MY-AHA

Contract # 689592

My-AHA

Deliverable 2.12

Long-term Living Lab Studies and Participatory Design I

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Abstract

This deliverable D2.12 here refers to a set of end-user related tests in living labs connected to the user groups in the project (incl. secondary stakeholders) in order to give further support to the establishment of an evidence-based practice in the ICT design of the overall my-AHA platform. It is the first in a series of three deliverables with updates in M36 (intermediate) and M48 (final).

Main focus of this series of deliverables is on real life end-user settings, and testing of usability, accessibility, user experience and acceptance (incl. secondary stakeholder perspectives).

Disclaimer

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[Document title] Long-term Living Lab Studies and Participatory Design I

[Editor: Name, Partner] USI (lead), DSHS, FHP, IBV, ISMB, JOAFG, UNITO

[Work-package leader: Name, Partner] Rainer Wieching, USI

Executive summary

This deliverable provides a first set of end-user experiences and feed-back from a longer use of the my-AHA prototype and associated components like the dashboard, cognitive games, nutrition app, risk visualizations, interventions and related original platforms.

After the presentation of the related state of the art, users, settings and methods were described, including secondary stakeholder aspects, especially health insurances perspectives.

In total 21 end-users from various settings in Germany and 13 end-users from other EU countries were included in the living lab studies, aged between 61-92 years (mean age 72,5 years).

A set of more qualitative methods (interviews, workshops, etc.) but also some quantitative measures (questionnaires) were applied during a use period of 3-6 months, depending on the availability of the different components of the overall my-AHA system.

The my-AHA prototype was tested regarding its usability, accessibility, user experience and acceptance, whereby the focus was on primary end-users, but also some secondary stakeholders could be addressed.

Results provided a series of inputs and implications for the re-design of the system for the RCT, i.e. general aspects, risk visualizations, dashboard, cognitive games, nutrition app and original platforms as well as social aspects of the use (group courses, stakeholder involvement, etc.).

Finally, some new use cases emerged which were suggested to the consortium for implementation, including new games, technology vendors, human-computer interaction, and a tutorial for the overall system.

List of Authors

Company	Author
USI	Daryoush Vaziri, Rainer Wieching, Claudia Müller, Volker Wulf
DSHS	Eleftheria Giannouli
FHP	Maria Vasconcelos
IBV	Helios de Rosario
ISMB	Antonella Frisiello
JOAFG	Doris Bleier
UNITO	Innocenzo Rainero

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Abbreviations

AHA .... *Active and healthy ageing*
BMI .... *Body mass index*
CBM .... *Cognitive bias modification*
HDL .... *High-density-lipoprotein*
HCI .... *Human Computer Interaction*
ICT .... *Information and communication technology*
IT .... *Information technology*
LDL .... *Low density lipoprotein*
M .... *Mean*
PC .... *Personal computer*
PD .... *Participatory design*
RCT .... *Randomized Controlled Trial*
SUS .... *System usability scale*
UEQ .... *User experience questionnaire*
UI .... *User interface*

1 Introduction

A user-centered and participatory design approach is essential when facing the complexity of the domain at hand, where “parachuting” in technology has caused many failures in concurrent eHealth projects for older adults. To avoid these mistakes, my-AHA will adopt an ethnography-based approach in order to gather an extensive and thorough understanding of the subtleties of practices in the different project-relevant settings in home and organizational contexts. This living lab based approach with a mix of qualitative and quantitative methods is mainly targeting objective 3 of the overall my-AHA project:

Objective 3:

my-AHA will propose and design ICT tools that are able to continuously support changes in behaviour of older adults in daily life, in order to tackle subsequent negative consequences of ageing and frailty. My-AHA will provide advanced user-centred and participatory design adjusted to the capabilities of older adults to leverage usability and accessibility of the platform, improving the overall user experience and acceptance.

Based on the already established my-AHA living labs (see deliverable D2.11) a first testing period of the my-AHA pilot has been carried out in the last months since the prototype is available. The actual deliverable D2.12 is the first report in a series of three during the project; updates will be delivered in months M36 (midterm report) and M48 (final report).

This deliverable D2.12 here refers to a set of end-user related tests in living labs connected to the user groups in the project (incl. secondary stakeholders) in order to give further support to the establishment of an evidence-based practice in the ICT design of the overall my-AHA platform. By doing this, it was crucial to test the systems in a real environment to: 1. explore complex problems which come up with everyday home use, 2. explore new use cases as opportunities for novel functionalities and 3. provide solutions for re-development of tested services and components.

Main focus will be on accessibility, long time usability and high flexibility to address the broad range of end-user demands. There will be user groups in different EU countries (and abroad later on) to compare the appropriation of the system and identify cultural differences and necessary adaption for wider acceptance.

2 State of the art

2.1 Health monitoring

The idea of monitoring technologies is relatively new. In 2004, Dishman discussed the potentials of such technologies to support interventions by collecting data on behaviors and detecting problems in a timely manner (Dishman, 2004). Consequently, a vast amount of research in the health domain concentrated on exploiting those potentials by addressing challenges associated with ageing; for instance physical activity, nutritional or cognitive behavior. Today, monitoring technology applied to self-tracking behavior provides the performance and cost-effectiveness to be distributed among a wide user base. Self-tracking devices support the self-management of a variety of life aspects like sleep, nutrition, exercise or mood through the provision of feedback, made possible by recording and analyzing personal health data related to those areas. In general, the provided feedback follows a persuasive strategy with the goal to help users to change their behavior towards a desirable healthy lifestyle (Fogg, 2007). Examples for such devices in the research context are BeWell (Lane et al., 2014), BiFit (Consolvo et al., 2008) and Fish 'n' Steps (Lin et al., 2006). Additionally, commercial applications like Nike+ or FitBit increasingly enter the market. Many of these technologies have been developed for general populations and not older adults in particular. Nonetheless, much research has been conducted in the space of health applications targeted specifically at older adults. Accordingly, developed systems aim to support functional abilities (Lee and Dey, 2011), physical (Doyle et al., 2010a; Uzor and Baillie, 2013), social (Doyle et al., 2010b) or cognitive (Jimison et al., 2010) well-being. Typically, wearable sensors such as pedometers, blood pressure cuffs or pulse oximeters are applied for data collection. However, long-term usage of systems targeting older adults in real environments and older adults' willingness to buy such systems seems limited (Brodaty et al., 2005; Robinson et al., 2009; Wan et al., 2016). Literature suggests that usability and user experience aspects, as well as reliable information channels play a major role in uptake and long-term usage of health-related technologies by older adults (Uzor and Baillie, 2013; Wan et al., 2016). But what seems to be more important when addressing needs of older adults is that technologies for AHA support follow a holistic approach, which includes all relevant aspects of health and well-being, rather than focusing on only one (Thompson et al., 2011). Hence, there is a demand for platforms integrating different devices in order to process health-related data, and orchestrate relevant activities, according to the needs and demands of older adults.

