Design speaks
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Chapter 10

General discussion and conclusion
This thesis aimed to provide new insights on needs and use of mHealth and patient portals by older patients, with the overall aim to improve patient-centeredness for these patients within the development and evaluation of eHealth. In particular, this thesis:

1. Synthesized knowledge on older adults’ use of mHealth and patient portals and provided a structured overview of barriers and facilitators identified in scientific literature;
2. Validated identified barriers and facilitators by means of case studies with (chronically ill) older adults to give sight on relevant factors influencing mHealth’s and patient portals’ development and use;
3. Explored user-centered design methods with older adult patients to enhance eHealth’s effectiveness.

In this chapter the principal findings will be discussed via the themes of this thesis, respectively for mHealth (part 1, focusing on aim 1 and 2), patient portals (part 2, focusing on aim 1 and 2) and methodology (part 3, focusing on aim 3). Per theme, an overview of practical implications and recommendations is given on how to improve patient-centeredness for older patients in a digitalizing healthcare context. This is followed by the general conclusions of this thesis and directions for future research.

**Part 1: Current mHealth designs for older adult patients**

**Principal findings**
A synthesis of the literature (chapter 2) provided an in-depth exploration of the aging barriers influencing usability of mHealth. Based on this synthesis, a framework was developed of four influencing aging barriers that may negatively impact older adults’ interaction and communication with mHealth interfaces and functionalities; cognitive, motivational, physical abilities and perceptual barriers. The MOLD-US framework, mHealth for older users, provides a visual and accessible overview of these barriers. It can be used for systematic empirical testing and analysis of mHealth usability issues, as it enables results to be classified and interpreted based on impediments intrinsic to usability issues experienced by older adults.

To assess the usefulness and utilization of the framework in classifying usability results, usability evaluations were performed on two mHealth case-study apps for older adult patients (chapter 3). Usability issues of older adult patients interacting with the two apps were identified by using the think-aloud method; in total 28 high severe issues were identified. Aging barriers intrinsic to these issues were then classified by means of MOLD-US, through which it was found that half of the issues were provoked by motivational barriers, such as a
patient’s low knowledge on how to use unknown smart device functionalities or a low trust in one’s own capacities in doing so. One-third of the issues were provoked by cognitive barriers; for example, users did not know how to return to previously shown relevant information due to an unclear hierarchy in the apps. This research further shows that existing knowledge from user interface guidelines on perception, cognitive and physical ability barriers of older adults is currently not applied to the fullest in designing mHealth interfaces. Aging barriers might additionally influence end-users usability evaluations performed with older patients. Specific adjustments to these methods are recommended so that they become better suited to user-testing with older adult patient populations. Part 3 of this thesis therefore examined methodologies used to develop and evaluate eHealth from the perspective of older patients and provides recommendations on these kind of adjustments.

**Practical implications and recommendations**

The insights resulting from part 1 of this thesis can aid project teams during the development and evaluation of mHealth for older patients, particularly regarding the specification of requirements, analyses of usability issues and creation of interface (re)design solutions. To prevent usability issues for older patients in the use of mHealth, it is important to apply existing guidelines on how to best design interfaces for older people. For example, by distinguishing buttons from other visual display features in the interface design and by creating consistency in navigational structures, aligned with expectations of older patients. Further, clear instructions as well as feedback messages should support an older patient when the patient has made an interaction error while using an app. These insights have foremost shown that usability is especially important within the older adult user context of mHealth as aging barriers may influence usability of mHealth negatively. mHealth designs will be more apt to older patients’ needs when the development of mHealth is realized from a user-centered design (UCD) perspective, as is described in part 3 of this thesis. Using such an approach and adjusting mHealth designs to aging barriers may result in more natural interactions and communication patterns of older patients with the provided mHealth functionalities. Presumably, more natural interactions and communication patterns will enhance older patients’ possibilities and willingness to engage with mHealth. Such engagement with mHealth will allow them to take advantage from mHealth use, such as taking control in managing their health by monitoring their own biometrics, leading to improved patient-centeredness and care benefits.

