Clarifying the Concepts of Personalization and Tailoring: An Interview Study with Experts

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Abstract

Background: Although personalization and tailoring are identified as alternatives for a 'one-size-fits-all' approach for eHealth technologies, there is no common understanding of these two concepts and how they should be applied. In the current study, our aim is to describe (1) how tailoring and personalization are defined according to eHealth experts, and what the differences and similarities are, (2) what type of variables can be used to segment eHealth users into more homogenous groups or on the individual level, (3) what elements of eHealth technologies are customized to those segments, and (4) how the segments are matched with eHealth customizations.

Methods: Ten eHealth experts were included via purposive and snowball sampling for an interview consisting of two parts: (1) questions about definitions of personalization and tailoring and questions related to segmentation and customization, (2) responses to three vignettes on examples of eHealth technologies, varying in personalization and tailoring strategies to elicit responses about their views on how the two components were applied and matched in different contexts.

Results: Responses were analyzed using a combination of deductive and inductive coding. First, deductive codes were assigned to fragments related to Definitions (n = 25), Segmentation (n = 298), Customization (n = 100) and Matching (n = 56). Within the theme 'Definitions' participants mentioned several distinguishing factors (n = 25) between personalization and tailoring. Within the theme 'Segmentation' participants mentioned nine types of variables that can be used (n = 227) and eight data collection methods (n = 71). Within the theme 'Customization' five elements were mentioned that can be customized (n = 100), namely channeling, content, graphical, functionalities and behavior change strategy. Within the theme 'Matching' participants mentioned substantiation methods (n =24) and the variable level on which matching takes place (n = 32).

Conclusions: We observed that personalization and tailoring are multidimensional concepts in which multiple factors come into play that determine how these concepts should be applied to eHealth. Intra- and inter-individual differences among the target group and technology affordances determine whether and how personalization and tailoring can be applied most effectively to eHealth technologies according to participants.

1. Introduction

eHealth technologies can provide opportunities to overcome the increased burden on healthcare (1). For example, they can provide a more cost-efficient approach and improve quality of care by exploiting the additional possibilities from technology such as continuous monitoring and allowing patients to move in a virtual world (2). eHealth can be defined as "the use of technology to improve health, well-being and healthcare" (2), and is an umbrella term that encompasses multiple digital health care technologies, for example mobile health apps, web-based monitoring systems, and internet-based interventions (3). Although eHealth technologies show significant improvements on health and wellbeing, these

improvements are often small (4–7), adherence and engagement are regularly low (8), and the effectiveness seems to decrease in the long term. This suggests that the full potential of eHealth technologies has not been reached. Since eHealth technologies that adapt to individuals are associated with more effective interventions (9–11), a possible explanation for the suboptimal effectiveness is that a "one-size-fits-all" approach is not sufficient. This means that, when designing an eHealth technology, one must consider the variation in patients' needs, life experiences and other factors (12). For example, eHealth technologies focusing on stress management appeared to be effective amongst those reporting increased stress whereas this type of intervention is not effective when used by all employees (5). While adapting healthcare in general relies largely on information about medical characteristics of the patient (e.g. genes) (13), advances in eHealth technologies create new possibilities for continuously gathering more holistic data about a patient. Thus, information about, for example, stress levels might be obtained using ecological momentary assessment or wearables connected with the eHealth technology. Changing the eHealth technology accordingly to the individual user is thought to increase effectiveness and implementation. This is referred to as tailoring and personalization in the context of eHealth technologies. Personalization and tailoring seem to be a logical way of overcoming suboptimal effectiveness, but there is no unambiguous agreement on how personalization and tailoring are defined and what the differences and similarities are. In addition, it remains unclear how personalization and tailoring are and can be applied to eHealth technologies. We need to understand more about personalization and tailoring to maximize the impact and to come one step closer to reaching the full potential of eHealth technologies.

1.1 Personalization and Tailoring

Tailoring and personalization are two terms that are used in the context of adapting eHealth technologies to individual users. The definitions of tailoring and personalization have in common that a certain adaptation is made to the eHealth technology based on factors related to the user (14–16). Yet, definitions vary in what information about the user (e.g., eHealth literacy, symptoms) is considered and how the eHealth technology is adapted accordingly. To illustrate: personalization is sometimes described as including the name of the user (17), whereas other definitions go beyond this definition and include adjustments to messages that convey that the eHealth technology is adapted to the user through identification (e.g., "Hi, Kate"), contextualization (e.g., "This information is relevant for mothers.") and raising expectations (e.g., "This information is especially designed for you.") (15). Another broader definition is that personalization concerns adapting the content or service of eHealth technology (16), such as presenting the most relevant information for the user first (e.g., presenting information about fruit intake first for users who indicated that they do not eat fruit). Tailoring, on the other hand, is sometimes described as an overarching term for personalization, feedback, and content matching (15). Following this definition, personalization is a form of tailoring. However, tailoring is also defined as a term that is distinctive from personalization. Oinas-Kukonen distinguishes personalization and tailoring by considering adaptations to groups of users as tailoring and to individual users as personalization (16). This is in contrast with the definition of Revere and Dunbar in which tailoring is seen as adaptations to

individual users and adaptations to groups of users as a form of targeting eHealth technologies (17). Overall, we observe that several attempts have been made to describe personalization and tailoring in an unambiguous manner, but that these definitions are sometimes contradictory and that the understanding of the differences and similarities between these two concepts varies.

1.2 Segmentation, Customization and Matching

As mentioned previously, it remains unclear how personalization and tailoring are applied to eHealth technologies. For this, Hawkins developed a framework in which the application of personalization and tailoring is described in terms of segmentation and customization (15). Segmentation is “the degree to which the audience is divided into increasingly more defined, homogenous groups”. Based on user characteristics such as lifestyle, the ability to understand health information, or health status, segmentation takes place, in which groups ranging from very small (one person) to large (all females) are created. Based on these segmentations, customization of the content and/or design of an eHealth technology takes place (15). Customization is described as “the degree to which the messages (i.e., a combination of content, source, graphics, channel, etc.) audience receive reflect relevant individual characteristics” (15). A meaningful link between segmentation and customization results in a personalized or tailored eHealth technology that can be described on a continuum of segmentation and customization. A limitation of this model is that it merely focuses on messages, whereas advances in eHealth technologies highly broaden the ways in which they can be adapted. This means that the focus of adapting messages can, and should, be extended to, for example, changing virtual environments and intensity levels of workouts in a gamified sports game. Another limitation of this model is that the way in which segmentation and customization can be linked in a meaningful matter is not described. In the current study, we refer to this aspect of creating a meaningful link as ‘matching’.