2.2 Challenges in the design of AHA technologies

Technology can be a very valuable tool for addressing the rising health needs of the aging population. Research on the use of ICT has shown that it may positively impact quality of life for older adults (Jacqueline K. Eastman and Rajesh Iyer, 2004; Schulz et al., 2015) by improving social support and psycho-social well-being (Charness and Schaie, 2003; White et al., 2002). In this context, technological progress appears to improve infrastructures and facilitates connections with the outside world helping older adults avoid or reduce feelings of social isolation and loneliness, for instance by engaging in physical activity with peers over distance (Bradley and Poppen, 2003; Mueller et al., 2007; White et al., 1999; Wulf et al., 2004).

In addition, wearable sensors, mobile devices and exergames have also been used in order to detect early-risk and assess frailty in different domains of ageing, like physical activity, cognition, emotional state and social connectedness and have provided preventive measures for such domains (Botella et al., 2012; Gschwind et al., 2015; Schoene et al., 2015). There is strong evidence for the effectiveness of technology-based interventions for the promotion of health (Fanning et al., 2012; Gschwind et al., 2015; Vaziri et al., 2017). However, a remaining challenge is long-term motivation in older adults to use such technologies. Here, the design of health technologies needs to address heterogeneous requirements and capabilities of older adults, for instance, (1) older adults' limited capability to understand technical terms or artefacts and articulate requirements and obligations, (2) their longer learning curve and need for multiple iterations to get used to health technologies and (3) their need for social support infrastructures not only for technical issues but for social participation (Chaudhry et al., 2016; Eisma et al., 2003; Lindsay et al., 2012). Moreover, privacy and trust play an important role as many current technical solutions collect personal health data in order to provide new opportunities for connecting end users with secondary stakeholders such as doctors, business companies, health insurance companies or the government (Braun, 2013; Heart and Kalderon, 2013; Lee et al., 2013; Miller and Bell, 2012; Morris and Venkatesh, 2000). Health technologies need to address such considerations and should be personalized and tailored to the needs of the end users (Andrews and Williams, 2014; Kiosses et al., 2011). However, the design of health technologies should not only align to the needs of primary end users but must also take into account the perspectives of other relevant stakeholders within the healthcare system, such as physicians, policy makers or health insurance companies. Such challenges require appropriate methodologies and instruments that allow and support collaboration and cooperation of all relevant stakeholders as well as mediation and moderation between them by researchers.

2.3 Participatory design

Participatory Design (PD) enables different modes and levels of stakeholder participation in the design process. On the one hand, PD distinguishes a normative and emancipatory direction, which is grounded in the design of information systems in the workplace context (Bjerknes and Bratteteig, 1995). Here, an important aspect is the influence of employees they take in the design of information systems they will work with. On the other hand, a more pragmatic and production-oriented perspective requires the involvement of users in the design process as a fundamental approach to designing meaningful and appropriate products or services. A major challenge here is the mediation and moderation of different stakeholder interests and perspectives and to aim for a balance between stakeholder goals and potential contradictions with respect to IT-design (Dorst, 2006). In this context, we may understand participatory design in accordance to following definition: "Participatory design is, as we see it, no longer primarily a professional issue for software developers, but has to be extended to the relationships between different user-designers, and, beyond that, between them and their clients/customers/ service-seeking citizens in general." (Dittrich et al., 2002). Referring to Bodker et al., participatory design may be seen as a process of mutual experiences and learning among different stakeholders including all relevant stakeholders and designers (Bodker et al., 2004). Here, participation means to involve these users and thus reach a common understanding of practices, attitudes and perspectives. Furthermore, this process may create opportunities to discuss contradictive conceptions, boundaries and conditions relevant to the design context. In order to realize participatory design different methods and tools may be applied (Bodker et al., 2010; Muller, 2003; Muller and Kuhn, 1993). Selecting appropriate methods and tools mainly depends on the context of PD. Different approaches here focus on certain situations and the context of use (contextual design), on use and usability aspects (user-centered design), and on the creation of a space where the user may experience design artefacts (experience design). Regardless of the selected approach, the focus of PD is on people engaging in the process as co-designers (Ehn, 2008). However, management, application and the role of the user may differ in each PD approach. Relevant distinguishing characteristics here are for instance, providing access to relevant information, creating opportunities to take independent decisions or providing a space for alternative arrangements with respect to technology and organization (Clement and Van den Besselaar, 1993). Therefore, designers need to make decisions about such aspects in advance, while at the same time allowing adaptations during the PD process. This requires an appropriate environment that facilitates the handling and alignment of complex cooperation and collaboration among designers, end users and different stakeholders.

2.4 Living Lab

In order to realize the theoretical foundations of PD in the work with older adults, living labs with a focus on older adults and related stakeholders can provide the required environment for close collaboration and cooperation between end users, researchers and relevant stakeholders. The living lab concept embodies a systematic user co-creation approach that integrates research and innovation processes. The co-creation, exploration, experimentation and evaluation of innovative ideas, scenarios, concepts and related technological artefacts in real life use cases are key elements of living labs and thus living labs combine essential aspects of different PD approaches described above (Abowd et al., 2002; Panek et al., 2007). As all relevant stakeholders are involved, potential adoption and acceptance of products and services by primary end users, as well as interactions with relevant stakeholders can be considered concurrently (Pallot, 2009; Schaffers et al., 2011). Important success factors of living labs are (1) the realistic setting in homes of participants, (2) the situation of research in participants' everyday life and (3) the long-term character of conducted field studies running over several months (Budweg et al., 2012; Müller et al., 2015a, 2015b; Wan et al., 2014).

However, in the domain of healthcare innovations little research exists which exploits the potential of living labs and describes the collaboration and cooperation processes with older adults in detail (Lievens et al., 2010; Mulvenna et al., 2011; Ogonowski et al., 2016; Ståhlbröst, 2004). Previous living lab projects reported on the role of researchers, the handling of skill sets and learning needs, the degree of active involvement, and varying duration and commitment of participants that have been positively affected by following the living lab methodology (Carroll and Rosson, 2013; Ley et al., 2015; Ogonowski et al., 2013). Therefore, living labs constitute an appropriate methodology in the context of PD to learn about practices, attitudes and perspectives of older adults and investigate their complex interactions and relations with other relevant stakeholders.