In the development of mHealth services, researchers are thus encouraged to thoroughly analyze usability issues and consequences of these issues in relation to older adult users. Based on this thesis’ insights we further suggest to (re)design mHealth based on the outcomes on older adults’ needs and capacities accordingly. The MOLD-US framework provides a reference model for these activities. The overview presented in MOLD-US of older adults’
(medical conditions related to) degradation of sensory, physical and cognitive abilities can assist researchers in setting inclusion criteria of study participants, assuring representativeness of the overall user population, and selecting specific usability metrics relevant to user-based usability testing by the user population. MOLD-US further adds value to existing classification tools used to interpret usability testing results, because it is unique in integrating aging barriers and categories of usability aspects that (may) influence user-experience. This framework can thus be used to classify and interpret usability issues based on older adults’ impediments intrinsic to these issues and contribute to creating awareness on aging barriers and disease complexities of older adults amongst stakeholders involved in mHealth development. In creating awareness on these aging barriers, we emphasize to mHealth development teams to be aware in general that motivational barriers to the use of mHealth are a central issue in the user-experience for older patients. Despite older adults’ interest in using smartphones and tablets, most of them indicate they need support in the process of learning how to use new (functionalities on) smart devices. This is especially relevant within the context of mHealth, which often involves using functionalities that are new to older users, mostly paired with using multiple smart devices, such as a blood pressure monitor connected to a smartphone. To lower the motivational barriers of older patients in using these innovations, we endorse the use of clear instructions on how to use the technology. We advise to create instructions that are easily comprehended by older patients with declining cognitive and visual perception skills, as well as speak to patients with no decline in cognitive skills. This can for instance be done by using animated videos combined with spoken word. These communication means are explained in more detail in the recommendations given in part 2. We likewise advise to ensure the availability of reliable and accessible technical support that can answer questions that older patients may have regarding the technology. General strategies accepted by industry, suggest to answer users’ ad-hoc questions on a technology via computer-generated chats. Such chats make use of artificial intelligence in responding to the users’ questions. Taken together, the results of this thesis suggest that such strategies might not be applicable to helping older patients in the use of mHealth. Providing older patients with a technological solution to answer questions on (motivational) problems they experience in the use of a technology, may have a counter-effect in actually helping these patients. Therefore, the advice based on this thesis is to provide technical support to older patients’ use of mHealth by means of a support team that is available to patients per telephone and/or in-person. Further, we advise to involve older patients in co-creation and user-testing activities in order to optimize the usability of mHealth innovations. Methodological considerations on how to adjust these activities in order to involve older patients are described in part 3 of this thesis.
Recommendations - improving patient-centeredness by adjusting mHealth designs to older adult patients:

- Specify age clusters of the target group of an mHealth innovation;
- Analyze aging barriers possibly influencing usability of an mHealth innovation (MOLD-US framework can be used as guidance);
- Use insights and knowledge from existing guidelines on how to design mHealth for older adult patients [1-3];
- Take motivational barriers of older adults into account in designing mHealth by creating a forgiving interface design and by providing a reliable and accessible technical support team that can answer questions that older patients may have regarding the mHealth product.

