

Evaluating the Perceived Persuasiveness Questionnaire by Applying a Closed Card Sorting Task

B.Sc. Psychology

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Abstract

Background: The Perceived Persuasiveness Questionnaire (PPQ) is an evaluation measure used to evaluate whether persuasive design elements are perceived by the user of technology during and after development. In this study, the PPQ comprises nine constructs, namely perceived primary task support, perceived dialogue support, perceived credibility, perceived social support, perceived persuasiveness, perceived unobtrusiveness, perceived effort, perceived effectiveness, and use continuance.

Aim: This research aims to contribute to the validation of the PPQ by investigating whether the items of the PPQ match the original constructs.

Methods: This study includes 35 participants, mostly German university students around the age of 23 with a scientific background of Behavioural, Management & Social Science. A within-subject design was employed. Participants conducted a closed card sort by sorting the PPQ items with the nine constructs of the PPQ. The researcher analysed the data in form of a qualitative analysis, based on two types of frequency tables of all the sorted items and conducted a hierarchical cluster analysis using SPSS.

Results: Most of the PPQ items were found to match the constructs they are intended to measure, except for some items which turned out to match an alternative construct more than the original construct or seemed to match two constructs. The cluster analysis resulted in a formation of five constructs of which two were similar to the original constructs. Furthermore, one new construct was found containing items of four different constructs and the other two constructs consisted of the items of several clusters combined.

Conclusion: Contrasting results with previous research underline the need for further research to contribute to the validation of the PPQ. A final version of the questionnaire could contribute to facilitate the use of persuasive elements used in eHealth technologies during the development and after implementation.

Keywords: perceived persuasiveness questionnaire, eHealth, persuasive technology, persuasive systems design model, card sorting

Introduction

In today's modern society, technology is part of our daily lives not only for entertainment purposes, but it becomes increasingly popular for health assistance and maintenance. There is a multitude of existing research on *eHealth* interventions concerning all kinds of different health-related issues, for instance, overweight or obesity (Raaijmakers, Pouwels, Berghuis, & Nienhuijs, 2015), cardiac recovery (Nguyen, Carrieri-Kohlman, Rankin, Slaughter, & Stulbarg, 2004), support in diabetes self-management (Rollo et al., 2016), as well as mental illnesses (Naslund, Marsch, McHugo, & Bartels, 2015). The term eHealth technology includes a broad spectrum of communication and information technologies, which aim to enhance health behaviour and health care of the user, for instance, computers, mobile or smartphones, wearables, the internet, videoconferencing, telemedicine, remote patient monitoring and electronic health records (Murray, 2014; Morrison, Yardley, Powell & Michie, 2012). Options to upgrade the quality and quantity of health care without expanding the costs are in demand due to the increasing longevity of people living with long term conditions and chronic illnesses (Murray, 2014).

The characteristics of eHealth technologies are that they are self-managed and that users enjoy the freedom of decision making (Eysenbach, 2005). One specific type of eHealth technology is *persuasive technology*. Persuasive systems can be defined as software which is specifically designed to strengthen, modify or sculpt attitudes and behaviour without using force or fraud (Oinas-Kukkonen & Harjumaa, 2008). As stated in Fogg (2003), persuasive technology has several advantages over human persuaders. It is more persistent than human beings, can offer greater anonymity, manage huge volumes of data, use many modalities to influence and grow quickly when demand increases. Additionally, it can go where humans cannot go or may not be welcome and it is tailored to the individual user based on the user's inputs, needs, and situations (Fogg, 2003).

Especially because eHealth technologies support the freedom of decision making and are self-managed, it is critical to persuade the users and tie them to the technology, otherwise, they will not keep using the technology. This depicts one major issue with eHealth technology, the discontinuance of usage or non-adherence (Kelders, Haugtvedt, Stibe, Kok, & van Gemert-Pijnen, 2011). Non-adherence is related to the effectiveness of the technology and has shown to negatively influence the results of interventions (Donkin et al. 2011; Manwaring et al., 2008). According to Kelders et al. (2011), the use of persuasive technology is positively linked to adherence. Also, former studies demonstrate an influence that persuasive technology has on increasing adherence (Kelders, Kok, Ossebaard, & Van Gemert-Pijnen, 2012). Persuasive

design is applied to today's eHealth Technology, to increase adherence to technology and to positively affect the user's health behaviour (Fogg, 2003; Morrison et al., 2012).

Persuasive design not only increases adherence but also, according to Lehto, Oinas-Kukkonen and Drozd, (2012), affects the user's perception and behaviour is affected by persuasive technologies, which use behaviour change strategies and tactics to achieve desired outcomes. The basic assumption of persuasive systems is that the user adopts a persuasive system and the designer includes persuasive mechanisms into the system. A framework that helps designers to include these persuasive mechanisms is the persuasive system design model.

The Persuasive Systems Design Model

According to Oinas-Kukkonen and Harjumaa (2009), persuasive systems are developed in three steps. Firstly, one needs to understand the key design issues related to persuasive systems. Secondly, the persuasion context is analysed and thirdly, the system qualities are designed. Oinas-Kukkonen & Harjumaa (2009) defined four categories of design principles of persuasive design, namely *primary task support*, *dialogue support*, *credibility support*, and *social support*.

Primary task support fosters the performance of the user to reach the goal by breaking target behaviour into small steps and supplying monitoring strategies of progress and performance. Furthermore, comprehension is increased by presenting information in personalized and small steps. Dialogue support fosters interaction between user and technology by including persuasive features that aim to employ and motivate to achieve the goal. Credibility support ensures the reliability and trustworthiness by providing persuasive features that bring transparency to technology. Social support includes persuasive features that stimulate users by taking advantage of the social influence of other people. Users are enabled to compare themselves and share information with friends, family, and strangers, who follow the same goal (Oinas-Kukkonen & Harjumaa, 2009)

These design principles serve as guidelines for software requirements and as an evaluation method for persuasive systems (Oinas-Kukkonen & Harjumaa, 2009). Persuasive features according to the persuasive system design framework are incorporated into the technology to facilitate the interaction between system and user, such as tailoring, reminders and social learning (Oinas-Kukkonen & Harjumaa, 2009). However, the question arises: do people actually perceive these persuasive elements?

Despite the increased interest and growing numbers of applications, many researchers point out the lack of theoretical and empirical studies that are studying persuasive systems

(Lehto et al., 2012; Kelders et al., 2011). Specifically, studies are needed that discover how the technology interacts with users and how the users engage with the technology (Kelders et al., 2011; Lehto et al., 2012). Certainly, persuasive technology aims to change the user's attitude and behaviour, but the outcome of software design features on persuasion is still vastly undiscovered. Thus, more research needs to be conducted to study and validate the effects of using these design features and principles (Alahäivälä, Oinas-Kukkonen, & Jokelainen, 2013; Van Gemert-Pijnen, Kelders, Kip, & Sanderman, 2018). One tool of studying persuasive elements of technology is the Perceived Persuasiveness Questionnaire (PPQ).

The PPQ

The PPQ according to Lehto et al. (2012) is an evaluation measure, which was created based on the persuasive system design model to evaluate the persuasiveness of technology, not only during development but also after the implementation of persuasive technology. The PPQ is used to evaluate whether persuasive design elements are perceived by the users of technology. The first version of the PPQ included eight constructs of which three were based on the persuasive systems design model, namely *primary task support*, *dialogue support*, and *perceived credibility*. Furthermore, the constructs *design aesthetics*, *perceived persuasiveness*, *unobtrusiveness*, *intention to continue using the system and usage* were added based on existing literature (Lehto et al., 2012).

In subsequent research, the PPQ was adapted and several constructs were added or deleted over time. In the study of De Jong, Wentzel, Kelders, Onias-Kukkonen and van Gemert-Pijnen (2014) the constructs *primary task support*, *perceived persuasiveness*, *unobtrusiveness*, and *perceived credibility* were adopted. The constructs *design aesthetics* and *dialogue support*, which were part of the PPQ as it was available at the time of the study as well as *social support* were deleted to fit the research aim of the study. Based on the results of the evaluation study three constructs were added, namely *perceived effort*, *perceived effectiveness*, and *use continuance* and it was suggested that the constructs *perceived effectiveness* and *perceived task support* should be merged (De Jong, et al. 2014).