The research presented in this thesis has been conducted in a research environment where living lab methodology and participatory design conflate into what is called PraxLabs. The PraxLabs approach has been developed at University of Siegen in Germany (Müller et al., 2014). Unlike many living lab approaches, PraxLab research is conducted in real households and every-day life contexts of end-user groups, for instance older adults. The duration of PraxLabs generally spans several months to years. PraxLabs may be considered a holistic approach and allow a thorough investigation of the socio-cultural environment of older adults and thus enable researchers a wider perspective on technology adoption by that target group. The every-day proximity in the design process supports the understanding and creation of a common communication sphere among researchers, older adults and relevant stakeholders and by doing so, promote the design of realistic design artefacts that address visions of future user scenarios more accurately (Müller et al., 2014).

3 Methods

3.1 Living Lab settings

3.1.1 Siegen Living Lab, Germany

The living lab infrastructure in Germany was separated into three settings across the area of Siegen, 1) Bad Berleburg which is a more rural area, 2) a care home facility, and 3) community dwelling older adults living in Siegen. Following paragraphs describe each setting.

Setting in Bad Berleburg: Bad Berleburg is a small city in North Rhine-Westphalia, Germany in the middle of the ”Rothaargebirge”, a mountain region up to 700 m above sea-level, which belongs to the district Siegen-Wittgenstein. The setting in this rural area combines guided fall prevention group activities (certified fall prevention courses) and the independent long-term use of technical devices and sensor systems in the daily life of seniors and at their home. The strong link between the group course and home-based technology should achieve a sustainable and long-term motivation and use of the fall prevention program, which positively contributes the to independence and mobility in the elderly life by lowering several fall risk factors like balance, strength, and others. A heterogeneous target group of nine older adults living independently in this rural area participate and meet weekly in the scope of the community centre Elsoff (Lukasgemeinde) in Bad Berleburg, where they take part in a fall prevention course conducted by two certified, experienced trainers. The scope of the community centre is stocked with a floor sensor (SensFloor) for analysing the way of walking and also with the iStoppFalls system. All participants live independently in this rural area and have an average age of 73.2 years (Number of participants = 9 , range = 61 - 81 years) and represent a heterogeneous target group composed of a balanced gender (4 male / 5 female) ranging from "fit" to pre-frail seniors. In addition to a couple which takes part at the course, the group consists of single-living seniors and some who lives together with the partner. In addition to the weekly fall prevention course, the seniors are playing balance games and accomplishing strength training with the iStoppFalls system for prevention and fall risk measurement at home. By the use of the 6-meter-long grounded SensFloor, additional analyses are were carried out to determine gait patterns and the risk of falling (see also chapter 6.1). In combination to the guided coached group activities in the community centre, the elderly also use other technical devices and sensor systems in their everyday life and at home for general prevention of functional decline, e.g. related to physical activity, sleep and nutrition. In addition, the Smart Companion App and the my-AHA Cognitive Games which were used by the elderly, and following the seniors get an overview over their own vital parameters and health information such as sleep and nutritional behaviour or mobility status by using a fitness tracker, a sleep sensor and the nutrition app in their daily life. Furthermore, the iStoppFalls system is also installed in the senior's home, where they carry out self-sufficient preventative exercises in their own homes in combination with the guided course. Every two weeks an additional technique-training-course related to tablet and smartphone use has takeing place in the community centre, to support the seniors in technical problems and to encourage the social exchange.

Setting in care home facility Marienheim: The care home facility Marienheim is a very modern and comfortable atmosphere that offers its residents the possibility to age healthy due to a wide variety of health courses. While there are caregivers that tend to the residents they are also allowed (and motivated) to still stay autonomous to a certain degree (i.e. shopping themselves, going for a walk). Six residents (3 female, 3 male) in the age of 81-92 (M=84,17) take part in our project permanently, while the project gained more interest in the facility. The participants had barely any knowledge with tablets and other variants of technology and are therefore getting trained once per week within the project.

Setting in Siegen: Siegen is a city in Germany with around 100 000 inhabitants in the south Westphalian part of North Rhine-Westphalia. It is located in the district of Siegen-Wittgenstein. The university town is the district seat and is ranked as a "higher centre" in the South Westphalian urban agglomeration. The participants are older adults living independently in the city centre or the neighbourhood of Siegen. The target group has an average age of 68.3 years (number of participants = 6, range = 64 – 76 years) with five male and one female participant. Except one, who lives alone, they share their homestead or flat with their partner. The seniors mainly do their household on their own and feel very comfortable in their homes. They are fully integrated in social life. They are members in different group activities e.g. sport groups or voluntary service and are all in good contact with their families and friends. The older adults are quite mobile and feel fit. For transportation, they go by feet, use public transportation or their own car. Most of them have some basic knowledge about new media and computer usage. The older adults use technical devices in their everyday life and at home for general prevention of functional decline, e.g. related to physical activity and sleep. They use Apps like Medisana, MioGo or Beddit to get an overview over their own vital parameters and health information such as blood pressure and pulse, sleep or mobility status by using a fitness tracker, a sleep sensor and medical devices in their daily life. Furthermore, the iStoppFalls system is also installed in four homes, where they carry out self-sufficient preventative exercises in their own living room. The whole group meets approximately every four month for workshops or sharing their experiences. Single meetings with one participant occur depending on their demand or technical problems, approximately every two months.

3.1.2 Other research settings across Europe

In addition to the living lab infrastructure in Germany, we established further research settings in Valencia, Vienna, Turino and Porto. Following paragraphs describe these settings. For a detailed description of research activities in these settings please refer to deliverable 2.11.

3.2 Participants

In total, 34 participants took part in our study to investigate usage indicators of the current MY-AHA prototype. Table 1 provides an overview of participants and their socio-demographic characteristics.

No.	ID	Sex	Age	Study center
1	TN 16	male	64	Germany, Siegen
2	TN 24	male	66	Germany, Siegen
3	TN 25	male	76	Germany, Siegen
4	TN 26	female	72	Germany, Siegen
5	TN 27	male	66	Germany, Siegen
6	TN 28	male	66	Germany, Siegen
7	TN 29	female	79	Germany, Bad Berleburg
8	TN 30	male	61	Germany, Bad Berleburg
9	TN 31	male	70	Germany, Bad Berleburg
10	TN 32	male	74	Germany, Bad Berleburg
11	TN 33	female	71	Germany, Bad Berleburg
12	TN 34	female	81	Germany, Bad Berleburg
13	TN 35	male	72	Germany, Bad Berleburg
14	TN 36	female	75	Germany, Bad Berleburg
15	TN 37	female	76	Germany, Bad Berleburg
16	TN 38	female	85	Germany, Siegen
17	TN 39	female	81	Germany, Siegen
18	TN 40	female	92	Germany, Siegen
19	TN 41	male	84	Germany, Siegen
20	TN 42	male	82	Germany, Siegen
21	TN 43	male	81	Germany, Siegen

22	T0-01	male	60	Italy, Turino
23	T0-02	female	69	Italy, Turino
24	T0-03	male	69	Italy, Turino
25	T0-04	female	61	Italy, Turino
26	T0-05	female	74	Italy, Turino
27	WI01	female	55	Austria, Vienna
28	WI02	male	72	Austria, Vienna
29	WI03	male	65	Austria, Vienna
30	SP_M_001	female	82	Spain, Valencia
31	SP_M_002	male	82	Spain, Valencia
32	SP_M_003	male	62	Spain, Valencia
33	SP_M_004	female	68	Spain, Valencia
34	SP_M_005	male	73	Spain, Valencia

Tab 1. Study participants

We distributed questionnaires to all participants across all study centers. Interviews and observations were conducted only in the German study centers.