1.3 Aim of the Study

The goal of the current interview study is to describe in detail (1) how tailoring and personalization are defined according to eHealth experts, and what the differences and similarities are, (2) based on what type of variables users are segmented to allow for customization of eHealth technologies, (3) what elements of eHealth technologies are customized to those segments, and (4) how the segments are matched with eHealth customizations.

2. Method

2.1 Participants

Participants were researchers with a fluency in English, that work or have been working with eHealth technologies and published at least one scientific article in the field of personalized or tailored eHealth technologies. They were included via purposive and snowball sampling by asking participants to identify researchers with an expertise in personalizing and tailoring eHealth technologies. Ten participants consented to participate in the interviews, of whom 4 males, 2 females, 1 non-binary (3 participants did

not disclose their gender). Their mean age was 39 years (SD = 5.93; 4 missing values), and the majority works as a professor (n = 4). Other professions were associate professor, professor emeritus, lecturer and physiologist.

2.2 Materials and Procedure

The interviews took place online to adapt to the COVID-19 restrictions. The interviews had a duration of around 60 minutes and were recorded after asking for permission. Participants received a short introduction, after which questions were asked in two parts, namely (1) general questions about personalization and tailoring and (2) questions related to vignettes with three examples of eHealth technologies, varying in personalization and tailoring strategies (see Appendix 1 for the full interview scheme). General questions were related to definitions of personalization and tailoring (e.g., 'Do you think there are differences between personalization and tailoring or any other similar terms, such as targeted, individualized, adapted?'), questions about how participants segmented users in their projects (e.g., "How would you segment the users of eHealth technologies to provide them with personalized content?"), their experience with customizing eHealth technologies (e.g., "How can eHealth technologies be customized to the end user?") and how these two were matched (e.g., "How do you think customization and segmentation are related?").

The second part of the interviews consisted of three vignettes to stimulate a reaction or opinion of the participant towards the depicted situation on the vignette. They depict three eHealth technologies that differ in their level of segmentation and the way in which the technologies are customized. The first vignette is the Brain Aging Monitor (18) in which users are segmented in lifestyle profiles. Customization to those lifestyle profiles include feedback about lifestyle and the in- or exclusion of relevant content. The second vignette consists of a virtual reality behavior therapy for tobacco cessation (19) in which users are segmented in personas based on emotional response data. Customizations entail the use of either positive (i.e., cessation coach) or negative scenarios (i.e., receiving a diagnosis of emphysema). The third vignette is a cardiovascular risk calculator (20) in which users are segmented based on several cardiovascular risk factors. The eHealth technology is customized by indicating their cardiovascular risk and whether they are normal weight, overweight or obese. The participants were introduced to a vignette and were asked to point out the personalized parts, as well as how they would further segment and customize the eHealth technology themselves.

2.3 Data Analysis

Data were transcribed manually and anonymized for analysis in Microsoft Excel. A mix of inductive and deductive coding was used to analyze the interview data. As a first step, fragments were coded along the previously defined themes based on the research questions: (1) definition, (2) segmentation, (3) customization and (4) matching. Within these codes, fragments were inductively coded. One interview was coded by two researchers (HK and IK). The inter-reliability was 0.95 for themes, 0.93 for main codes and for subcodes 0.77. Differences were discussed until consensus was reached and the coding scheme was adapted accordingly.

3. Results

During the interviews, fragments regarding definitions of personalization (n = 66), segmentation (n = 298), customization (n = 100), and matching (n = 54) were identified. Within these previously defined themes, several main and sub codes were identified which are presented in the next sections.

3.1 Definitions

Within the theme 'Definitions', we summarized the general definitions mentioned by the participants (see Appendix 2), and one main code was identified, namely 'Distinguishing factors' (n = 25).

3.1.1 General definitions

General definitions given by the participants are summarized in Appendix 2. Participants mentioned that personalization and/or tailoring entails segmenting eHealth users based on the 'person their behavior, their context or a timeline that has been derived from their previous exposure, or behavior' (# Participant 3). Moreover, segmentation was also described as 'make it as much preference-based as possible' (# Participant 10) or as dividing users in (groups) of individuals that have a similar 'context or situation' (# Participant 4). Several forms of customization were formulated in the definitions by the participants, for example 'adapt […] your assessment and the treatment' (# Participant 6), customize the eHealth technology so that 'feedback […] should be experienced as personal' (# Participant 8), and 'mimicking what you do with a counselor' (# Participant 1).

3.1.2 Distinguishing factors

Participants mentioned several differences and similarities between personalization (see Table 1), tailoring and other related concepts (n = 25), namely segmentation level (n = 13), user input (n = 4), degree of customization (n = 4), perspective (n = 2) and segmentation variables (n = 1).

Table 1
Sub codes related to main code 'Distinguishing Factors'

Distinguishing factors (n = 25)	# of Codes	# of Participants
Segmentation level	13	7
User input	4	3
Degree of customization	4	2
Perspective	2	1
Segmentation variables	1	1

Segmentation level (n = 13) was most often mentioned as a distinguishing factor between personalization and related concepts. Segmentation was defined as the continuum on which users are divided into smaller groups to the individual level. An example is mentioned by Participant 2:

“[…] And of course, you can go from many degrees and it's probably more of a gliding scale from things as tailoring towards personalization where personalization is more focusing on the individual, whereas tailoring would be in my view a little bit more focusing on groups. […]” # Participant 2

Next to the segmentation level, user input was mentioned as a distinguishing factor (n = 4). This subcode is related to whether the user decides how the technology is customized. Participants mentioned that personalization involves the adaption of eHealth technology in which the user decides themselves how the technology is customized, whereas tailoring involves a customization strategy that was chosen by the designer or researcher of the eHealth technology. An example of this distinguishing factor was mentioned by Participant 3:

“For me, tailoring is involving an allocation decision that is made by an external agency or by an algorithm. Whereas personalization also involves personalization by choice. […]” # Participant 3

The degree of customization was also mentioned as a distinguishing factor between personalization and similar concepts (n = 4). This means that sometimes, tailoring or personalization refer to only the customization of the content of an eHealth technology, whereas other concepts concern a broader customization of eHealth technologies (e.g., adapt functionalities, way of delivering the intervention). Yet, sometimes tailoring is mentioned as only related to adapting the content, whereas sometimes this is pointed out as personalization.