This PPQ utilized in the study of Beerlage-de Jong et al. (2016), contains 31 items linked to the following nine constructs: *perceived primary task support*, *perceived dialogue support*, *perceived credibility*, *perceived social support*, *perceived persuasiveness*, *perceived unobtrusiveness*, *perceived effort*, *perceived effectiveness*, and *use continuance*. The items of the PPQ adjusted to the *Runkeeper application* are displayed in Appendix A. Runkeeper is an application that promotes and encourages fitness behaviour (<https://runkeeper.com>).

The construct *perceived primary task support* contains three items and focuses on whether the technology helps to achieve the goal, for example, Item 23 “Runkeeper application helps me change my exercising habits.”. The three items of *perceived dialogue support* deal with whether the technology provides feedback and guidance to the user. An example item is Item 17 “Runkeeper application provides me with appropriate counselling.”. *Perceived credibility* asks about the perceived reliability and trustworthiness of the information given in the technology, which includes five items, one of them is Item 19 “Runkeeper application is clearly made by health professionals.”. *Perceived social support* consists of three items, dealing with whether the technology allows the user to share and learn from their peers. An example is Item 21 “I get support from my peers through Runkeeper application when I need it.”. *Perceived persuasiveness* includes three items and deals with questions about whether users think that the technology is valuable and has an influence on them, for example, Item 20 “Runkeeper application has an influence on me.”. *Perceived unobtrusiveness* consists of four items, for instance, Item 1 “Using Runkeeper application disrupts my daily routines.” and it is related to how noticeable the technology is in daily life. The construct of *perceived effort* questions the endeavour that the technology entails and includes three items. An example item for this construct is Item 31 “Using Runkeeper application is difficult.”. Furthermore, *perceived effectiveness*, consisting of three items questions the efficacy of the technology, for example, Item 3 “My chances of starting with exercising improve by using Runkeeper application.”. Lastly, *use continuance* includes four items regarding whether the user would adopt the technology in the future or not, for example, Item 8 “I will be using Runkeeper application in the future.”.

A seven-point Likert scale is implemented on every item to measure attitudes ranging from 1 (*strongly disagree*) to 7 (*strongly agree*) with the intermediate steps *disagree*, *more or less disagree*, *undecided*, *more or less agree* and *agree* (Lehto et al., 2012). Because no standard scoring exists for the PPQ, the mean score is calculated for every construct resulting in a score between one and seven. A high score implies that the participant has a positive attitude about what the construct measures, whereas a low score implies a negative attitude.

Regarding the PPQ some research has been conducted resulting in different outcomes relating to the constructs and as underlined by the different versions of the questionnaire over the years, the construct validity and reliability have not been extensively studied yet. Accomplishing a valid version of the PPQ is an important step that research should strive for so that the PPQ can contribute to comparing different eHealth technologies and their usage in different situations (De Jong et al., 2014). A valid PPQ could facilitate technology designers to

notice features that may lead to the success or failure of persuasive technologies (Alahäivälä et al., 2013).

Stibe and Cugelman (2016) underline that not every eHealth technology is successful, they may even unintentionally have negative effects. Such a certain type of negative outcome is called *backfire*, in which the opposite of the desired behaviour is adopted by users of an intervention, caused by the intervention itself. Stibe and Cugelman (2016) point out the possible risks when designing persuasive technology and underline the importance of removing the stigma of reporting on negative intervention outcomes. Ultimately, only being aware of these pitfalls and negative consequences helps to avoid backfiring or negative outcomes in general. The PPQ could contribute to prevent backfiring, by repeatedly evaluating, whether the persuasive elements are effective, during development as well as after the implementation.

To be able to prevent backfiring and due to reduced effectiveness of results in eHealth interventions in relation to non-adherence, persuasive technology is in demand to facilitate the interaction between user and technology and increase adherence to eHealth technology. The current lack of research on how design principles affect users creates a demand for further research on evaluation measures, which help designers to develop and improve eHealth technologies. Therefore, the purpose of this study is to contribute to the evaluation of the construct validity of the PPQ by collecting data of a German population conducting a closed card sort task (PPQ items and constructs). The main focus of this study is to find out if the items of the PPQ match the constructs they are intended to measure. Furthermore, two sub-questions emerge, firstly, how many participants sorted the items in the original construct? Secondly, how many clusters emerge based on the data of the card sorting task?

Methods

In the current study, a within-subject design was employed. Specifically, a closed card sort was conducted, where participants sorted the items with the constructs of the PPQ. This study was approved by the Behavioural Management and Social Science (BMS) ethical committee of the University of Twente (Request Nr.: 190129).

Participants

The participants for this study were selected via convenience sampling, and mainly friends, family, and fellow students were asked to participate. Some participants were also recruited through *SONA system*, which is an Experiment Management System of the University of Twente (n.d.). It allows students and researchers to promote their research to be able to gather

participants. The data collection took place from April 1st to May 13th, 2019. The inclusion criteria were that the participants should be at least 18 years old, that they should be German university students and sufficiently speak English. The frequencies of demographic data about the participants can be found in Table 2. In total 35 participants volunteered their time for the study, of which 14 were male and 21 were female. Most of the participants were German university students. One of them was a former university student and two of the participants were of another nationality than German, namely Iranian and Taiwanese. According to the inclusion criteria, these two participants should have been excluded, however, it was decided to include them in the data analysis because they were living in Germany for several years. The participants age ranged from 19 to 54 ($M = 23$, $SD = 5.609$). Furthermore, the participants had various educational backgrounds. The majority, 60% were somewhat familiar with eHealth technology, 14.3 % were very familiar and 25,7% were not familiar with it at all.

Table 2
Demographics of the participants (N=35)

	N	Percentage
Age		
<i>Mean (Min. - Max.)</i>	23.20 (19-54)	
<i>SD</i>	5.60	
Nationality		
German	33	94.3
Other	2	5.7
Gender		
Male	14	40.0
Female	21	60.0
Scientific background		
Behavioural, Management & Social Science	27	77.1
Information & Communication Technology Science	1	2.9
Science & Technology	2	5.7
Electrical Engineering, Mathematics & Computer Science	-	-
Other	5	14.3
eHealth familiarity		
Very	5	14.3
Somewhat	21	60.0
Not at all	9	25.7

Note. The dash indicates that no data was obtained from this group.

Materials

The materials for this study consisted of an information sheet (see Appendix B) with information about the aim, content, and process of the study, as well as information about how the anonymity of the data was ensured. Furthermore, an informed consent form (see Appendix C), which guaranteed the voluntary participation of the participants and informed them about their rights, for instance, pausing or quitting the study at any time and how the data was used. Additionally, a PowerPoint presentation was incorporated, which gave instructions about the process of the card sorting task and explained the PPQ constructs in detail (see Table 3). This description had the purpose of introducing and making the participants familiar with the different PPQ constructs so that they would be able to execute the card sorting task. The description of the PPQ constructs was enhanced with examples (see Appendix D) to further clarify the application of the constructs. The presentation and the information sheet (see Appendix B) ensured that all participants received the same information so that bias by the two researchers was reduced.

The card sort in this study was an offline card sort where items and constructs were printed on paper. An offline instead of an online card sort was chosen for this study so that the researcher had the opportunity to interact face to face with the participant. The card sorting method was developed to identify how people arrange and categorize their knowledge (Wood & Wood, 2008). As reported by Spencer (2009), in an open card sort, the groups of to be sorted cards are designed and defined by the participants. In contrast to that, a closed card sort contains predefined groups in which cards are to be sorted. Generally, a closed card sorting task should be applied if (a) groups or constructs exist that cannot be changed, (b) one is satisfied with the existing groups, and (c) when the focus lies on exploring the details of how the content is placed within the groups (Spencer, 2009). Furthermore, as stated in Wood & Wood (2008) a closed card sorting task should be conducted for the validation of previously analysed data. Therefore, a closed card sorting method was chosen for this study, instead of an open card sorting method.

