Different Perspectives on Technology Acceptance: The Role of Technology Type and Age

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Abstract. Although eHealth technologies offer an enormous potential to improve healthcare, the knowledge about key determinants of acceptance for eHealth technology is restricted. While the underlying technology of eHealth technologies and Information and Communication technology (ICT) is quite similar, utilization contexts and using motives are quite different. In order to explore the role of technology type on acceptance, we contrasted central application characteristics of both technology types using the scenario technique. A questionnaire was administered (n = 104) measuring individual variables (age, gender) and attitudes regarding an eHealth application (blood sugar meter) in contrast to an ICT device (Personal Digital Assistant, PDA). Older users basically approved the utilization of health-related technologies and perceived lower usability barriers. In addition, we identified main utilization motives of eHealth technology and technology-specific acceptance patterns, especially regarding issues of data safety in the eHealth context. Effects of age and gender in acceptance ratings suggest a differential perspective on eHealth acceptance. Finally, practical interventions were derived in order to support eHealth device design and to promote acceptance of eHealth technology.

Keywords: technology, eHealth, ICT, acceptance, user diversity, age, gender, usability.

1 Introduction

European health care systems will have to face enormous challenges in the coming years, which are caused by fundamental demographic changes, decreasing financial budgets for health care and innovative technological developments.

Demographic changes. Life expectancy in Western Europe has increased consistently since the 1950s by around 2.5 years per decade, and it is expected to continue to increase. At the same time, within the EU, a decrease in population is predicted due to migration patterns and low fertility rates [1]. A combination of these factors, as well as the ageing of the 'baby boomer' generation, will lead to dramatic changes in the demographic structure of Europe in the next fifty years. According to national census data every third inhabitant in Germany in 2050 will be 60 years or older, almost 50% of the population will be older than 50 years [2]. The proportion of people aged 80 years or

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older will outnumber the proportion of newborns. Considering the life expectancy of each generation, the societies' aging process is already predetermined. Increasing birth rates or immigration might have a moderating role; however the process of demographic change is irreversible and will fundamentally change our society [1]. Therefore, one of the central challenges of political and health care systems in the 21st century is to master the demands of an aging society.

Decreasing financial budgets for healthcare. The growing number of older adults increases demands on the public health care system and on medical and social services. Chronic diseases, which affect older adults disproportionately, contribute to disabilities, diminish quality of life, and increase health- and long-term-care costs. The health-care cost per capita for persons aged >65 years in developed countries is three to five times higher than the cost for persons aged <65 years, and the rapid growth in the number of older persons, coupled with continuing advances in medical technology, is expected to create upward pressure on health- and long-term-care spending [3]. Due to changing family structures (smaller families living decentralized due to divorces, job-related mobility, etc.) informal health care services provided by relatives, who care for their older family members, are also predicted to decrease. Therefore, a growing number of frail older people will need long term care provided by official health care systems and the demand for long-term care is predicted to triple by 2051 [4].

Innovative technical developments. On the other side, the ongoing technological change and innovations in information and communication technology (ICT) will provide promising possibilities to face the growing pressure on health care systems, i.e. to improve patients' medical care and reduce the financial pressure on health care systems. Technical innovations will offer novel and/or improved medical diagnosis, therapy, treatment and rehabilitation possibilities. Besides progress in biomedical sciences or genetics, especially *eHealth technologies and applications* offer an enormous potential to reduce the pressure on health care systems, because they deliver significant improvements in access to and quality of care for users/patients and the efficiency and productivity of the health sector [5, 6].

1.1 eHealth Technologies

eHealth technologies cover the interaction between patients and health-service providers, institution-to-institution transmission of data, or peer-to-peer communication between patients or health professionals. eHealth technologies also include health information networks, electronic health records, telemedicine services, and personal wearable and portable communicable systems in the small screen sector (e.g. wristwatches, PDA) for continuously monitoring patients' health conditions and providing health-related information [5, 7-9].

Health-related technologies promise to deliver significant improvements in access to care, quality of care, and the efficiency and productivity of the health sector. Both, patients and healthy users can benefit enormously from eHealth technologies by increasing their mobility. eHealth technologies support their users in managing their own diseases, risks – including work-related diseases – and lifestyles. An effective integration of eHealth applications could also improve users' quality of life by enabling safer independent living and increased social inclusion. For example, eHealth could help older and disabled people to remain in their own homes for longer by providing them and their caregivers with increased safety and reassurance, reducing social isolation, and supporting treatment, rehabilitation and intermediate care. Summarizing so far, eHealth technologies and applications can help to shorten or to completely avoid the stay of patients in hospitals or rehabilitation centres, to enhance patient safety and therapeutic success at home after discharge from hospital and to maintain a prolonged independent lifestyle. Moreover, eHealth applications also have the potential to provide flexible forms of support that meet the individual needs of other stakeholders such as care-providers and therapists.

However, in order to fully exploit the potential of eHealth applications, not only aspects of technical feasibility but also of acceptance and usability issues of eHealth applications have to be considered. Improved health care services - especially in the home-care and rehabilitation sector - substantially depend on the ability and the acceptance of recipients to use eHealth applications. However, the knowledge about the antecedents of eHealth acceptance and utilization behaviour on the user side is restricted. Therefore it is necessary to explore and analyze user acceptance of eHealth technologies.

1.2 Technology Acceptance

The issue of technology acceptance has been researched from multiple perspectives, e.g. information theory, diffusion of information or social psychology. It can be described as the approval, favourable reception and ongoing use of newly introduced devices and systems. The majority of theoretical models of technology acceptance refers to the acceptance of information and communication technologies (ICT) in a job-related context [10].

