personalization	4	2
Negative aspects	24	5
Design issues	11	4
Privacy concerns	5	2
Resource-intensive	5	2
No added value of particular features	3	3
Suggestions for improvement	14	4
Emotions related to app usage	13	5
Positive emotions	9	5
Enjoyment	5	3
Excitement	2	2
Pride	2	1
Negative emotions	4	2
Unhappiness	1	1
Guilt	1	1
Boredom	2	1

Table 1 (continued)

Main and subcodes	Code frequencies	Number of interviews in which the code was used (n = 5)
Meaning	87	5
Reasons for using a particular app	21	5
Role of app in achieving goals	36	5
Knowledge of app functions	8	4
Changes in relevance over time	22	5
Increase in relevance	10	4
Decrease in relevance	12	5
Flow experience from a user's perspective	17	5
Fluency of performance	8	5
Absorption by activity	7	4
Perceived fit of demands and skills	2	2

Description of app characteristics and app usage

Participants reported making use of one or two free self-care apps promoting physical health, among which MyFitnessPal, the Fitbit app, Nike+ Run Club and Mi Fit. Three participants used at least one of their apps in combination with a compatible wearable. All of them reported using their apps for tracking calorie intake and/or keeping track of physical activities. Social features such as connecting with friends and taking part in competitions were used less frequently. Respondents had been using their apps for between one month and three years. Participants who recently downloaded the app used it at least once per day, whereas participants who had been using it for a longer period of time reported that there had been breaks during usage or that they do not use the app every day. All but one participant mentioned that they make use of their apps when needed, regardless of time and situational context.

Evaluation

In general, participants were satisfied with their apps and would recommend it to friends and family members. Especially the simplicity of the apps was emphasized by all participants. This is reflected in statements such as *"Installing the app on my phone and connecting the app with my wearable was quite simple"* (respondent 1, female). Moreover, three participants

appreciated that they did not have to pay for app usage and that app usage is not time-consuming. Another three participants described their apps as being quite exhaustive. One of them gave the following example: *"The app has a large database – it even contained the Domino's pizza I ordered some time ago"* (respondent 5, male).

Nevertheless, participants also talked about negative aspects of health apps. Design issues such as system errors, annoying push-notifications and lacking explanations were most often mentioned, which adds up to eleven times. One participant explained: *"Sometimes, I simply do not have the time to exercise - for example, when learning for a test - and I do not want to receive push notifications then"* (respondent 3, female). Another participant even stopped using an app because she received too many push-notifications: *"I used an app (...), I think it was called Runtastic. However, I received too many push notifications. It was annoying. And that is why I stopped using it"* (respondent 1, female). Furthermore, privacy concerns were expressed by two participants even though this does not keep them from using their health apps: *"I know that lots of personal data is revealed and that the company uses it for its own purposes. I am aware of it, but I am totally okay with it since I benefit from using the app"* (respondent 1, female). Another two participants criticized that using health apps may be time-consuming and cost-intensive: *"The app is only useful when owning a compatible wearable but the wearable costs more than 100 Euro. Not everyone is willing to pay the price"* (respondent 3, female). Finally, three participants believed that some of their app's functions are not useful. One of the female participants reported, for example: *"On the wearable's display, I can see whether I took 10.000 steps or not. (...) The app does not add that much information"* (respondent 2, female). Another participant mentioned that social features does not add value to the app: *"I do not use these kind of functions. I have 'real' friends with whom I can talk about things like that. We discuss about the pros and cons of quark and Skyr, for example."* (respondent 5, male).

Moreover, participants gave some suggestions for improving health apps. Personalized features were generally regarded as positive even though two participants believed that they could be improved. One of them gave the following suggestion: *"(...) when I am running slowly, it would be awesome to hear [personalized comments] like 'Your heart rate is very high. You should consider interrupting your run in order to prevent physical health problems'"* (respondent 4, male). Another frequently mentioned suggestion for improvement was to include a particular function of one app in another app in order to make health app usage more convenient: *"[MyFitnessPal has] a large database with a variety of groceries – that is amazing! The Fitbit app does not have such a large database. But [in MyFitnessPal,] I miss a function*

for accurately monitoring my physical activities. (...) I would like to have a combination of these two apps" (respondent 3, female).