Part 2: Patient portal use by older adults

Principal findings
To get insight into what inhibits and stimulates older patients’ use of patient portals, literature on barriers and facilitators to older adults’ patient portal use was synthesized (chapter 4). After an extensive search process, 8 out of 245 potentially relevant studies were included. Factors were classified by textual analysis of the included studies via the themes of the Unified Theory of Use and Acceptance of Technology (UTAUT) model. This study reported that a main barrier consists of a lack of facilitating conditions, such as limited access to technology and internet or privacy and security concerns. Another barrier is involuntariness to use a patient portal as some patients prefer face-to-face contact with their physician and patients may have a limited health literacy. Main facilitator to portal use was patients’ expected usefulness of patient portals; older adults appreciated a means to have access to their own medical data for reviewing their health problems and overseeing the planning of appointments. Patients with a positive attitude towards patient portals further find the beneficial aspect of being able to digitally ask questions to their treatment team via a patient portal appealing. These identified barriers and facilitators were evaluated in a case study on experiences of older adult patients with the use of a patient portal implemented in the Amsterdam University Medical Center (chapter 5) and a cross-sectional study with two large Dutch patient associations on preferences of chronically ill patients on patient portal functionalities (chapter 6). Main facilitators from the literature review were confirmed: reviewing medical information and appointments via a portal is indeed experienced as useful by older patients, as is being able to communicate via a portal with their healthcare providers. In doing so, older patients prefer to have multi-provider access, across different healthcare organizations. Yet, overviews of medical information do not have to be digitally exportable
for older patients, since they prefer to print such overviews. Regarding the barriers to portal use, older adults experience usability problems, in particular at the authentication and login stage. Instead of preferring the most secure login method, which verifies the identity of users via a minimum of two security factors, older patients indicated their need for user-friendly access to portals and thus preferred using solely an username and password to log in. They further favor accessing a portal via a desktop instead of via smart devices. Additionally, reported barriers to portal use were related to patients’ expectations regarding presented content and communication via a portal. A delay of two weeks to publish medical content in a portal is received negatively by older patients and patients expect a more extensive overview of medical content than solely their registered diagnoses, medications and allergies. Nevertheless, patients prefer a summary of the medical information presented in laymen’s terms above a complete uncensored medical file. Furthermore, we showed that if there is no response to patients’ sent messages via a portal, the option to communicate with providers via a portal becomes a barrier to patient portals in improving patient-centeredness; patients were currently dissatisfied due to unresponsiveness of providers on this matter.

Practical implications and recommendations
Continuous use of patient portals can increase the sense of patient-centeredness for patients, through having more control on their own medical data and by being able to digitally communicate with their healthcare team. The studies as described in part 2 of this thesis, have progressed knowledge on an effective strategy that could lead to higher continuous use rates of patient portals by older adults, relevant to the exponential growth of patient portals being implemented [4-8]. Study results from chapter 5 are consistent with those of other studies confirming that older adults are a large use group registering to patient portals [7], implying older adults’ willingness to use portals. Nevertheless, adoption rates of patient portals by older adults seem to be low [7, 9-10]. Based upon our insights from part 2, this matter is approached from two perspectives: 1) older adults’ readiness level regarding patient portal technology use and 2) older adults’ digital needs regarding healthcare communication. Regarding the first technological perspective the focus is on tackling barriers, such as the lack of access to technology and internet in some circumstances as well as experienced usability problems. Regarding the second communicative perspective, the focus is on design solutions for digital communication with patients supplementary to patient/provider communication via a patient portal.

On older adults’ readiness level regarding technology use, insights from the studies in part 2 show that the preferences and needs of these patients concerning patient portal use foremost seem to rely on solid and user-friendly access to basic functionalities of a portal. Technology and internet access among older adults are relatively high in The Netherlands [11]. Nevertheless, it is important to verify if the main target group of patient portals, chronically
ill (older) patients, has access to up-to-date smart devices and reliable internet services. To illustrate, in The Netherlands chronic illnesses are more prevalent and more severe amongst low educated people and non-western migrants [12], often with a low socio-economic status [13]. Such contextual issues of the target group are important to bear in mind within the development and implementation of patient portals, since patients with a low socio-economic status often own outdated technology and their internet connection at home is poor [14]. This issue raises an intriguing question regarding how to minimize the digital divide in access to patient portals and eHealth in general. One solution could be to make the functionalities of an eHealth technologically available to older operating systems and devices. This would require reducing designs and functionalities of a patient portal that need ‘state-of-art’ technologies, whereas it are these technologies that can offer smart design solutions to current experienced barriers to the use of eHealth. An example of such a design solution is to use a patient’s biometric data for login to prevent usability problems at this stage, as is described in the next paragraph. Another approach to make eHealth more accessible could be to provide (older) patients with the needed technology for eHealth in case they do not own this themselves. An investment on this matter may be worthwhile for stakeholders involved in lowering healthcare costs; foremost healthcare insurers and municipalities in a Dutch context, since they are key stakeholders in coordinating care and accompanying costs [15]. Dutch health insurers’ current role in eHealth is related to reimbursement: applying an eHealth innovation as part of care can be reimbursed when proven to be appropriate and effective [16]. Paradoxically, evidence-based eHealth research on effectiveness in supporting improved health for older patients is jeopardized by under-recognizing barriers to eHealth use by this target group as is shown in part 3 of this thesis. By providing those patients who do not have the means with the needed technology for eHealth, Dutch health insurers could take a step in lowering a main barrier to eHealth use, ultimately increasing chances for its effectiveness. Within a broader perspective of digital inclusion, a similar plea could be made for Dutch municipalities. They can provide technological access to (older) people to minimize the digital divide and help civilians to become more self-reliant in our digital society as is likewise recommended by the municipality of Amsterdam [14]. A note of caution is due here, since a lack of technological access is not the only barrier of older adults to eHealth use. Providing technological access to these patients can work when combined with providing solutions to other issues these patients encounter in eHealth use, solutions such as adjusting the designs of mHealth to older adults’ aging barriers as described in part 1 of this thesis and involving older patients in the development of eHealth, as described in part 3 of this thesis.