The most influential approach of ICT acceptance and utilization is the Technology-Acceptance-Model (TAM)[10]. Based on the theoretical assumptions of the Theory of Reasoned Action [11] the TAM offers a link between technology acceptance and actual utilization behaviour. According to the assumptions of the Theory of Reasoned Action, an individuals' behaviour is determined by the intention to show certain behaviours. This intention is a function of one's own attitude toward the behaviour and individual norms. According to the TAM, a users' decision to use a new technology is determined by the behavioural intention to use the technical system. This behavioural intention is in turn determined by the perceived ease of use of the technical system and its perceived usefulness. The ease of use describes "the degree to which a person believes that using a particular system would be free from effort", the perceived ease of use is "the degree to which a person believes that using a particular system would enhance his or her job performance" [10]. Empirical studies proved that the perceived ease of use and usefulness were the main predictors of technology acceptance and actual system usage [12-14]. However, one of the main criticisms of the TAM was that external factors such as the influence of individual user variables on technology acceptance were almost completely disregarded. In the extended version of the TAM [15] a number of external variables was added, which were assumed to influence the behavioural intention to use a system, e.g. social and cognitive processes (subjective norm, system image and relevance, quality of output). The latest version of the TAM

– the UTAUT model (Unified Theory of Acceptance and Usage of Technology) [16] – assumes four key constructs (performance expectancy, effort expectancy, social influence, and facilitating conditions), which are direct determinants of technology usage intention and behaviour. Individual user variables such as gender, age, experience, and voluntariness of use are assumed to mediate the impact of the four key constructs on usage intention and behaviour.

Another characteristic of existing models of technology acceptance such as the TAM and its successors is that they almost exclusively focus on acceptance patterns of information- and communication technologies, predominantly in a job-related context. A transfer of their assumptions on eHealth technology acceptance is highly disputable though this has not been analyzed yet. Up to now, only a few studies investigated the special nature of eHealth technology acceptance [17-22]. However, we assume that the acceptance of eHealth technology distinctly differs from acceptance-patterns of ICT for several reasons: First, the *utilization context* of eHealth technologies will be different from ICT usage as eHealth devices will not be used voluntarily, but for medical reasons. Moreover, although eHealth applications might improve patient safety and reassurance, they refer to “taboo-related” areas, which are strongly associated with disease and illness. Second, utilization *motives* will be different, because using an eHealth device, e.g. to keep informed about one‘s own health status is not comparable to e.g. mobile phone usage to communicate with friends. In recent studies it was found that participants – in case of using an eHealth device- reported to fear to be continuously controlled- while this was not ascribed to a device in the ICT context, as e.g. a mobile phone [17-22]. Third, a higher *heterogeneity* in user groups and an even stronger impact of individual factors on acceptance is expected for eHealth technologies, as users/patients might be far older than “typical ICT-users” and they might additionally suffer from multiple physical and psychological restraints in comparison to healthy user groups. In the following section, the factors contributing to a higher heterogeneity in user groups will be described in more detail.

1.3 The Impact of User Variables on Technology Acceptance

In the last decades, the “human factor” or the user perspective has received more attention in research and the development of technical solutions [23-28]. However, the integration of user characteristics in the design process and in the explanation of technology acceptance still has been mainly restricted to information- and communication technologies like computers, mobile phones, Internet, etc. ICT have proliferated into most professional and private areas and they are voluntarily used even in older age groups. ICT are predominantly perceived in a positive way because they facilitate communication, information access and many activities of daily living [19, 29].

However, from ICT-research it is also known that technology perception, acceptance and utilization behaviour varies considerably among users. ICT acceptance is affected by individual differences such as demographic variables, experience, cognitive abilities, cultural factors und personality factors [30-35]. Research concordantly showed that older adults express lower levels of technology acceptance and that they more hesitantly adopt new technologies [19, 36]. Moreover, especially older users with restricted levels of technical experience or computer knowledge and age-related declines cognitive abilities (spatial and memory abilities) face greater difficulties in acquiring ICT skills and successfully interacting with ICT devices and perceive higher usability and acceptance [26, 33, 34, 37]. Apart from that restricted self-confidence to use technical devices also exerted negative effects on technology acceptance [38]. As potential users of eHealth applications might suffer from multiple physical und psychological restraints (e.g. restricted mobility, medicament-induced side-effects, pain, dementia, cognitive deficits, etc.), an even stronger (negative) impact of individual factors on eHealth technology acceptance is expected than in healthy user groups.

Beyond the above-mentioned individual variables, which generally reduce technology acceptance, we identified factors in previous studies, which promote technology acceptance – especially in older users [21, 22, 26, 28, 29]. Older users basically are highly interested in the technological progress and new technical developments, but they are much more critical regarding usability issues [19, 39]. Seniors are more likely to accept technologies (ICT), when the usefulness or benefits of system usage are made transparent, and when comprehensive instructional support (tutor, manuals, help system) is provided [19, 39].

However, as not only the characteristics of potential users, but also the usage context (medical reasons, mandatory usage) and usage motives (health-related reasons) of eHealth technologies distinctly differ from those of ICT, we doubt that existing knowledge about the user perspective in ICT can be one-to-one transferred to eHealth technologies, but that further research is necessary to explore the complex picture of acceptance factors and their interdependency. In the following section the research aims of the present study are described.

1.4 Research Aims

The current study aimed for an investigation of the complex nature of eHealth acceptance and its comparability to ICT acceptance patterns. A user/patient-centred approach was pursued, which considered the characteristics of a highly heterogeneous user group in a health-related utilization context.

First, general issues of eHealth acceptance were investigated, in order to gain insight into central determinants of eHealth acceptance.

Second, a comparative analysis of ICT- and eHealth acceptance patterns was conducted. As we assumed that the utilization context and utilization motives of eHealth technologies would be different from ICT, we contrasted central application characteristics of both technology types using the scenario technique.

Third, the exploration of factors contributing to eHealth acceptance and knowledge about context-specificity of technology acceptance will provide valuable insights into information needs, usability demands usage contexts and mental models of potential users, which can support designers of eHealth devices and applications in developing "acceptable" products.

2 Methodology

In the following section, more detailed information about the questionnaire, the scenario technique and the study sample will be provided.

2.1 The Questionnaire

In order to examine a large number of participants and to consider the diversity within the older age group, the questionnaire-method was chosen. The questionnaire was designed to obtain information about (1) demographic data (age, sex, education), (2) health-related variables (health status), (3) equipment with ICT and eHealth technologies, and (4) attitude towards eHealth technology (general attitude, confidence and intention to use eHealth, conditions and advantages of eHealth usage, utilization scenarios).

Before administering the questionnaire it was revised by a sample of older adults (n = 10) and by a usability expert with respect to issues of comprehensibility and wording of items. The final version of the questionnaire comprised closed multiple-choice and open-ended questions. Multiple-choice items had to be answered on a six-point Likert scale ranging from 1 (do not agree at all) to 6 (fully agree). Mean values < 3.5 were regarded as disapproving answers, values > 3.5 as affirmative answers. Additional space for comments was available in order to provide deeper insight into attitudes and needs towards eHealth technologies. The total time to fill in the questionnaire took approximately 30 minutes.

