Smart Home Technologies: Insights into Generation-Specific Acceptance Motives

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Abstract. In this research we examine the generation specific acceptance motives of eHealth technologies in order to assess the likelihood of success for these new technologies. 280 participants (14 - 92 years of age) volunteered to participate in a survey, in which using motives and barriers toward smart home technologies were explored. The scenario envisaged was the use of a medical stent implemented into the body, which monitors automatically the health status and which is able to remotely communicate with the doctor. Participants were asked to evaluate the pros and cons of the usage of this technology, their acceptance motives and potential utilization barriers. In order to understand the complex nature of acceptance, personal variables (age, technical expertise, health status), individual's cognitive concepts toward ageing as well as perceived usefulness were related. Outcomes show that trust, believe in the reliability of technology, privacy and security as well as intimacy facets are essential for acceptance and should be considered in order to proactively design a successful rollout of smart home technologies.

Keywords: Aging, technology acceptance, smart home technology, perceived usefulness, TAM, medical technology.

1 Introduction

The profound demographic change in many countries of the world imposes considerable challenges on modern societies. Due to increased life expectancy, improved medial health care, and reduced fertility rates, increasingly old and frail people will need medical care in the near future, e.g. [1] [2] [3]. At the same time, considerable bottlenecks arise from the fact that increasingly fewer people are present which may take over the nursing and decreasing supply shortfalls of societal health insurance funds [2].

In order to master the requirements of an aging society, technological innovations in information and communication technologies as well as medical engineering technologies come into fore, which offer novel or improved medical diagnosis, therapy, treatments and rehabilitation possibilities. Technologies in this context are subsumed

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under different terms, as e.g. electronic health systems (ehealth), smart health, ambient assisted living (AAL), or personal health care systems, e.g. [4] [5] [6]. Technological innovations in this sector are fast developing. Yet, the spectrum of technical applications in the eHealth sector available covers a broad variety of developments, reaching from internal technologies (implants for monitoring bio signals, so called medical stents or chips) over devices integrated into clothes (tissue engineering) up to healthcare robots, which continuously monitor the health status by wireless technologies and support older people to keep up safe and independent living at home (e.g., [7] [8] [9] [2]).

However, recent experience shows that it is not predominately the technical barrier, which hampers a successful rollout and a broad responsiveness of users. Rather, far-reaching acceptance barriers are prevalent which represent serious obstacles to technical solutions, which are so badly needed [10] [11]. One major reason for this reluctant acceptance and a still negative evaluation might be due to the fact that current developments in this sector are predominately focusing on technical feasibility, inspired by technical disciplines, in combination with medical and computer science knowledge, while the "human factor" in these systems is fairly under developed. Of course, the technical aspect and the concentration on feasibility, signal power and compatibility with other systems is a sine qua non for smart technologies [7], which must be the primary goal of technical design in the first round. However, at least at the current maturity of technical solutions, the human perspective should be incorporated into technical designs as soon as possible. This is especially important for the older user group, which is not basically disinclined to the usage of technology in general [12], but has specific demands, needs and requirements and put strong emphasis on usability and acceptance issues [13] [14] [15] [16]. Thus, we need to understand seniors' needs and wants, and their specific using motives as well as acceptance barriers. This problem space was addressed in the present study. We examined users of a broad age range and collected their acceptance ratings and barriers towards smart health technologies.

1.1 Technology Acceptance

Looking back, it is evident that peoples' acceptance of technology is predominating the public discourse and the scientific discussion in times of technological cycles in which new technologies are penetrating into personal and working environments. In the 1980ies and 1990ies, alongside with the ubiquitous introduction of personal computers, there was a boom of research dealing with technology acceptance [17] [18] [19]. As technology cycles are increasingly faster, technology acceptance continued to be a key research issue. Technology acceptance deals with the approval, favourable reception and ongoing use of newly introduced devices and systems and explores the relation of end-users using motives, cognitive and affective attitudes toward the respective technology and the technological impact assessment. The huge majority of technology acceptance studies dealt with the impact of information technologies in the working context and addressed the young and healthy adult as a major user group of information and communication technologies (e.g.). It was found that the perceived ease of using a system and the perceived usefulness are the key components of technology acceptance (e.g. [20] [17] [18]). However, with the increasing diversity of

users, the diversity of technical systems (visible vs. invisible, local vs. distributed) and using contexts (fun and entertainment, medical, office, mobility) end-users are confronted with, more aspects are relevant for understanding users acceptance – beyond the ease of using a system and the perceived usefulness. Especially, user characteristics (economic status, culture, gender, age, experience, and the voluntariness of system usage) had been added to the original model and considered in the comprehensive UTAUT-model [21].

To date, a few studies were concerned with acceptance of medical and ehealth technologies from the human perspective [22] [23] [3] [24] [25] [26]. Outcomes show that it is highly questionable that acceptance for medical technologies can be fully understood on the base of the prevailing knowledge of technology acceptance drivers so far. Rather, technology acceptance for the medical technology sector seems to be still more complex than it is for other technical systems, out of different reasons. A first argument in this context is that eHealth technologies are predominately addressing the seniors, which are increasingly prone to diseases with increasing age. Ageing, dependency and illness are – still - negatively connotated in our societies and, thus, carry a stigmatizing potential, which could impact the acceptance of medical technology. A second argument refers to the fact that many technologies incorporated in smart homes (walls, furniture or clothes) do overstep personal intimacy limits and therefore could be bothered by justifiable worries about privacy, intimacy and loss of control. Third, it should be considered that the status of health and resulting feelings of independency or dependency on technology also could impact the willingness to accept ehealth applications. Finally, and this is of specific interest, the acceptance of medical technology might also be influenced by age, and the generational perspective. As aging is a key factor in this context, the next section will detail the aging impact on acceptance of medical technologies.