The materials included 31 white cards, of which each contained an item with the matching item number of the PPQ as well as nine coloured cards, which contained the construct of the PPQ and its definition. The definitions of the constructs were identical to the definitions of the constructs provided in the PowerPoint presentation and can be found in Table 3. An overview of the PPQ items and constructs can be found in Appendix A. The nine constructs were *perceived primary task support*, *perceived dialogue support*, *perceived credibility*, *perceived social support*, *perceived persuasiveness*, *perceived unobtrusiveness*, *perceived effort*, *perceived effectiveness*, and *use continuance*. Moreover, a short questionnaire with

demographic questions about age, gender, scientific background and familiarity with eHealth technology was included (see Appendix E). This questionnaire contained no names of the participants, only the participant number and was, therefore, an anonymous way to collect demographic data about the participants.

Table 3

Constructs cards and definition of the PPQ constructs used for the card sorting

Construct	Definition
Perceived Dialogue Support	Perceived dialogue support defines the key principles in keeping the user active and motivated in using the system and involved in his or her behaviour change process.
Perceived Credibility	Perceived credibility contains both a subjective and objective component. <u>The subjective component</u> is based upon people's initial evaluations of the system credibility on their first impressions. <u>The objective component</u> might be bolstered by providing endorsements from respected and renowned sources.
Use Continuance	Use continuance is the users' intention to continue using the technology.
Perceived Social Support	Perceived social support is the perception and actuality that one is cared for, has assistance available from other people, and that one is part of a supportive social network.
Perceived Effectiveness	Perceived effectiveness is defined as the degree to which using a technology will provide benefits to consumers in performing certain activities.
Perceived primary Task Support	Perceived primary task support encompasses the means to aid the individual in performing his or her primary task.
Perceived Effort	Perceived effort is the effort expectancy and the degree of ease associated with consumers' use of technology.
Perceived Persuasiveness	Perceived persuasiveness consists of the individual's favourable impressions toward the system.
Perceived Unobtrusiveness	Perceived unobtrusiveness reflects whether the system fits with the user's environment in which he or she uses the system.

Note. Table from Beerlage-de Jong et al. (2016).

Procedure

The data collection was executed by two researchers of the University of Twente, each conducting the card sorting task with the participants separately. Before the start of the card sorting task, an information sheet (see Appendix B) and an informed consent form (see Appendix C) were handed to the participants, which they were asked to read and sign. Subsequently, the PowerPoint presentation was shown and explained to the participants.

The instructions given on the slides comprised three steps. Step one was to read the definitions of the nine PPQ constructs (see Table 3). Step two was to receive the construct and item cards. Finally, step three was to place the items with the corresponding constructs. For this step, it was specified that every construct was on a different colour of paper and that the items were on white paper. Moreover, it was indicated that multiple items and a minimum of one item could be placed with each construct and that all the item cards had to be used.

After going through the presentation, the participants were asked if they understood the constructs and were ready to start the card sorting task. When the participants agreed and no more questions remained, the cards were handed out to them. It was clarified that the card sorting task solely was about the PPQ's items and constructs and that the Runkeeper application was mentioned on the item cards only for exemplification. During the card sort, the participants could consult the definitions of the constructs and were able to think out loud but were not forced to do so.

If questions arose during the card sorting task regarding comprehension of the language used, the process of the task or definitions of the constructs, the researcher was able to respond and give the German translation of words. However, on any questions regarding the placement of the cards the researcher was not allowed to be responsive. Most of the participants did not experience any trouble during the task, however, a few participants repeatedly asked for word translations and engaged for a longer time than other participants in the card sorting task. On average it took participants between 15 to 20 minutes to complete the card sort.

When the participants placed all the item cards and no construct card was left without an item card, they had the chance to rearrange any of the item cards previously placed. Finally, when the participants completed the task, the researcher took a picture of the sorted cards for the data analysis. Lastly, the short questionnaire with demographic questions was handed to the participants, which they were asked to fill in (see Appendix E). After the participants filled in the questionnaire, they were debriefed and informed that they successfully completed the study. Participants were thanked for their participation and the participants which joined the study through SONA were granted their credit points.

Data analysis

Several steps were taken to analyse the data of the card sorting. Firstly, the demographic information of the participants was entered into SPSS version 24 for analysis of descriptive statistics (IBM, n.d.). Secondly, to answer the first sub-question how many participants sorted the items in the original construct, a table was created depicting the number of correct item placement. For each participant, the data of the card sorting task was checked to see whether they placed none, one, two, three, four or five items of a construct within the original construct. Thirdly, to answer the main research question do the items of the PPQ match the constructs they are intended to measure, the data of the card sorting was entered into SPSS and the frequencies of item placement within different constructs were derived. This data was displayed in a table showing for each item how often it was placed within the original and alternative constructs. The approach to this type of analysis was deductive and aimed at testing whether the items of the PPQ match the constructs they are intended to measure by having an overview of how many participants sorted the items within the original construct and alternative constructs.

Lastly, a cluster analysis was performed using SPSS. This was done to answer the second sub-question of how many clusters emerge based on the data of the card sorting task. The cluster membership was arranged to form between 2 and 31 clusters. For the cluster method, the between-groups linkage method was chosen with a measure of intervals based on squared Euclidean distance. As output, a table of cluster membership, a dendrogram, and an icicle chart was requested from which the results, specifically the arrangement of items within clusters emerged. First, the cluster membership table which depicted the items assigned to each cluster (2 to 31) was analysed. Based on this, a table was created depicting the items belonging to each cluster starting with nine clusters, because the original PPQ consisted of nine constructs. The same was done for eight, seven, six and five clusters. The final number of clusters was chosen depending on the number of items contained in each cluster. A minimum of two items was set to be included in each cluster. Second, a reference line was added to the icicle chart depending on the previously decided number of clusters and red dashed lines were added to the dendrogram marking the clusters. Based on these two figures the relation between several items and constructs was compared. The Icicle chart depicted how well items were joined. In the Dendrogram, short branches suggested a strong linkage, while long branches suggested a weak link between the items.

Results

An overview of the number of participants which sorted items within the original construct is given in Table 4. For only two constructs most participants placed the maximum number of items within the original construct, *perceived social support* (n=27) and *use continuance* (n=25). Moreover, for *perceived credibility*, participants placed mostly four (n=14) of the maximum five (n=12) items within the construct. Noticeably, in all cases, at least one item was placed within this construct. For four constructs mostly two of the items were placed in the original construct. These were *perceived dialogue support* (n=19), *perceived unobtrusiveness* (n=13), *perceived effort* (n= 16) and *perceived persuasiveness* (n=14). Strikingly, for *perceived persuasiveness* one item was placed just as many times as two items with the original construct (n=14). Only one item was placed most often by the participants within the original construct for *perceived effectiveness* (n=14) and *perceived primary task support* (n=21).

Table 4

Number of participants which sorted items within the original construct (N=35)

Construct	Number of items					
	0	1	2	3	4	5
Perceived Primary Task Support	6	21	6	2		
Perceived Dialogue Support	3	8	19	5		
Perceived Credibility	0	2	4	3	14	12
Perceived Social Support	1	1	6	27		
Perceived Persuasiveness	7	14	14	0		
Perceived Unobtrusiveness	1	5	13	9	7	
Perceived Effort	4	6	16	9		
Perceived Effectiveness	4	14	10	7		
Use Continuance	1	0	0	9	25	

Note. Number of items: Perceived Credibility = 5; Perceived Unobtrusiveness & Use Continuance = 4; The remaining constructs contain three items. The largest groups of participants that sorted the items in the original construct are marked in bold.

Overall item placement

The frequencies of item placement are described for each of the nine PPQ constructs in the following and the table of results is displayed in Appendix F.

Perceived primary task support. This construct originally consists of the Items 15, 23, and 26. The frequencies per item for this construct are provided in Table 5. Item 26 was placed by the majority of the participants within the original construct (n=24), whereas items 15 (n=10) and 23 (n=5) were placed by the minority of participants with the original construct. Therefore, overall the number of times participants placed items within alternative constructs was higher for the items 15 (n= 25) and 23 (n=30) than the number of times participants placed the items within the original construct. Item 23 was sorted most often with *perceived effectiveness* (n=20), as well as item 15 (n=13).