Scenario Technique

In order to examine the context-specificity of technology acceptance (ICT vs. eHealth) we used the scenario technique. Two utilization scenarios were presented, in which participants were asked to assess functionalities, characteristics and utilization barriers of a PDA (ICT scenario) and a blood sugar meter (eHealth scenario). As exactly the same functionalities, characteristics and utilization barriers were presented in both scenarios (Figure 1), differences in ratings can be attributed to the different technology type (ICT vs. eHealth).

The instruction in the ICT scenario was: “Imagine, your boss would ask you to use a PDA (a pocket computer with a digital diary, a digital to-do-list and a digital address book) at work for the next 14 days. Please indicate if you would approve the following functions and characteristics of a PDA.”

In the eHealth scenario, the instruction was: “Imagine, you suffer from diabetes and your doctor would ask you to use a Blood Sugar Meter (a pocket computer which stores your blood sugar values) for the next 14 days. Please indicate, if you would approve the following functions and characteristics of a Blood Sugar Meter.

Both instructions contained a picture of a PDA or a Blood Sugar Meter, respectively, in order to facilitate the recognition of both technical devices and to enhance the comprehensibility of the instruction.

2.2 The Sample

The data of 104 respondents, 52 university students (m = 25.4 years, s = 4.2, 55.6% female and 52 older adults (m = 55.8, s = 8.4, 48% female) was analyzed. Both age groups did not differ in their educational background. Regarding the recruitment of participants a benchmark procedure was pursued: “younger and comparably healthy older adults” were questioned, which were still active part of the work force. This selection of the “best user case” was based on the assumption that this sample might resemble the group of “future seniors”. Respondents of the older age group came from

Contrast of technology scenarios		
Technology type	ICT	eHealth
Technical Device	Personal Digital Assistant (PDA)	Blood Sugar Meter (BSM)
Device example used in the instruction		
Characteristics and functions of the device	Automatic data storage Automatic data transfer Warning signal for misentries Reminder signal for appointments Password protection Data security Data diagram Handy size	
Utilization barriers	Exposure of personal data Monitoring by technology Technology dependency Restrained usability Feeling controlled by technology Technology too close to own body Visibility of the device for others Abundance of technology Unwilling to adapt to techn. innovations Impersonality of technology Fear of radiation Feeling embarrassed to use technology	

Fig. 1. Contrasting of technology scenarios (ICT vs. eHealth)

different professional fields (engineers, administrative officers, secretaries, teachers, nurses, architects, physiotherapists, physicians, craftsmen). In the younger group, students of engineering and humanity sciences took part.

3 Results

The results are presented according to the structure of the questionnaire, i.e. first, health-related variables and respondents' equipment with ICT and eHealth technologies are presented, followed by the results regarding attitudes towards eHealth technologies and the comparative analysis of technology-specific acceptance patterns. Moreover, in each section the effects of age and gender are reported. Data was statistically analyzed by t-Tests and ANOVAs. The level of significance was set at $\alpha = 0.05$, but, due to the higher variance in the older sample significance levels of $\alpha = 0.1$ are also reported.

3.1 Health-Related Variables

Health status ratings showed that a rather healthy sample was under study ($m = 4.1$ out of 6 points, $s = 0.9$). According to that finding, the sample was suited to fit in our "best case study sample"- approach (see section 2.2). Older adults reported a generally lower health status than younger adults ($m_{young} = 4.5$, $m_{old} = 3.6$; $F(1,44) = 4.7$, $p < 0.05$). Regarding further health-related variables, such as the number of absence days from work due to sick leave, the number of doctors' appointments or preventive medical check-ups, no age differences were found. Male and female participants did not differ in their self-reported health status. An interaction of age and gender was also not found.

3.2 ICT and eHealth Equipment

Participants were comparably well equipped with ICT (Table 1) such as computers, mobile phones, and digital cameras. However, although the older sample was comparably technology-prone and also well-equipped with personal computers, DVD players, navigation systems and PDA, older adults did significantly less possess mobile phones, video recorders, digital cameras, laptops and computer game consoles.

Table 1. Technical equipment with ICT and eHealth devices for both age groups (in %)

ICT	Young adults	Older adults	p
Mobile phone	98.3	88.0	p < 0.05
Computer	82.9	75.6	n.s.
Video recorder	25.8	65.3	p < 0.01
DVD player	60.0	65.5	n.s.
Digital camera	77.5	53.8	p < 0.05
Navigation system	25.8	35.4	n.s.
Laptop	81.7	27.9	p < 0.01
PDA	7.5	9.6	n.s.
Game console	20.8	2.1	p < 0.05
eHealth	**Young adults**	**Older adults**	**p**
Blood pressure meter	14.8	56.0	p < 0.01
Pulse watch	13.0	20.0	n.s.
Hearing aid	1.9	6.0	n.s.
Blood sugar meter	3.7	12.0	n.s.
In-house emergency call	1.9	2.0	n.s.

Compared to ICT, eHealth devices were considerably less frequent in the total sample. The most frequently owned eHealth device was the blood sugar meter, followed by the pulse watch (for heart rate monitoring during sports). The blood pressure meter was more frequently used in the older group ($F(1,100) = 4.4$; $p < 0.01$), presumably due to a higher prevalence of cardiovascular diseases in the older group (16% vs. 3% in the younger group). No effects of gender or interactions of age and gender were revealed.

3.3 Attitude towards eHealth Technology

In the following sections, participants' general attitude and confidence to use eHealth technologies and their intention to use eHealth devices are reported. In addition, the necessary conditions which should be fulfilled for eHealth device usage as well as the perceived advantages or motives of eHealth technology utilization are described.

General Attitude and Confidence to Use eHealth Technologies

In order to assess the general attitude and utilization confidence towards eHealth technology, participants were asked to rate their confidence to use eHealth devices, the perceived usefulness of eHealth devices for themselves and for others and the relative advantage of eHealth devices in relation to conventional medical treatments for themselves and for others.

In Figure 2 and Table 2 it can be seen that the general confidence to use eHealth devices, the usefulness of eHealth for oneself and others and the relative advantage of eHealth for oneself and others were rated positively in the total sample (as indicated by mean values > 3.5).

Interestingly, the usefulness of eHealth technology ($t(101) = -7.4$; $p < 0.01$) and the relative advantage in relation to conventional medical treatments was perceived to be significantly higher for others than for oneself ($t(100) = -6.0$; $p < 0.01$).