To a lesser extent, the perspective on adapting the technology is named as a distinguishing variable (n = 2). One participant mentioned that personalization is applied from a consumer-perspective, whereas other related concepts (tailoring and targeting) are applied for commercial purposes (such as reaching the target group). Finally, the type of segmentation variables is named as a distinguishing variable (n = 1) by Participant 4:

“I think tailoring is more referring to the context of use. Personalization is more referring to the context of a user. And targeting is more referring to a certain situation for example targeting in the context of self-care, targeting in the context of treatments, personalization is more referring to a use and the user, I think, to a user. And tailoring is more in the context of tailoring to a certain usage or situation. So, you can have very personalized technologies that are not tailored.” # Participant 4

3.2 Segmentation

During the interviews, participants described ways in which users are divided into smaller groups to allow for customizing the eHealth technology. Two main codes were found related to the theme ‘Segmentation’, namely segmentation variables (n = 228) and ‘Data collection methods’ that can be used for segmenting eHealth users (n = 70).

3.2.1 Variables

Participants mentioned a variety of segmentation variables that can be used to divide them into smaller groups (see Table 2).

Table 2
Sub codes related to main code 'Variables'

Variables (n = 227)	# of Codes	# of Participants
Demographic	46	8
Preferences	43	8
Health	32	8
Psychological	25	8
Behavioral	25	5
Determinants	23	7
Environmental	20	4
Intervention interaction	9	4
Technology	6	4

3.2.1.1 Demographic

Demographic variables were mentioned most by the participants (n = 46). Examples of demographic variables that were mentioned are gender, age, education level, ethnicity, nationality, occupation and place of residency. During the interviews, participants mentioned that demographic information largely consists of variables that are unchangeable and therefore, preferably other types of variables are used for segmenting eHealth users.

3.2.1.2 Preferences

Next to demographic variables, preferences were regularly mentioned as a variable for segmenting eHealth users (n = 43). Behavioral preferences were related to whether eHealth users prefer different behaviors, related to the target behavior of the eHealth system (e.g., whether users like an exercise, or food and sports preferences). Participants also mentioned preferences that were related to the functionalities within the eHealth technology. An example is to use the needs of the user for segmenting eHealth users:

"[…] people may themselves perceive themselves as, you know, maybe in need of some information, but not so much therapeutic strategies or changing lifestyle while from a professional or clinical perspective, that may be exactly what you want to offer to this specific person. Again, this is something that relates to perceived need." # Participant 10

Channeling preferences that were mentioned by the participants were related to preferences on how a technology delivers the behavior change intervention. Examples are preferences on when to receive messages, how they want to communicate with their healthcare provider and preferences for communication styles. Next to the channeling preferences, graphical preferences were mentioned as a variable that can be used for segmenting eHealth users (e.g. preference for graphics within eHealth technology, color preferences, layout and interface preferences).

3.2.1.3 Health

Participants regularly mentioned variables related to health as a way to segment eHealth users (n = 32). First, biomedical risk factors were mentioned by the participants, e.g., BMI, cholesterol levels, blood pressure and weight. Next to biomedical risk factors, participants mentioned medical conditions as a way to segment eHealth users (e.g., type of diabetes). Medications taken by the eHealth user and the treatment process are also mentioned as variables for segmenting eHealth users.

3.2.1.4 Psychological

Psychological variables were also mentioned by the participants as a way to segment users of eHealth technologies (n = 25). These variables were related to the personality of the eHealth user, to their wellbeing, to psychological distress (e.g. depression, anxiety), and to the emotions that users experience. Participant 1 mentions psychological variables to segment eHealth users and describes how these variables relate to other variables, such as behavioral variables and environmental variables:

“But also needs more psychological variables. So, I think on all of them you can customize the contact, but it's probably different what you do. Because like the behavior tells us something about how a person behaves but not why, the psychological aspect tells you more about why a person does that, the environmental things like more a situation. So, they all have their own values, so to say.” # Participant 1

3.2.1.5 Behavioral

Behavioral variables that were mentioned by the participants (n = 25) were related to things that can be observed from the outside, such as psychical activity, sleeping and extended sitting. An example of psychical activity was mentioned by participant 8, in which the behavioral variables are preferred above demographic variables that are unchangeable:

“[…] But you can divide people who sport a lot from people who don't ever do that. So, then you have two groups. But then it's based on their personal behavior, and they are able to go from the one group to the other. […]” # Participant 8

Behavioral variables ranged from more specific behaviors (e.g. steps, extended sitting) to more overarching behaviors that includes more than one behavior (e.g. lifestyle). Moreover, an example of a more indirect variable was weighting behavior, which was used as an indication of whether the user was still engaged in losing weight.

3.2.1.6 Determinants

Determinants that were mentioned by the participants were related to the users' internal factors that determine behavior, such as attitudes, knowledge and stage of change (n = 23). Participants mainly mentioned determinants that were related to theory and models of behavior and behavior change. An example of a determinant was mentioned by participant 1 in which the participant describes that using determinants for segmenting eHealth users increases the potential for changing someone's behavior:

"[…] And if you personalize them on that then it almost doesn't matter which gender you are, you know, it's much closer to what you think about this topic. And you might be the female exception on this topic, or I may be the male exception. But if the content is tailored to what I think, I think that has much more potential there for change." # Participant 1

3.2.1.7 Environmental

Participants also mentioned environmental variables (n = 20) that are related to the surroundings of the eHealth user. Examples are the time, the place, exposures and day of the week. More distant examples are culture and climate. An example of place was mentioned by participant 3:

"Context is everything from the obvious, the obvious would be if you are outside of a McDonald's restaurant, message on snack food might be beneficial. So that's the low hanging fruit." # Participant 3

3.2.1.8 Intervention Interaction

The interaction of the user with the eHealth technology was also mentioned as a way to segment eHealth users (n = 9). These include the more specific parts of how they interact with the system (e.g., how many times a specific functionality is used), as well as the more encompassing usage characteristics (e.g., adherence, uptake and engagement).

3.2.1.9 Technology

Factors related to technology were mentioned least by the participants (n = 6) to segment users into smaller homogeneous groups. These variables include the extent to which the user is able or experienced in using different forms of technologies. Example of variables related to technology were related to how skilled or experienced users are with technology in a broad sense, meaning that it is independent of the form of the technology (e.g. digital skills, experience with technology, computer literacy, attitude towards health technology) or were related to a specific form of a technology (e.g. experience with VR). An example of computer literacy was mentioned by participant 10:

"But one that relates or is associated with the use of technology et cetera, in that specific group would be important, whether that's age or whether that it's literacy, computer literacy […] # Participant 10

3.2.2 Data Collection

The second main code within the theme 'Segmentation' was 'Data collection methods' (see Table 3). Several data collection methods were mentioned by the participants for segmenting eHealth users,

namely questionnaires (n = 20), activity trackers (n = 15), ecological momentary assessment (n = 11), other sensor data (n = 10), log data (n = 5), health trackers (n = 4) and qualitative data (n = 1).