Similar to the insights discussed in part 1 of this thesis, studies of part 2 showed that an optimal usability is crucial to the user-experience of older adults in patient portal use. Adding to the practical implications from part 1 on this matter, we want to emphasize that user-experience of patient portals is further jeopardized by the variety of usability of different
healthcare institutions’ patient portals. Whereas older patients often receive care from multiple institutions and prefer to have a multi-provider overview on medical data, as is shown in chapter 6, portals are offered to patients as silos per healthcare institution. Each portal for example has its own type of authentication, login and functionalities. Current developments within the field of personal health records (PHR) support patients on this matter by creating a multi-provider overview in one digital environment [17]. These developments are supported and development teams within this field are encouraged to minimize aging patients’ burden in obtaining a complete multicenter overview of their health data by creating interoperable systems. We encourage the development of authentication methods that are simplified in usability, yet safe in ensuring privacy, to provide easy access to such overviews. For example, by using a scan of a patient’s face or voice during authentication and login, instead of probing older patients’ decreasing cognitive and physical abilities in manually registering usernames, passwords and numeric authentication codes.

Regarding the communication processes supported by patient portal use, this thesis has shown that the beneficial aspect of portals in facilitating one-on-one patient/provider communication outside of consultation moments is a key driver for patient portal use by older patients. A possible explanation for this is that patients may feel to be placed at the center of their care if providers give an interpretation of the often complex health information published in the portal. However, for successful patient/provider communication via a portal, it is crucial to engage providers in responding promptly to patients’ sent messages as well as to enable these providers to be able to do so during their work schedule. We encourage patient/provider communication via patient portals, yet it is best combined with smart design solutions to present and explain complex medical data and information in a portal in order to minimize the workload of providers in individually explaining health information to patients. One of these smart design solutions is to apply information processing theories in the presentation of complex, abstract or numeric medical content [18-19]. These information process theories, such as the duel-process theory, the duel-coding theory or the cognitive theory of multimedia learning [18-19], describe that several cognitive systems are involved in information processing, including intuitive processing and converting non-verbal information as well as analytical processing and converting verbal information. By stimulating a combination of these cognitive systems, information is processed more easily and more extensively [18-19]. In presenting complex medical data in a patient portal, video animations that explain the interpretation of this data by means of simple line drawings and spoken word could be used. A recent study on providing cancer screening information to older adults showed that such spoken animations are the best way to communicate complex health information to older adults with low health literacy, whereas they suit people with high literacy levels as well [20]. The spoken animations proved to be more effective in recalling the presented information and creating a positive attitude towards the message given, compared to solely non-animated illustrations [20]. Using this communication means may not only help the
processing of information by older patients with diminishing cognitive skills, the spoken word may also help older patients with diminishing visual capacities; thereby providing a solution to two important aging barriers of older patients’ digital health use as described in part 1 of this thesis. We thus advise to add context to textual and numeric data by using visual aspects, preferably animated and supported by a spoken explanation.