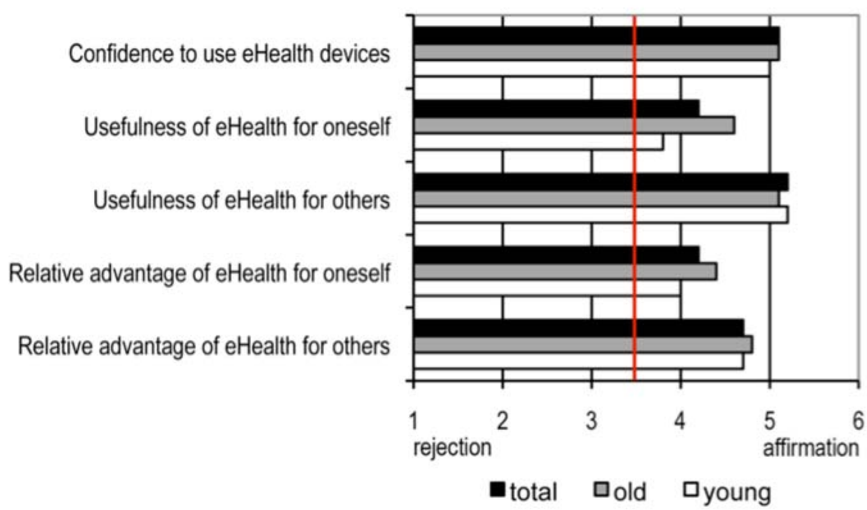

Fig. 2. General attitude and confidence to use eHealth technologies

Older adults reported a significantly more positive attitude towards eHealth technologies ($F(1,96) = 17.6$; $p < 0.01$) than the younger group, especially regarding the usefulness of eHealth for themselves. Effects of gender or interactions between age and gender were not found.

Table 2. Mean values of general attitudes and confidence ratings to use eHealth technologies (max. = 6)

	Total	Young adults	Older adults	p
Confidence to use eHealth devices	5.1	5.0	5.1	n.s.
Usefulness of eHealth devices for oneself	4.2	3.8	4.6	p < 0.01
Usefulness of eHealth devices for others	5.2	5.1	5.2	n.s.
Relative advantage of eHealth devices for oneself	4.2	4.0	4.4	n.s.
Relative advantage of eHealth devices for others	4.7	4.7	4.8	n.s.

Intention to use eHealth Devices

Participants were also asked to rate their intention to use specific eHealth devices. As depicted in Figure 3 ("total" bars in black), participants reported a positive intention towards the use of established eHealth devices, such as blood pressure meters, pulse watches, blood sugar meters, in-house emergency calls, and hearing aids. Regarding future eHealth technologies, such as computer rehabilitation exercisers, thirst sensors,

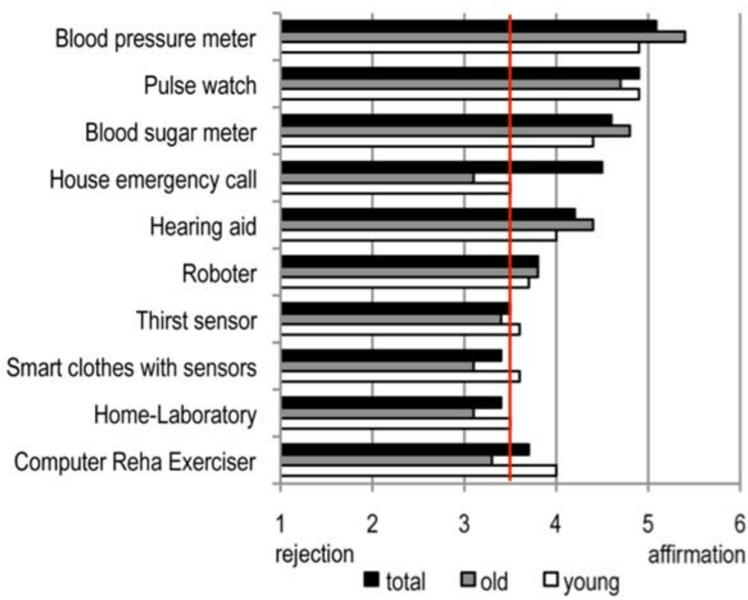

Fig. 3. Intention to use specific eHealth devices

domestic robots, smart clothes with sensors or home laboratories, participants reported an indifferent of even negative attitude (as indicated by mean values < 3.5).

Effects of age, gender, and interactions. Moreover, significant effects of age ($F(10,85) = 2.1$; $p < 0.05$) and gender ($F(10,85) = 1.8$; $p < 0.1$) as well as interactions between age and gender ($F(10,85) = 1.7$; $p < 0.1$) regarding the intention to use specific eHealth devices were detected.

Older adults reported a more positive intention to use blood pressure meters ($F(1,94) = 5.7$; $p < 0.05$), in-house emergency call ($F(1,94) = 3.9$; $p < 0.05$), and blood sugar meters ($F(1,94) = 3.1$; $p < 0.1$) than younger adults. Contrary to that, younger respondents were more positive about using electronic physiotherapists in future ($F(1,94) = 4.5$; $p < 0.05$) in comparison to older participants.

Gender effects were only found for the usage of blood pressure meters, which were more strongly approved by women ($m_{female} = 4.9$, $m_{old} = 4.2$; $F(1,94) = 7.5$; $p < 0.01$).

The interaction between age and gender ($F(1,94) = 3.9$; $p < 0.05$) indicated that the usage of household robots is favoured more strongly by older women and younger men ($m_{young\ female} = 3.3$, $m_{young\ men} = 4.3$, $m_{old\ female} = 4.1$, $m_{old\ men} = 3.6$). Regarding the usage of smart clothes with sensors, especially young men reported a highly positive usage intention, whereas older respondents even rejected the usage of smart clothes with sensors ($m_{young\ female} = 3.1$, $m_{young\ men} = 4.2$, $m_{old\ female} = 3.4$, $m_{old\ men} = 2.8$; $F(1,94) = 3.9$; $p < 0.05$).

Conditions of eHealth Technology Utilization

In a next step participants were queried about necessary conditions, which – to their view – should be fulfilled for an effective, efficient and satisfying interaction with eHealth technology (“I would use eHealth technologies if…”). Most interesting – and the highest rated condition – was that participants accepted the utilization of eHealth devices *only* in case of severe illness (Figure 4).