Emotions related to app usage

Participants experienced a variety of positive and negative emotions related to app usage. With regard to positive emotions, participants mentioned enjoyment (i.e. a feeling of deep pleasure) most often. However, participants did not really enjoy app usage but the results they achieve by using the app. This is reflected in statements such as *"I enjoy using [the app] when I lost weight"* (respondent 1, female) or *"[App usage] is fun, except when you stop exercising"* (respondent 3, female). Furthermore, two participants reported feeling excited (i.e. greatly enthusiastic) when they started app usage. Another participant mentioned feeling proud (i.e. being satisfied as a result of one's own achievements) when looking at positive outcomes.

Concerning negative emotions, participants reported feeling guilty (i.e. culpable for one's own wrongdoing) when relapsing into unhealthy behaviours and mentioned feeling unhappy (i.e. displeased) when looking at negative results. One of the female participants reported, for example: *"Two weeks ago, I went to a wedding with the intention to eat healthy but it did not work out. I ate two pieces of wedding cake and put on 900 gram! Watching this damn graph going up again was depressing"* (respondent 1, female). Another female participant, who had been using the app for more than a year, also expressed boredom (i.e. a feeling of weariness) with regard to app usage. The strong feelings of enjoyment and excitement she experienced shortly after starting app usage had gradually declined over time: *"In the beginning, I was really engaged with the app. I spend lots of time using [it]. (...) I did not take the wearable off. That was so sick! (...) It is addictive – you look at your phone very often and worry about the number of calories you have burnt. However, I have [been using] the app for three years now and it has become less exciting"* (respondent 3, female).

Meaning of health apps

Participants differed with regard to the reasons why they started using a particular app. Three times, compatibility with a wearable was mentioned: *"[The app] is compatible with my wearable. I needed [it] in order to use all of the wearable's functions"* (respondent 2, female). One of the participants chose for his app because *"one of [his] house mates recommended [it]"* (respondent 5, male). Personal traits were also considered important when downloading a health app. In total, four participants took individual characteristics into consideration when choosing

their apps. One of the female participants reported: *"I like having everything under control and that is what the app is made for"* (respondent 3, female). Another four participants downloaded an app because they believed its functions to be useful for achieving their goals.

The code "knowledge of app functions" was used eight times in total. Two participants reported that they do not know all of their apps' functions, with one of them associating his ignorance with a lack of connectedness to the app: *"I do not even know who developed the app. If I was connected to the app, I would know who developed it and I would also know all of its functions. But I do not"* (respondent 5, male). The other participants believed that they know all of their apps' functions even though they did not make use of all of them.

All respondents believed their apps to be important for achieving their goals, among which improving physical fitness, meeting physical activity recommendations and weight-related goals. Even though participants did not experience app usage as a hobby on its own, they described it as an important part of their hobby physical fitness. All participants mentioned that they *"would not been able to motivate [themselves] without [being supported by an app]"* (respondent 4, male). App usage had become an important part of their lives. For instance, one participant mentioned that he does not exercise without being accompanied by his app any longer: *"The app knows exactly how many kilometres I ran. It verifies that I really did the run and that I was doing it well. You can enter a run manually, but it feels like cheating. (...) Some time ago, the app did not track my run. I was really upset and considered doing it again just in order to have the confirmation that I did it"* (respondent 4, male).

