A Change Is Gonna Come

The Effect of User Factors on the Acceptance of Ambient Assisted Living

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Abstract. In the course of demographic change, an increasing proportion of older people in need of care pose enormous burdens for the care sectors of today's society, which could dramatically aggravate in the next decades. Developing Ambient Assisted Living (AAL) technologies is one approach to support older people and people in need of care to live as long as possible independently at their own home. Besides technical opportunities and functions, future users' acceptance is decisive for the success and long-term usage of innovative technologies. Thus, for AAL technologies it has to be explored which factors are crucial for acceptance and to what extent those factors differ with regard to diverse user groups. Referring to existing technology acceptance models (in particular the UTAUT2-model), it is questionable whether such models can be adapted and are appropriately usable for the context of AAL technologies. In this paper, we therefore investigate potential users' attitudes towards AAL systems as well as the importance and relationships of technology-related and user-specific characteristics in a scenario-based online questionnaire study using an adapted and extended version of the UTAUT2-model. The undertaken adaption led to a better understanding of influencing factors for AAL acceptance: privacy concerns need to be addressed as an additional predictor. Regarding user factors, age, Attitude Towards Technology (ATT), and caregiving experience were revealed as influencing factors, whereas gender and health status did not show any effects on AAL acceptance.

Keywords: Ambient Assisted Living · Technology acceptance
UTAUT2 model · User diversity · Aging

1 Introduction

An aging population and rising care needs in the course of demographic change represent enormous strains for today's societies and in particular for the care sectors [1]. An increasing number of older people in need of care due to chronic

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diseases or disabilities is confronted with a lack of care specialists especially in geriatric and nursing care institutions [2,3]. One approach to address this growing gap refers to the development of ICT and AAL technologies in order to enable a safer and facilitated life for older people within their individual home environments. Those very diverse technical approaches can be used to detect falls [4,5], to monitor vital parameters, to facilitate life by smart automation, or to serve as a daily reminder, e.g., for drugs or (medical) appointments [6,7]. Although the technical possibilities and functions are promising, those systems have rarely been used in real life so far [8]. This is exactly the area technology acceptance research focuses on, aiming for an understanding and weighting of factors that influence the acceptance and adoption of technologies [9]. In light of demographic change and rising challenges, user diversity in terms of age, gender, and health status has to be integrated in technology acceptance models to examine if different factors are decisive for e.g., younger vs. older or healthy vs. diseased people's perception of supporting technologies. In this study, we therefore adapted the UTAUT2 model to the context of a holistic AAL system in order to examine acceptance-relevant factors, especially focusing on differences regarding user diversity (i.e. age, gender, attitude towards technology, health status, caregiving experience).

2 Perception of AAL Technologies

This section presents Ambient Assisted Living (AAL) technologies and systems as a possible solution to the challenges of demographic change, and raises the questions of user acceptance and the impact of user diversity factors.

2.1 Acceptance of Assisting Technologies

As introduced, present and future western societies face great challenges dealing with the effects of demographic change [1]. Besides political and societal processes [10], technical inventions can play a crucial role providing solutions to these challenges. With the development of 'ubiquitous computing' [11] and continuous improvements in information and communication technologies (ICT) [12], the widespread and everyday use of smart home [13] and AAL technologies, from the technological point of view, could be state of the art. There are several research projects and prototypes for single as well as ubiquitous home integrated assistive technologies [14,15]. However, AAL technologies, as one sort of smart home solutions, still do not play a key role in assisting everyday life. Besides challenges of market entrance barriers for new technologies [8], there is one key player for the use of AAL-technologies: the user's acceptance.

Considering technology acceptance research there are several approaches in modeling the understanding, measuring, and prediction of usage intention of technologies. Starting with the Theory of Planned Behavior (TBP) [16] and the Technology Acceptance Model (TAM) [17], which both have their advantages and disadvantages [18] and the integration of several other models [19],

these models were continuously improved, extended, and also led to a Unified Theory of Acceptance (UTAUT) [20]. This unified model was extended as the UTAUT2 model [21] and is used in this research paper. Although the unified models tempt to be used as they come for all technologies, the adjustments for the specific type of technology is still necessary (here AAL technologies, see Sect. 3.2.2). In order to apply new attributes to existing models, an exploratory and qualitative pre-study leads to new insights for new technologies in addition to a validating quantitative model-based user study.