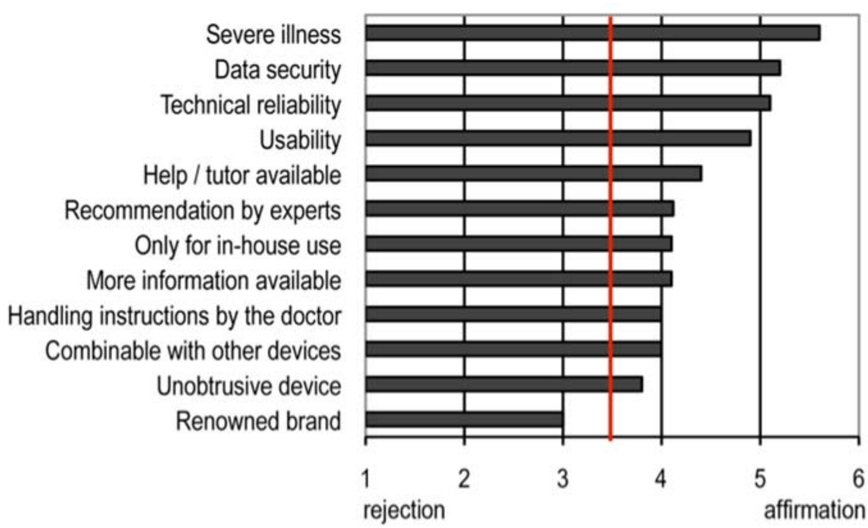

Fig. 4. Conditions of eHealth technology utilization

Further important conditions – apart from a poor personal health status – were technical reliability and data security of eHealth technology, followed by usability aspects and informative help functions. The only aspects or utilization conditions, which were rated as unimportant and negligible, were the devices' brand and the combinability with other devices (e.g. mobile phones). Age differences were also found: In contrast to the younger adult group, older adults significantly more strongly approved the availability of informative help functions ($m_{young} = 3.9$, $m_{old} = 4.7$; $F(1,68) = 5.5$; $p < 0.05$) and data security aspects ($m_{young} = 4.9$, $m_{old} = 5.4$; $F(1,68) = 3.1$; $p < 0.1$). Further effects of age, gender or interactions were not found.

Advantages and Motives of eHealth Technology Utilization

Moreover, participants were asked about perceived advantages and usage motives of eHealth technology utilization. In general, participants approved utilization advantages offered by eHealth technologies (Figure 5, next page).

The highest perceived advantages or utilization motives of eHealth were warning functions in case of emergencies, higher mobility for patients, fast data access, the possibility of a prolonged independent lifestyle and certainty or information about one's own health status. A higher quality of life, a reminding function and a more health-conscious lifestyle as "side-effects" of eHealth usage were also approved. The relief of health system budgets and general attributes of technology ("exciting", "indispensable") were also approved, but to a lower extent. Main effects of age and gender or interactions were not found.

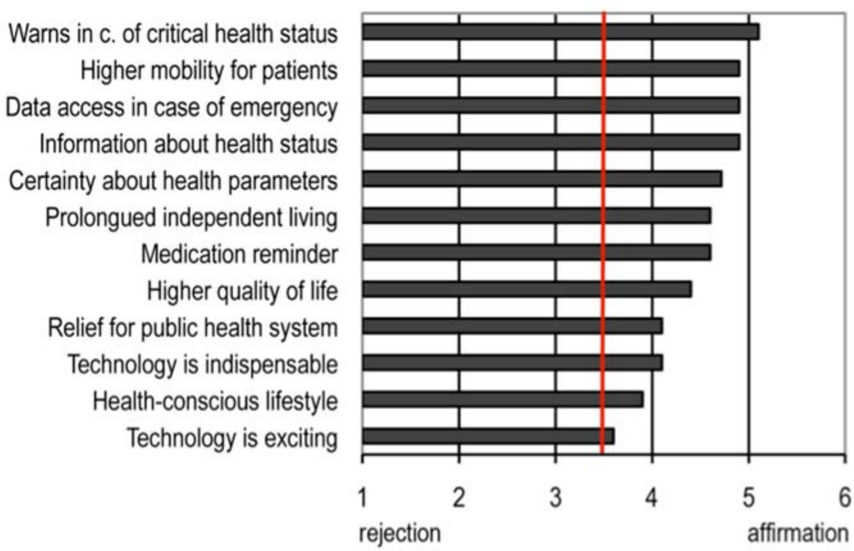

Fig. 5. Perceived advantages and motives of eHealth technology utilization

3.4 Comparison of ICT- and eHealth Technology Acceptance

In the following sections, the results of the technology scenario comparison between job-related ICT usage (using a PDA utilization scenario) and health-related eHealth technology usage (using a Blood Pressure Meter scenario) are reported. First, key characteristics of ICT and eHealth devices are contrasted, and second, perceived utilization barriers for both technology types are detailed.

Comparison of Characteristics and Functions

In two scenarios, in which the utilization of a PDA and a blood sugar meter were described, participants were asked to give ratings about characteristics and functionalities of both technology types.

In general ("total"/black bars in Table 3 and Figure 6), participants approved the given characteristics and functions of a PDA and a blood sugar meter (except "automatic data transfer"). The most important characteristic for participants was the size of the device, followed by a data diagram function for appointments (PDA) or the blood sugar level (BSM), a reminder signal for appointments, a warning signal for faulty entries, password protection and automatic data storage. The only rejection of a technical function (in total) referred to the automatic data transfer function.

However, the ratings regarding characteristics and functions of technical devices differed significantly depending on the specific technology type.

Effects of technology type. Considerable differences in ratings were found for both technology types. The technical functions "automatic data storage" ($F(1,98) = 31.4$; $p < 0.01$), "warning signal for faulty entries" ($F(1,98) = 12.7$; $p < 0.01$) and "automatic data transfer" ($F(1,98) = 80.0$; $p < 0.01$) were rated significantly more positive in the eHealth scenario than in the ICT scenario (grey bars in Figure 6).