3.3 Research objects

3.3.1 My-AHA system components

3.3.1.1 My personal dashboard

The my personal dashboard has been designed to provide a unifying layer to users, as an entry point of the senior into the my-AHA system. It is a Single Page Application that allows having experiences similar to traditional native apps inside the web browser. The web interface is responsive, accessible through the main recent browsers on the PC and on smartphones, in particular Firefox, Google Chrome and Microsoft Edge on the pc and the last versions of the browsers in the mobile platforms (Android and iOS). The dashboard delivers following functionalities at the users' disposal:

- Register to the platform
- Connect with and use the MY-AHA applications
- see the risks associated with their situations and monitor (aggregated) data coming from the different platforms
- set personal goals
- follow their intervention plans and track their progress
- receive notifications from MY-AHA system

Figure 1 illustrates the current version of the *my personal dashboard* entry screen after logging into the platform.

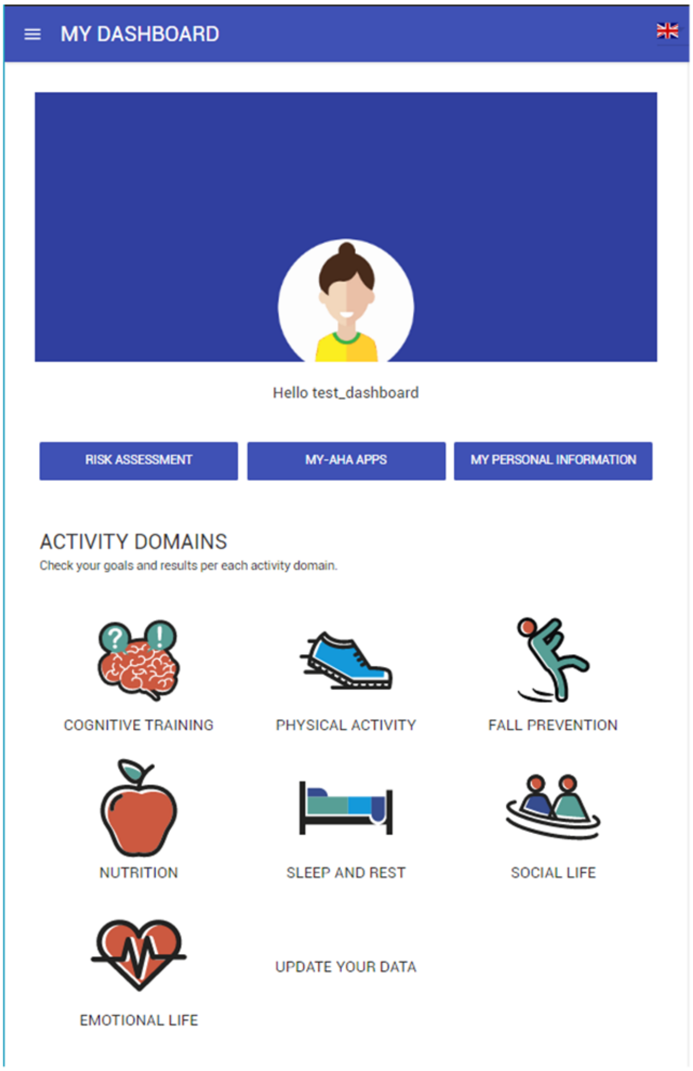


Fig 1. My personal dashboard entry screen

3.3.1.2 My-AHA Cognitive games

The cognitive games implementation has been based on the WP2's and WP3's outputs. D2.9, D3.6 and D3.5 have been strongly considered in order to propose the most suitable activities and interventions, able to affect the individual's behavior. Cognitive games are available on TVs and mobile devices through a Windows application or an android application. Due to this situation, independently by the device used, the system collects data and it synchronizes them in order to provide to the user a coherent interaction and a continuous experience. This capability is fundamental for ensuring the efficacy of the gamification. Each game follows an appropriate and predictable logic and provides several modules that allow customization according to the specific needs and risks of the users. For example, the difficulty level of the games can be dynamically personalized on the users' frail status or their confidence with the system. The *Working Memory*

Training application delivers a variety of cognitive interventions. It is a cognitive training that addresses the specific requirements of the working memory. To ease access and promote motivation to use the application, the development followed gamification concepts. Currently, there are three games available, 1) n-back Training, 2) Visual Spatial Training, and 3) Cognitive Bias Modification Training. Figure 2 provides illustration screens of the current prototype.