2.2 Effects of User Diversity on AAL Acceptance

Regarding technology usage and the factors influencing acceptance as well as usage intention, the greatest empirical variance is caused not by one technology or technology attributes but by the user itself [22,23]. To understand acceptance it is crucial to know and understand the user, as diverse as she or he is. Concerning the definition of AAL-technologies, the user addressed is an older or needing adult, whose condition could be improved or could stay better by applying to these technologies [14]. Therefore, three influencing user factors play an important role when analyzing AAL acceptance: age, gender, and health status. As there are several studies on the impact of theses factors on medical and assisting technologies with different outcomes (from positive and negative to no significant influence) [24–26] and there are also interacting effects [22], we will not state three different hypotheses, but examine their individual impact on our adapted UTAUT model.

In addition, the general attitude towards technology (ATT) [27] often influences technology acceptance [28], although recent studies also showed different effects on acceptance of AAL technologies and the intercorrelation with gender and age [22,25]. However, the effect of ATT on factors influencing the usage intention will be examined in our adapted UTAUT model.

Recent research shows another factor influencing AAL acceptance concerning the private [29] and professional [30] caregiving point of view. Caregiving experience as a user factor will be a fifth factor influencing UTAUT predictors in this research study (see Fig. 1).

3 Empirical Approach

This section describes the qualitative preceding study presenting the basis for our quantitative approach, the online questionnaire design, our applied statistical procedures as well as the study's sample.

3.1 Qualitative Prestudy (in AAL Research Context)

Preliminary to the development of the questionnaire, two focus group studies were performed. The two groups differed in age: the younger group with 5 participants had a mean age of 24.4, whereas the 7 participants in the older group

were on average 60.7 years old. For obtaining comparable results, a joint focus group guide was used in both groups. The group discussions were recorded and later on transcribed, so that a code system based on an inductive approach could be created to group and compare the contributions of the participants.

Both group discussions were started with a brief introduction in aims and capabilities of Ambient Assisted Living, followed by detailed video presentations of four concrete AAL systems. The participants were asked to discuss their initial impressions of the systems and to form and rank general requirements and conditions for using an AAL system. At the end of the group sessions, new living concepts as for example multi-generational houses were discussed as an alternative to AAL.

The evaluation revealed several conformities and also differences between the younger and older group. For the presented systems, the younger group tended to choose their role as an involved relative over emphasizing their own situation as older adults. Thereby, they rated the usability of the devices for the current elderly generation. Regarding privacy concerns and evaluating the usefulness, the age difference seemed to be not decisively. The groups chose the same favorite out of the four systems and also had similar concerns using a camera-based system for fall detection.

In consensus, it was stated as a general requirement, that the privacy in no case should be fully devoted to a complete security. Also, the alarms generated by the system should not be handled by relatives but special emergency centers. The younger group added, that the system should act unobtrusively and only step in if the user needs help. The older adults claimed that they want to choose the recipients of the collected data.

The permanent recording and processing of audio and video signals through sensors was rejected by both groups. Only the infrared sensor (which technically also works like a video camera) seemed to be an acceptable trade-off between privacy protection and system detection precision.

Several social factors also emerged in the discussions. The older participants mentioned, that the use of such a system also depends on the social integration of elderly people. If there is a large family which lives nearby, they rated the use as rather superfluous and preferred the care of a relative over a system. But for living alone seniors they valued AAL as notable improvement and saw it as a possible way of connecting to far off living relatives.

With those findings, a further quantitative study seemed quite interesting to have a closer look on the similarities and differences of different age groups in behalf of AAL use intention, requirements and conditions and also for detecting further user factors which influence those properties.

3.2 Questionnaire Study

The questionnaire consisted of three parts who were used for (1) obtaining demographic information, (2) presenting an AAL scenario and (3) evaluating the scenario through UTAUT items. The design was motivated by the findings of two focus group interviews with each 5 and 7 people carried out prior this study.

3.2.1 SF-12 and Health Scale for AAL

The SF-12 delivers a physical and psychological component summary for the classification of the current health state of an individual [31]. The greatest advantage of this measurement lies in its low item count as it uses only a third of the 36 questions originally used in SF-36 which it was derived from for determining the two values. For this study, only the physical component summary was considered, because our study was limited to systems that treat physical health impairments.