Table 5

Frequencies of the items originally belonging to the construct perceived primary task support (N=35)

Item	Original construct	Alternative constructs						
		PE	PP	DS	SOC	UC	PF	PC
15	10	13	5	4	1	1	1	-
23	5	20	7	2	-	-	-	1
26	24	3	1	5	-	1	1	-

Note. PE = Perceived Effectiveness; PP = Perceived Persuasiveness; DS = Perceived Dialogue Support; SOC = Perceived Social Support; UC = Use Continuance; PF = Perceived Effort; PC = Perceived Credibility. The dash indicates that no data was reported.

Perceived dialogue support. The construct *perceived dialogue support* originally consisted of the Items 11, 17 and 18. In Table 6 the frequencies of item placement are displayed for this construct. The majority of participants (n=24) placed Item 17 and 18 within the original construct. However, the variation was more diverse for Item 11, where most participants placed the item within the original construct (n=13) but overall less often than within alternative

constructs (n=22). This placement within alternative constructs varied between *perceived persuasiveness* (n=8), *perceived primary task support* (n= 7) and *perceived effectiveness* (n=6).

Table 6

Frequencies of the items originally belonging to the construct perceived dialogue support (N=35)

Item	Original construct	Alternative constructs					
		PP	PTS	PE	PC	SOC	U
11	13	8	7	6	-	1	-
17	24	1	4	1	3	-	2
18	24	1	6	1	2	1	-

Note. PP = Perceived persuasiveness; PTS = Perceived Primary Task Support; PE = Perceived Effectiveness; PC = Perceived Credibility; SOC = Perceived Social Support; U = Perceived Unobtrusiveness. The dash indicates that no data was reported.

Perceived credibility. The construct *perceived credibility* originally consisted of the Items 4, 10, 16, 19 and 27. In Table 7 the frequencies of item placement are displayed for this construct. Most of the participants placed four of the items within the original constructs, namely Items 4 (n=29), 10 (n=26), 19 (n=33) and 27 (n=29). Only Item 16 was placed almost as many times within the original construct (n=19) as in the alternative constructs (n=16). The alternative constructs in which it was placed were *perceived dialogue support* (n=4), *perceived task support* (n=4), *perceived persuasiveness* (n=3) and *perceived effectiveness* (n=3).

Table 7

Frequencies of the items originally belonging to the construct perceived credibility (N=35)

Item	Original construct	Alternative constructs						
		PP	DS	PTS	PE	PF	UC	SOC
4	29	1	1	1	3	-	-	-
10	26	2	1	1	3	1	-	1
16	19	3	4	4	3	1	1	-
19	33	1	-	-	-	1	-	-
27	29	5	-	-	-	-	-	1

Note. PP = Perceived Persuasiveness; DS = Perceived Dialogue Support; PTS = Perceived Primary Task Support; PE = Perceived Effectiveness; PF = Perceived Effort; UC = Use Continuance; SOC = Perceived Social Support. The dash indicates that no data was reported.

Perceived social support. The construct *perceived social support* originally consisted of the Items 21, 28 and 30. In Table 8 the frequencies of item placement are displayed for this construct. All items were placed almost consistently within the original constructs, Item 21 (n=32), 28 (n=30) and 30 (n=32). The remaining items were sporadically scattered over several different alternative constructs.

Table 8

Frequencies of the items originally belonging to the construct perceived social support (N=35)

Item	Original construct	Alternative constructs					
		DS	PC	PTS	U	PP	UC
21	32	1	1	1	-	-	-
28	30	2	1	1	1	-	-
30	32	-	1	-	-	1	1

Note. DS = Perceived Dialogue Support; PC = Perceived Credibility; PTS = Perceived Primary Task Support; U = Perceived Unobtrusiveness; PP = Perceived Persuasiveness; UC = Use Continuance. The dash indicates that no data was reported.

Perceived persuasiveness. The construct *perceived persuasiveness* originally consisted of the Items 5, 20 and 25. The frequencies of item placement are displayed in Table 9. Compared to the earlier described constructs, the items of this construct showed a more diverse variety of item assembly than an association with the original construct. The minority of people placed Item 25 within the original construct (n=10) compared to alternative constructs (n=25). Interestingly, Item 25 was placed the same number of times within the construct *perceived effectiveness* (n=10) as in the original construct, followed by *perceived task support* (n=7) and *perceived dialogue support* (n=3). Two items were placed almost half as much within the original construct, Items 5 (n=16) and 20 (n=18), as in alternative constructs. They were placed second-most within *perceived effectiveness*, Item 5 (n=8) and Item 20 (n=12).

Table 9

Frequencies of the items originally belonging to the construct perceived persuasiveness (N=35)

Item	Original construct	Alternative constructs						
		PE	PTS	UC	U	DS	PC	PF
5	16	8	2	3	3	-	2	1
20	18	12	1	1	1	1	-	1
25	10	10	7	2	-	3	2	1

Note. PE = Perceived Effectiveness; PTS = Perceived Primary Task Support; UC = Use Continuance; U = Perceived Unobtrusiveness; DS = Perceived Dialogue Support; PC = Perceived Credibility; PF = Perceived Effort. The dash indicates that no data was reported.

Perceived unobtrusiveness. The frequencies of item placement for the construct *perceived unobtrusiveness*, which originally consisted of the Items 1, 6, 14 and 24, are displayed in Table 10. Two of the items in this construct, Item 6 (n= 30) and 14 (n= 27), were placed most frequently within the original construct. Item 24 was placed slightly more than half of the time within the original construct (n=19) and it was placed second-most within the construct *perceived effort* (n=12). Strikingly, Item 1 was sorted by the minority of the participants (n= 10) within the original construct, thus it was scattered more widely within the alternative constructs than the other items. After the original construct, Item 1 was placed most often within *perceived effort* (n=9) and *perceived persuasiveness* (n=7). Noticeably, *perceived effort* was the alternative construct in which all the items were placed most frequently.

Table 10

Frequencies of the items originally belonging to the construct perceived unobtrusiveness (N=35)

Item	Original construct	Alternative constructs					
		PF	PP	PE	UC	PTS	PC
1	10	9	7	4	3	2	-
6	30	2	-	1	2	-	-
14	27	6	1	-	-	1	-
24	19	12	-	1	2	-	1

Note. PF = Perceived Effort; PP = Perceived Persuasiveness; PE = Perceived Effectiveness; UC = Use Continuance; PTS = Perceived Primary Task Support; PC = Perceived Credibility. The dash indicates that no data was reported.

Perceived effort. The construct *perceived effort* originally consisted of the Items 2, 9 and 31. The frequencies of item placement for this construct are displayed in Table 11. The lowest variance between alternative constructs was displayed by Item 31, which was placed by the majority of participants within the original construct (n=29). So was Item 2 (n= 24), but prominent is the placement within *perceived unobtrusiveness* (n=5) and *perceived persuasiveness* (n=5). Contrastingly, Item 9 was placed least often within the original constructs (n=12), however, the variance was great between alternative constructs. It was placed second-most within *perceived persuasiveness* (n=7), followed by *perceived unobtrusiveness* (n=6), *perceived dialogue support* (n=3), *use continuance* (n=3) as well as *perceived effectiveness* (n=2) and *perceived primary task support* (n=2). Apparent is that *Perceived unobtrusiveness* and *perceived persuasiveness* are the alternative construct in which most items were placed.

Table 11

Frequencies of the items originally belonging to the construct perceived effort (N=35)

Item	Original construct	Alternative constructs					
		U	PP	DS	UC	PE	PTS
2	24	5	5	1	-	-	-
9	12	6	7	3	3	2	2
31	29	3	1	-	1	-	1

Note. U = Perceived Unobtrusiveness; PP = Perceived Persuasiveness; DS = Perceived Dialogue Support; UC = Use Continuance; PE = Perceived Effectiveness; PTS = Perceived Primary Task Support. The dash indicates that no data was reported.