Table 3
Sub codes related to main code 'Data collection methods'

Data collection methods (n = 71)	# of Codes	# of Participants
Questionnaires	20	8
Activity trackers	15	7
Ecological momentary assessment	11	7
Other sensor data	10	6
Log data	5	3
Health trackers	4	3
Electronic health records	1	1
Qualitative data	1	1

3.2.2.1 Questionnaires

Questionnaires were mostly mentioned as a way to collect data for segmenting eHealth users (n = 20). Examples of questionnaires given ranged from very short questions to full questionnaires. An example of a full questionnaire is a personality questionnaire within the eHealth technology that can be used to segment users into smaller groups. Participants mentioned that the way in which a questionnaire is used and what sort of questionnaire is dependent on several factors. First, the questionnaire should be as unobtrusive as possible to reduce effort from the participants and therewith, for example, avoid drop out due to the data collection. Moreover, the extent to which the segmentation variable varies over time determines how many times a questionnaire should be administered: segmentation variables that vary a lot over time (e.g. emotions) should be measured via ecological momentary assessment, whereas variables that (almost) do not change over time such as gender can be measured through questionnaires. Moreover, the validation of the questionnaire decides whether a questionnaire can be used for segmentation.

3.2.2.2 Activity Trackers

Activity trackers were also mentioned as a way to collect data about eHealth users (n = 15). These are related to measuring activities of the user through, for example wearables. Participants mentioned that the added value of activity trackers is that the obtrusiveness for collecting data is lower compared to questionnaires allowing for more frequent data collection about the users:

"[…] So, I think that's more what has changed over time. So, I think that the technology offers one thing to do things more unobtrusive to you, to measure a lot of things automatically and be to unobtrusive and

continuous. So, I think that has changed to you and you can use that in your personalization." # Participant 1

3.2.2.3 Ecological Momentary Assessment

Ecological momentary assessment was regularly mentioned by the participants as a way to collect data from eHealth users (n = 11), which involves administering questionnaires multiple times via the eHealth technology. Examples are a single question with the of use smileys through which an eHealth user indicates his or her mood every hour or an electronic diary. An example was mentioned by Participant 6, in which the participant described that the questionnaire was administered three times a day since the segmentation level varies during the day:

"So, with this first project we are asking three times a day to fill in the mood and pain scores. But we already got some information back from participants that, that most of them found it too much. But at the other hand, well, you can feel quite sad in the morning, for example, and then even half an hour later, you can feel completely different. So yeah, what is a good time frame and a good amount of data?" # Participant 6

3.2.2.4 Other Sensor Data

To a lesser extent, sensor data was mentioned as a data collection method for eHealth users (n = 10). Sensor data includes data collected via sensors that are related to other than activities and health trackers of the eHealth users. Examples that were given by the participants are sensors in clothes or sensors that are connected to a WiFi system for observing the environment. Another example of an activity trackers is the use of eye tracking which can be connected to related concepts such as engagement:

"[…] but also maybe eye tracking and things like that, to see their engagement in a more automated way." # Participant 2

3.2.2.5 Log Data

Log data was also mentioned as a way to collect data for segmenting eHealth users (n = 5). Log data is an automatic registration of user activities within the eHealth system. Like the other automatic data collection methods, the added value of using these data is that the obtrusiveness of segmenting eHealth users is less compared to, for example, questionnaires and therefore the frequency of data collection can be increased:

"[…]. If you collect it, if you ask people all the time, then you should probably leave some time between because people will get sick of you asking, Hey, is this still working? Hey, is it working now? And now and now, so it's not going to be feasible. If you can collect the data automatically and infer it from how to use the system? Or how they interact or how are their responses? If you can do it automatically, then of course, you can do it with much higher intervals or very more frequently than when you need to ask them. […]." # Participant 2

3.2.2.6 Health Trackers

Health trackers were also mentioned by participants (n = 4), and these are related to measurement instruments through which health values can be obtained, such as heart rates, electrocardiograms and glucose levels. Another example was mentioned by Participant 3 in which the participant describes a project in which a personal home scale was used:

“So, in the new level trial, for example, we ask people to use personal home scales, that they can step on and can weigh themselves, these personal home scales would automatically communicate with a mobile phone network. So, you didn't even need wireless internet at home.” # Participant 3

3.2.2.7 Electronic Health Records

Electronic health records were mentioned by one participant as a way to collect data for segmenting eHealth users (n = 1). This entails data that is collected electronically by the health care provider.

3.2.2.8 Qualitative Data

Lastly, one participant mentioned qualitative data as a way to segment eHealth users (n = 1). The participant mentioned that qualitative data is a way to get insight into segmentation variables in more depth compared to the other data collection methods:

“An online chat simulation so that there you can really go into much more depth like what people think about this topic or in this case ambiguity, you have this reflective journey, so people have goals and things like that. Um, so I think this has a lot of possibilities to tailor.” # Participant 1

3.3 Customization

Within the theme ‘Customization’ all sub codes were related to the strategies for customization (see Table 4). The strategies were grouped along the parts of the eHealth technologies that were adapted to the eHealth user, namely channeling (n = 46), content (n = 24), graphical parts of the technology (n = 16), the functionalities (n = 10) and the behavior change strategy that is employed by the eHealth technology (n = 4).

Table 4
Sub codes related to strategies for customization

Strategy (n = 100)	# of Codes	# of Participants
Channeling	46	8
Content	24	8
Graphical	16	8
Functionalities	10	4
Behavior change strategy	4	2

3.3.1 Channeling

Strategies on channeling of the eHealth message were related to adapting the way in which the eHealth technology was delivered. Participants named channeling as a strategy (n = 46) in which several ways of adaptation were mentioned, namely including personals details in messages, adapting the timing of messages, adapting the way that messages were delivered, and adapting the technology that is used for delivering the eHealth intervention.