To obtain a greater focus on the AAL context, we used a further scale which asks for different medical needs and chronic diseases [27]. The scale value indicates, if one of the four used items was answered with yes and therefore a participant has some kind of health impairment (value = 1 for health impairment, 2 for no impairment for uniformity with SF-12). The strong correlation with the physical component summary of the SF-12 shows its validity and suitability for evaluating the physical health state in AAL context ($r(147) = 0.413$; $p < 0.01$).

3.2.2 Adjusting UTAUT to AAL Contexts

The UTAUT model was initially created by Venkatesh et al. in 2003 and received a revision in 2012 to extend the original model with HM, PV and HT as additional constructs to the existing PE, EE, SI and FC [20,21]. It provides age, gender and experience as influencing user diversity factors. The optimization in 2012 were validated through a user study concerning the use of mobile Internet technology.

For using UTAUT2 with our user study, we had to fit the items to AAL contexts and the scenario which was used in our questionnaire design (see Sect. 3.2.3). The existing constructs already cover interesting influence areas such as the Expectancy to which degree effort is accepted to derive benefit from an AAL system (EE). Also the relevance of Social Influence (SI) mirrors in AAL contexts and possibly clarifies the role of relatives in decision making to buy or not to buy such a system. The construct Price Value (PV) seemed questionable as the scenario in our study was based on an exemplary system.

The qualitative prestudy showed privacy as an important component of the discussed requirements and conditions for system use. Therefore, we designed the construct Privacy Concerns, which deals with fears in terms of privacy and data security and also includes conditions for the involvement of relatives and doctors. Other research indicated, that also the design of the system components and their integration into the user's home could play a role for acceptance [32]. The second added construct Design and Integration covers the perception of the system in visual aspects.

3.2.3 Questionnaire Design

The first part of the questionnaire contained general demographic items (age, gender, education level). For a deeper insight on possible factors for AAL acceptance, user factors like health status (measured through SF-12 and own scale, see Sect. 3.2.1), social situation and attitude towards technology (ATT, Cronbach's Alpha $\alpha = 0.844$) were measured. The analysis of the social situations contained the living situation (alone/in community), the availability and distance to caregiving relatives, and prior knowledge of caregiving (if he/she gives active care or if a family member needs care).

The questionnaire's second part started with an introduction into a scenario. It was used to familiarize the participants with possibilities to use an AAL system in everyday life and pointed out security functions (fall detection, reminder for medicine intake) as well as comfort functions (automatic light switch, fitness tracker). The scenario narrated a full regular day living with the system, beginning with waking up in the morning till going to bed at the end of the day. It also involved communication with a doctor and family members.

Subsequent to the scenario, the UTAUT items were surveyed. They were randomized for each participant and comprised 36 items spread over the dimensions Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), Hedonic Motivation (HM), Price Value (PV), Experience and Habit (EH), Behavioral Intention (BI) who were derived from the UTAUT2 model of Venkatesh et al. (2012) and Privacy Concerns (PC) and Design and Integration (DI) who were added due to the experiences of the prior focus group studies. Each dimension contained 2 to 5 items. Completing the full questionnaire took about 25 min. All items were set as mandatory, so that only complete datasets were used for further analysis. Data was collected in Germany in summer 2016 by using an online survey tool and in addition a paper-and-pencil questionnaire to both enable younger and older people's participation, because we wanted to collect a preferably broad age span for comparing differences through age in further analysis. Participation was voluntary and not gratified.

3.3 Statistical Methods

All items concerning the UTAUT model and ATT were evaluated through a 6-Point Likert scale (1 = totally disagree to 6 = totally agree). Data was analyzed using bi-variate correlations and independent-samples t-tests of model- and user-related factors,

3.4 Description of the Sample

In total, n = 177 people participated voluntarily in our study and filled in the online survey. In order to reach also older people who wouldn't have access to the online survey, also a printed paper-based version of the questionnaire was provided. Due to incomplete answers, 32 data sets were excluded so that 145 complete data sets remained for the further evaluation.

The mean age of the participants (n = 145) was 41.6 years (SD = 17.56; min = 19; max = 75) The sample comprised 53.1% females and 46.9% males. 43% of the total sample completed an university degree which shows an above average level of education in comparison to the German population, of which 16% hold an university degree [33].

The measurement of the participants' health state was conducted by inquiring the SF-12 and an own scale (compare Sect. 3.2.1), which correlated strongly and showed with a mean of 52.1 (SD = 7.34) for the SF-12 a slightly better average than the standardized value for the American population (Mean = 50, SD = 10). As measured by the own health scale, 38.1% of the sample had to deal with some kind of health impairment in their everyday life.