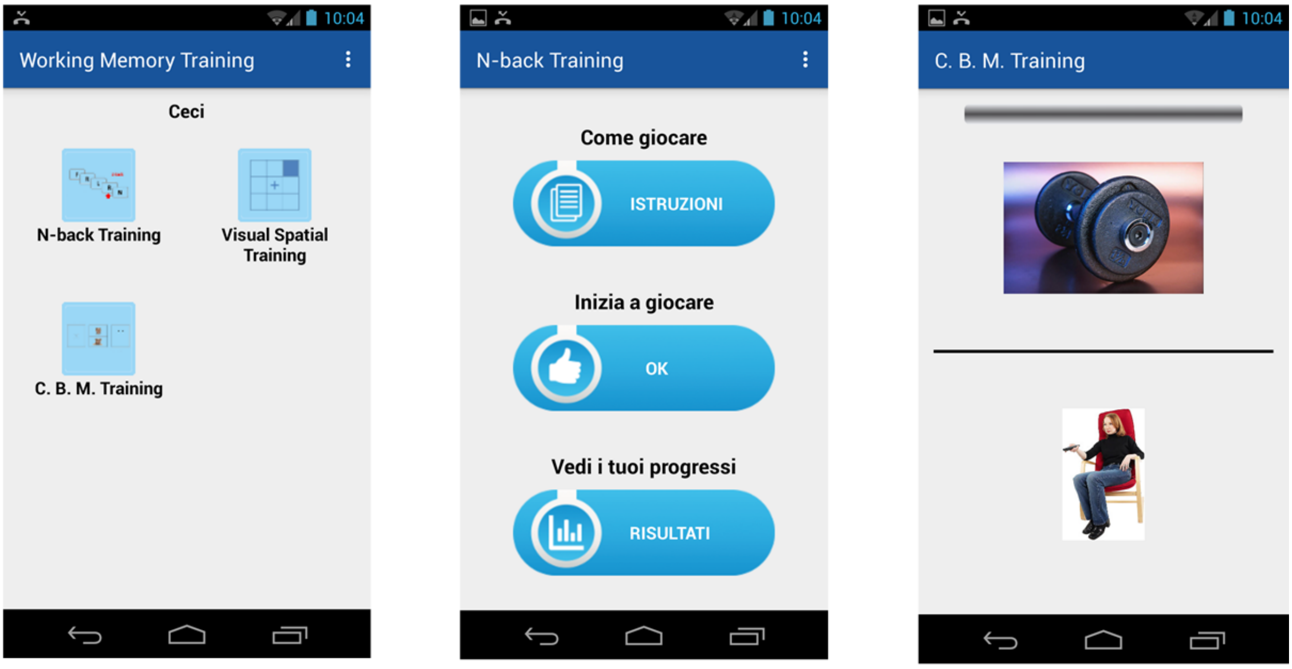


Fig 2. Cognitive games

3.3.1.3 My-AHA Nutrition Application

A first version of the nutrition prototype includes an application for mobile devices that provides a self-reporting system with respect to daily nutritional intake and, based on that, delivers nutritional advices and recommendations (see Deliverable 3.9) tailored to the needs of older adults. The main goal of this prototype is the creation of simple and intuitive interfaces in order to ease access to and motivate usage of this application as a companion to support older adults in maintaining a healthy nutrition. As the day progresses, older adults enter the ingredients for each meal into the food journal, including carbs, fats and proteins. Based on these information, the amount of calories of the daily intake is updated. The application will provide daily and weekly summaries of food intake to the users. Further, older adults will receive nutrition-related advices and recommendations on how to follow a healthy diet, based on the provided information. Figure 3 illustrates the current prototype of the nutrition application.

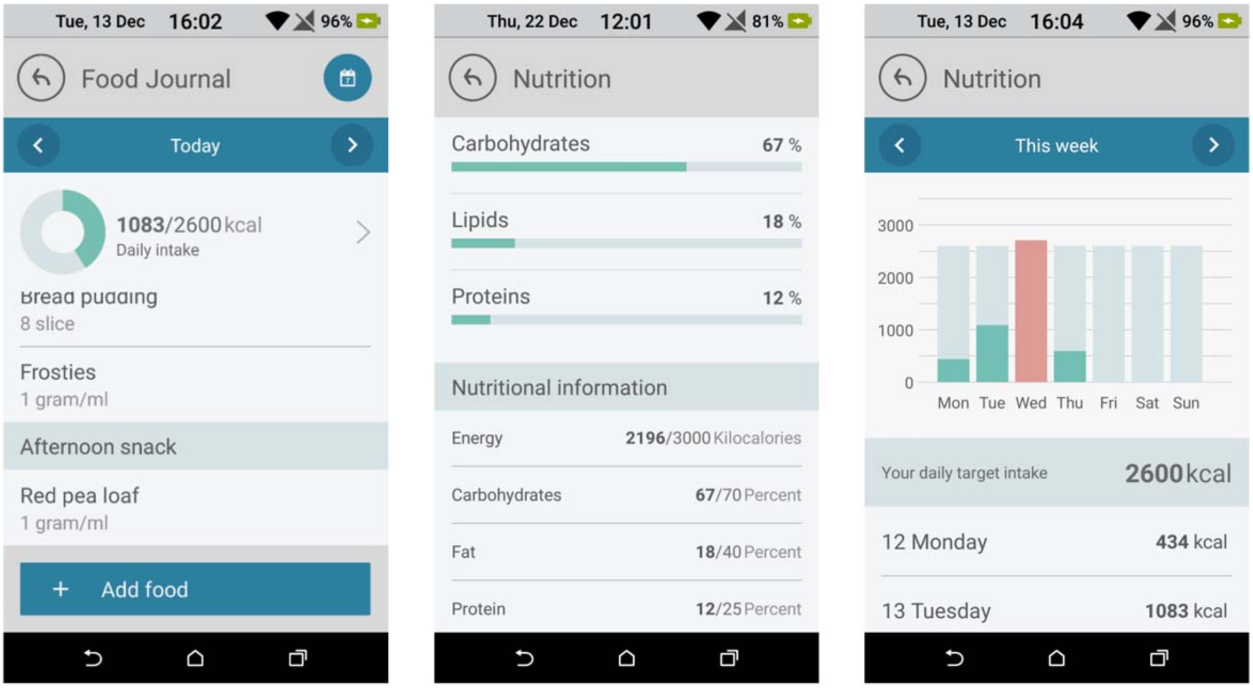


Fig 3. Nutrition application

3.3.1.4 *Original platform: iStoppFalls*

As an original platform, iStoppFalls will deliver physical interventions in form of ICT-based exergames that focus on physical functions, particularly strength and balance, but further incorporate dual tasks with cognitive components. Here, iStoppFalls provides a series of strength exercises for the lower limbs based on the Otago program, as well as three different balance games (see figure 4):

- Bumble Bee Park focused on step movements
- Hills ’n’ Skills focused on crouching
- Balance Bistro focused on side movements of the whole body

Fig 4. iStoppFalls exergames

3.3.2 My-AHA overall concept

3.3.2.1 Primary stakeholder perspectives

During the last months we focused especially on the study group in Bad Berleburg to investigate how they experienced the convergence of group training classes, home-based training with an ICT system and ICT support for AHA in general. We conducted interviews and observations in this context. Further, we were interested in participants' attitudes and perspectives towards the risk visualizations. Therefore we held a workshop with participants to evaluate the current version of risk visualizations and elaborate on their recommendations for improvement. We report on these results in section 4.3 of this deliverable.

Besonderes Augenmerk auf Setting in Bad Berleburg

3.3.2.2 Secondary stakeholder perspectives

With respect to secondary stakeholders the previous deliverable in WP 2 elaborated extensively on their perspectives and attitudes towards health, ageing, quality of life and technology use in this context. However, due to restricted access to the field, health insurance companies where somewhat underrepresented in those deliverables. However, they constitute stakeholders of major relevance, when considering sustainable implementation into the healthcare system. Therefore, in this deliverable we will provide a more detailed view on health insurance companies and their attitudes and perspectives to the abovementioned categories. Further, this deliverable will provide a space to present and discuss success factors for sustainable implementation of AHA technologies like MY-AHA into healthcare systems from the perspectives of health insurance companies. We conducted semi-structured interviews with 4 representatives of health insurance companies, 1 caregiver, 1 nutrition counsellor, 1 physiotherapist and 1 1 NGO. For further information on data collection and analyses here, please refer to deliverables 2.5 and 2.14 where we explained in detail these procedures. We report on the results in section 4.4 of this deliverable

3.4 Research instruments

3.4.1 Questionnaires

We used two validated questionnaires to assess usability and user experience of MY-AHA system components. Both paper based questionnaires were distributed among and returned by participants via post way.