Even though all participants mentioned that app usage had become an important part of their lives, relevance of health apps was reported to be subject to change. The code "changes in relevance over time" was used 22 times. For example, one of the participants reported that she did not use the app very often when she downloaded the app. She did not believe it to be useful but needed it for using all of her wearables functions. However, she also admitted that she still do not know all of the apps' functions and mentioned that the more she learns about its functions, the more she likes the app. Another participant reported that the app becomes less important over time and that he will stop app usage when he did not need the support of his app any longer: *"When you have been using the app for a while, you learn how many calories a particular meal has. You can go on without being supported by an app"* (respondent 5, male). It was also emphasized that health apps will become less important after participants accomplish their goals: *"I can imagine [to stop app usage] after achieving my goals. (...) I do not think that I will carry on after losing enough weight. Maybe, I will use it for exercising but*

I will definitely not track calories any longer" (respondent 1, female). However, participants also believed that they will start using their apps again when they set themselves new health-related goals.

Flow experience from a user's perspective

The main category flow experience comprises the three subcategories fluency of performance, absorption by activity and perceived fit of demands and skills. The code "fluency of performance" was used in all five interviews (eight times in total). Four participants mentioned that they use their apps intuitively. One participant described this experience as follows: *"Yes [, I am able to use the app without having to think about it]. I turn on Bluetooth, have a quick look at the data, wait until synchronizing is completed and log out"* (respondent 3, female). It had become a *"routine"* (respondent 1, female).

When it came to absorption by activity, participants brought up that they use their apps while other activities such as watching TV or eating breakfast draw off their attention. Moreover, it was mentioned that they did not spend enough time on app usage to be totally absorbed by this activity: *"For checking how many steps I have taken, I log in for only a few seconds. In those cases, I am not totally absorbed [by] what I am doing"* (respondent 1, female). Only one participant reported being *"completely lost in thought when looking at [his running data]"* (respondent 4, male).

The code "perceived fit of demand and skills" was used only twice. Concerning this element of flow, participants mentioned that they do not feel challenged by health app usage since their apps are simple to use: *"Using the app is quite simple and I like it that way"* (respondent 4, male). In the rare situations in which participants did not know where to find a particular function or how to use it, they knew where to get help: *"[App usage] is not too difficult. When you are using a function for the first time, [it] is explained to you. And if you have any questions, you can click on the help-button"* (respondent 1, female).

DISCUSSION

The present study aimed at investigating user experiences with health-related apps in order to get a better understanding of mobile app engagement. Data analysis resulted in the overarching theme "experience with health apps", comprising the four main categories evaluation, emotions related to app usage, meaning of health apps and flow experience from a

user's perspective. It was found that participants were generally satisfied with their apps, even though they also reported negative aspects. They talked about positive emotions such as enjoyment, excitement and pride as well as about negative emotions such as unhappiness, guilt and boredom but asserted that the intensity of some emotions may change over time (e.g. participants mentioned that they became less enthusiastic about their apps). Nevertheless, participants considered their apps important for achieving their health-related goals and reported that the apps had become an important part of their lives. However, they also mentioned that health app usage may become less relevant after reaching the goal. Regarding a participant's experience of flow, it was found that even though some elements of flow such as fluency of performance and absorption by activity could partially be found in participants' descriptions, other important characteristics of flow as defined by Rheinberg et al. (2003) were completely lacking, indicating that participants did not experience flow when using health apps.

In evaluating their health apps, participants mentioned positive aspects as well as negative aspects. Surprisingly, however, negative aspects of health apps were slightly more often talked about than positive aspects, even though participants were generally satisfied with their apps and would recommend it to friends and family members. This discrepancy might be explained by the formulation of the questions used to assess the positive and negative aspects of health apps (Clark & Schober, 1992). For example, participants were asked to give suggestions for improvement but they were not directly asked to specify what they like about their apps. However, the fact that participants make use of health apps even though they could think of various negative aspects implies that a health app does not have to be "perfect" to be engaging. This is in line with research by Angst and Agarwal (2009), who investigated the adoption of health technology in the presence of privacy concerns. In their study, participants allowed their medical information to be digitized even when they had high concerns for privacy, indicating that the perceived benefits of eHealth technologies may outweigh potential disadvantages. This finding was supported by the present study in which participants asserted that negative aspects do not keep them from using their health apps since they need them to accomplish their goals.