Furthermore, some questions aimed on analyzing the experience and contact with caregiving tasks of the participants through affected family members. 27.1% of them stated that at least one of their family members were in need of care. 8 participants (5.1%) took active care for a family member.

Concerning attitude towards technology, the sample had above average means compared to the German population (Mean = 4.9, SD = 0.87). The scale ATT consisted of five items and showed a high reliability (Cronbach's Alpha $\alpha = 0.844$).

Describing our sample, the overall correlations between the examined user factors can be seen in Table 1. It shows that age and health correlated meaning older people had more health impairments, lower caregiving experience, and a slightly lower ATT as well as there were slightly more older men than women. Also women had a lower ATT than men. Participants with a better health status had a slightly higher ATT.

For further analyses, group segmentations referring to age and ATT as user diversity factors were carried out using a median split. Thereby, two age groups were differentiated: "young" (≤40 years) and "old" (>40 years). Referring to ATT (min = 1; max = 6), a group with a comparably "lower ATT" score ($M \leq 5$) and a group with a "higher ATT" score (M > 5) were considered.

Table 1. Inter-correlations of user factors (bottom), ATT = Attitude Towards Technology, Health = Physical Health Status (SF-12), CGEXP = Caregiving Experience). $^{\dagger} = p < .1$, * = $p < .05$, ** = $p < .01$.

	Age	Gender	Health	ATT	CGEXP
Age	—	.166*	−.368**	−.206*	−.219**
Gender		—		.307**	
Health			—	.177*	
ATT				—	
CGEXP					—

4 Results

This section presents the results of our quantitative questionnaire study starting with the results referring to the adapted UTAUT2-model (model-related dimensions) and followed by analyses regarding user diversity influences. Subsequently, the results of regression analyses are presented (a) for the whole sample and (b) for diverse user groups (participants with a low and a high ATT; participants with/without caregiving experience).

4.1 General UTAUT Results

The main approach of this study was to examine the suitability of the UTAUT model evolved by Venkatesh et al. and to modify it for AAL contexts, if necessary. As described in Sect. 3.2.3, we aimed to fit the existing UTAUT model to AAL contexts and therefore added the dimensions Privacy Concerns and Design and Integration.

Most of the classic dimensions gained high reliability scores (Cronbach's Alpha above $\alpha = 0.8$, see Table 2). SI an FC still showed values above $\alpha = 0.5$. Only the Price Value was unacceptable in its reliability with $\alpha = 0.451$ and was not considered for the further evaluation.

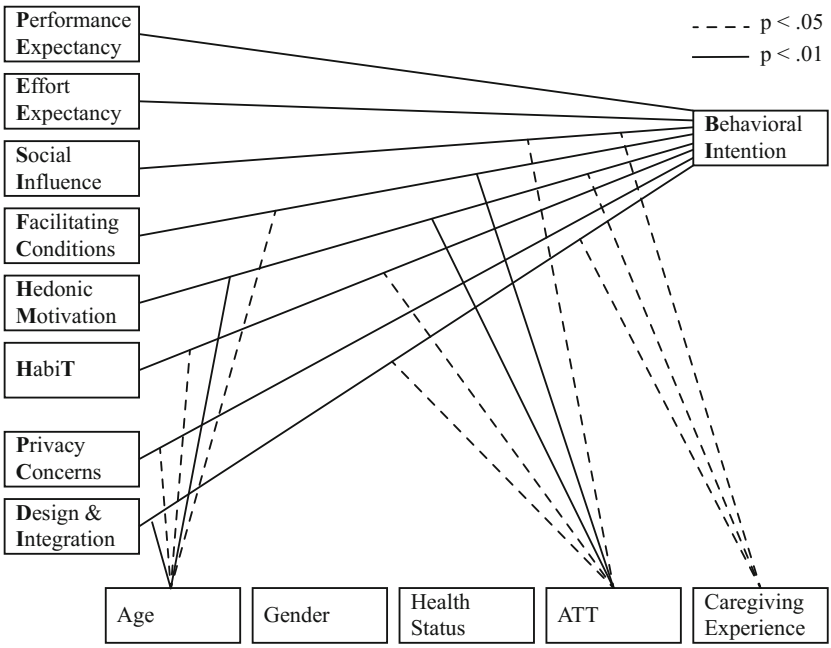

Fig. 1. General influence of UTAUT dimensions on Behavioral intention, $n_{total} = 145$.