To begin with, including personal details in messages were mentioned as a way to adapt an eHealth technology, ranging from including the first name, second name or gender in the communication to the eHealth user. One participant connects this way of adapting the eHealth technology to the cocktail party effect:

“There are some indications that personalized material increases someone's attention to it so, the cocktail party effect, when we hear our name, we process that information differently.” # Participant 5

Secondly, the timing of delivering the eHealth technology was mentioned as a way to adapt the channel to the eHealth user. Examples range from adapting the frequency of sending messages to the user, whether or not to send reminder, when to send a reminder and sending messages after an alarm was generated for a certain value. An added value of timing the eHealth technology was mentioned by Participant 8:

“And well, if you're able to shape that in a personal way, then I think it's helpful and something that the human coach cannot do, especially when it comes to the timing. Yeah, at the moment, you feel tempted to eat unhealthily or to sit on the couch and do nothing or something, while actually it's better to move at that moment, then the human coach is not there in general. But the technology can help you to at that moment make a healthier choice.” # Participant 8

Another example is given by Participant 5, in which the intended use of the eHealth technology is adapted to the extent in which the eHealth users experience health problems:

“when and how long it is used. And there are also things that you can tailor, you can also say someone uses this for two days as a booster and someone else has to use it for six weeks because their issues are much worse.” Participant 5

Thirdly, adapting the way in which messages are delivered to the eHealth user is mentioned by the participants as a way to customize eHealth technology. Examples range from adapting the person who provides a message in a video, adapt the tone of voice to the eHealth user (e.g., one that is more reflective and one that is more telling you what to do), the amount of information that is provided to the user and the order in which different parts of the eHealth technology are provided:

“[…] as professionals assume that a certain order is helpful or is logic or is this is the way we do it? This is how we've always done it. While a person using that application or that program may think otherwise,

may think, well, I want to start with this. I want to start with relaxation. I don't want to start with cognitive restructuring or whatever. So, I find it a bit of a struggle between what we think we know this is the way to do it in terms of order and allowing persons to do whatever they like at any point in time, which would be the ultimate personalization like this." # Participant 10

Lastly, the medium that is used for delivering the eHealth technology is also mentioned by the participants as a customization strategy for customizing the technology. Examples are using either an app of web-based eHealth technology, sending messages either through email or push messages via phone, or to inform the user via text or via video. An example is given by participant 5:

"But maybe by offering it in different channels and then allowing people to choose whether they want to read, because that seems to be the only thing that they can do here or maybe they want to use the information in another way or via video or audio." # Participant 5

3.3.2 Content

The content was also mentioned by the participants (n = 24) as a part that can be customized to the eHealth user. The customization of content ranged from receiving different content (e.g., offer different therapeutic approaches), providing feedback that is related to user input (e.g., compare provided data with goal of the eHealth user), compare data of the eHealth user with data from peers, and giving advice to the eHealth user which is based on the data provided by the eHealth user.

3.3.3 Graphical

Graphical aspects of the eHealth technology were mentioned by the participants as a part that can be customized to the user (n = 16). Examples given by the participants ranged from very basic adaptations (e.g., changing the colors), to changing the lay-out of the technology, to the more complex adaptations such as changing an environment in VR or to create avatars adapted to the eHealth user:

"And people can also develop their own avatar, which, of course, gives already a nice personalization aspect to it." # Participant 9

3.3.4 Functionalities

The functionalities were mentioned by participants as a part that can be customized to the eHealth user (n = 10). This is related to including or excluding certain parts of the eHealth technology based on the data that is provided by the eHealth user. Examples that participants mentioned range from in- or excluding certain modules to adapt the activities that eHealth users can do within a virtual environment. One example is to adapt the treatment that is provided in the eHealth system to their disease:

"[…] or maybe even actually personalize the intervention so that one person with heart failure gets another treatment compared to another person with heart failure." # Participant 6

3.3.5 Behavior Change Strategy

Lastly, 4 participants mentioned examples of adapting the behavior change strategy to the user. This is related to adapting the way in which the eHealth technology aims to change behavior, for example providing different persuasive strategies to characteristics of the eHealth users. An example was given by participant 2 in which, depending on the data provided by the user, gamification is used as a way to change behavior only when this is a suitable strategy for that person:

“And I think sometimes, and there's been lots of work on, for example, whether or not gamification has added value. And the general feeling is that, yes, it does have some added value. But it's pretty small still. And I think that, at least, partially, because it works well for some and not so for others. […].” Participant 2

3.4 Matching

Two main codes were found related to the theme ‘Matching’. These main codes are ‘Substantiation’ (n = 24) and ‘Variable level’ (n = 32).

3.4.1 Substantiation

Participants named several substantiation methods through which the segments of eHealth users can be matched to customized forms of the eHealth technology. These are pilot studies (n = 12), using theory for matching (n = 6), carrying out interviews (n = 4), and individual data science (n = 3) (see Table 5).

Table 5
Sub codes related to the main code ‘Substantiation’.

Substantiation (n = 24)	# of Codes	# of Participants
Pilot-studies	12	4
Theory-based	5	2
Interviews	5	5
Individual data science	3	1
Guidelines	2	1

3.4.1.1 Pilot-Studies

Firstly, participants mentioned several forms of pilot-studies as an example of how segmentation and customization can be matched. These are studies in which a (prototype) version of the eHealth technology is available for use and used as material during the study. Examples of pilot-studies that were mentioned are N = 1 studies, match-mismatched trial design and asking users to rate which messages they like within the eHealth technology:

“so, I did a large surveys with, you know, 500 people, ask them to rate certain messages and how motivated they thought these messages were or not, could also be demotivating. And then also asked their personality and of course, age and gender and other demographic information. Based on that I

found, you know that certain messages fit better with certain personality types, and certain genders." Participant 7

Moreover, mixed-methods pilot-studies were also mentioned by the participants. For example, a way to match segmentation and customization is to pilot an eHealth technology, and to interview users who are congruent with the intended use and people who are not congruent with the intended use. This way, the views of the users on why a technology (does not) fit with their characteristics can be translated into a personalization or tailoring strategy. Another example of a pilot-study was given by participant 2:

"So, what you can do is get people to try out different versions of an intervention and just measure their response and engagement and as engagement is a predictor of effectiveness, we could also use, well, the version of the intervention that provokes the most engagement to an individual might also be the version that's most, that's best personalized to them. And that has the highest chances of being effective for this individual." # Participant 2

3.4.1.2 Theory-Based

The use of existing theories or developing theory for a personalization or tailoring strategy were also mentioned by the participants (n = 5) as a way to match the segmentation and customization strategy of an eHealth technology. An example of using existing theory, is to include segmentation variables that were found to be predictors of the target behavior from previous research.