1.2 The Aging Impact for the Use of Technology

In the last decades, an increasing number of studies had been concerned with the interacting of older users with different technologies, as e.g. Internet and web applications (e.g. [27]), computers (e.g. [28] [29]) and mobile small screen devices (e.g. [20] [30] [31] [32] [33] [34]). Outcomes show that older adult face enormous difficulties when interacting with modern technology. Though, it had been also demonstrated that a human-centred design of devices' interfaces might considerably reduce, if not compensate, the aging handicap and enable older adults to efficiently handle modern technical devices (e.g. [31] [32]).

With respect to older adults' acceptance, considerably less and less unequivocal knowledge is prevalent. On the one hand, older users' hesitant approach towards new technical devices in general is well known (e.g., [20] [30] [11] [14]), and older adults' hesitant acceptance towards ehealth technology in particular (e.g., [23] [34] [11]). A possible source of older adults' lower acceptance is their lower computer knowledge [35], and a completely different understanding of how technology works. Older adults were often educated in times where technical devices were far less complex and, therefore, are often not experienced with the handling of current technology models. In addition, the olds' lower levels of self-confidence when using technology might be a serious obstacle for accepting a technology [20] [36] [33] [16]. On the other hand,

there are studies which reveal that older adults show high interest in modern technologies (e.g. [12] [33]), but they are much more critical regarding the social compatibility of technology, the usefulness and the fair balance between costs and benefits of the respective technology [14] [15]. Also, older adults have a much more exclusive claim for usable technical designs compared to younger technology users [20] [30] [11] [37].

Especially for the evaluation of acceptance of ehealth technologies, age and technology generation is assumed to play a prominent part. For young and technology-experienced adults (about 20-30 years of age), which are not personally touched by the application of medical technologies in the near future, medical technology could represent attractive and appropriate technological solutions for societal problems. The middle-aged adults (about 45-60 years of age) could adopt another attitude. As they have the duty to care for their older parents, ehealth technologies could guarantee the well-being of their parents. Also, modern medical technologies could help save them costs (e.g. for nursing homes) and could spare them family caring duties. Finally, from the perspective of the over 70+ years olds, still different and controversial aspects could impact the degree of acceptance of medical technologies. One the one hand, medical technologies could allow them to feel safe in the privacy of one's home and to stay independently from the help of others. On the other hand, feelings of being permanently controlled in combination with low trust in technology could provoke ambivalent feelings towards medical technologies.

1.3 Questions Addressed and Working Model

The main goal of this research was to analyze the contribution of age and technical generation to the motivation patterns for the intention to use an implanted stent if necessary. In order to differentiate the different technology generations, we rely on a model of technology generation [38], in which three technology generations and age groups, respectively, are distinguished: the *early-technical generation* (65+), the *household revolution generation* (49+), and the *computer generation* (26+). As the mentioned research stems from 1989, there was a need to categorize still younger participants accordingly. To this end, the *GameBoy generation* was established, comprising an age range from 14-25 years of age.

The goal was to determine technology acceptance for medical technology in each generation and to identify the impact of potential generation specific barriers (con's) and using motives (pro's) on the intention to use the respective technology. In order to consider the generation related user factors, we examined the health status of participants and their experience with technical devices.

According to the model, the following hypotheses were specified:

H1: Generations differ in their ageing concepts.
H2: Generations differ in their intention to use the medical device.
H3: Age concepts are affecting the pros and cons for usage of medical technology.
H4: The barriers and using motives directly influence the using intention.
H5: Technical experience is related to barriers and using motives within generations.
H6: Generations differ within reported using motives and barriers in relation to the reported intention to use medical technology.
H7: No specific hypotheses for gender effects were on hand (dashed line in Figure 1), and were therefore not considered in this paper.

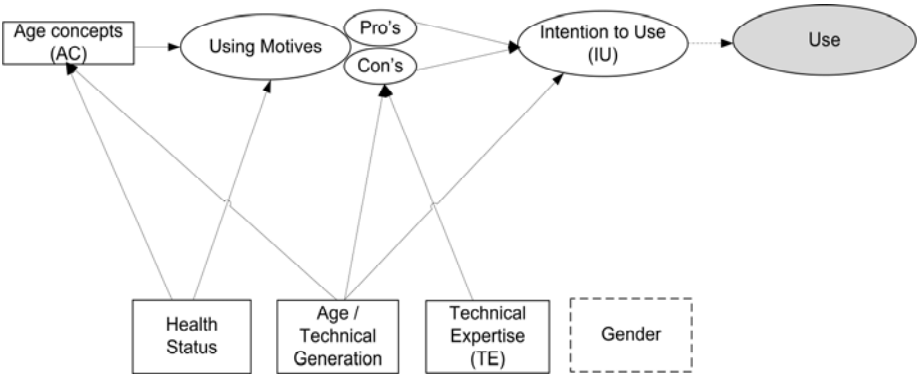

Fig. 1. Research Model comprising variables selection in our study. Independent variables are given in quadratic, dependent variable in round boxes.

2 Method

We assume that acceptance of (smart) medical technology is a rather complex phenomenon. In order to learn which components might be decisive for the forming of technology acceptance toward medical technology, we used an investigative and explorative approach. In order to examine a large number of participants and to consider the diversity within the older age group, the questionnaire-method in combination with a scenario technique was chosen as empirical approach.