System usability scale: The System Usability Scale (SUS) measures the usability of a product and consists of 10 items which are evaluated on a 5-point Likert scale ranging from 1 “strongly disagree" to 5 “strongly agree". Table 2 lists the relevant items for the SUS.

Item	Item description
1	I think that I would like to use the system more often.
2	I found the system unnecessarily complex.
3	I found the system was easily to handle.
4	I think I would need the help of a technical person to be able to use the system.
5	I found the different functions in the system were well integrated.
6	I think the system were too instable.
7	I can imagine that most of the people can easily learn to handle the system very quickly.
8	I found the system very uncomfortable to use.
9	I felt very safe while using the system.
10	I needed to learn a lot of things before I could get going with this system.

Tab 2. SUS items

The results are distributed on a specific scale ranging from 0 for "worst imaginable" to 100 for "best imaginable" (Brooke, 1996). The scale allows to classify a systems’ usability and further provides acceptability ranges for each classification, based on empirical data collected in numerous studies (see fig 5)

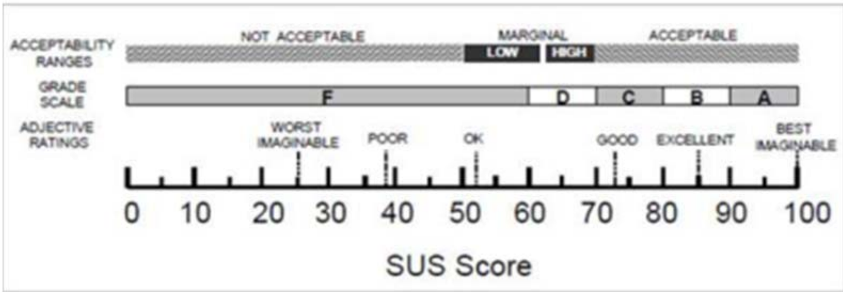


Fig 5. SUS score

SUS is an appropriate and robust usability measure with easy application for the user (Bangor et al., 2008; Borsci et al., 2009). It is frequently applied in design studies evaluating the application of interfaces (Raptis et al., 2013). Recent publications illustrate a meaningful application of the SUS in evaluation settings with older adults and a health context (Grindrod et al., 2014; Nawaz et al., 2014).

User experience questionnaire: The user experience questionnaire (UEQ) measures the user experience of interactive products and allows a fast and immediate measurement. The scale has been applied in a variety of research contexts, for instance the evaluation of business software (Rauschenberger et al., 2011), development tools (Wieschnowsky and Heiko Paulheim, 2011) or social networks (Hartmann, 2011) and constitutes a robust measure for user experience of ICT-based products and services. The UEQ consists of six scales with a total of 26 item pairs (see tab 3).

Scale	Scale description	Items
Attractiveness	General impression towards the product. Do users like or dislike the product? This scale is a pure valence dimension	annoying / enjoyable, good / bad, unlikable / pleasing, unpleasant / pleasant, attractive / unattractive, friendly / unfriendly
Efficiency	Is it possible to use the product fast and efficiently? Does the user interface look organized?	fast / slow, inefficient / efficient, impractical / practical, organized /cluttered
Perspicuity	Is it easy to understand how to use the product? Is it easy to get familiar with the product?	not understandable / understandable, easy to learn / difficult to learn, complicated / easy, clear / confusing
Dependability	Does the user feel in control of the interaction? Is the interaction with the product secure and predicable?	unpredictable / predictable, obstructive / supportive, secure / not secure, meets expectations / does not meet expectations
Stimulation	Is it interesting and exciting to use the product? Does the user feel motivated to further use the product?	valuable / inferior, boring / exiting, not interesting / interesting, motivating / demotivating
Novelty	Is the design of the product innovative and creative? Does the product grab the attention of users?	creative / dull, inventive / conventional, usual / leading edge, conservative / innovative

Tab 3. User experience questionnaire

The scales of the UEQ presented in tab 3 can be grouped into pragmatic quality (Perspicuity, Efficiency, Dependability) and hedonic quality (Stimulation, Originality). Pragmatic quality

describes task related quality aspects, hedonic quality describes the non-task related quality aspects. Consequently, attractiveness, pragmatic quality and hedonic quality represent the relevant scales to assess the user experience of a product or service. Thus, the UEQ does not provide one mean value, but three mean values to interpret user experience.
The range of the scales is between -3 (horribly bad) and +3 (extremely good). However, in real applications it is extremely unlikely to observe values above +2 or below -2. Values between -0.8 and 0.8 represent a neutral evaluation of the corresponding scale, values > 0,8 represent a positive evaluation and values < -0,8 represent a negative evaluation.

3.4.2 Usability testing

Usability testing is an evaluation method to identify usability problems, collect qualitative data and determinate the participants satisfaction with the product by observing the users behaviour, while they use the product. We conducted usability tests with representative users to identify usability problems of the MY-AHA Dashboard and the MY-AHA Cognitive game. The usability test consisted of specific use cases and exercises we constructed for the Working Memory app and the MY-AHA Dashboard.

Regarding to the Working Memory app we first asked participants to deal with the application for 5 minutes so that we were able to investigate their interaction and impressions. After this period participants were asked to articulate their thoughts about the goals and intentions of the application and to describe its operation. In the next step, we showed them the cognitive games. The games were constructed so that they would have to use all possible actions in the application. In case of questions, we provided manuals and personal instructions and support. Subsequently, we conducted brief interviews with participants with the intention of examine whether their thoughts and impressions about the application has changed or not. During these interviews, we discussed with participants the main issues of the application from their perspective and necessary change requests to improve usability. Each usability test had a duration of approximately 1½ hours.

With respect to the usability test of the dashboard we applied a somewhat different procedure. The participants used the application for the first time, so that the test started with the general registration process. During the test the participants were asked to perform specific tasks like (1) getting an overview of the app, (2) connecting the Dashboard with the my-AHA applications, (3) checking and interpreting the risk model, (4) changing the language and (5) finally logging out from the system. Here, each usability test had a duration of approximately 20 – 40 minutes.

In general, all usability tests were conducted by two trained research assistants. During all tests the participants were asked to use the “Thinking Aloud” Method while using the application. This means that they are encouraged to tell whatever they were thinking about and thereby explaining why they were executing certain actions or followed certain behaviors. Relevant statements or interesting user behaviors were put down in field notes.