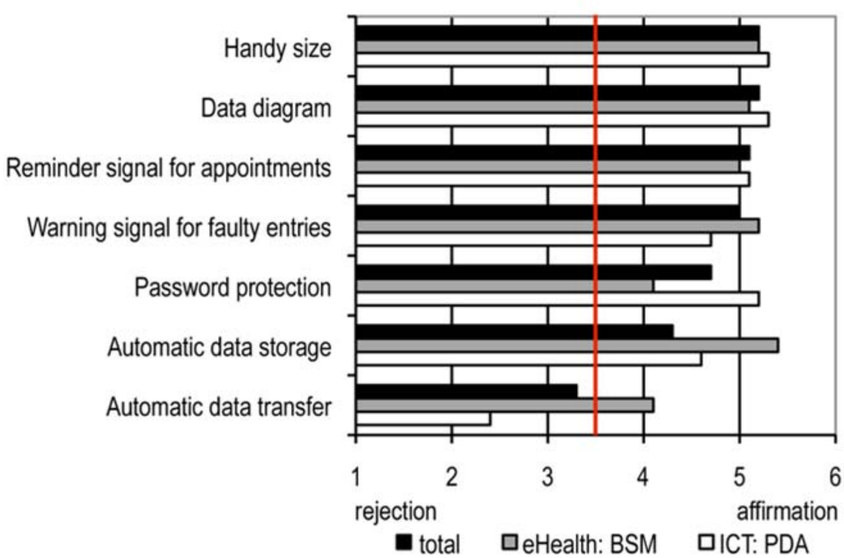

Fig. 6. Characteristics and functions of eHealth (Blood Sugar Meter) and ICT (PDA) devices

In the ICT scenario (white bars in Figure 6), the function “password protection of personal data” was significantly more approved ($F(1,98) = 41.4$; $p < 0.01$), whereas the function “automatic data transfer” was distinctly rejected. For the technical characteristics, “handy size”, “data diagram” and “reminder signal for appointments” no statistical differences between the two technology types were found.

Table 3. Mean ratings for characteristics and functions of a PDA and a Blood Sugar Meter (BSM) (max. = 6)

	total	ICT: PDA	eHealth: BSM	p
Automatic data transfer	3.3	2.4	4.1	p < 0.01
Password protection	4.7	5.2	4.1	p < 0.01
Reminder signal for appointments	5.1	5.1	5.0	n.s.
Warning signal for faulty entries	5.0	4.7	5.2	p < 0.01
Data diagram	5.2	5.3	5.1	n.s.
Automatic data storage	4.3	4.6	5.4	p < 0.01
Handy size	5.2	5.3	5.2	n.s.

Effects of age, gender, and interactions. Participants’ ratings regarding specific functionalities and characteristics of both technology types were also influenced by main and interacting effects of age and gender.

A handy size of technical devices was significantly more important for younger participants than for older respondents (m_{young}= 5.4, m_{old}= 5.0; $F(1,98) = 6.7$; $p < 0.05$). For older adults, automatic data storage was more important than for younger adults (m_{young}= 4.8, m_{old}= 5.2; $F(1,98) = 3.0$; $p < 0.1$), as well as password protection (m_{young}= 4.4, m_{old}= 4.9; $F(1,98) = 5.7$; $p < 0.05$).

Women approved automatic data storage more strongly than men (m_{female}= 5.1, m_{male}= 4.8; $F(1,98) = 4.1$; $p < 0.05$). Moreover, automatic data storage is considerably more important for older adults in the eHealth than in the ICT scenario ($m_{ICT\ young}$= 4.9, $m_{eHealth\ young}$= 5.3, $m_{ICT\ old}$= 4.2, $m_{eHealth\ old}$= 5.4), taken from the interaction between age and technology type ($F(1,98) = 5.7$; $p < 0.05$). Password protection is distinctly less important for younger adults in the eHealth than in the ICT scenario, whereas older adults’ highly approve a password protection in both technology contexts ($m_{ICT\ young}$= 5.2, $m_{eHealth\ young}$ = 3.6, $m_{ICT\ old}$ = 5.2, $m_{eHealth\ old}$= 4.6, ($F(1,98) = 8.5$; $p < 0.05$.

Comparison of Utilization Barriers

Participants were also asked to rate utilization barriers in the ICT- and in the eHealth scenario (Table 4).

In general (“total”, Table 4), participants disapproved the utilization barriers (mean values < 3.5, “total”/black bars in Figure 7). This suggests a positive utilization motivation of technical devices in general. The only approving rating referred to the barrier “exposure of personal data”. Further aspects such as feeling monitored by, controlled by and being dependent from technology, or the fear of health risks (radiation) were not perceived as utilization barriers.

Table 4. Mean values for utilization barrier ratings (max. = 6). Low ratings indicate positive attitude (small barriers).

	total	**ICT: PDA**	**eHealth: BSM**	**p**
Exposure of personal data	4.0	4.1	4.0	n.s.
Monitoring by technology	3.3	3.4	3.1	$p < 0.1$
Technology dependency	3.2	3.4	3.0	$p < 0.05$
Restrained usability	3.0	2.9	3.1	$p < 0.1$
Feeling controlled by technology	3.0	3.4	3.1	$p < 0.1$
Technology too close to own body	2.6	2.6	2.6	n.s.
Visibility of the device for others	2.4	2.3	2.5	$p < 0.05$
Abundance of technology	2.8	2.9	2.6	$p < 0.05$
Rejection of technical innovations	2.9	3.0	2.7	$p < 0.05$
Impersonality of technology	2.6	2.7	2.5	$p < 0.1$
Fear of radiation	2.4	2.3	2.4	n.s.
Feeling embarrassed to use technology	2.2	2.0	2.3	$p < 0.01$

Effects of technology type. In conformity with the findings regarding specific characteristics and functions of technical devices, utilization barriers differed according to the contrasted technology type (ICT vs. eHealth).

Utilization barriers such as the feeling of being monitored ($F(1,99) = 3.3$; $p < 0.1$), and controlled ($F(1,99) = 3.3$; $p < 0.1$) by technology or the impression of being dependent ($F(1,99) = 6.4$; $p < 0.05$) from technology, getting inundated by technology ($F(1,99) = 5.5$; $p < 0.05$), the global rejection of technical innovations ($F(1,99) = 5.1$; $p < 0.05$), the perception of "impersonal" technology ($F(1,98) = 2.8$; $p < 0.1$) or the feeling of being embarrassed to use these technical devices ($F(1,99) = 12.9$; $p < 0.01$) were significantly less pronounced in the eHealth context (grey bars in Figure 7) than in the ICT context (white bars in Figure 7). Thus, the technology type is distinctly affecting usage motives and utilization barriers, and a significantly more positive attitude towards eHealth technologies is present compared to ICT.