Participants were introduced into a medical scenario: "Imagine that in the year 2025 a vast majority of people in our societies are 65 years and older. Many of these people will be frail and therefore reliant on medical care. Due to shortcomings in the caring sector (economic bottlenecks and a decreasing number of nursing staff) it is a basic question how older people can live independently at home, and have access to medical services. Yet, there are already mature technical developments, which enable continuous medical care at home. One example for these developments is a so-called medical stent, an electronic miniature chip, which can be implemented in a blood vessel inside the body. This device is able to monitor bio signals continuously and unobtrusively (e.g. blood pressure, blood quality). The device communicates bio signals automatically to the doctor/medical staff and contacts the emergency ambulance if necessary." Participants were instructed to envisage the use of such a device and to evaluate, if it may be helpful for them, to state if they would accept technologies like these and to report the most important pros and cons regarding the usefulness of these technologies. In order to ensure peoples' understanding of the scenario and its consequences the described scenario was tested in a sub sampling before the main data collection began.

2.1 Variables

Independent variables: Independent variable is the age of participants. As age can only be taken as an indicator of other critical variables, which might be carried by age and which influence the attitude towards medical technology and the acceptance of it,

we classified participants according to their technology generation [38] and, in addition, assessed mediating factors as the technical expertise and individual health status.

Dependent Variables: Dependent variables were the perceived usefulness of the medical technology and the intention to use the medical device if necessary. Participants were instructed to envisage the use of this device and to evaluate the pro's and con's regarding its usefulness and their willingness to use it. Items were formulated from the perspective of participants (first person), in order to enhance understandability by the very olds. Items were to be confirmed or denied on a four-point Likert-Scale from 1 (totally disagree) to 4 (totally agree). Usefulness and intention to use were formulated as pros and cons.

The potential using motives (pro's) focused on potential

-*pragmatic* reasons ("the usage of the device reduces the duty to constantly visit the doctor")

-*control* reasons ("I prefer using the device in order to have continuous feedback about my health status").

The potential barriers (con's) focused on

-*dependency* reasons ("I do not trust the reliability of the device")

-*privacy* reasons ("I fear that others could come to know about my health status").

In order to collect potential individual annotations, the questionnaire offered at some places the possibility, to note personal remarks if necessary.

2.2 The Questionnaire

Overall, the questionnaire was arranged in different sections. First socio-demographic variables were assessed, followed by the items to individual aging concepts. Then the scenario was introduced to which the questions regarding the intention to use, using motives and utilization barriers were related to. In the following, dimensions and items are described in detail.

Aging Concepts (AC)

For the assessment of aging concepts, the following questions had to be answered:

Table 1. Items for Ageing Concepts (1 = totally disagree to 4 = totally agree)

When I am aged
I want to live independently from others
I do not want to burden s.o. with the care for me
I would accept to rely on technical support
I plan to move into a nursing home
I would accept to rely on mobile nursing services
I plan to move into my children's homes

Intention to Use (IU)

Participants were given the following answers regarding their intention to use the technology, if necessary.

Table 2. Items for the Intention to Use (1 = totally disagree to 4 = totally agree)

Using the medical device… (implanted chip)
… would increase my life contentment and satisfaction
… allows a sensible medical care
Can you imagine to use the device to…
… live longer independently at home?
… facilitate your living conditions?

Pro's and Con's

Using motives and barriers were assessed through the following questions:

Table 3. Items for the pros (using motives) (1 = totally disagree to 4 = totally agree). "Under which conditions would you use the medical stent?".

I would use the implemented medical device
… in order to save caring costs
… in order to escape from the indignity of being cared
… in order to keep independency
… because it reliefs me from worries about life-menacing situations
… because this medical device is unobtrusive without attracting public attention
… because it reliefs me from the duty to constantly visit the doctor
No, I would be reluctant to use the implemented medical device
…because I fear that the device is not reliable
…because others would come to know about my health status
…because I do not want to feel stigmatized as old and sick
…because the implemented device could shift and get out of place inside my body
…because I dislike the idea of a contaminant and foreign particle inside my body

Technical Expertise (TE)

Technical experience might also be connected to acceptance outcomes. However, technical experience is a broad construct and is not limited to the experience with information and communication technologies, especially not in the older generation. Therefore, we assessed technical experience in a broad context (Table 4).

Table 4. Items for Technical Expertise (1 = totally disagree to 4 = totally agree)

Which of the following actions apply to you
I can assemble a prefabricated object (e.g. furniture) from pieces by myself
I can hang up a picture on the wall by myself
If something breaks I usually seek to repair it by myself
I easily handle a mobile phone and use it regularly
I easily handle a computer and use it regularly

2.3 Reliability and Validity of Scales

In order to assure a high measuring quality, reliability and validity of items were analyzed prior to testing. The reliability of the (latent construct) scales *Intention to Use* (IU) and *Technical Experience* (TE) was assessed by scale reliability analysis. Table 5 shows the outcomes.

Table 5. Factor analysis of the scales IU and TE. Bold values indicate items' loadings on correct latent construct.