Perceived effectiveness. The construct *perceived effectiveness* originally consisted of the Items 3, 12 and 29. The frequencies of item placement are displayed in Table 12. The item mostly placed within the original construct by participants is Item 29 (n= 27). Strikingly, Item 12 was placed as often within the original construct as within *perceived persuasiveness* (n=15). Finally, for Item 3 the variance of item placement was the greatest. It was placed less than half the times within the original construct (n=14), the placement within alternative constructs, therefore, amounted to a greater number (n=21). Item 3 was placed second-most within *perceived primary task support* (n=9), followed by *perceived persuasiveness* (N=6) and *perceived dialogue support* (n=3).

Table 12

Frequencies of the items originally belonging to the construct perceived effectiveness (N=35)

Item	Original construct	Alternative constructs					
		PP	PTS	DS	U	UC	PF
3	14	6	9	3	1	1	1
12	15	15	5	-	-	-	-
29	27	4	1	1	1	1	-

Note. PP = Perceived Persuasiveness; PTS = Perceived Primary Task Support; DS = Perceived Dialogue Support; U = Perceived Unobtrusiveness; UC = Use Continuance; PF = Perceived Effort. The dash indicates that no data was reported.

Use continuance. In Table 13 the frequencies of item placement are displayed for *use continuance*, which originally consisted of the Items 7, 8, 13 and 22. Compared to the items of other constructs, these items were very often placed within the original construct, item 7 (n=32), 8 (n=34), 13 (n=28) and 22 (n=33). The variance of placement within alternative constructs was therefore very sporadically scattered. Item 13 was sporadically spread over alternative constructs, being sorted most with *perceived effectiveness* (n=3) and *perceived primary task support* (n=2).

Table 13

Frequencies (N=35) of the items originally belonging to the construct use continuance

Item	Original construct	Alternative constructs				
		PE	PP	U	PPT	DS
7	32	-	2	1	-	-
8	34	-	-	-	-	1
13	28	3	1	1	2	-
22	33	-	-	1	1	-

Note. PE = Perceived Effectiveness; PP = Perceived Persuasiveness; U = Perceived Unobtrusiveness; PPT = Perceived Primary Task Support; DS = Perceived Dialogue Support. The dash indicates that no data was reported.

Cluster analysis

Based on the outcomes depicted in the table of cluster membership (see Appendix G), a table giving an overview of items divided within nine to five clusters is depicted in Appendix H. A minimum of two items within each cluster only appears with a total number of five clusters. Strikingly most of the items are divided within the same clusters independent of the total number of clusters, with the exception of three items. Item 5 appears alone in one cluster with a total number of six or more clusters, Item 15 from a total number of seven and Item 11 from a total number of nine clusters. The distribution of items within the five constructs is depicted in Table 14.

Two of the five clusters were similar to the original constructs, cluster 4 contains the items of *use continuance* and five of *perceived social support*. The clusters one, two and three depict newly discovered clusters, whereas the items in cluster four *use continuance* (7, 8, 13, 22) and cluster five *perceived social support* (21, 28, 30) appeared exactly like the original

constructs. As visible in the Icicle chart (see Appendix I) and the dendrogram (see Appendix J), the items of *perceived unobtrusiveness* (6, 1, 14, 24) and *perceived effort* (9, 2, 31) demonstrate a strong relation. They form the first cluster together with the Items 12, 20 and 5. The second cluster consists of the Items 3, 11, 23 and 25, which all descend from different original constructs, namely *perceived effectiveness*, *perceived dialogue support*, *perceived task support*, and *perceived persuasiveness*. Cluster three contains items of the constructs *perceived credibility* (4, 10, 16, 19, 27), two items of *perceived primary task support* (15 and 26), two items of *perceived dialogue support* (17 and 18) as well as Item 29 of the construct *perceived effectiveness*.

Table 14

Outcome of results of the hierarchical cluster analysis

Cluster	Original constructs and items	Items within the construct
1	Perceived Unobtrusiveness, Perceived Effort, Perceived Persuasiveness (- item 25), + item 12	1 2 5 6 9 12 14 20 24 31
2	New cluster	3 11 23 25
3	Perceived Credibility, Perceived Primary Task Support (- item 23), Perceived Dialogue Support (- item 11), + item 29	4 10 15 16 17 18 19 26 27 29
4	Use Continuance	7 8 13 22
5	Perceived Social Support	21 28 30

Discussion

This research aims to contribute to the validation of the Perceived Persuasiveness Questionnaire (PPQ) and based on all the gathered data it is possible to answer the research question, whether the items of the PPQ match the construct they are intended to measure. Generally, most of the PPQ items were found to match the constructs they are intended to measure. Some exceptions emerged, which turned out to match an alternative construct more than the original construct or seemed to be ambiguous whether matching two constructs. Concerning the first sub-question, *how many participants sorted the items in the original construct*, the results are very different for each construct. For three constructs participants

sorted most of the items and for two constructs participants sorted only a few of the items in the original construct. For the remaining constructs, mostly half of the items were placed in the original construct. Regarding the second-sub question, *how many clusters emerge based on the data of the card sorting task* a clear answer can be given. In this study, five clusters emerge based on the data of the card sorting task.

Interestingly, the overall results of this study regarding in which construct each item was mostly placed replicate the results found in Beerlage-de Jong et al. (2016), meaning the construct in which each item was placed most often by the participants is the same one in both studies, with few exceptions. One example of a similar finding between this study and the study of Beerlage-de Jong et al. (2016) is, for instance, Item 1 “Finding the time to use Runkeeper application is a problem for me.” (*Perceived unobtrusiveness*). This item is sorted most often with *perceived unobtrusiveness* and *perceived effort* in both studies. One explanation might be that the definitions of the two constructs seem to be very similar (see Table 3).

However, the number of times the items were placed within the most sorted construct differed for all items, but for some items, the difference is greater. In this study some items were found to match two constructs, some of these ambiguities of items between two constructs are similar and some are different from the findings of Beerlage-de Jong et al. (2016). One contrasting finding is related to Item 23, “Runkeeper application helps me change my exercising habits.” (*perceived primary task support*). In Beerlage-de Jong et al. (2016) it was mostly placed within the original construct closely followed by *perceived effectiveness*. In this study, however, this item is most often matched with *perceived effectiveness* followed by *perceived persuasiveness* and then the original construct. This could be explained by the fact that five of the six items (29, 12, 3, 15 & 25), which were sorted most with *perceived effectiveness*, include the word *exercising* (see Appendix A). This word might have biased the participants in such a way that items containing this word were mostly placed within one construct.

Similar results were also found in the study of De Jong et al. (2014), which suggested merging the constructs *perceived primary task support* and *perceived effectiveness* because items were not distinguishable in the interviews. This is supported by the results of this study. The two Items 15 “Runkeeper application does not help me to start with exercising.” and 23 “Runkeeper application helps me change my exercising habits.” (*perceived primary task support*) match *perceived effectiveness* better than the original construct. This might be explained by the similarity between the definitions of the constructs (see Table 3).

In the paper of Drozd, Lehto, and Oinas-Kukkonen (2012) it was found that *perceived dialogue support* is connected to the three constructs *perceived primary task support*, *perceived credibility*, and *perceived persuasiveness*. Based on this study this can be partly supported as a similar connection between three of the constructs occurred, except for *perceived persuasiveness* which was not found to be related to these constructs. One reason for this might be that based on the findings of this study, the items measuring *perceived persuasiveness* do not match the construct well, meaning they do not accurately seem to measure *perceived persuasiveness*.

Regarding the cluster analysis similar as well as different outcomes than in the study of Beerlage-de Jong et al. (2016) were found. In contrast to this study where five clusters emerged, the cluster analysis in Beerlage-de Jong et al. (2016) resulted in seven, from originally nine clusters. These seven clusters are *perceived effort*, *unobtrusiveness*, *use continuance*, *perceived credibility*, *dialogue support*, *social support* and finally a new construct *perceived goal support* consisting of the three original constructs *perceived primary task support*, *perceived persuasiveness* and *perceived effectiveness* plus Item 16 “Runkeeper does not provide confidence” (Beerlage-de Jong et al., 2016).