Table 2. Correlations of user factors (bottom) and the AAL system's evaluation (upper) on the adapted UTAUT model's dimensions (PE = Performance Expectancy, HM = Hedonic Motivation, HT = Habit, EE = Effort Expectancy, SI = Social Influence, FC = Facilitating Conditions, BI = Behavioral Intention To Use, ATT = Attitude Towards Technology, HEALTH = Physical Health Status (SF-12), CGEXP = Care Giving Experience). $^{\dagger} = p < .1$, * = $p < .05$, ** = $p < .01$.

	PE	EE	SI	FC	HM	HT	PC	DI	BI
PE	—	.787**	.566**	.584**	.565**	.801**	−.652**	.193*	.787**
EE		—	.530**	.678**	.637**	.824**	−.591**	.275**	.779**
SI			—	.345**	.327**	.430**	−.380**		.463**
FC				—	.638**	.717**	−.426**	.335**	.708**
HM					—	.740**	−.483**	.392**	.723**
HT						—	−.639**	.314*	.851**
PC							—		−.689**
DI								—	.239**
BI									—
Age				−.166*	−.236**	−.170*	−.171*	−.481**	
Gender		−0.156†							
Health									
ATT		.138†	−.172*	.373**	.317**	.191*		.187*	.161†
CGEXP		.149†	.166*		.173*			.171*	

In terms of interrelatedness, DI and SI revealed the weakest correlations to the other UTAUT dimensions. PE, EE, FC, and HT were strongly correlated with BI and also among each other. PC showed consistently at least medium negative correlations with the UTAUT dimensions and also a strong correlation with BI ($r(147) = -0.689$, $p < 0.01$).

4.2 Influence of User Diversity

We included various factors regarding user diversity in our study to investigate their influences to the applied UTAUT model. Besides the classical factors for user diversity like age and gender, also the health state, the attitude towards technology, and the caregiving experience were examined to check their relevance for the AAL context.

1. **Age:** The age of the participants correlated with FC, HM, EH, PC, and DI as stated in Table 2. With raising age, the participant's evaluation of their ability to use the system, the fun, concerns with Privacy, and importance of design and integration decreased. The factors PE, EE, SI, and BI were not related to age for this sample. Especially the missing correlation to BI, which was used to evaluate the acceptance in the UTAUT model, showed an interesting result.

By investigating relations to the other user diversity factors, two significant correlations were obtained: with raising age, the attitude towards technology and the health state decreased.

2. **Gender:** T-Tests revealed that only the EE dimension of the UTAUT model was rated slightly different by women compared to men. Men were less willing to put effort in learning the system use (Mean = 4.2, SD = 1.16) than women (Mean = 4.5, SD = 1.05, t(145) = 1.9, p = 0.06).
3. **Health Status:** As mentioned in Sect. 3.2.1, the health scale was significantly related to the SF-12. Surprisingly, the current health state of the participants didn't show any impact on the UTAUT factors.
4. **ATT:** The ATT showed small correlations with the UTAUT dimensions SC and DI and medium correlations with FC and HM. In contrast to the other User diversity factors, the ATT indicated a relationship to the Behavioral Intention.
5. **Caregiving Experience:** The results revealed significant group differences for the Caregiving Experience with the factors EE, SI, HM, and DI (see Table 2).

4.3 Intention to Use Results

To analyze the predictors for the intention to use more precise relating to the emerging user diversity factors, a regression analysis was conducted. At first, the analysis of the whole sample indicated HT, PE, PC, and FC as predictors with 80.3% explained variation of variance (see Fig. 2). In addition, we conducted regression analyses to uncover user diversity influences. As gender and health status revealed almost no significant correlations with the model-related dimensions, those two factors were not investigated in more detail. Instead, the factors age, ATT, and caregiving experience were focused: "young" vs. "old" (see Fig. 3), comparably "lower" vs. "higher" scores ATT (see Fig. 4), and "having" vs. "having no caregiving experience" (see Fig. 5).

The regression analysis for the two age groups revealed two different models: for the young group, 76.6% variance of AAL acceptance was explained based on the model dimensions HT, PC, and PE; for the older group, the regression model explained 83.0% variance of AAL acceptance based on five model dimensions: HT, HM, PE, SI, and DI.