Another smart design solution to decrease complexity in the presentation of medical data and information, is to customize patient portals’ functionalities to the needs and preferences of (older) patients and specific groups sharing similar patient characteristics. This is in line with the insights on older patients’ preferences on this matter as described in chapter 6 of part 2, where it is reported that especially regarding medical information publication’s timing and terminology, preferences differ per patient group. A means to enable sophisticated customizability is to create different user-profiles in a patient portal, each varying in which functionalities they offer to patients. It is best to tailor these functionalities per profile to the needs and preferences of specific patient groups, for example by using the UCD method of creating ‘personas’. Such personas can correspond to different patient clusters, for example differing on health literacy level and type or stage of their disease, with various preferences for the presentation of medical data and information. By this means, profiles can differ in how and when they present this data and information. Providing customized user-profiles as well as apt presentation of contextual information to published medical content, is not only relevant to facilitate patient portal use; these formats can be applied to facilitate the use by older patients of any other eHealth services providing similar functionalities as a portal.

**Recommendations - improving patient-centeredness by stimulating older adults’ patient portal adoption:**

- **Tackle main barriers to older adults’ patient portal continuous use by:**
  - facilitating technological access to portals and portal functionalities for patients with a low socio-economic status;
  - providing multi-provider overviews, for example via a personal health environment;
  - simplifying and adjusting usability of authentication and login to portals and personal health environments to aging needs and characteristics by using biometrics, while adhering to privacy and security standards.

- **Facilitate the provision of context to medical data provided in a portal by:**
  - engaging providers in patient/provider communication via a portal;
  - apt presentations of (complex) medical data and information, preferably using a combination of animated visual aspects and spoken words that add to the numeric and textual medical data as well as using user-profiles to offer information tailored to users’ needs and preferences.
Part 3: Patient-centered eHealth research for older adults

Principle findings
To examine the effectiveness of eHealth in supporting improved health for older patients, Part 3 begins with a literature analysis of studies showing effectiveness of eHealth services (chapter 7). Of the 348 potentially relevant papers, 10 studies were included. The studies each examined the effect of an eHealth intervention on either patients' behavior change, self-efficacy or health-related outcomes. The Systems Engineering Initiative for Patient Safety model (SEIPS 2.0) was then applied to classify possible Human Factors reported in these studies that might have influenced the resulting measured effectiveness of an eHealth service. It was found that a formal approach towards measuring the potential influence of Human Factors on eHealth's effectiveness was lacking in these studies, whereas the studies did report Human Factors' influence on eHealth's effectiveness. For example, patients' characteristics as a person's confidence in his or her abilities to perform required actions and achieve desired results, had a positive impact on eHealth's effectiveness. Part 3 of this thesis continues with a reflection upon an important possible reason why Human Factors are often not an integral part of eHealth research (chapter 8). Using co-creation activities of patient portal development as an example, chapter 8 argues that one of the main challenges in the development phase of portals, is that barriers of older patients to patient portal use often remain under-recognized. Patient portals thus seem to be effective in use while older patients may not benefit from the use of these portals. A reason for this is that patient participation efforts used to develop portals, such as co-creation and user-testing, are often performed with autonomous and younger patients that are willing to participate in such efforts. Consequently, proposed (re)design solutions specifically benefit eHealth use suited for those patients, whereas it does not do justice to needs and capacities of less independent (older) patients. As is shown in part 2 of this thesis, there are several barriers of older adults hampering their use of patient portals that eHealth design teams should consider. Not acknowledging these barriers in the development of patient portals increases the risk of widening the digital divide in patient portal use; the gap may grow between those who can use and benefit from the effects of patient portal use and those who cannot. It is therefore proposed to consider methodological aspects in co-creation and user-testing activities with these patients to get better insights on barriers to eHealth use during the development phase (chapter 9). These methodological considerations were constituted by means of consensus-seeking process during an expert workshop, in which expert experiences and insights were shared on how characteristics of older patients influence (usability) evaluation studies and user-testing. Through transcript analysis, three main themes and 9 recommendations emerged for such methodological considerations. The first theme focused on having an empathetic approach and trust-building and understanding that partaking in user-testing is a social experience for older adults. The second theme focused on new requirements to testing
General discussion and conclusion