One explanation for the contrasting results regarding the different number of constructs and the diverse results regarding the construct *perceived goal support* is that some outliers occurred. Specifically, the differing results could be explained by participants with not good enough English skills. Generally, it could be because of the different nationalities. In the study of Beerlage-de Jong et al. (2016) participants with a mostly Dutch and also Finnish nationality participated. According to Education first (2018) Dutch people speak English better than Germans, so the level of understanding of items and constructs can be different between the two nationalities.

Two of the five constructs found in this study (*perceived social support* & *use continuance*) were similar to the original construct and to two of the seven found clusters in Beerlage-de Jong et al. (2016). One reason why use continuance might be strongly represented is that it is present since the first version of the PPQ. The construct *perceived social support*, despite being part of the PSD model by Oinas-Kukkonen & Harjuma (2009), was not included in the first version of the PPQ because at that time persuasive systems did not promote communicating and interacting with peers (Lehto et al., 2012). This has changed drastically nowadays, due to increasing social media use, the exchange of information through social media has become one of the most important features of the technology of modern times. This

is clearly reflected by the results of this study, as this construct is represented most strongly by its items.

One of the five constructs found in this study is a new construct, which is different but also similar to *Perceived goal support*. It includes the Items 3 “My chances of starting with exercising improve by using Runkeeper application.” (*perceived effectiveness*), 11 “Runkeeper application encourages me.” (*perceived dialogue support*), 23 “Runkeeper application helps me change my exercising habits.” (*perceived primary task support*) and Item 25 “Runkeeper application makes me reconsider my exercising habits.” (*perceived persuasiveness*). Because these items mostly deal with the support and motivation of starting the desired behaviour, the new construct is named *perceived motivation*. Despite the fact, that different results were found regarding the construct *perceived goal support* and *perceived motivation*, there are similarities between these two newly found constructs. Three items (3, 23 and 25) appear in both constructs, which indicates a possible connection between the three constructs *perceived primary task support*, *perceived effectiveness*, and *perceived persuasiveness*.

Strengths and Limitations

This study has several strengths that are worth mentioning. One of the main strengths of this study is that the number of participants that were included in the analysis of the data consisted of more than enough participants for a card sorting task. Based on the research of Tullis and Wood (2004) the number of participants for a card sorting study to achieve sufficient results should lie between 20 and 30 participants, whereas Lantz et al. (2014) concluded 15 to 25 participants to be a sufficient number.

Furthermore, another strength is that the definitions of the constructs were clearly described in a PowerPoint presentation and participants had the opportunity to ask questions any time. This is in compliance with the recommendation of Wood and Wood (2008), which states that the researcher should be explicit about the intended purpose of the card sorting task instead of giving non-directive instructions to avoid bias. Moreover, construct definitions were provided on the cards to improve understanding as it is recommended by Wood and Wood (2008).

There are several limitations present in this study. Firstly, researchers noticed during the data collection that the participants varied in their English-speaking skills. The exclusion criteria of this study imply good English language skills, however, some participants seemed to be struggling with the construct definitions in English. A few participants repeatedly asked for word translations and engaged a long time in the card sorting task. This might have had an

influence on the comprehension of constructs and items during the card sorting task, which could have resulted in participants placing items within certain constructs because of misunderstandings. When transcribing the results from the pictures to the data table, the participants 7, 10 and 26 were conspicuous regarding their item placement.

Furthermore, a limitation prevails regarding the demographics of the participants. The participants of this study are mostly Behavioural, Management & Social Science students. Participants with other scientific backgrounds are only scarcely represented, for instance, Information & Communication Technology Science, Science & Technology and other scientific backgrounds. Electrical Engineering, Mathematics & Computer Science is not represented at all. Behavioural, Management & Social Science students are more likely to be familiar with persuasive technology and the related concepts than participants of other scientific backgrounds. This might have influenced the findings in a way that participants who are familiar with the PPQ or terms and concepts related to persuasive technology could perceive and sort the items differently than participants who are not familiar with them.

Implications and future research

This study gives insight into the construct validity of the PPQ. In general, knowledge is gained on whether the items are actually measuring the constructs they are supposed to measure. Because the PPQ has been subject to change since its development and only a few papers have focused on validating the PPQ, the need for validation of the PPQ is in demand (Alahäivälä et al., 2013; Van Gemert-Pijnen et al., 2018). Especially, due to the increasing importance of eHealth technologies within society (Fox et al., 2002). Without question, more research is necessary to take steps in further validating the PPQ using different types of technology so that it can be used to ultimately improve the design of persuasive technology.

Several practical recommendations can be given for future research. One suggestion would be to translate the materials into multiple languages to be able to accurately test it on different populations. This would facilitate the understanding of the participants, and it would expand the population of possible participants by including people who do not speak English. The results of the card sorting task can only be valid if participants fully understand the constructs, therefore conducting a training task before the card sorting task would increase the understanding of the participants and produce more reliable and valid results. Lastly, it is suggested to conduct an exploratory factor analysis to detect items that do not match the constructs they are supposed to measure. These items could then be improved or reformulated to obtain a valid and reliable questionnaire.

Conclusion

The findings of this research contribute to the validation of the PPQ, specifically giving insight into whether the items of the PPQ match the original constructs. The PPQ facilitates and detects the use of persuasive design within eHealth technologies which are yet to be developed or are already on the market. The current study has found replicating as well as contradicting results regarding the construct validity compared to previous research and based on the cluster analysis different constructs emerged than in the original version. Therefore, more research is necessary to ultimately obtain a questionnaire that accurately helps during and after the development of persuasive technology.

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Appendix A

Overview of PPQ Constructs and Items adapted to the Runkeeper application
(<https://runkeeper.com>)

Construct	Item	Item description
Perceived Primary Task Support	15	Runkeeper application does not help me to start with exercising.
	23	Runkeeper application helps me change my exercising habits.
	26	Runkeeper application provides me with means to exercise.
Perceived Dialogue Support	11	Runkeeper application encourages me.
	17	Runkeeper application provides me with appropriate counselling.
	18	Runkeeper application provides me with appropriate feedback.
Perceived Credibility	4	Runkeeper application shows expertise.
	10	Runkeeper application is unreliable.
	16	Runkeeper application does not provide confidence.
	19	Runkeeper application is clearly made by health professionals.
	27	Runkeeper application is trustworthy.
Perceived Persuasiveness	5	Runkeeper application is not personally relevant for me.
	20	Runkeeper application has an influence on me.
	25	Runkeeper application makes me reconsider my exercising habits.
Perceived Unobtrusiveness	6	Using Runkeeper application fits into my daily life.
	14	Using Runkeeper application is practical / convenient for me.
	1	Using Runkeeper application disrupts my daily routines.
	24	Finding the time to use Runkeeper application is a problem for me.

Use Continuance	7	I am not going to use Runkeeper application from now on.
	8	I will be using Runkeeper application in the future.
	13	I am considering discontinuing using Runkeeper application.
Perceived Effort	22	I am going to continue using Runkeeper application
	9	Using Runkeeper application is straightforward for me.
	2	Using Runkeeper application does not require a lot of effort from me.
Perceived Effectiveness	31	Using Runkeeper application is difficult.
	12	In my opinion, using Runkeeper application has an effect on my willingness to exercise.
	3	My chances of starting with exercising improve by using Runkeeper application.
Perceived Social Support	29	In my opinion, Runkeeper application has no effect on my exercising habits / weight.
	21	I get support from my peers through Runkeeper application when I need it.
	28	Through Runkeeper application, I cannot share my experiences with my peers.
	30	Learning from my peers' actions is beneficial for me.

Note. PPQ as in Beerlage-de Jong et al. (2016).

Appendix B

Study information sheet

Introduction

You are being invited to participate in a research study titled “Evaluating the Perceived Persuasiveness Questionnaire by Applying a Closed Card Sorting Task”. This study is being done by Jessica Bormann and Philipp Kill from the Faculty of Behavioural, Management and Social Sciences at the University of Twente.

This research aims to validate the Perceived Persuasiveness Questionnaire (PPQ), which is a questionnaire designed to evaluate the subjective persuasiveness of technologies.