The regression analysis for two ATT groups revealed HT, PC, and FC as coincident predictors for the two groups. The model explained a higher variance of AAL acceptance for the low ATT group ($adj.r^2 = .810$) compared to the high ATT group ($adj.r^2 = .769$). The results showed differences for the relevance of HM, which was an additional predictor for the high ATT group and PE as a predictor for the low ATT group. HT was the most predictive factor for both groups, whereby this factor differentiated clearer from the other predictors for the high ATT group.

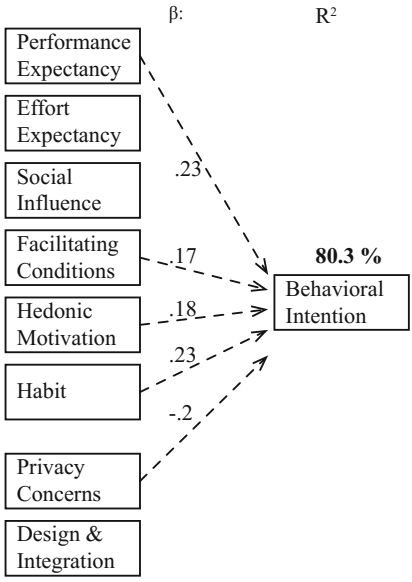

Fig. 2. General influence of UTAUT dimensions on Behavioral intention, $n_{total} = 145$.

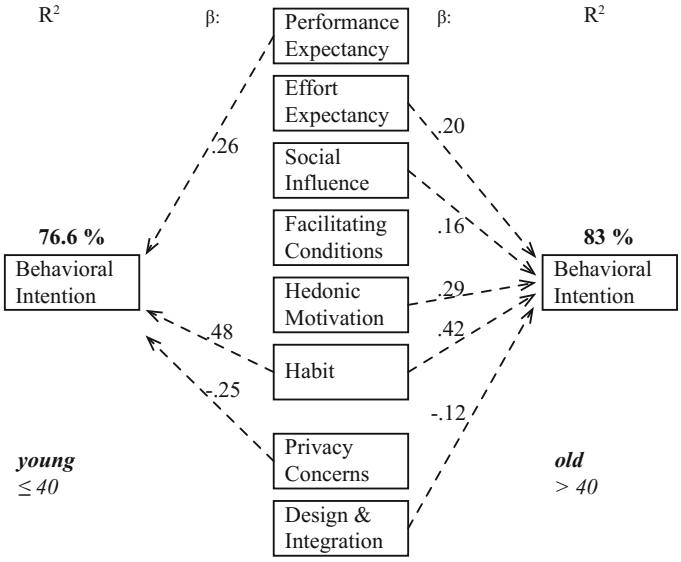

Fig. 3. Influence of UTAUT dimensions on Behavioral intention, comparing younger ($\leq$ 40) and older ($>$ 40) participants.

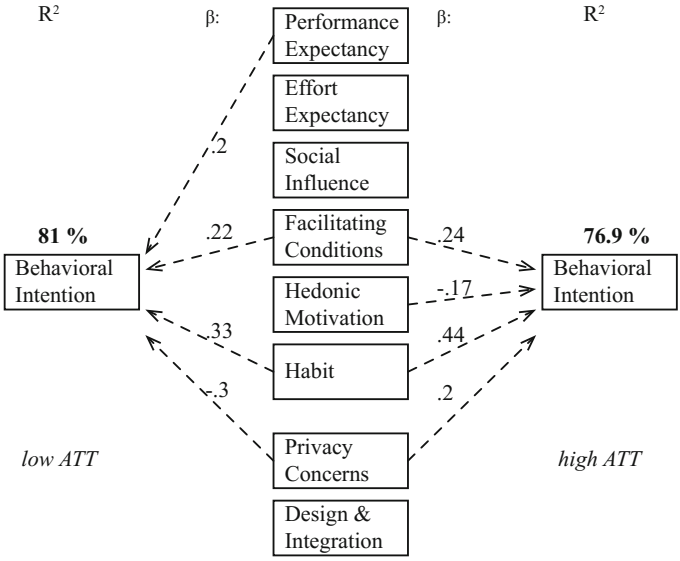

Fig. 4. Influence of UTAUT dimensions on Behavioral intention, comparing participants with lower and higher scores referring to their attitude towards technology.