App usage was found to be associated with positive emotions such as enjoyment, excitement and pride as well as with negative emotions such as unhappiness, guilt and boredom. Moreover, the outcomes of the present study indicate that the intensity of some emotions may change over time. A participant, who recently downloaded the app reported that the more she learned about the apps' functions, the more she liked the app, whereas a participant, who had

been using the app for a longer period of time, reported that app usage had become less exciting. These is in line with the outcomes of a study by Magni, Taylor and Venkatesh (2010), who investigated the impact of hedonic factors on students' intentions to use a personal digital assistant. Their results suggest that enjoyment has a strong influence on initial adoption of a new technology but that the intensity of enjoyment decreases over time since people get used to the technology. Bearing in mind that mobile app engagement is considered to be composed of an individual's subjective experiences with health apps, it might be assumed that the intensity of mobile app engagement is also be subject to change. Even though users may experience high levels of mobile app engagement shortly after starting app usage, they may experience lower levels of mobile app engagement later in time which holds important implications for future health app design. Since Dennison, Morrison, Conway and Yardly (2013) found that positive emotions encourage continued usage, creators should facilitate ongoing positive emotional responses to health apps in order to increase mobile app engagement in the post-adoption stage. Feelings of excitement, for instance, could be elicited by frequent updates and the incorporation of new functions. Dennison et al. (2013) also concluded that negative emotional responses to health-related apps lead users to discontinue app usage. In the present study, however, some participants reported uninstalling an app because they got annoyed by receiving too many push-notifications, whereas others reported continuing using their apps despite of the experienced negative emotions. Feeling displeased when looking at negative results, for example, resulted in a more frequent use of the app, suggesting that negative emotions may also act as a motivator for continuing app usage. This may indicate that negative emotions triggered by design issues such as an oversupply of push-notifications may lead to a decrease in mobile app engagement whereas negative emotions triggered by a discrepancy between the current health state and desired outcomes may lead to an increase in mobile app engagement. However, this assumption has to be verified by subsequent studies.

Another interesting finding was that participants considered health apps to be important for achieving their health-related goals. After achieving a goal, however, app usage became less important. In a study by Murnane, Huffaker and Kossinets (2015), 10.3 percent of the users who discontinued app usage, stopped using their apps since they were no longer needed after achieving a goal. This finding suggests that mobile app engagement may also rapidly decline after app users reach their health-related goals. However, one of the participants in the present study mentioned that he will start using the app again when he will need it to accomplish a new goal, indicating that people may experience some kind of connectedness to their apps even after

stopping app usage. This feeling of connectedness may arise as a result of the satisfaction associated with achieving a health-related goal through the support of an app. However, it is questionable whether this experience is identical to the concept of mobile app engagement since the multidimensional model of mobile app engagement assumes usage of an app to be a necessary requirement for experiencing engagement with this app (Perski et al., 2016). Nevertheless, future research should examine how to elicit and maintain this feeling of connectedness experienced in the post-usage phase to ensure that people return to their health apps when needed.