During the study we will run through two phases.

In the first phase you will perform a closed card sort. Card sorting is a method aimed at evaluating or developing a system’s information structure. In this method, participants are asked to sort cards with excerpts of the system’s content on it, into (for them) meaningful groups. In this study, you will first get introduced to the nine constructs of the PPQ. The researcher will explain these constructs to you in a short PowerPoint presentation. Then the closed card sorting task follows. We ask you to group the cards with the PPQ items into predefined categories (the nine PPQ constructs). Lastly, a picture is taken to document the result of the card sorting, which does not include the participant.

In phase two you will evaluate the Runkeeper application. You will receive a scenario-based-task which simulates a real-life-user-experience with this application. After this task you will get the opportunity to freely explore the application. Finally, you are asked to fill in the PPQ based on the experiences you had with the Runkeeper application.

Your participation in this study is entirely voluntary and you can pause or withdraw at any time. To the best of our ability your answers in this study will remain confidential.

Study contact details for further information:

Philipp Kill, p.s.kill@student.utwente.nl

Jessica Bormann, j.bormann@student.utwente.nl

Contact Information for Questions about Your Rights as a Research Participant

If you have questions about your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the Secretary of the Ethics Committee of the Faculty of Behavioural, Management and Social Sciences at the University of Twente by ethicscommittee-bms@utwente.nl

Appendix C

Informed consent form

Title research: Evaluating the Perceived Persuasiveness Questionnaire by Applying a Closed Card Sorting Task

I hereby declare that I have been informed in a manner which is clear to me about the nature and method of the research. My questions have been answered to my satisfaction. I agree of my own free will to participate in this research. I reserve the right to withdraw this consent without the need to give any reason and I am aware that I may withdraw from the experiment at any time. If my research results are to be used in scientific publications or made public in any other manner, then they will be made completely anonymous. My personal data will not be disclosed to third parties without my express permission.

If you have any complaints about this research, please direct them to the secretary of the Ethics Committee of the Faculty of Behavioural Sciences at the University of Twente, Drs. L. Kamphuis-Blikman P.O. Box 217, 7500 AE Enschede (NL), telephone: +31 (0)53 489 3399; email: l.j.m.blikman@utwente.nl).

Signatures

_____	_____	_____
Name of participant	Signature	Date

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____	_____	_____
Researcher name	Signature	Date

Study contact details for further information:

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Appendix D

Examples of constructs in PowerPoint presentation

Construct	Examples
Perceived Dialogue Support	System-to-user prompts, praise and reminders, appropriate counselling and feedback
Perceived Credibility	Information in the system stems from a trusted organization
Use Continuance	The user stops using the technology after the first time, so the use continuance is low
Perceived Social Support	Feeling supported by peers, or the degree to which a person is integrated in a social network
Perceived Effectiveness	Using the technology will make you lose weight. So it is effective
Perceived Task Support	Providing the information, one needs to lose weight
Perceived Effort	A system that is time consuming and expensive, so not easy to use
Perceived Persuasiveness	Information or messages that shift the recipients' attitudes toward the advocated attitude
Perceived Unobtrusiveness	The system fits in daily life without requiring large changes

Note. Examples derived from Beerlage-de Jong et al. (2016).

Appendix E

Demographic questions

Question	Answer possibility
1. What is your age?	
2. What is your gender?	Male Female Other I prefer not to answer
3. What is your Nationality?	German Other
4. What is your Scientific background?	Behavioural, Management & Social Science Information & Communication Technology Science Science & Technology Electrical Engineering, Mathematics & Computer Science Other
5. How familiar are you with eHealth technology?	Very Somewhat Not at all

Appendix F

Frequencies of item placement sorted by construct (N=35)

Items	Original construct	Alternative construct
1	Perceived Unobtrusiveness (n=10)	Perceived Effectiveness (n=4) Perceived Effort (n=9) Perceived Persuasiveness (n=7) Perceived Primary Task Support (n=2) Use Continuance (n=3)
2	Perceived Effort (n=24)	Perceived Unobtrusiveness (n=5) Perceived Persuasiveness (n=5) Perceived Dialogue Support (n=1)
3	Perceived Effectiveness (n=14)	Perceived Primary Task Support (n=9) Perceived Persuasiveness (n=6) Perceived Dialogue Support (n=3) Use Continuance (n=1) Perceived Unobtrusiveness (n=1) Perceived Effort (n=1)
4	Perceived Credibility (n=29)	Perceived Dialogue Support (n=1) Perceived Persuasiveness (n=1) Perceived Effectiveness (n=3) Perceived Primary Task Support (n=1)
5	Perceived Persuasiveness (n=16)	Perceived Effectiveness (n=8) Perceived Primary Task Support (n=2) Perceived Unobtrusiveness (n=3) Perceived Credibility (n=2) Use Continuance (n=3) Perceived Effort (n=1)
6	Perceived Unobtrusiveness (n=30)	Use Continuance (n=2) Perceived Effort (n=2) Perceived Effectiveness (n=1)
7	Use Continuance (n=32)	Perceived Persuasiveness (n=2) Perceived Unobtrusiveness (n=1)

8	Use Continuance (n=34)	Perceived Dialogue Support (n=1)
9	Perceived Effort (n=12)	Perceived Persuasiveness (n=7) Perceived Unobtrusiveness (n=6) Perceived Dialogue Support (n=3) Perceived Effectiveness (n=2) Use Continuance (n=3) Perceived Primary Task Support (n=2)
10	Perceived Credibility (n=26)	Perceived Effectiveness (n=3) Perceived Persuasiveness (n=2) Perceived Primary Task Support (n=1) Perceived Effort (n=1) Perceived Dialogue Support (n=1) Perceived Social Support (n=1)
11	Perceived Dialogue Support (n=13)	Perceived Persuasiveness (n=8) Perceived Primary Task Support (n=7) Perceived Effectiveness (n=6) Perceived Social Support (n=1)
12	Perceived Effectiveness (n=15)	Perceived Persuasiveness (n=15) Perceived Primary Task Support (n=5)
13	Use Continuance (n=28)	Perceived Effectiveness (n=3) Perceived Primary Task Support (n=2) Perceived Unobtrusiveness (n=1) Perceived Persuasiveness (n=1)
14	Perceived Unobtrusiveness (n=27)	Perceived Effort (n=6) Perceived Persuasiveness (n=1) Perceived Primary Task Support (n=1)
15	Perceived Primary Task Support (n=10)	Perceived Effectiveness (n=13) Perceived Persuasiveness (n=5) Perceived Dialogue Support (n=4) Use Continuance (n=1) Perceived Social Support (n=1) Perceived Effort (n=1)

16	Perceived Credibility (n=19)	Perceived Dialogue Support (n=4) Perceived Primary Task Support (n=4) Perceived Effectiveness (n=3) Perceived Persuasiveness (n=3) Perceived Effort (n=1) Use Continuance (n=1)
17	Perceived Dialogue Support (n=24)	Perceived Primary Task Support (n=4) Perceived Credibility (n=3) Perceived Unobtrusiveness (n=2) Perceived Persuasiveness (n=1) Perceived Effectiveness (n=1)
18	Perceived Dialogue Support (n=24)	Perceived Primary Task Support (n=6) Perceived Credibility (n=2) Perceived Social Support (n=1) Perceived Effectiveness (n=1) Perceived Persuasiveness (n=1)
19	Perceived Credibility (n=33)	Perceived Effort (n=1) Perceived Persuasiveness (n=1)
20	Perceived Persuasiveness (n=18)	Perceived Effectiveness (n=12) Perceived Primary Task Support (n=1) Perceived Dialogue Support (n=1) Perceived Effort (n=1) Perceived Unobtrusiveness (n=1) Use Continuance (n=1)
21	Perceived Social Support (n=32)	Perceived Dialogue Support (n=1) Perceived Credibility (n=1) Perceived Primary Task Support (n=1)
22	Use Continuance (n=33)	Perceived Unobtrusiveness (n=1) Perceived Primary Task Support (n=1)
23	Perceived Primary Task Support (n=5)	Perceived Effectiveness (n=20) Perceived Persuasiveness (n=7) Perceived Dialogue Support (n=2)