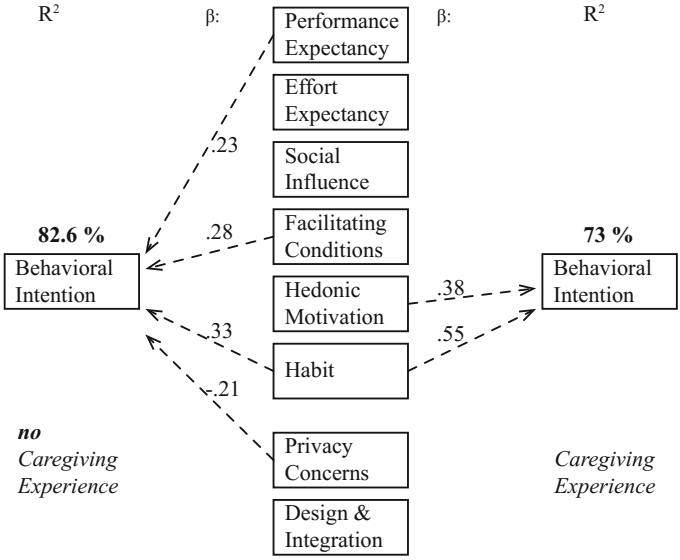

Fig. 5. influence of UTAUT dimensions on Behavioral intention, comparing participants with and without caregiving experiences.

The comparison of the regression analysis results for the caregiving experience groups showed very different models. The only similarity laid in the predictor HT, which explained the highest amount of variance variation for both models. For participants with caregiving experience, HM was the only further predictor and 73.0% of variance were explained. For participants without caregiving experience, the model reached an adjusted R square of 82.6% and was - in contrast - based on four predictors: HT, FC, PE, and PC.

5 Discussion

Within this section, the results are discussed starting with an assessment of using an adapted version of the UTAUT2-model for the evaluation of AAL technology acceptance. Further, user diversity influences are discussed, limitations of the presented study are considered, and recommendations for future research are given.

5.1 Using Acceptance Models for AAL

The previously reported results show, that the UTAUT2 model contains several constructs which are affecting the behavioral intention. The most influencing constructs were HT,PE, and EE which leads to the assumption that in particular the familiarization to everyday use, the effective advantage, and the required effort for using an AAL system matters for its acceptance. Therefore, it is important that such systems are easy to integrate into the user's everyday life offering clearly visible advantages, while the additional expense is preferably low. Further, privacy concerns are also a crucial factor for acceptance since the measured construct influences all other UTAUT factors negatively including the behavioral intention. AAL systems thus should provide high security of personal data and the user's privacy.

Those findings are also supported through previous research. Weegh et al. examined 16 papers to develop an Acceptance Model based on TAM2 by Venkatesh and Davis and the System Acceptability Model by Anderson. Besides additional acceptance criteria as financial ability & willingness, human replacement, awareness, and government/politics/legal aspects, their findings also include perceived usefulness, perceived ease of use, control and security, privacy versus independence/safety, user involvement, reputation/alignment to current lifestyle, and experience as relevant for the acceptance.

The study of Steele et al. focusing on a concrete wireless sensor based system showed that it is rather important for the user that the system is affordable and that he is able to interact with it and stays in control [34]. Most of the participants were unable to fully recognize the potentials of such a system and took the view that it should be used for emergencies only in the sector of elderly care. Interestingly, they also were at least concerned about the privacy of the collected health data because the fast availability of help was far more important for them than their privacy of medical data. Steele concluded, that a system with a simple interface and least amount of interaction are more likely to be accepted by elderly persons.

The results of Demiris also show that the user's perceptions of AAL technology focuses mostly on a reactive role (for detecting emergencies). For the participants of his study, privacy importance was depending on the level of need [32].

Regarding to medical technology in particular, Ziefle et al. saw the Importance of Privacy in terms of data protection as a strong universal claim which corresponds to the perception in our results. Hence, the importance and relevance of privacy as an acceptance criterion can be rated as very high and should be included by acceptance models for AAL technology.

Further research should also examine to include additional factors for measuring acceptance such as Steinke, who considered trust as further extension and found positive influence of trust at perceived ease of use and perceived reliability, though trust seemed not to be directly related to the intention to use [35].

Concluding, the application of our adapted UTAUT model pointed out, that it is feasible to measure the acceptance of AAL technologies with conventional acceptance models, but that a certain adaption to this context is mandatory and the proposed model is still not complete since it omits further possible barriers besides the privacy concerns.