	Factor loadings	
	IU	TE
Intention to Use: Using the medical device…		
…would increase my life contentment and satisfaction	**.925**	.133
…allows a sensible medical care	**.853**	.183
Can you imagine to use the device to…		
…live independently at home?	**.900**	-.033
…facilitate your living conditions?	**.912**	.117
Technical expertise		
I can assemble a prefabricated object (e.g. furniture) from pieces by myself	.111	**.820**
I can hang up a picture on the wall by myself	.108	**.756**
If something breaks I usually seek to repair it by myself	.100	**.726**
I easily handle a mobile phone and use it regularly	-.044	**.722**
I easily handle a computer and use it regularly	.146	**.720**

Cronbach's Alpha values for IU reached .93, .80 for TE, suggesting high reliability. Convergent and discriminant validity were examined using principal factor analysis with varimax rotation. The rotated factor matrix in Table 6 suggested convergent validity within scales (loadings greater than .70) and discriminant validity across scales (cross-loadings less than .20).

2.4 Participants

A total of 280 respondents participated, with an age range between 14 and 92 years of age (M = 46.7). Participants were recruited through the social network of authors and came from a broad range of professions. All participants volunteered to take part and showed a very high and personal interest in the topic, what can be taken from - for questionnaire studies - high response rates of about 80%. Participants were not gratified for their efforts. The sample was allocated to four technology generation groups, according to the theory of technology generations by Sackmann and Weymann, 1998.

-*Early-technical generation* - Group: 71 participants (42% men, 58% women), between 65 and 92 years of age (M=75.4, SD=6.2).
-*Household revolution generation* - Group: 72 participants (47% men, 53% women), with an age between 49 and 64 years of age of M=54.1 years (SD=3.8).
-*Computer generation* - Group: 75 participants (45% men, 55% women), with an age between 26 and 48 years of age of M=33.8 years (SD=8.1).
-*GameBoy generation* - Group: 64 participants (53% men; 47% women), with an age between 14 and 25 years of age of M= 21.4 years (SD=3).

Participants' health status and the experience with the usage of medical technology were assessed (Table 6).

Table 6. Health status and experience with medicine-technical aids. Given is the absolute number of participants, which suffer from a chronic disease and which use medical devices (the total number of participants in the respective generation is given in brackets).

	"I suffer from a chronic disease"		"I use a medical technical device (e.g. blood pressure device, hearing aid, heart pacemaker)."	
Group	**N (N all)**	**%**	**N (N all)**	**%**
1 Early-technical generation	34 (71)	47.9	39 (71)	54.9
2 Household revolution	23 (72)	31.9	9 (72)	12.5
3 Computer generation	11 (75)	14.7	3 (75)	4.0
4 GameBoy generation	4 (64)	6.3	2 (64)	3.1

As shown in table 6, the number of persons suffering from a chronic disease rises with increasing age ($r = .3.8$; $p < 0.05$) and also the need of using medical technology ($r = .48$; $p < 0.05$). Though, in all generation groups there were participants, which indicated to suffer from a chronic disease and which reported to use medical technical devices, respectively.

3 Results

Results were analysed by ANOVA - procedures (differences between generation groups) and bivariate correlation analyses (Pearson, Spearman as well as nominal correlation procedures) to assess the interrelation between factors and variables. ANOVA - procedures were carried out which are sufficiently robust regarding varying numbers of participants in different groups.

The result section is structured as follows. First, the findings regarding aging concepts, the intention to use the medical technology and the using motives and utilization barriers in the different technology generations are reported. If necessary, the quantitative findings are underpinned with qualitative findings (personal remarks and free answers of participants). The section closes with the research model in which the relations between factors and variables are complemented.

3.1 Aging Concepts in the Different Technology Generations

H1 states differences in the generations' aging concepts. In order test this hypothesis multivariate tests with technical generations as between factor was conducted. The analysis revealed a significant main effect for generations ($F(18,738)= 2.68$; $p<0.01$). Descriptive outcomes are illustrated in Figure 2.

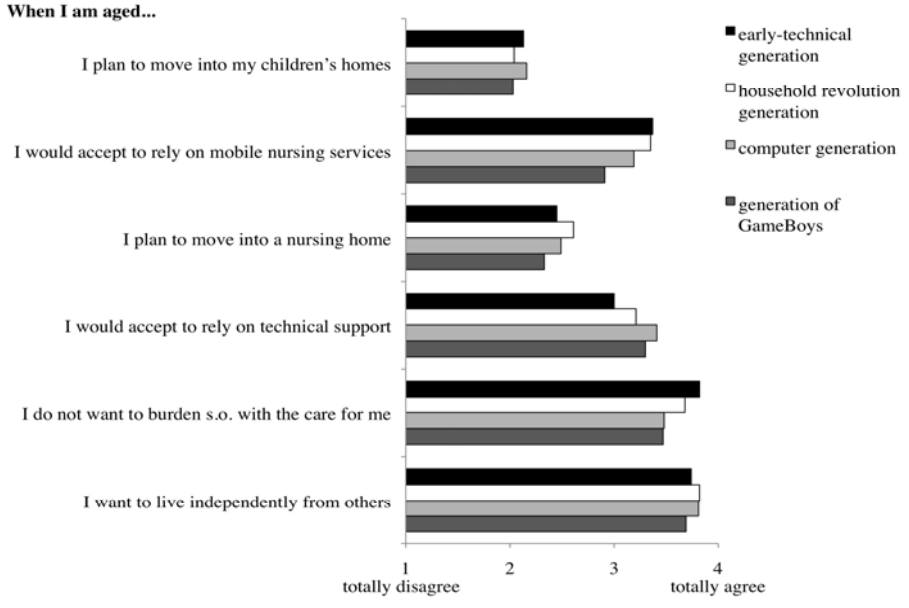

Fig. 2. Aging concepts of the different technology generations

For the early-technical generation it is most important that they do not want to burden s.o. with the care for them (M = 3.8 out of four maximal points; SD = .49). In contrast, acceptance for technical support is less pronounced (but not refused) in this generation (M = 3; SD = .91) compared to the computer generation (M = 3.41; SD = .74). The possibility of relying on mobile nursing services is more confirmed by the early technical and the household revolution generation compared to both younger generations. Beyond the differences between generations, it is though insightful to look at the non-differences. All generations prefer to live independently from others when they are aged. Also, none of the generations really envisaged the possibility to move into their children's homes.