In the present study, participants did not report experiencing flow as it is described by literature. In contrast to earlier studies on flow, for example, participants did not describe this feeling as a short-lasting peak experience (Bakker, 2008) and did not report feelings of deep satisfaction resulting from app usage (Jackson & Marsh, 1996). The finding that users did not experience flow during health app usage might be explained by a variety of app characteristics and situational circumstances. First of all, Piotrowski and Meester (2018) demonstrated that flow is only induced when an individual believes that he or she has the skills to cope with situational demands being above average for this person. Using health apps, however, was not experienced as a cognitively demanding activity since health apps are typically designed to be easy to use. Moreover, participants mentioned that they use their apps while other activities draw off their attention, preventing them from experiencing a state of total concentration. It might be argued whether it is even possible to be totally absorbed by short-lasting activities as described by the participants in the present study. Mental health apps often include more long-lasting, cognitively demanding activities which are more likely to induce flow (Rodríguez-Sáncheza, Schaufelib, Salanovaa, Cifrea, & Sonnenschein, 2011). Similarly, gamified health apps (e.g. Pokémon Go) might be more likely to induce flow (Cugelman, 2013). Interviewing people using this kind of health apps might thus result in new insights on flow experience during health app usage. A final factor precluding flow experience during app usage is related to the feelings of enjoyment reported by the participants. Participants did not enjoy app usage by itself but the goals they achieved by using the app. This rises the question whether an activity that is not experienced as enjoyable can actually induce flow experience. However, researchers in the field of flow experience suggest that flow might be induced by any activity with a clearly defined goal, indicating that flow might also be induced by health app usage (Stavrou, Psychountaki, Georgiadis, Karteroliotis, & Zervas, 2015).

Since participants did not experience flow when using health apps, it might be reasonable to conclude that mobile app engagement is not identical to flow experience. This is inconsistent with the theory of Calvo-Porral et al. (2017), who assumed engagement with a technology and flow experience to be related constructs. A difference in the definitions of flow experience might explain this discrepancy. Whereas Calvo-Porral et al. (2017) conceptualized flow experience as "the holistic sensations that individuals feel" (p. 402) when interacting with a technology, the present study assumes flow to be an autotelic experience occurring when body or mind are trying to accomplish something difficult. Calvo-Porral et al.'s (2017) definition of flow resembles the operationalization of mobile app engagement (i.e. mobile app engagement as subjective experience) in the present study, explaining the relation between these constructs as found by the researchers.

Strengths and limitations

As a possible limitation of the present study, the previously developed interview scheme should be discussed. The questions on flow experience were based on existing questionnaires which were developed with regard to theoretical principles, possibly not targeting what is important from a participant's perspective (Finneran & Zhang, 2005; Mesbah, Kreiner, & Christensen, 2013). However, adding questions on particular characteristics of flow to the interview scheme was inevitable to encourage participants to talk about this abstract construct. If the researcher had not asked about flow, participants would probably have not talked about this construct, which is supported by the fact that almost all participants reported difficulties in answering the questions on flow, with most of them asking the researcher for explanation. This implies that adding questions on flow was actually a strength of the present study.

The development of the coding scheme and the process of coding might also be regarded as a limitation of the present study. As only one researcher was engaged with analyzing the data, concerns arise with regard to the reliability of the present study (Cornish, Gillespie, & Zittoun, 2013). With multiple coders involved, it would have been possible to assess inter-rater reliability, where agreement between coders is usually taken as evidence of the rigour of an analysis (Lu & Schulman, 2008). However, Cornish et al. (2013) argue that agreement between coders does not automatically warrant objectivity, since two coders may also agree because of a shared understanding of the topic. Therefore, having only one coder is not necessarily a disadvantage.

Another possible limitation is that even though the concept of mobile app engagement was investigated, respondents might not have been engaged with their health apps. As mobile app engagement could not be usefully defined at the beginning of the study, it was chosen to simply operationalize mobile app engagement as "usage", resulting in interviewing people making use of health apps on a regular basis. Indeed, the characteristics of the study sample resembled the characteristics associated with frequent app used as examined by Carroll et al. (2017), who found younger individuals with high levels of education, higher income and self-reported excellent health to be the main users of health-related apps. Operationalizing mobile app engagement as "usage", participants of the present study might thus be regarded as engaged. However, in future studies on mobile app engagement, it should also be assessed how potential participants experience their apps to ensure that they are really experiencing mobile app engagement. Moreover, it is questionable whether studies on health promotion should focus on young individuals reporting excellent health as limited health literacy is typically associated with older individuals who report lower levels of education, lower income and perceived poor health (Protheroe et al., 2017). Investigating how to increase mobile app engagement in this target group might be an interesting starting point for future research.