and study design, such as beta-testing of the technology, involvement of family and care takers and an intake meeting to get sight on older participants’ characteristics, context and needs to specify the organizational requirements for user-tests. The MOLD-US framework can be used here to get sight on aging barriers possibly influencing these tests. The third theme focused on adjustments to user evaluation methods for testing with older patients. Suggestions were for example to adjust standard evaluation methods by including more social elements, such as peer discovery in which older adults can test the technology together with a family member or care taker. The overview of recommendations can give support and advice on aspects needing attention at the design, planning and execution phase of user-based evaluations of eHealth with older patients.

Practical implications and recommendations

The studies described in part 3 of this thesis aimed to create awareness on the importance of involving older patients in the development of eHealth in order to attain eHealth’s effectiveness for this population. The insights from part 3 can support eHealth evaluators and stakeholders in eHealth’s development regarding recruitment as well as in- and exclusion of older participants to user-tests. More importantly, these insights contribute towards more greater ‘evidence-based eHealth’ for the older patient, since results of user-tests will be more robust when applying the recommendations on how to best approach such tests with older people. For over 25 years ‘evidence-based healthcare’ (EBHC) has become the norm to drive modern healthcare forward [21]. EBCH is defined as the “conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients” [22].

In doing so, it consists of three elements: 1) clinical expertise; 2) best scientific evidence and 3) patients’ values and expectations [22]. Within this EBHC setting, the randomized controlled trial (RCT) is used as a golden standard study design. Nevertheless, as seen in chapter 7, the amount of RCT’s performed to study the evidence on eHealth’s effectiveness on outcomes remains low. This may be explained by the fact that evidence-based eHealth research via RCT’s is challenging to conduct. This type of study design does not easily allow for a rigorous analysis on the third element of EBCH, the influencing contextual factors of the various eHealth users possibly influencing their values and expectations, such as age and related visual, cognitive, perception, and motivational barriers as shown in this thesis. Specifically for mHealth, the constantly and rapidly changing technological environment further does not match the rigor of studying a variety of mHealth interfaces, content and social interactions triggered by mHealth [23]. Yet, as this thesis has shown, to guide and evaluate eHealth innovations upon evidence-based insights within the perspective of older adults’ eHealth usage, it is especially relevant to include an analysis of older adults’ interaction and contextual factors on eHealth in the study design. Not only do older adult eHealth users’ interactions and contexts differ from those of middle-aged and younger adult users, the means to involve older adults in research to develop and evaluate eHealth differ as well: it is
needed to take these interdependencies between technology, human characteristics, and the socio-economic environment into account in order to demonstrate the effectiveness of eHealth accurately [24-25]. This thesis therefore aimed to provide clear guidelines on how to best involve older patients in research on contextual factors surrounding their values, expectations and experience in using eHealth. It is advised to use the instructional guidelines on user-testing with older adults within the field of eHealth development and evaluation. Performing rigorous analysis of interactions and contextual aspects of eHealth users as part of study protocols on evidence-based eHealth research is encouraged. Whereas current standards of the International Standards Organization (ISO) in Europe do state that a usability analysis and documentation should be part of the study protocol in case a medical device intervention is to obtain a Conformité Européenne (CE) mark [26], specific guidelines on methodology to be used to perform such an analysis are not given and a lot of eHealth innovations do not require such an CE mark. To gather robust and evidence-based insights on usability of eHealth innovations, this thesis proposes the use of methodological guidelines for involving older patients in the development and evaluation of eHealth. It is suggested to include usability tests with end-users as well as context analyses of anticipated end-users for each eHealth innovation as parts of those guidelines. These tests and analyses should involve a variety of anticipated end-users with different age ranges and (health) backgrounds in order to obtain better quality insights on how to tailor the innovation to the anticipated end-users’ needs.