3.2 Intention to Use

First, the four items of the intention to use were analyzed and for further analysis a total mean was calculated for each generation. It was hypothesized (H2) that generations differ in their intention to use the medical stent if necessary, as they might have a very different technical model, knowledge and a different attitude towards technology.

Multivariate analysis reveals that intention to use the medical device differs across generations ($F(12,688) = 2.03$; $p<0.05$). However, it is important to note that all generations have a basic positive disposition to the use a medical stent (Table 7). Altogether, the most decisive reason in all generations *for* using the medical stent is that the device allows a sensible care ($M_{total}=2.88$; $s=0.92$). In contrast, the lowest agreement for using the stent is its ability to increase life contentment and satisfaction ($M_{total}=2.52$; $s=0.95$). While this was given again in all generations, it was most pronounced for the very olds (early-technical generation) (Fig. 3).

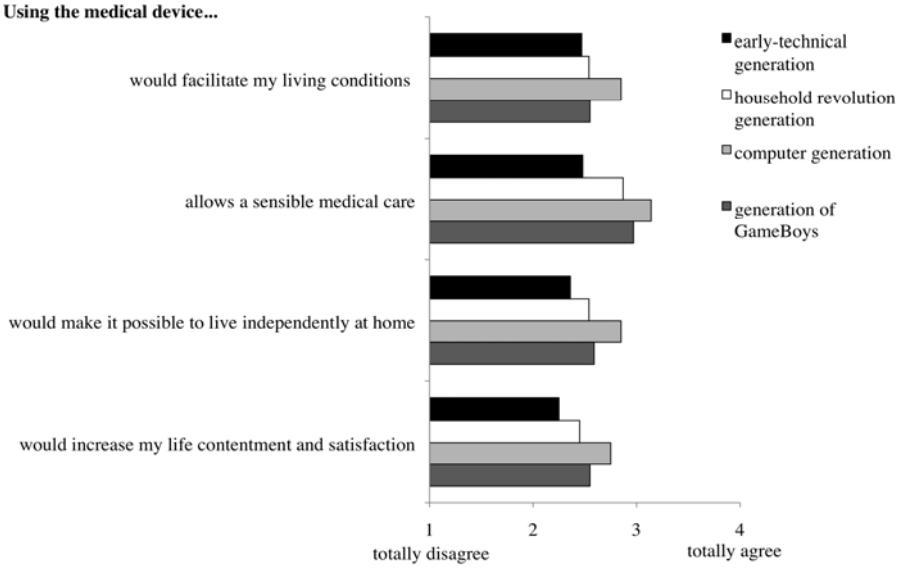

Fig. 3. Intention to use the medical stent in all generations

When focusing on the overall acceptance, the computer generation (average 33 years) turns out to be the group that shows the highest degree of acceptance towards using the medical stent ($M = 2.9$; $SD = 0.78$), whereas the early-technical generation (average 75 years) shows the lowest, but still positive, attitude ($M = 2.38$; $SD = .91$).

Table 7. Total mean IU for each generation

	Intention to use the medical stent	
	M	SD
early-technical generation (N=69)	2.38	.91
household revolution generation (N=72)	2.59	.82
computer generation (N=74)	2.90	.78
generation of GameBoys (N=64)	2.66	.76

3.3 Barriers and Using Motives

In this section, we report the using motives (Table 8) and barriers (Table 9). Comparing the pro's and con's for using the medical stent in each generation, MANOVA analyses revealed that generations differ in their weighting of reasons for and against usage.

First, the using motives are discussed. It is an interesting finding that - independently of the generation - the unobtrusiveness of the device for avoiding public attention is the less important feature of the device. Within the reasons, which are perceived as

Table 8. Using Motives. Bold values indicate the less important motive in each generation (Standard deviations are given in brackets. Items are abbreviated - for full item text see 2.2).

I would use the medical device…	**early-technical** (N=67)	**household revolution** (N=72)	**computer** (N=73)	**GameBoys** (N=64)
	M	M	M	M
save caring costs	2.52 (.99)	2.75 (.95)	2.91 (.95)	2.75 (.94)
escape from indignity	2.63 (.99)	2.81 (.87)	3.06 (.81)	2.84 (.86)
keep independency	2.57 (.93)	2.8 (.90)	3.03 (.87)	2.91 (.75)
no worries about life-menacing situations	2.60 (1.1)	2.78 (.95)	2.75 (.95)	2.61 (.92)
unobtrusiveness	**2.30** (1.1)	**2.40** (1.0)	**2.6** (1.0)	**2.45** (.99)
less frequent doctor visits	2.64 (1.1)	2.65 (1.0)	2.97 (.88)	2.55 (.89)

Table 9. Barriers towards using the medical stent - bold values indicate the most important barrier in each generation (Standard deviations are given in brackets. Items are abbreviated -for full item text see 2.2).