"[…] you need to have a very strong mixed methods approach, you really need to, so maybe if I write a few things down here. But any intervention on health should be based on a logic model, a logic model, since you really need to have a clear theory of what you're doing, and you need really to understand the issue. […]" # Participant 3

3.4.1.3 Interviews

The use of interviews means that data is collected in an open format and subsequently translated into a segmentation and customization strategy (n = 4). Participants mentioned that one way of extracting information about a strategy is to explore whether there are differences within the target group during the interviews, or to ask explicitly for their preferences. Participants mentioned that due to the open form of the interviews, one can go in more depth compared to other methods and therefore the personalization or tailoring strategy can also go in more depth. Moreover, another added value that was mentioned was that segmentation variables or customization strategies can be developed, that the developer or designer of the eHealth technology had not thought of beforehand. In one example related to interviews, the participant describes that a part of the user target group expresses different needs in the way in which they could navigate through the eHealth technology:

"And from the interviews with them, we found out that it was more that they were looking for someone who took them by the hand and did everything step by step. So how we translated that in the intervention

was that the only control they had, in terms of navigating an intervention was clicking next and previous. […]" # Participant 5

3.4.1.4 Individual Data Science

The use of data science on the users' level was mentioned as a way to substantiate the matching of segmentation and customization (n = 3). This way of creating a customization strategy, means that on an individual level it is decided what works for whom (customization strategy) using techniques from data science. This stands apart from different substantiation strategies, since other substantiation are more focused around what works for whom on a group level:

"Well, for example, if I take an extreme example now, but just to make a case. So, the kind of research that I do is I can model individual behavior. So, we model your sleeping behavior for three weeks, and based on modeling your own behavior, we design interventions that fit your pattern, […]" # Participant 3

3.4.1.5 Guidelines

The use of guidelines for a personalization or tailoring strategy was mentioned least by the participants (n = 2) for matching segmentation and customization. One example mentioned by participant 6 was related to the customization of the treatment, which must be in line with criteria and guidelines from healthcare. Moreover, the same participant mentioned a collaboration with dietitians to find guidelines on customized diet recommendations for the user.

3.4.2 Variable Level

Besides 'Substantiation', the second main code related to the theme 'Matching' was 'Variable level'. Participants mentioned several variable levels to match the segmentation with the customization strategy (see Table 6), namely grouping variables (n = 18), direct input (n = 8) and per variable (n = 6).

Table 6
Sub codes related to the main code 'Variable level'.

Variable level (n = 32)	# of Codes	# of Participants
Grouping variables	18	6
Direct input	8	2
Per variable	6	5

3.4.2.1 Grouping Variables

Participants mentioned several ways in which variables can be grouped for personalizing eHealth and varied in the way in which these methods can be applied (n = 18). Firstly, participants mentioned that users can be grouped into smaller segments using several segmentation variables. Personas and profiles are two specific examples that were mentioned. Personas consist of groups of users with similar characteristics on a broad range of variables (e.g., similarities on demographics, eHealth literacy and

preferences), where profiles consist of segments that are described on several variables related to a certain concept (e.g. lifestyle profiles, risk profiles).

Participants mentioned two examples of how these personas and profiles can be used. Firstly, personas can be created in the beginning of the eHealth development process, and one can in turn translate these distinct personas to develop a customization strategy that aligns with the characteristics of the persona-descriptions. Secondly, these profiles or personas can be used within the eHealth system for segmenting the eHealth users on which a customization strategy is applied. Participant 5 describes this application of personas and profiles:

“[…] We assume it's personalized because it's personalized to the persona. But the persona is a fictional representation of a group of individuals. So, it's not personalized to the individual. It's personalized to individuals like that person as seen by the designer or researcher.” # Participant 5

Next to the use of representatives for groups of users, one participant mentioned that variables can also be combined so that profiles are created that are similar to ‘Facebook profiles’ in which every user is unique. This can be translated into a continuum on which personas and profiles can be created from a variety of variables on the individual level to a group level. Participant 5 described how one can decide on which level these personas and profiles can be created to allow for tailoring or personalization:

“To the degree that they show maximum diversity between the groups, and maximum homogeneity within the groups. And I would do that and have done that in a data driven way.” # Participant 5

3.4.2.2 Direct Input

Direct input from the user was also mentioned by the participants as a way to match the segments with the customization strategies (n = 8). One participant mentioned that this way of matching segmentation and customization is not included in the Hawkins’ model, which assumes that the developer of the eHealth technology collects information about the user and translates this into a customization strategy. The use of direct input means that the user customizes the eHealth technology themselves, meaning that there is no information about the user collected for segmentation beforehand. Participant 5 describes how this can be applied:

“So that cuts out the middleman, so you no longer have to measure something because you're both the person that is being measured and the one that is adapting. So, if someone is going to choose the color of their phone, they don't have to ask themselves what is your favorite color and then process or produce that fitting phone case, they can immediately make one themself or choose one themselves. […]” # Participant 5

3.4.2.3 Per Variable

Lastly, participants mentioned that segments and customization strategies can be matched per variable (n = 6). This means that users are segmented on one variable and that customization strategies are developed on that single variable. Participants mentioned that this can be either done on an absolute

measurement of variables (e.g., segment on the variable name and match this one variable with including a name in messages) and that changes on that single variable can be used for matching segmentation and customization:

“so, I think you have to also adapt immediately to changes in the data. I think that's one way to personalize and get well, then you don't even need groups, I think, to form groups.” # Participant 6

Moreover, participant 5 mentioned that matching per variable is mainly useful for customization strategies related to the content of the eHealth intervention:

“It's a different extent in whether it's on the level of the individual. The thing is, I know that you are able to generate a tailored message using computer tailoring for example, that you measure psychological constructs and on the basis of that you use information and look at the message database to construct a completely unique message for the individual. And I like this principle. I think it works for content, but I think it doesn't work for graphics, channel and source.” # Participant 5

4. Discussion

In this interview study, we sought to gain insight into definitions and distinguishing factors of personalization and tailoring, into their two components (segmentation, customization) and how these two are matched.

4.1 Principal Results

Several differences and similarities between personalization and tailoring were mentioned during the interviews. There was a consensus that personalization and tailoring means that several types of information of the user are collected and translated into a customized eHealth technology. Although there was a variation in distinguishing factors between personalization and tailoring, participants mostly mentioned that tailoring involves segmentations in groups of users (e.g., for people with diabetes type 1 and type 2), whereas personalization focuses on segmentations on the individual level (e.g., almost mimicking a counselor). Examples of relevant variables for segmenting eHealth users concerned demographic information (e.g., age), preferences (e.g., liking or disliking an exercise), health (e.g., symptoms), psychological variables (e.g., distress), behavioral variables (e.g., physical activity), determinants (e.g., self-efficacy), environmental information (e.g., whether the user is at work), intervention interaction (e.g., number of visits) and technology (e.g., eHealth literacy). Participants mentioned different methods for collecting segmentation variables through eHealth technologies, ranging from single measurements (questionnaires), measurements on several points in time (ecological momentary assessment, qualitative data, electronic health records), to continuous measurements (activity trackers, health trackers, sensor data, log data). These segmentation variables can be matched with a customization strategy in which the customization reflects one variable, a group of variables or the direct input from the user. We identified five elements of eHealth technologies to which customization strategies relate to, namely channeling (e.g., including one’s name in feedback messages), content (e.g.,

provide normative feedback), graphical (e.g., avatars with similar appearance as the user), functionalities (e.g., in- or excluding self-monitoring) and behavior change strategy (e.g., in- or excluding certain persuasive strategies). The match between the segments and customizations can be based on pilot-studies, theory, interviews, individual data science and/or guidelines. During the interviews, participants mentioned that these substantiations contribute differently to matching segmentation and customization. Based on the interviews, we have summarized the substantiation methods for matching segmentation and customization with a description of their goals and examples of research questions in Table 7.