The tests were conducted in the premises of the University of Siegen or in the care home facility Marienheim. In total, 5 usability tests were conducted, one with the cognitive games, three with the MY-AHA Dashboard application and one with the nutrition application. The usability tests of the dashboard in the care home facility were held in the weekly internet cafe and were less structured than the test in the university. In this setting the researchers took a more passive role with a focus on observations. Except of one usability test where participants used their own smartphone, the participants used a tablet device which was provided by the University as part of the study.

3.4.3 Interviews

We conducted semi-structured interviews with participants with a view to assessing their experience they made with the MY-AHA system components. For instance, we asked them (1) for their general experiences regarding the used devices made during the last months, (2) for their willingness to use such systems in future, (3) whether using these devices affected their health-related behaviour, (4) if they have specific desires or recommendations for the development of MY-AHA, (5) how they decide whether to use a health device or not, (6) how they perceived the possibility of setting goals, if goals had a motivating character and how they used them, (7) if they required support to use the devices, (8) how they perceived notifications and reminders and (9) their attitude towards data privacy and sharing of personal health data. Participants were allowed and required to elaborate freely on those topics. Two trained research assistants conducted and moderated all interviews. Each interview was audio-recorded and afterwards transcribed.

The data material was analyzed by applying a thematic analysis approach (Braun and Clarke, 2006). Based on the transcribed audio files four coders performed an inductive analysis of the data material and generated main categories. Coding discrepancies were discussed and eliminated by adding, editing or deleting codes, based on the group discussion outcomes of the coders. The final code system covered categories relating to participants perspectives on health and prevention and how these can be supported by self-assessment technologies, their perceived benefits and drawbacks of self-assessment technologies, usability aspects, the perceived role of self-assessment technologies, effects on personal well-being induced by self-assessment technologies and trust aspects affecting the use of these technologies. Based on the material analyzed, we derived implications for the design of the prototype. Coders used the software application MAXQDA for the thematic analysis.

4 Results

4.1 Usability tests

We conducted usability tests for the personal My-AHA dashboard, the cognitive games and the nutrition application. The following sections will report on the respective findings.

4.1.1 My personal dashboard

The usability test of the MY-AHA dashboard provided considerable insights regarding the usability and accessibility. The problems concern mainly with different aspects of performance, interaction and navigation, user interface and affordances, general meaning of wordings and icons and wrong or missing translations from the English to the German version.

In this context, some *general usability problems* deal with a flawed saving, transmitting or displaying data process. Some profile data and also some health data weren´t saved from the registration process, so that a new data input was necessary. Also the data used for registration in the browser was not transmitted to the app. Other problems occurred regarding the results of the cognitive training which weren´t displayed in the dashboard although they have been played and successfully added to the Dashboard. A high user frustration was caused by the numerous break downs and malfunctions of the app and also by delayed feedback of some buttons which only appear after multiple clicking. Following list summarizes the general usability problems

- Profile data is not saved from registration (the data from the second page of the registration)
- Health data has not saved from the registration data
- Data used for registration in the browser was not transmitted to the app
- Cognitive Training results are not shown although they have been played / Results didn't change after playing cognitive games

Other problems concerned with the *interaction flow* of the users and led to unnecessary steps in the interaction. In this context, the application required a new log-in after the registration process. Another problem which impeded the user interaction was that the view of a page often started at the bottom so that the user had to scroll up to get to the beginning of the page. Some users have also expected a navigation functionality within the registration process through the buttons on the top (General, Lifestyle, etc.) which actually didn't exist.

- When a new page is displayed on the screen, the screen often positions at the bottom so that the user has to scroll up to come to the beginning of the page.
- After registration, a new log-in is needed, which is perceived by the users as an unnecessary step. Users could be automatically logged in after registration
- Users tried to navigate the registration process through the buttons on the top (General, Lifestyle, etc.). Buttons aren't clickable, even though the affordance is there.
- In order to change the value of a field with personal data in it the user is requested to delete the old value first, which in many cases was perceived as annoying by the users

A general problem occurred regarding the *language changing*. Some participants didn't notice the language flag and got frustrated opening the app because they weren´t familiar with the English language. Other users would like to change the language but they didn't find out how to change it.

- Some Participants didn't notice the language flag and got frustrated opening the app, stating they do not understand English language
- Users didn't find how to change the language
- Users didn't find the way back to the first dashboard screen

Many other problems emerged in the German version as a result of a wrong or missing *translation* from English language into German language. Participants didn´t understand the meaning of "Scholarship Level" in the German version. Also the German translation of Scholarship level caused confusion because of a misleading translation (After "Ausbildungslevel" the unit was missing, like "Scholarship Level (in years)). A general problem was that some texts were still in English although the language has been changed in the settings menu.

- Scholarship level caused confusion (German translation was misleading)
- Also the Meaning of "Scholarship Level" in the German version was unclear
- -The app asked for "Geburtsjahr" instead of "Geburtsdatum", which requests the user to put in only their year of birth, excluding month and day.
- Some texts are still in English (like "Fill in all the fields to calculate your risk factors")
- Information text is in English, although language was changed
- After changing the language not everything was displayed in German language (i.e. the title's beneath the icons) but after restarting the app it was
- Text is still in English ("System will refresh them receiving data from My-Aha Apps")

Despite of a correct translation *wording* caused additional confusion. A few elderly persons struggled with the word “cognitive” because the meaning wasn’t clear for them. Also the “Systolic blood pressure” led to confusions because some participants didn’t know the meaning of it. One person tried to insert both values (120:80) instead of one (120). Another user said that his pressure is always different and it is difficult to insert a certain value. Another user didn´t know his cholesterol value because it had no meaning for him.

- A few elderly persons struggle with the word “cognitive” => User doesn’t know what cognitive means
- Units of measurement are missing especially for the height (cm or meters?)
- Systolic blood pressure: Users say that his pressure is always different and it is difficult to say a certain value
- Users doesn’t know their cholesterol value; it has no meaning for him
- Some Participants had problems to read the text because it was too small

Similar misunderstandings occurred with the meaning of some *symbols or icons*. Users didn´t understand what the icon in the section of risk assessment means (i.e. “emotional icon looks like measuring the heart rate”). Also the meaning of other displayed information (for example Weight Goal = 1) wasn’t clear for the user and lead to confusions.

- Users doesn’t understand what the icons mean because they never saw them before (i.e. “emotional icon looks like heart rate”)
- Dashboard: Symbols (like Cognitive Training, etc.) = Goals: Meaning is unclear and units doesn’t fit the users expectations (for example Weight Goal = 1, whereas uisers would have expected a value in kilogram)

Furthermore, some misinterpreted *affordances* lead to problems and uncertainty by the users. In this regard, some symbols were not clickable, even though users perceived them as clickable. Multiple users tried to click on a brain symbol, but nothing happened. For some users it wasn´t clear where to enter the data in the form because respective fields didn´t look like input fields. Users tried to click on the text “Not yet registered?” for registration because they didn't recognize the “here” link. Also the password encoding which was displayed in a different length to the given password led to uncertainty because it seemed that the password has changed.