I would not use the medical device because I fear…	**early-technical** (N=67)	**household revolution** (N=72)	**computer** (N=73)	**GameBoys** (N=64)
	M	M	M	M
device is not reliable	**2.58** (.67)	**2.44** (.71)	**2.59** (.80)	**2.6** (.77)
others come to know about my health status	2.37 (.84)	2.29 (.87)	2.11 (.75)	2.18 (.90)
stigmatized	2.17 (.91)	1.96 (.97)	1.95 (.83)	2.05 (.99)
chip could shift	1.98 (.85)	2.08 (.89)	2.14 (.93)	2.34 (.84)
foreign particle inside my body	2.10 (.99)	2.15 (1.0)	2.15 (.99)	2.33 (1.1)

most important, the generations show different ratings. For the early - technical generation, the lower frequency of seeing the doctor, and the escape from the alleged indignity of being cared by others are the most critical factors, which militate in favor of the usage of the medial stent. In all other generations - the household, the computer and the GameBoy generation - there are two prominent reasons for using the stent: the escape from indignity of care and the benefit of keeping independency in older age (Table 8).

Second, the reported barriers are detailed (Table 9). On a first sight, it is noticeable that the barriers were perceived as less significant (lower values indicate a less crucial barrier). Independently of the generation, the most important worry is that the device is not reliable, showing a small trust in technology. The less relevant barrier for not using the device is the fear of being stigmatized as old and frail.

3.4 Qualitative Insights into Using Motives and Barriers

Any quantification of using motives and barriers in this sensitive field is only a superficial analysis, as long as it is not understood which underlying cognitions or affects determine the extent of acceptance or rejection of the respective using contexts and device characteristics. Therefore, participants had been given the possibility to comment on possible reasons in the questionnaire. Overall, participants frequently used this possibility and showed an enormous commitment to participate in the discussions about this topic. In the following, some of the comments of participants are detailed as supplement to the quantified pro's and con's. It allows a fruitful qualitative insight into possible objections and proposals people have. Here are some examples of what they wrote.

Arguments, which were given by participants in the category "pro's", reveal first and foremost the increased mobility and the timely feedback of health status by the devices as important reasons. This is illustrated by the following original comments.

Mobility:

- "More mobility when I am aged - e.g. when I go on holiday or do not want to stay always at home" (female, 21years)
- "to be independent from my flat" (male, 52 years)

Timely feedback of health status:

- "to facilitate diagnostics" (female, 22 years)
- "to simplify conversation with the doctor" (female, 50years)
- "For Sports: to attain more security if my individual limit is reached" (female, 48 years)

However, some participants reported that they would use this device only under certain circumstances, and that using a chip would be their last alternative when they have no other opportunities. Interestingly, this conditional acceptance is not age-specific, but has been reported by participants of all ages.

- "Only, if no family members are nearby" (female, 23 years)
- "Only, if I suffer from a really heavy illness" (male, 64 years)

On the other hand, there are also some significant fears connected to using the implemented device. It is noteworthy that the number of negative comments connected to fear, reservation towards the usage and the general disliking outnumbered the positive

comments. The primary fear or sorrow referred to feeling of constantly being controlled and even manipulated by technology or others. Also, the fear of physical intolerance reactions inside the body was strongly expressed. This is illustrated in the following quotations.

Control:
-"Pursuing of my movements by the State" (male, 20 years)
-"Exactly reconstruction of my activities and emotions with the help of physiological values by strangers, doctors or nursing staff" (female, 23 years)
-"Manipulation!!" (male, 57 years)
Physical Intolerance:
-"chip could block smaller blood vessels" (male, 21 years)
-"inflammation as consequences" (male, 75 years)
-"intolerance" (female, 26 years)
-"allergic reactions" (female, 33 years)

But also fear of losing the control in form of having no ability to finally control the device was mentioned several times.

- "The fact that the device could be controlled from outside and I cannot stop it myself" (female, 32 years)

Other fears refer to more fundamental critics touching ethical or normative values. It is astounding that the intrinsic function of medical technology - to save life and to enable older adults to life in dignity at home for a longer time - is also critically evaluated by some participants. This can be demonstrated by the comment of a 58 years old man who refused to use this technology because he fears that the stent would prolonging his lifetime improperly.

- "if I would use this device, I would not feel human anymore" (female, 52 years)
- "support life for too long" (male, 58 years)

3.5 Generation Specific Acceptance Patterns

We also hypothesized that the participants' intention to use the medical device depends on the pattern of barriers and using motives, which on their part differ in generations (H6). So far it became clear that generations differ in the weighting of their pro's and con's. Now we examine if these patterns might correlate with the reported intention to use and if we can predict the intention to use by the respective using motives and barriers (stepwise regression analysis).

In regression analyses, we used the intention to use as dependent variable and those pro's and cons as predictor variables, which turned out to reveal significant generation differences (see 3.3.). The outcomes are reported for each generation, consecutively.

Acceptance Patterns of the Early-technical Generation
In this generation, there were two key factors, which predicted the intention to use for the oldest participant group (average: 75 years of age). Together, the argument that the stent would *save caring costs* and would allow *escaping from the indignity of being cared* explained solid 70% of variance ($F(1,62)=71.93$; $p<0.01$, table 10).

Table 10. Regression analysis for the early-technical generation

Dependent variable: IU				
Predictor	**Adj. R^2**	***ß***	***p***	***t*-Value**
Saving caring costs	0.70	0.55	0.00	3.84
Escape from indignity of care		0.31	0.03	2.19

Acceptance Patterns of the Household Revolution Generation

Table 11 shows the regression analysis of the acceptance pattern of the 55-year-old group (household generation). Again, a very clear predictive picture was found, with one main key player *using the stent allows living independently*, which explained 64% of variance after all ($F(1,62)=71.93$; $p<0.01$).