Effects of age and gender. Utilization barriers were significantly influenced by main effects of age and gender. No interacting effects were revealed.

Older adults were found to be generally more reluctant and gave consistently higher ratings to each of the single usability barriers ($F(18,36) = 1.8$; $p < 0.1$, Table 5 and Figure 8, next page). In comparison to the younger group, older adults significantly more strongly rejected the exposure of personal data ($F(1,100) = 6.4$; $p < 0.05$), feared to be hampered by restricted usability issues ($F(1,100) = 25.4$; $p < 0.01$), felt monitored by ($F(1,100) = 12.7$; $p < 0.01$), controlled by ($F(1,100) = 12.6$; $p < 0.01$) and dependent from technology ($F(1,100) = 10.1$; $p < 0.05$), refused to "wear" technologies too close to the body ($F(1,100) = 17.1$; $p < 0.01$), complained about the abundance ($F(1,100) = 6.9$; $p < 0.05$) and impersonality of technology ($F(1,100) = 14.0$; $p < 0.01$) and reported a greater fear of radiation ($F(1,100) = 15.8$; $p < 0.01$).

Gender effects were also present: Women significantly more strongly refused to wear technology close to body ($m_{female} = 2.3$, $m_{male} = 2.8$; $F(1,100) = 6.3$; $p < 0.05$).

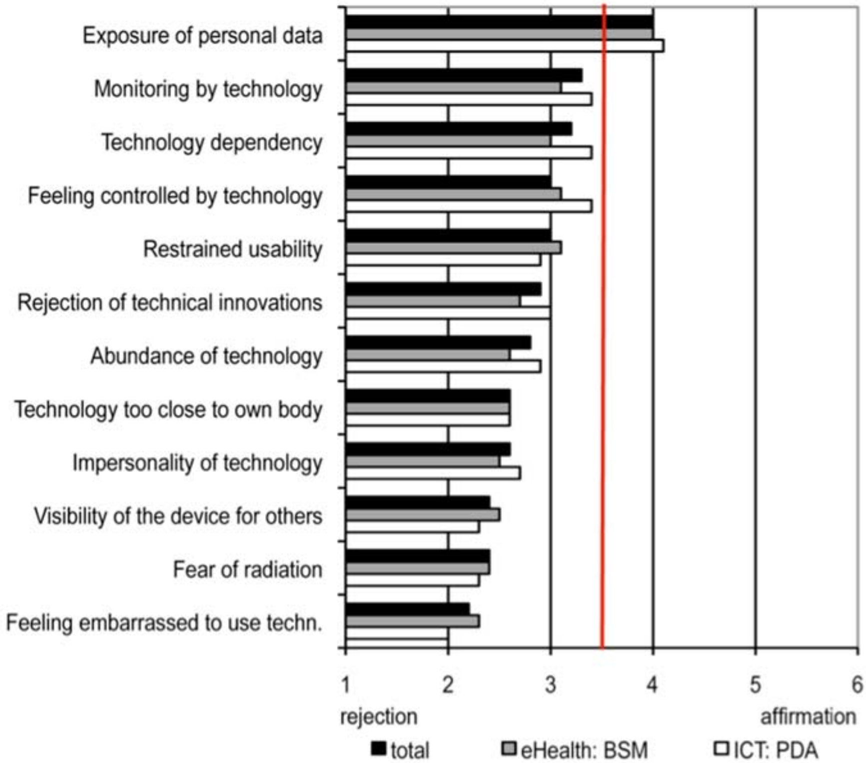

Fig. 7. Barriers to use ICT and eHealth technology. Low ratings indicate positive attitude (small barriers).

Table 5. Age differences in usability barrier ratings (max. = 6)

	Young adults	Older adults	P
Exposure of personal data	3.6	4.4	$p < 0.05$
Monitoring by technology	2.8	3.8	$p < 0.01$
Technology dependency	2.8	3.6	$p < 0.05$
Restrained usability	2.4	3.7	$p < 0.01$
Feeling controlled by technology	2.8	3.7	$p < 0.01$
Technology too close to own body	2.1	3.0	$p < 0.01$
Visibility of the device for others	2.2	2.6	$p < 0.1$
Abundance of technology	2.4	3.1	$p < 0.05$
Rejection of technical innovations	2.3	3.5	$p < 0.01$
Impersonality of technology	2.2	3.0	$p < 0.01$
Fear of radiation	1.9	2.7	$p < 0.01$
Feeling embarrassed to use technology	2.0	2.3	$p < 0.05$

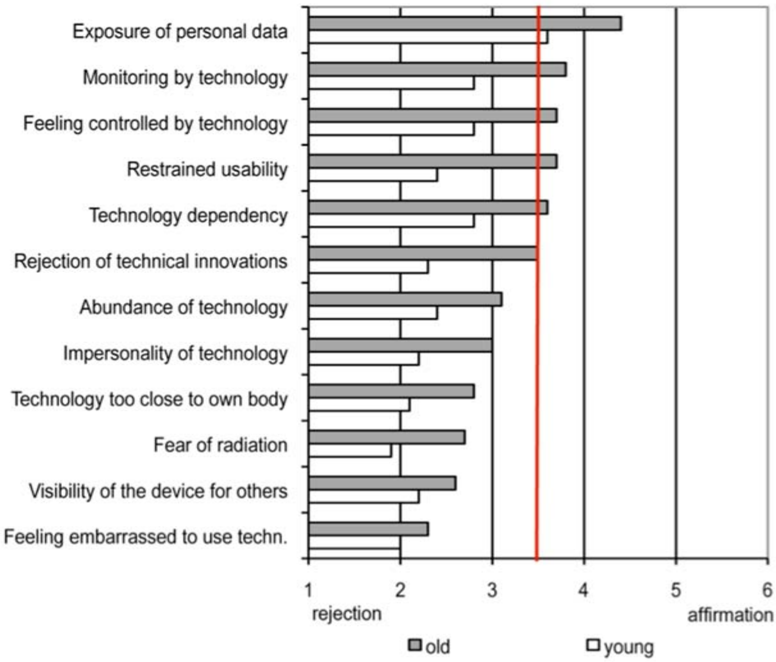

Fig. 8. Age differences in usability barrier ratings

4 Discussion

The present study aimed at an investigation of eHealth acceptance and focused on potential factors, which contribute to persons' attitude towards medical technology as well as on the determinants, which form eHealth technology acceptance. In order to learn more about the impact of technology type and usage context on acceptance outcomes, we compared a scenario, in which either a PDA or a blood sugar meter device was used. Also, the impact of user diversity, i.e. influences of age and gender on acceptance ratings was considered.