Recommendations - improving patient-centeredness by modifying methods used to develop and evaluate eHealth to aging barriers:
- Use the instructional guidelines provided in this thesis on user-testing with older adult patients within the field of eHealth development and evaluation;
- Formalize methodological guidelines on usability testing and user-context analysis in eHealth study protocols.

Conclusions of this thesis and directions for future research

This thesis ‘Design speaks: Improving patient-centeredness for older people in a digitalizing healthcare context’ contributes to our understanding of usability and contextual influences of eHealth’s adoption by older patients. Taken together, over the last decades eHealth technologies gained traction among autonomous (younger) patients coinciding with their increasing (smart) technology use. This paved the way for a growth in development of eHealth, specifically of mHealth and patient portals, two main eHealth domains examined in this thesis. Besides the younger adopters of eHealth, eHealth technologies have the potential
General discussion and conclusion

to place a large group of older patients at the center of care through sharing their medical data with them and digitally tailoring care to their individual information needs. Despite eHealth’s benefits for these older patients, especially chronically ill patients, adoption of eHealth by older patients is low. The evidence from this thesis has shown that aging barriers inhibit interaction and adoption of these technologies by older patients, yet, their willingness to use such services is growing. It thus seems to be the right momentum to stimulate continuous use of eHealth by this large potential older user group. In doing so, the current data in this thesis highlights the importance of designs that optimally support older users’ interactions and communication, of eHealth’s interfaces as well as functionalities. The fast pace of innovations within the field of eHealth risk an imbalance with the (digital) needs of our aging populations. In developing and evaluating eHealth it is therefore important to preserve a balance between the technical possibilities of the eHealth service and the design and functionalities adjusted to aging barriers and capacities. Such a balance can be achieved by using smart design solutions, such as animated videos to explain complex health information and user-profiles with customized features to better tailor eHealth functionalities to the needs of the variety of older patients. Using such smart design solutions does do justice to older patients in improving their patient-centeredness in a digital context. Patient-centeredness in this form must be approached with some caution for vulnerable older patients, such as those with severe mental illnesses, extreme low socio-economic conditions or elderly of very old age. For these patients attention to their individual needs and preferences might entail in-person contact rather than patient-centered care through eHealth. Notwithstanding, the scope of this study was outlined by examining how to improve patient-centeredness through eHealth designs for potential older adult eHealth users, as is shown in the Concluding Figure of this thesis. In this Concluding Figure, the three clusters of patient groups, autonomous patients which are adopting eHealth, older patients as a (potential) eHealth user group and vulnerable patients are represented by the three triangles. Older patients’ needs and preferences on eHealth are mirrored below the triangle of this patient group. The blue dotted square represents current eHealth’s alignment with these patient groups. The orange dotted square represents the possible eHealth’s alignment with these patient groups, when eHealth would be adjusted to older patients’ needs and preferences. The scope of this thesis was to perform research and provide recommendations on how to expand eHealth’s alignment with its first adopters to alignment with the older patient group.

Future research can focus on how to best preserve the balance in patient-centered eHealth for younger and older patients that works together with (equally patient-centered) non-digital safety nets for non-eHealth users. In doing so, we encourage researchers to further expand knowledge on mobile interface designs for older patients and to examine whether some barriers are disease specific as well, regardless of age. This can for instance be assessed by expanding the MOLD-US framework with disease specific barriers, correlations between
age-related and disease-related barriers and by adding design suggestions accordingly. Further research could likewise determine how to best support patient/provider communication in a digital context attuned younger, older and vulnerable patients; balancing online and offline communication. We further stimulate future research that addresses aging and patients’ aspects in formalizing methodological guidelines on usability testing and user-context analysis in research on effectiveness within the field of eHealth.

**Concluding Figure:** Scope of this thesis in relation to eHealth (non)user patient groups
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