Table 11. Regression analysis for the household revolution generation

Dependent variable: IU				
Predictor	**Adj. R^2**	***ß***	***p***	***t*-Value**
Living independently	0.64	0.80	0.00	11.3

Acceptance Patterns of the Computer Generation

In contrast to the early technical and the household generation, the acceptance pattern of the computer generation mean age 33 years does not count on one or two main factors, but relies on four factors to reach a prediction of 66% ($F(4,72)=35.91$; $p<0.01$), possibly hinting at a more diverse acceptance profile (table 12). Among these predictors, the possibility to *save caring costs*, benefit by *escaping from life-menacing situations through technology* and the prevention of the *indignity of being cared* were among the predictors. It is astonishing that the generation, which grew up with digital technology, and the ubiquity of chips, is the one who is reluctant to tolerating a medical chip inside the body and perceives this *as a foreign particle*.

Table 12. Regression analysis for the computer generation

Dependent variable: IU				
Predictor	**Adj. R^2**	***ß***	***p***	***t*-Value**
Saving caring costs	0.66	0.31	0.00	3.00
Life-menacing situations		0.22	0.01	2.56
Indignity		0.30	0.00	2.98
Foreign particle		-0.22	0.00	-2.69

Acceptance Patterns of the Generation of GameBoys

Finally, in the gameboy generation (21 years of age), the possibility of *saving costs* by using the chip as well as *to live independently* were prominent predictors of the acceptance pattern in this generation (table 13). Among all generations, unexpectedly, it was the youngest generation, which disliked the possibility that *others could come to know about their health status*. The three items explained 59% of variance ($F(3,63)=31.45$; $p<0.01$).

Table 13. Regression analysis for the generation of GameBoys

Dependent variable: IU				
Predictor	**Adj. R^2**	**β**	***p***	***t*-Value**
Saving caring costs	0.59	0.37	0.00	3.36
Others come to know about my health status		-0.35	0.00	-4.12
Living independently		0.30	0.01	2.68

3.6 The Acceptance Model as a First Conclusion of This Work

We started this work by proposing a model, in which single user factors (health status, age and technology generation, technical experience) can be distinguished in their impact on the intention to use the medical stent and acceptance patterns for incorporated medical technology. On the basis of the outcomes these relations between factors can now be furnished. Figure 4 visualizes the overall interrelations for the whole sample, which were outlined in the model. To begin with the impact of age, we now can say that age and technical generation distinctly impacts acceptance, but also the selection of using motives (pro's and con's) as well as the underlying ageing concepts of participants. The most prominent factor within aging concepts is the willingness of participants to rely on technical support when they are aged (H3).

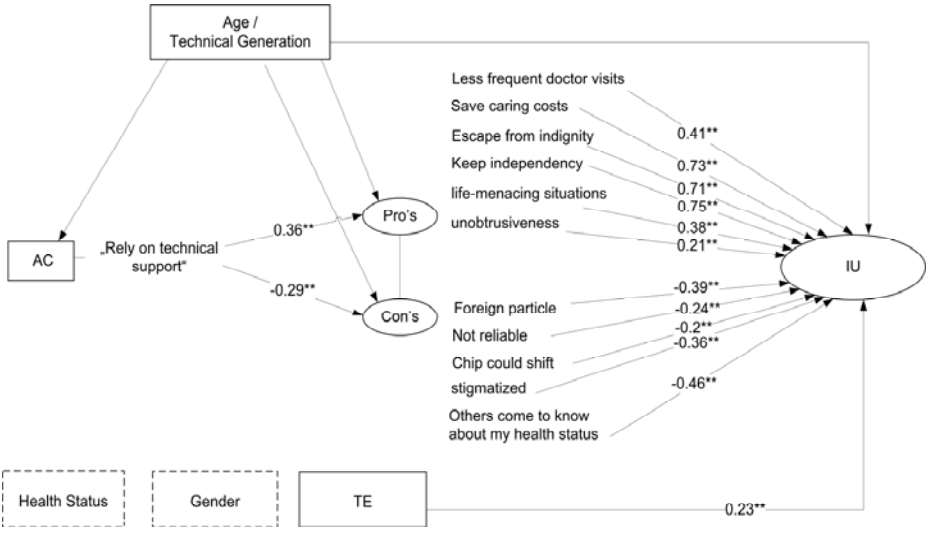

Fig. 4. Research model of acceptance for incorporated medical technology based on the quantitative outcomes

Even independently from generations a strong influence of pro's and con's on the intention to use was confirmed (H4). The pro's turned out to be more strongly related to the intention to use compared to the con's, which showed lower correlation. This finding reflects generation specific acceptance patterns and indicates a greater emphasis on the relevance of the usefulness of technology than of possible barriers, which impede the willingness to use the medical stent. Within the pro's the reasons for *saving caring costs* (.73, Fig. 4), *keeping independency* (.75, Fig. 4) and *escaping from indignity of being cared by others* (.71, Fig. 4) revealed to be the most powerful ones for using the medical stent.

The weakest relations were found for the using condition of unobtrusiveness (.21, Fig. 4) and *the fear that the chip could shift* (-.02, Fig. 4). Unexpectedly, the technical experience of participants was a rather unimportant factor. It relates to the intention to use only by .23 (Fig. 4) and is comparably low correlated to using motives. Thus, we have to assume that the acceptance pattern is not that much influenced by technical experience (H5). It is definitively noteworthy that in none of the analyses the health status did impact participants' acceptance. We had assumed that participants, which have to handle a chronic illness, would be more involved in medical technology, and, as a consequence, show a different intention to use pattern than healthy subjects. This was not the case. Possibly we will have to focus on this outcome in future studies (section 5).