4.1 Acceptance of eHealth Technologies

Summarizing so far, participants reported a generally positive attitude towards eHealth technologies. They recognized potential advantages and reported a high motivation to use eHealth technologies. The biggest perceived advantages referred to timely information and, by this, certainty about one's own health status. Also, the possibility to maintain personal independency and mobility and the avoidance of institutionalized care were positive drivers of acceptance. These perceived main advantages refer to vital personal motives, i.e. an unscathed and independent living. Therefore we assume that eHealth technologies have a great potential to become accepted and to improve living conditions of users/patients, if these central motives – information about the health status and maintaining of personal independency and mobility – are adequately considered in technical development and made transparent in an communication or marketing strategy.

Further important aspects, which were identified to contribute to eHealth acceptance, refer to issues of technical reliability and data security as well as usability aspects. Persons who “confide their well-being to technical devices” (a frequent comment of our participants about how they felt about eHealth utilization) expect highest standards regarding technical reliability, system safety and data security. According to that, high quality standards for eHealth technologies have to be defined in order to convey trust regarding the reliability of eHealth technologies. Apart from technical standards, usability standards should also be considered, because users’ acceptance will be lost, if restricted usability hampers a successful interaction with eHealth devices.

Another important factor, which influenced acceptance patterns, was the perceived personal closeness or distance to the eHealth topic. The usefulness of eHealth technology was perceived to be higher for others than for one self. Moreover, the majority of participants stated that they would not consider the usage of eHealth or medical technology until they are urged to and poor health conditions require them to do so. On the other side, it is promising that older adults, who usually have a more pragmatic or even rejecting attitude towards technology [29], assessed eHealth technologies more positively than younger adults. We assume that with increasing age adults tend to basically acknowledge the benefits of eHealth applications, but that they also feel intimidated by these new health-technologies, as they cannot appraise the consequences of using these devices for their living context. Further research is necessary to investigate the effect of perceived “closeness / distance” on eHealth acceptance and measures, which will help to reduce the “fear of context” regarding health-related technologies (e.g. demonstrations of eHealth devices on exhibitions, “sightseeing tours” in smart houses, etc.)

Interestingly, a positive perception of eHealth technologies was related to their diffusion rate: established eHealth devices (e.g. blood pressure meter, blood sugar meter) were evaluated more positively than “future” technologies (e.g. smart clothes with sensors), which have not permeated onto broader parts of our society yet. Future studies will have to investigate, if acceptance of future eHealth technologies is influenced by their diffusion rate or “popularity”, or if users generally reject the functionalities and characteristics provided by these technologies due to their stigmatizing nature [29].

4.2 Technology-Specificity of Acceptance Patterns

The comparative analysis between ICT and eHealth technology convincingly proved a technology-specificity of technology acceptance. In general, utilization barriers were perceived to be lower in the eHealth scenario than in the ICT scenario. However, it would be misleading to conclude that eHealth acceptance by potential users is easier to obtain than it is in the ICT sector. The evaluation of functions and characteristics of ICT and eHealth technology shows that users in fact differentiate between specific utilization contexts and therefore emphasize different aspects of technology interaction. Issues of data safety (password protection, data storage, safe data transmission) are perceived as much more important and are more willingly accepted in the eHealth context than in ICT context. Moreover, the willingness to exchange or share these data to persons that are perceived as competent (therapists or doctors) is higher for eHealth technology. These results indicate that potential users of eHealth applications demand higher technical reliability and data security on the one hand, and are willing to accept a higher monitoring and surveillance by technology on the other hand.

4.3 User-Specificity of Technology Acceptance Patterns

Also, effects of user diversity were identified to affect acceptance judgements. Age and gender differences suggest that potential users of eHealth technologies differ in their technology acceptance patterns, which requires a more differential perspective on eHealth acceptance. Older adults represent one specific user group, which should be considered in eHealth acceptance research [29]. They perceived higher utilization barriers and reported higher concerns about data safety issues. Gender differences in eHealth acceptance also require special attention: especially older female users reported problems to wear technology too close to the own body. These results confirm outcomes from recent studies of our workgroup [29]. Especially for older and female users of eHealth technology these aspects should be adequately addressed in design and communication (e.g. in training courses). This is of especial importance as - due to higher mortality rates in men [29] - predominately older women are the main end user group of future eHealth technologies [29].

4.4 Limitations of the Study and Future Research

Besides individual variables such as age and gender we assume that further health-related constructs (coping, compliance) have to be considered in a global theoretical model of eHealth acceptance and utilization behaviour. Individuals' coping strategies refer to specific psychological and behavioural efforts that people employ to master, tolerate, reduce, or minimize stressful events. They can be categorized in problem-solving vs. emotion-focused, active or avoidant strategies and were found to affect physical and psychological health outcomes [29]. The construct of compliance has been adopted to describe the degree to which patients follow their provider's recommendations. Modern definitions of compliance emphasize a proactive patient involvement instead of a patient-provider hierarchy [29].

Moreover, current approaches of technology acceptance describe a static perspective on technology acceptance, whereas the acceptance of eHealth applications might have dynamic components, which are influenced by disease-related changes in health state, coping strategies and compliance behaviour. Therefore we suggest the integration of health-related constructs such as compliance and coping-style and dynamic components of acceptance patterns in the theoretical explanation and modelling of eHealth acceptance and utilization behaviour. Moreover, we aim for a longitudinal research approach in order to investigate the process of "acceptance development" and changes in eHealth technology acceptance.

A further note refers to the sample of this study. A comparably young (20-70 years) and healthy sample, which was well equipped with technology (ICT), was under study. Older adults in this sample represent the aging "baby boomer generation", which will become the main target group of future eHealth technologies. Their attitudes and demands have thus to be considered by eHealth technology researchers and developers. However, apart from the main target group of “baby boomers”, future acceptance studies should also integrate older (> 70 years) and less healthy user groups, in order to provide a more complete picture of eHealth acceptance.

Finally, an interdisciplinary, user-centred approach is needed, which explores and weighs the contributing factors of eHealth acceptance, considers the demands of a highly heterogeneous user group and the dynamic character of ageing and diseases in a novel, health-related utilization context, identifies barriers and derives practical interventions in order to promote eHealth acceptance.

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