5.2 Influence of User Diversity

The observed influences of user diversity indicate that gender and health status seem irrelevant for the behavioral intention. In contrast, age, the individual attitude towards technology (ATT), and caregiving experience influenced AAL acceptance.

Ziefle et al. analyzed the attitudes of users towards different types of AAL services and found that the evaluation of different usage settings of AAL is unrelated to age and gender interpreting that the precautious attitude towards AAL applications is a universal phenomenon [23].

The performed regression analysis in our study with grouping the participants into low or high ATT resulted in a closer understanding of its effect on the behavioral intention which also appeared slightly in bivariate correlations ($r(147) = 0{,}161$, $p = 0{,}051$). Previous research already demonstrated that the acceptance of AAL systems significantly depends on the participant's experience with information and communication technology and increases with higher experience [36].

In other studies, the influence of age and health status has a contrary influence at the intention to use. While Himmel et al. found, that the acceptance of AAL technologies rises for older and more ill persons [22], Steinke revealed that younger people with a better perceived health condition are more willing to use AAL [37]. This shows, that those two user diversity factors seem to be too unspecific for differentiating of user groups. A possible improvement in further studies would be to connect them to other factors like the living situation as made by Steinke in 2012 [38]. However, as shown in Fig. 3 the current results revealed age-specific influences on the UTAUT dimensions: while younger people focus more strongly on Performance Expectancy and Privacy Concerns, for older people Effort Expectancy, Social Influence, Hedonic Motivation, and Design and Integration are more important.

Caregiving experience appeared as an additional interesting factor for user diversity and showed several relations to UTAUT dimensions (EE, SI, HM, DI) although it was only surveyed with one item and the investigated participants were not chosen in regard of this factor. The regression analysis revealed that the existence of caregiving experience lowered the count of UTAUT constructs as predictors for Behavioral Intention. This could lead to the assumption that experience with care simplifies the look on AAL systems, because it strengthens the awareness of the problems which are tackled by those systems and supportive technology for caregivers is initially rated more valuably. The study of Siegel et al. shows already, that the perspective of care professionals differs from the perspective from the actual target group as they directly refer to cognitive or health impairments while evaluating such technology [39]. It would be interesting to combine these perspectives in future research.

Having the demographic change in mind it can also be estimated that the raising demand for care will require new approaches including caring relatives and new community concepts as stated by Hong et al. [40]. For this development it is indispensable to further investigate the acceptance criteria for AAL technologies depending on more facets of caregiving experience.

5.3 Limitations and Future Work

Our empirical approach provided valuable insights into a model-based evaluation of a holistic AAL system and the suitability of adapting the UTAUT2-model for the context of AAL technologies. Nevertheless, there are some limitations and suggestions for subsequent research in the field, that should be considered.

Referring to the applied methodology, the dimensions of the UTAUT2-model were successfully adapted and extended for the context of AAL technologies and systems. However, the model-based approach is restricted on a fixed number of dimensions. In a very sensible field like care, aging, and assisting technologies, more affective evaluations (beyond the model-based factors) are of importance to do justice to perceived benefits or concerns referring the usage of technologies. Thus, future studies should aim for a combination of model-based and affective evaluations. Another aspect refers to the fact that the results depend on the applied method: in the present study a scenario-based approach with a “fictive” and not a real AAL system was under study. As previous studies showed [41] evaluations of a fictional system might influence the results and could lead to an overestimation of perceived barriers and an underestimation of potential benefits for instance. Thus, it is of importance for future studies to aim for hands-on evaluations of AAL technologies and systems.

There are also some limitations with regard to the study’s sample. First, the sample size was sufficient and the sample was balanced regarding gender and age. In contrast, there were significantly high proportions of people with high or very high levels of education and additionally also a very positive attitude towards technology (ATT). For future studies it would be useful to aim for a more diversified spectrum concerning education level and attitude towards

technology in order to do also justice to people with low education levels and a more negative attitude towards technology.

As a last sample-related aspect, the study was conducted in Germany representing only a single, very country- and culture-specific perspective. As health care systems, their (financial) regulation, and policy circumstances are extremely country-specific, we assume that also the acceptance of AAL technologies and systems as well as the trade-offs between benefits, barriers, and use conditions differ depending on diverse countries and cultures. Therefore, it is of importance to aim for comparative studies in the future addressing direct culture- and country-comparisons of AAL technology acceptance.

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