Table 7
Substantiation methods for matching segmentation(s) and customization(s)

Method	Goal	Examples of research questions
Pilot-studies	Test an existing (prototype version of) segmentation and customization strategy	Which version of the eHealth technology fits best with which segment of users?
Theory	Form a link between segmentation and customization	The target group varies highly in technology skills, how can we customize our technology on that?
Interviews	Form hypotheses about which customizations must be included in the eHealth technology	Does the target group express different needs or preferences during the interviews?
Individual data science	Develop customizations on the individual level	What behavioral patterns do we observe on the individual level and how can we customize the eHealth technology to those individual patterns?
Guidelines	Gather information about segmentation and customization on group level	What type of treatment must the eHealth technology offer to users with high blood pressure?

Altogether we observed that variability and technology affordances determine whether and how personalization and tailoring should be applied to eHealth technologies. In Fig. 1 we illustrate how these variables may be related to each other according to the participants. Variability in segmentation variables (seen on the Y-axis) may differ inter-individually (such as differences in country of birth), intra-individually (such as changes in emotions), or both intra- and inter-individually (e.g. a combination of emotions and country of birth). Moreover, technology affordances (X-axis) determine which customization strategy can be applied. For example, technology with high affordances such as VR allows customizations on channeling, textual content, graphical aspects, functionalities and behavior change strategies, whereas an SMS-based eHealth technology may only be customized on textual content, channeling and behavior change strategy. The area below the blue line depicts the area in which there is a mismatch between segmentation variability and technology affordances, resulting in ineffectively applied personalization and tailoring in eHealth technologies. Stars represent the desired combination of segmentation and customization levels which, according to the participants, are ideally at the same level. This means that

low segmentation should be combined with low customizations and the other way around. Below we provide an illustration of each star:

1. The target group of the eHealth technology shows inter-individual differences (differences between users) and technology with medium affordances allows for customizations on the same level. An example is an eHealth technology collecting the name of the user (inter-individual differences) at his or her first visit. During next visits to the eHealth technology, a text is displayed with 'Welcome, John!'. Another example is to segment users based on their visual appearance (inter-individual differences) and to customize characters in a virtual environment by making them look similar. As illustrated in these examples, data can be collected once (or on a very long interval) since intra-individual differences are low, for example through questionnaires and by collecting qualitative data.
2. The target group of the eHealth technology shows intra-individual differences (differences within users) and technology needs medium affordances to customize on these differences over time. An example is an eHealth technology segmenting users based on their location. When the eHealth user is in an environment in which there is a location nearby that allows for physical activity, the eHealth technology sends a message (channeling) to remind him or her to do a run. As illustrated in this example, data must be collected multiple times to allow for customizations to these intra-individual differences, for example through ecological momentary assessment, sensor data, log data and activity trackers. The eHealth technology must have the affordances to translate these data to customizations over time.
3. The third star represents the context in which eHealth users show both inter- and intra-individual differences. An example is an eHealth technology that segments users on both their preference for communication channel and the number of steps during the day. Users indicate whether they want to use an eHealth technology on their computer or mobile phone, through which it is subsequently used. Moreover, based on the number of steps, the users receive motivational messages when this number is below 2000. When this number of steps is above 2000 the user receives reinforcement messages. As illustrated in this example, data must be collected once related to inter-individual differences and multiple times related to intra-individual differences. The eHealth technology must have high affordances to allow for customizations that are stable and customizations over time.

To illustrate, one may use theory about eHealth literacy to tailor or personalize the eHealth technology. Yet, when there are no intra- or inter-individual differences in eHealth literacy (low on Y-axis), there is no added value by segmenting and customizing based on this concept. Moreover, if an eHealth technology has very low affordances, such as an SMS-based eHealth technology, there is a low allowance for applying the different customization strategies (low on X-axis), so, segmentation on multiple inter- and intra-individual variables will often be obsolete.

4.2 Implications and Recommendations

Literature indicates mixed results of the effectiveness of tailoring and personalization in literature. For example, the inclusion of a personalized mealplanner (21) or tailoring for smokers with low socioeconomic position (22) did not indicate better results compared to a similar eHealth technology. In contrast, tailored advice on action planning (23) and daily tailored feedback for energy and fat intake (24) did result in better outcomes. At this moment it is difficult to draw conclusion about the effectiveness of personalization and tailoring, because all forms (all different segmentations, customizations and matching) are put together. It may be that one form works better than the other, which could explain the mixed results in effectiveness. Moreover, we observed various distinguishing factors between personalization and tailoring during the interviews, of which some seem to be related to differences in definitions. For example, during the interviews the segmentation level appeared as a distinguishing factor, which is in line with the description of Oinas-Kukonen in which tailoring is described as customizations to user groups and personalization to individual users (16). On the contrary, whether or not the user gives input in how the eHealth technology is customized was also mentioned as a distinguishing factor between personalization and tailoring during the interviews. Thus, we observe a lack of agreement in the definitions of personalization and tailoring, and mixed results in terms of effectiveness that might be caused by putting together the different forms. Therefore, we suggest that the application of personalization and tailoring is reported in terms of segmentation, customization and matching. By reporting focused on segmentation and customization strategies (per 'matched' segmentation and customization) with a description of how these were matched, we can compare and take together different forms, and subsequently we may gain more insight into the working mechanisms of tailoring and personalization. For example, we can compare which theory yields best results for building a segmentation and customization strategy, which segmentation variables are most relevant for personalizing and tailoring eHealth technologies, and which customization strategy increases the effectiveness of eHealth technologies. The items in the box below could be included as an extension to CONSORT-EHEALTH checklist (25) as a first step to gain more understanding in the working mechanisms of personalization and tailoring.