With regard to the strengths of the present study it should be mentioned that time and interview locations were chosen with regard to participants' preferences. Interview locations were thus sensitive to participants' needs and interests, thereby creating a comfortable atmosphere. According to Elwood and Martin (2000), participants who are given a choice about the interview location may feel more empowered in their interaction with the researcher. This may have enabled participants to freely express their viewpoints and feelings related to their experiences with health-related apps.

CONCLUSION

The present study expanded the limited research on mobile app engagement by exploring how users experience health-related apps in terms of negative and positive aspects, emotions, meaning and flow experience. Gaining a better understanding of mobile app engagement may result in the development of health apps people are more likely to adhere to which is assumed to positively affect app effectiveness. With smartphone usage rapidly proliferating, effective self-care apps may significantly reduce expenditure in healthcare services.

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APPENDICES

Appendix A: interview guide

1) Welche App benutzen Sie?

2) Wie lange nutzen Sie diese App schon?

3) Warum nutzen Sie diese App?

4) Aus welcher Motivation heraus haben Sie die begonnen die App zu nutzen?

5) Welches Ziel wollen Sie mit der App erreichen?

6) Haben Sie schon andere Apps ausprobiert? Wenn ja, warum sind Sie bei dieser geblieben?

7) Welche Funktionen motivieren Sie um die App über einen längeren Zeitraum zu nutzen?

8) Können Sie zeigen oder erklären, wie Sie die App normalerweise nutzen?

9) Gibt es andere Funktionen die Sie nur gelegentlich nutzen?

10) Gibt es eine soziale Komponente in der App?

11) Wie oft nutzen Sie die App im täglichen Leben?

12) In welchem Kontext nutzen Sie die App?

13) Denken Sie, Sie kennen alle Funktionen der App?

14) Können Sie alle Funktionen in vollem Umfang nutzen?

15) Gab es innerhalb des Zeitraums in dem Sie die App bereits nutzen Pausen? Wenn ja, warum? Was hat dazu geführt, dass Sie die App erneut intensiv gebrauchen?

16) Was bedeutet die App für Sie?

17) Sie haben angegeben, dass die App wichtig für Sie ist. Können Sie dies näher ausführen?

18) Warum ist die App wichtig für Sie? *(nur fragen falls bislang nicht beantwortet)*

19) Ist die App wie ein Hobby für Sie?

20) Ist Sie zu einem Bestandteil Ihres täglichen Lebens geworden?

21) Passt die App zu Ihnen als Person?

22) Fühlen Sie sich der App verbunden?

23) Haben Sie Spaß daran, die App zu nutzen?

24) Wenn Sie die App benutzen…

    a. Fühlen Sie sich dann optimal beansprucht?

    b. Handeln Sie dann automatisch und ohne nachzudenken?

    c. Merken Sie dann wie die Zeit vergeht?

    d. Haben Sie dann Schwierigkeiten sich zu konzentrieren?

      e.   Ist Ihr Kopf dann völlig klar?

      f.   Sind Sie dann voll und ganz vertieft in das, was Sie gerade machen?

      g.   Wissen Sie dann bei jedem Schritt was Sie zu tun haben?

      h.   Haben Sie dann das Gefühl alles unter Kontrolle zu haben?

      i.   Sind Sie dann völlig selbstvergessen?

25) Erzählen Sie anderen von der App?

26) Gibt es Funktionen der App, die Sie davon abhalten diese über einen längeren Zeitraum hinweg zu nutzen?

27) Haben Sie zu dieser App Verbesserungsvorschläge? Welche Funktionen fehlen Ihnen? *(nur Verbesserungsvorschläge suggerieren wenn der Interviewte überhaupt keine Ideen hat, dies sollte aber in der Analyse deutlich gemacht werden)*

Appendix B: interview guide (translated into English)

1) Which app do you use?