		Perceived Credibility (n=1)
24	Perceived Unobtrusiveness (n=19)	Perceived Effort (n=12) Use Continuance (n=2) Perceived Effectiveness (n=1) Perceived Credibility (n=1)
25	Perceived Persuasiveness (n=10)	Perceived Effectiveness (n=10) Perceived Primary Task Support (n=7) Perceived Dialogue Support (n=3) Perceived Credibility (n=2) Use Continuance (n=2) Perceived Effort (n=1)
26	Perceived Primary Task Support (n=24)	Perceived Dialogue Support (n=5) Perceived Effectiveness (n=3) Perceived Persuasiveness (n=1) Perceived Effort (n=1) Use Continuance (n=1)
27	Perceived Credibility (n=29)	Perceived persuasiveness (n=5) Perceived Social Support (n=1)
28	Perceived Social support (n=30)	Perceived Dialogue Support (n=2) Perceived Primary Task Support (n=1) Perceived Credibility (n=1) Perceived Unobtrusiveness (n=1)
29	Perceived Effectiveness (n=27)	Perceived Persuasiveness (n=4) Perceived Dialogue Support (n=1) Perceived Primary Task Support (n=1) Use Continuance (n=1) Perceived Unobtrusiveness (n=1)
30	Perceived Social Support (n=32)	Perceived Persuasiveness (n=1) Use continuance (n=1) Perceived Credibility (n=1)
31	Perceived Effort (n=29)	Perceived Persuasiveness (n=1)

Perceived Primary Task Support (n=1)

Use Continuance (n=1)

Perceived Unobtrusiveness (n=3)

Appendix G

Outcome of hierarchical cluster analysis depicting the cluster membership of items

Item	Cluster 5	Cluster 6	Cluster 7	Cluster 8	Cluster 9
1	1	1	1	1	1
2	1	1	1	1	1
3	2	2	2	2	2
4	3	3	3	3	3
5	1	4	4	4	4
6	1	1	1	1	1
7	4	5	5	5	5
8	4	5	5	5	5
9	1	1	1	1	1
10	3	3	3	3	3
11	2	2	2	2	6
12	1	1	1	6	7
13	4	5	5	5	5
14	1	1	1	1	1
15	3	3	6	7	8
16	3	3	3	3	3
17	3	3	3	3	3
18	3	3	3	3	3
19	3	3	3	3	3
20	1	1	1	6	7
21	5	6	7	8	9
22	4	5	5	5	5
23	2	2	2	2	2
24	1	1	1	1	1

25	2	2	2	2	2	2
26	3	3	3	3	3	3
27	3	3	3	3	3	3
28	5	6	7	8	9	
29	3	3	3	3	3	3
30	5	6	7	8	9	
31	1	1	1	1	1	1

Note. The clusters in which the items appear alone are marked in bold.

Appendix H

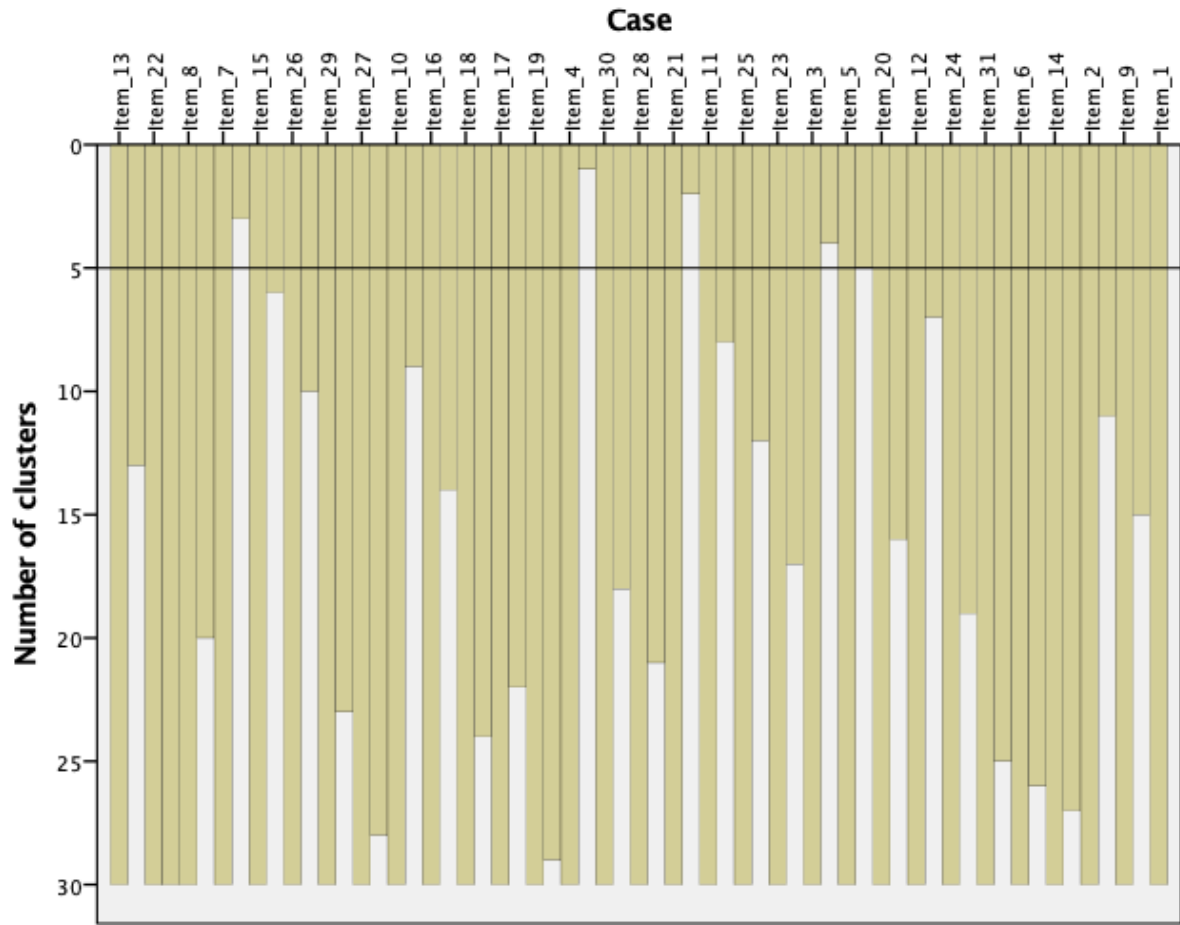
Overview of items divided within clusters based on the table of cluster membership

Clusters	Items
9 clusters	
1	1, 2, 6, 9, 24, 31
2	3, 23, 25
3	4, 10, 16, 17, 18, 19, 26, 27, 29
4	5
5	7, 8, 13, 22
6	11
7	12, 20
8	15
9	21, 28, 30
8 clusters	
1	1, 2, 6, 9, 24, 31
2	3, 11, 23, 25
3	4, 10, 16, 17, 18, 19, 26, 27, 29
4	5
5	7, 8, 13, 22
6	12, 20
7	15
8	21, 28, 30
7 clusters	
1	1, 2, 6, 9, 12, 14, 20, 24, 31
2	3, 11, 23, 25
3	4, 10, 16, 17, 18, 19, 26, 27, 29
4	5
5	7, 8, 13, 22
6	15
7	21, 28, 30
6 clusters	
1	1, 2, 6, 9, 12, 14, 20, 24, 31
2	3, 11, 23, 25
3	4, 10, 15, 16, 17, 18, 19, 26, 27, 29
4	5
5	7, 8, 13, 22
6	21, 28, 30
5 clusters	
1	1, 2, 5, 6, 9, 12, 14, 20, 24, 31
2	3, 11, 23, 25
3	4, 10, 15, 16, 17, 18, 19, 26, 27, 29
4	7, 8, 13, 22
5	21, 28, 30

Note. The items which appear alone in a cluster are marked in bold.

Appendix I

Icicle chart with reference line to the Y axis marking the outcome of five clusters



Appendix J

Dendrogram showing the five clusters found in the cluster analysis