Segmentation and customization (describe per 'matched' link of segmentation and customization).

a. Described the variables used to segment users into more homogenous groups and which data collection method was used to collect data for segmenting eHealth users through the eHealth technology.

b. Name which part of the eHealth technology was customized (channeling, content, graphical, functionalities, behavior change strategy) and how this part was customized to represent the user segments.

c. Describe how the match between segmentation and customization was substantiated (give details on the theory, pilot-studies, individual data-science, guidelines or interviews).

d. Clarify the variable level through which segmentation and customization are linked (direct input, per variable, grouping variables) and provide, where applicable, details about the algorithm or grouping that was used.

4.3 Limitations

An important limitation of the current study is its generalizability. We have interviewed ten eHealth experts through convenience sampling. Since the context in which eHealth technologies use segmentation and customization is of high importance, it is not clear whether we obtained insight into these contextual factors, and consequently the different ways in which segmentation and customization are applied to eHealth technologies. However, we have included vignettes that are related to different contexts so that participants also gave input to eHealth technologies related to other contexts. In future research, we will carry out a literature study to obtain a more detailed understanding of how eHealth technologies can be customized, and which variables come into play for these customizations.

4.4 Conclusions

All in all, we observed that personalization and tailoring are multidimensional concepts in which multiple factors come into play that determine how these concepts should be applied to eHealth. An important reason for the mixed results (21–24) of the effectiveness of tailoring and personalization might be that there is a variation in how effectively they were applied to eHealth technologies. For example, continuously providing personalized feedback on segmentation variables that do not vary that much over time might cause annoyance instead of an eHealth technology that is adapted to the user. In short, some behaviors might ask for a complex and idiosyncratic form of tailoring and personalization whereas others may not. Given the variation in added value per method, we suggest that a mixed-methods approach should be applied to substantiate the match between segmentation and customization.

Declarations

Below the declarations of the study are described.

5.1 Ethics approval and consent to participate

This study was approved by the BMS ethics committee of the University of Twente (request number 210375). The University of Twente complies with the European and national legislation regarding ethical standards for research involving human participants. The ethical approval implies that all methods were performed in accordance with the European and national legislation.

5.2 Consent for publication

Not applicable.

5.3 Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

5.4 Competing interests

The authors declare that they have no competing interests.

5.5 Funding

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5.6 Author's contributions

JG, HK and ITK contributed to the design of the study. ITK and HK analyzed and interpreted the interview data. ITK and SK were major contributors in writing the manuscript. All authors read and approved the final manuscript.

5.7 Informed consent

Informed consent was obtained from all subjects.

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Figures

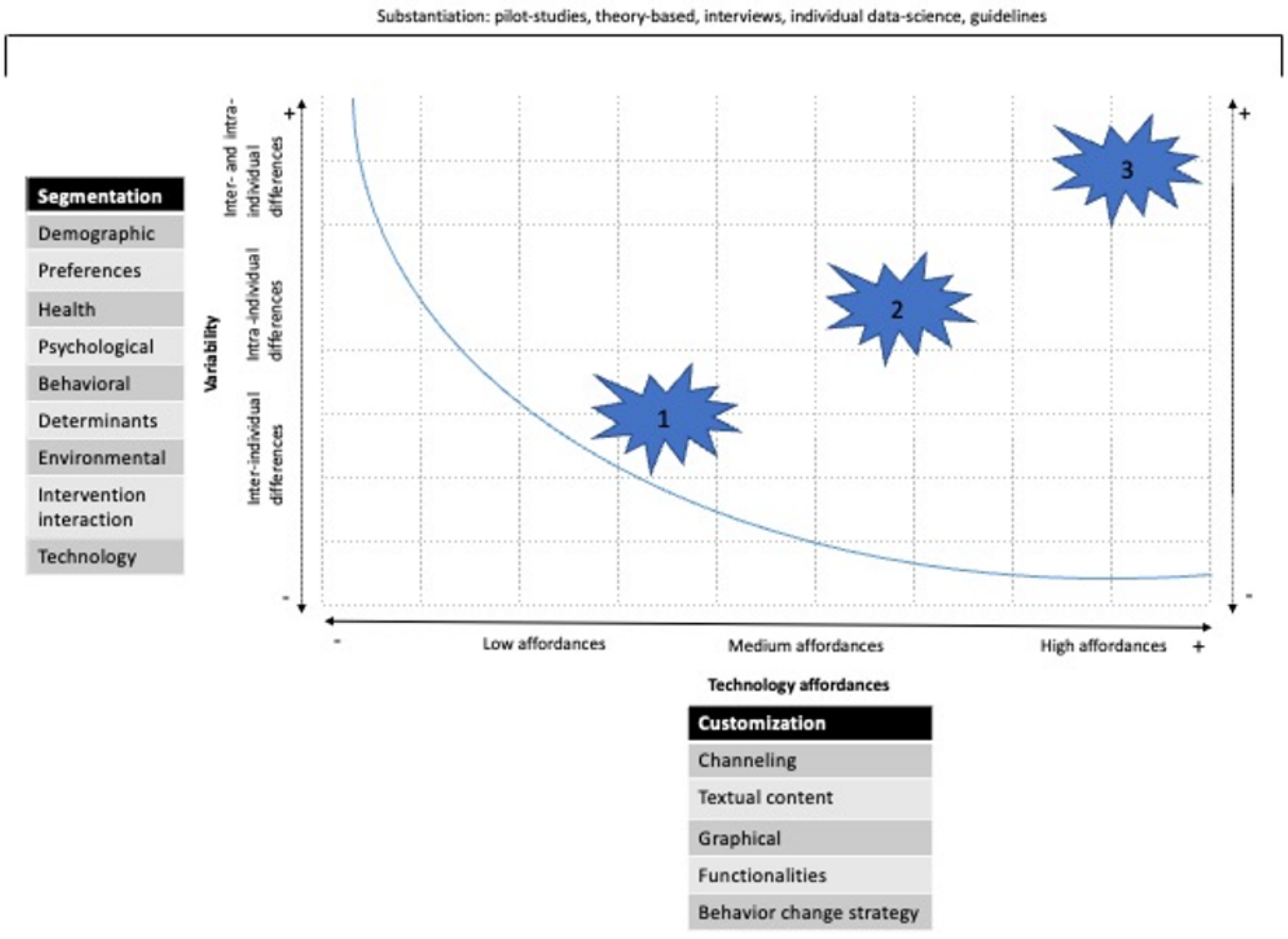

Figure 1

Segmentation and customization of eHealth technologies

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Appendix1.docx
- Appendix2.docx