2) For how long have you been using the app?

3) Why do you use this app?

4) What was your motivation to start using the app?

5) What is the goal you wish to achieve?

6) Have you tried other apps and if yes, why did you stick with this one?

7) Which functions do you find explicitly motivating for using the app over a long time?

8) Can you explain/show how you usually use this app?

9) Are there other functions you occasionally use?

10) Is there a social component in this app?

11) How often do you use the app in your daily life?

12) In which context do you use the app?

13) Do you think you know all its functions?

14) Are you able to use all the functions?

15) Have there been breaks during your usage? Why did you take a break? What made you start using it again (more intensively)?

16) What does the app mean to you?

17) You have indicated that this app is in some way important to you. Can you elaborate on this?

18) Why is it important to you? *(ask only if it is not already answered)*

19) Do you think the app is like a hobby to you?

20) Has it become a part of your life?

21) Is it something that fits with you as a person?

22) Do you have the feeling that you are connected to the app?

23) Do you enjoy using it?

24) When using the app…

    a. Do you feel just the right amount of challenge?

    b. Do you things automatically without having to think?

    c. Do you notice time passing?

    d. Do you have difficulty concentrating?

    e. Is your mind completely clear?

    f. Are you totally absorbed in what you are doing?

    g. Do you know what you have to do each step of the way?

    h. Do you feel that you have everything under control?

    i. Are you completely lost in thought?

25) Do you tell others about the app?

26) Which functions interrupt you from using the app for a long time?

27) Do you have any suggestions for improving the app? *(if the interviewee cannot think about any suggestions to improve the app, you as researcher can make suggestions for the interviewee, but you have to make it visible in your analysis what comes from the interviewee and what comes through your suggestions)*

Appendix C: coding scheme

Main code	1ˢᵗ subcode	2ⁿᵈ subcode	Example (quote)
Evaluation	Recommendation of health app		"I did recommend [the app] to my boyfriend"
	Positive aspect	Simplicity	"It is also very useful that the app remembers what I ate in the last few days"
		Personalization	"I like that you can personalize everything"
		Resource-conserving	"I like that I do not have to pay for a premium account"
		Completeness	"The app has a large database"
	Negative aspect	Design issue	"Sometimes it does not work but that is due to a system error"
		Privacy concern	"(…) lots of personal data is revealed (…)"
		Resource-intensive	"The app is only useful when owning a compatible wearable but the wearable costs more than 100 Euro"
		No added value of particular functions	"There is a community, but I do not need it. I have real friends"
	Suggestion for improvement		"I would like to have more audio support"

Emotion related to app usage	Positive emotion	Enjoyment	"I enjoy using [the app]"
		Excitement	"Actually, I do not really enjoy it. It is (…) interesting"
		Pride	"Knowing that I ran 60 kilometres (…) during the last week makes me proud"
	Negative emotion	Unhappiness	"Watching this damn graph going up again was depressing"
		Guilt	"I often felt guilty when I wore the Fitbit without exercising"
		Boredom	"[App usage] has become less exciting"
Meaning of health apps	Reason for using a particular app	Compatible with wearable	"I started using the Fitbit app only because I own the compatible wearable"
		Recommended by others	"(…), one of my house mates recommended the app"
		Match with individual characteristics	"I like having everything under control and that is what the app is made for"
		Useful functions	"The app has more functions"
	Role of app in achieving goals		"I would not been able to motivate myself without the app"

	Knowledge of app functions		"I believe that I know all of the app's functions"
	Changes in relevance over time	Increase in relevance	"I think that I would miss something if [the wearable] was not there anymore"
		Decrease in relevance	"When I started using the app, I synchronized the data more frequently"
Flow experience	Fluency of performance		"You do not really have to think about [what to do next]"
	Absorption by activity		"(...) I am completely lost in thought when looking at the data"
	Perceived fit of demands and skills		"I feel just the right amount of challenge"