4 Discussion

The aim of the present study was to analyze the contribution of generation specific using motive patterns for the intention to use an implanted stent if necessary. Therefore, we determined acceptance for medical technology (medical stent) in each of four technical generations: the *early-technical generation* (65-92 years), the *household revolution generation* (49-64 years), the *computer generation* (26-48 years), and the *GameBoy generation* (14-25 years). The impact of potential barriers (con's) and using motives (pro's) on the intention to use the medical stent were identified. We also considered generation-related user factors like health status of participants, and the experience with technical devices.

In order to empirically test our hypothetical considerations, 280 participants were asked to fill in a questionnaire that introduced them into a specific scenario in which they should imagine to be old and reliant on medical technical support (a medical stent).

Altogether results confirmed large effect of technical generation on the acceptance and intention to use a medical stent. Also, we identified generation specific acceptance patterns towards intention to use. On top of that, comments of participants on possible using motives and barriers gave a qualitative and fruitful insight into peoples' objections and proposals for using the medical stent.

4.1 Technology Generations and Their Intention to Use the Medical Stent

Overall, all respondents showed a high willingness to use a medical stent, however some of them stressed explicitly that the usage is conditional if there is nothing else

left. The fact that they reported several proposals for other pro's and con's beyond the questions to be asked showed great interest and a high involvement in the topic, quite independently of age. They also appreciated that potential end-users of technology are involved in the development process and confirmed the need of a participatory design in this sensitive topic.

The computer generation reported the highest degree of acceptance of the medical stent, followed by the youngest generation (generation of GameBoy) and the household revolution generation. But even the oldest participants (early-technical generation) widely agreed for using the stent though in this generation the variety of acceptance patterns was most pronounced.

These results suggest two main points: First, greater variety within response behavior illustrates the heterogeneity of the older age group and reveals the importance for considering this group as potential users of medical technologies in a special manner. Second, the high degree of acceptance within the computer generation might be a mixture out of a broader general understanding of technology (grown up with digital technologies), and already a higher involvement into the topic compared to the youngest generation (GameBoy). This will be detailed in section 4.3.

4.2 Barriers and Using Motives

Participants' ratings on possible reasons for and against using the medical stent as well as their numerous voluntary proposals for further pro's and con's gave a deeper insight into the topic and suggestions for further factors which should be considered in future research and product development. Basically, all participants reported greater agreement with potential using motives than their hassle with potential barriers. We take this as a confirmation of the current trend to invest in developments of future medical technology, but also as a hint that potential barriers should be taken seriously.

Potential using motives revealed a great difference between the early-technical generation and the other three generations. This generation is the one who are closest to the topic as they will be most likely use these technologies. They not only had the lowest acceptance for the pro's, and at the same time the highest rating on the con's. The main argument for the usage of a medical stent in the very olds is the less frequent visit at the doctor, while the other generations stressed the keeping independency as main acceptance driver.

Across all generation the motive for using the stent to escape the indignity of being cared by others was common. This of course reflects also cultural and societal aging attitudes and public preconceptions.

4.3 Aging Concepts and Generation Specific Acceptance Patterns

The examination of aging concepts revealed a very concise picture of societal trends. People want to be mobile and live independently, they are reluctant to move to the children when they are old and they refuse to move into a nursing home and concede this possibility only, if no other opportunities exist. Also, most respondents want to escape from the indignity of being cared. This picture was found to be universal and did not differ across generations, what could be rather culture-specific and reflect a

societal attitude. But people would like to have mobile nursing services which support them living independently at home. Somehow it is an ironic finding that the basic positive attitude towards medical technology could be due to the negative and stigmatizing picture of being old, which is avoided by respondents.

One could have assumed that these very specific aging concepts might be the driver of the positive evaluation of the usefulness of medical technology. However, correlation analyses did not corroborate this assumption. No relation was found between aging concepts and the using motives. On the basis of the present data we cannot explain this finding. Possibly however, yet we have a too small experience with ambient-assisted living technologies (while we all have profound experience and knowledge about family quarrels when caring old parents and negative message about a low quality of nursing homes).

Finally, a last remark is directed to the uniqueness of predictive factors, which turned out to be decisive for acceptance and intention to use. In the two older generations -the early technical generation and the household revolution - one or two factors were decisive (escape from the indignity of being cared, saving costs for care) to reach an explained variance of about 70 %. In the younger generations, more and more diverse factors were needed to reach comparable explained variance levels. Though this must be replicated in future studies, this could be taken as a first hint that the acceptance pattern of older persons is less ambiguous and more palpable in contrast to younger people for which the using situation of a medical device is a rather distant situation.

5 Limitations and Suggestions for Future Research

Future studies will have to investigate to what extent these outcomes may be generalized to specific illnesses or using contexts. A cross-cultural comparison of different societal aging concepts and their relation to acceptance of medical technology could also represent a valuable research topic. Furthermore, gender effects on acceptance of medical technology should be investigated in greater detail. Also, it will have to be found out if the caveats reported by respondents do vanish if people get to know these technologies. Within this context it is also interesting to take a deeper look on the role of technology adaption strategies among each generation. It is assumable that e.g. early-adaptors might be the only one who can imagine to use the technology (which is not yet available) although late adaptors would also use its, but not till they get to know it themselves. Future studies could also address learning style and aspects of life-long learning for deeper insights into the topic.

Finally, a medical device to be implemented in the body is only one form, which might be applicable to enhance mobility with aging. It should be investigated if intelligent clothes or walls or even robots may have another acceptance pattern.

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