- Not clear where to enter the data (description text is ON the input line), form field doesn’t look like an input field

- Symbols are not clickable, but they seem to be
- Two participants didn't know they were able to click on the icon or result for more information
- Users wanted to click on the symbol (brain), but nothing happened (They didn't find out that the text (number) is clickable
- Users didn't see the "here" link for registration. They tried to click on the text "Not yet registered?" for registration.
- Password encoding is not the length of the given password: this leads to uncertainty because it seems that the password has changed
- After saving nothing happened, only positive feedback is displayed. User expected a change of the page.

Some participants had also some problems to read a text because it was too small. Especially on the *smartphone* many problems occurred regarding to the displayed content. On the smartphone the risk information (percent value) was displayed on a wrong position so a connection between the symbols and the information was missing and not visible for the user. Other problems dealt with the size and with cropped elements in the app. E.g. in the adding process of the components the text was cropped so that the user couldn't read all the information. Also the risk model was displayed too small on the smartphone so that this user couldn't use it.

4.1.2 My-AHA Cognitive game

As for the usability test regarding the cognitive games the results differed among the three participant groups. While the care home facility Marienheim prefers the CBM training over the N-Back games because it's more intuitive and causes less frustration the other living labs rather like the challenge of the N-Back games. The participants of the Marienheim were very frustrated because of not understanding the N-Back games after reading the manual and getting them explained by the examiners. They mentioned: "We're already too old for these kind of games, let's just try a different game." Therefore, they rather preferred the CBM training for it's simplicity however they did not really enjoy it nor did they understand why it should help them. In contrary to this the participants of the other living labs liked the challenge of the N-Back games and did not like the CBM training as they found it too long and meaningless. However, one participant really enjoyed playing the CBM training in order to improve his reaction time. As for their opinion to the N-Back games they did not like the aspect of having to begin from the start when they made too many mistakes. The main issues of the N-Back games consisted in the explanation of the games and the complexity. The CBM training was easy to understand and did not cause any troubles. The interface itself was easy to understand and no participant had difficulties to find the option we asked them to show us in the use cases. However, the game logic had to be explained additionally by the examiners as the manual itself did not suffice. Especially the participants of the care home facility struggled as the video was too fast for them to read and understand. They also did not know that they were able to pause or rewind it as the buttons had been faded out. This might be a good precaution that the participants don’t end up accidentally pressing them but this aggravated the control over the speed of the manual. Short keys like tapping twice on the video are also not known by some of the participants. However even when the examiners stopped the video so that the participants could read everything at their own pace they had difficulties to understand how the games worked or what exactly their task would be. Some got a better visual understanding of the game mechanics of the N-Back training after playing the second N-Back game. During the game the participants were still struggling with understanding the N-Back games. When they started the N-Back games the participants were unsure where they should tap when they see a repeated image. It was also mentioned that it was confusing to have been reduced one level after failing one round. The participants started to understand the game logic towards the end and were not prepared having to tap directly when an image repeated once. The n-Back on top of the gameboard that indicates how much back they have to remembers an image had been overlooked. It has been deemed unimportant as the participants concentrated on the images they had to remember and did not notice the change each new round. The traffic light symbol on the left has not been entirely understood without the manual which indicates that the real-world connection did not work flawlessly. One participants thought the traffic light indicates how many mistakes she’s still allowed to make before she had to start the game completely from the beginning.

4.1.3 My-AHA Nutrition Application

During the usability tests for the Nutrition app VitalinQ the participants found the app to still be a prototype with a few issues in usability and bugs. Additionally, problems occurred due to the translation, an insufficient database of ingredients and a time consuming uncomfortable interaction with the app when adding all their meals.

The *bugs* that the participants mentioned were mainly that the app crashed after adding certain ingredients like i.e. water. After this experience, a few participants did not interact with the app again. Others however decided to choose similar ingredients (i.e. Cola instead of water) which changed the overall result. A few other users were unable to open the app at all as it wouldn’t load after the login.

In the course of the interaction with the app the participants also felt disturbed by some menu points as well as ingredients to still be in *another language* or badly translated. This also includes different metrics used for the amount of an ingredients, that are uncommon in Germany. Some did not know how to change the metrics during the usability test and ended up adding a different amount of an ingredient due to this. The participants don’t speak English which made them insecure in the interaction. Apart from the usability test they sometimes get Emails that notify them of changes but are in a different language (Dutch) they don’t understand.

Another aspect that disturbed the participants during the usability tests were that some of the ingredients or food choices they wanted to add were not included in the database. This however might also be because the *search function is not optimally implemented*. When the participant filled a search request for typical meals the search did not deliver a result or they were unknown to the app. In contradiction to that sometimes the search function also delivers too many results of the same meals where the participants find themselves unable to determine which the right result is. Even though such results are mainly the same or just slightly vary in the amount of an ingredient it still causes confusion and uncertainty. The search function also encountered problems and errors when a person did not write out the name of an ingredient completely (i.e. Knäcke instead of Knäckebrot). When the participants just wrote part of the word sometimes they got no suggestions even though the ingredient existed in the database. Further problems occurred because the participants had their own names or abbreviations to an ingredient unknown to the system (i.e. Knägge instead of Knäckebrot).

The biggest flaw however was that the interaction was very *time consuming*. Having to input every single ingredient with its amount by typing was felt to be inconvenient and in some cases even laborious. There was no option to change an ingredient within a meal which lead to the participants having to go through the entire menu again to add an ingredient extra to their meal (i.e. adding a small amount of sugar to the coffee). Some participants reported that they had to do this every morning as there’s no option to select what they ate the day before for i.e. breakfast, which made the interaction tedious.

Overall the participants did not enjoy the interaction with the app as it is too time consuming for what it has to offer, as the tips are not individualized either way or they were unable to find a good enough benefit from their “labour”. There’s one participant that liked the app though, as it helps him to realize what he ate throughout the week and that it motivates him to eat less sweets. He wouldn’t want to use the app forever as it is at the moment, and made just like the other participants quite a few recommendations to improve the app. Those recommendations will be covered in the implications section along with the deduced solutions from the researchers.

4.2 Usability and user experience questionnaires

4.2.1 My-AHA Dashboard

For the dashboard we received four completed questionnaires. Considering our sample size the return rate here is rather weak. However, we believe that participants were reluctant to use the dashboard application due to its the early development stage.

Usability: The usability of the dashboard application was rated by participants with a mean score of 48.13 (see fig 6).

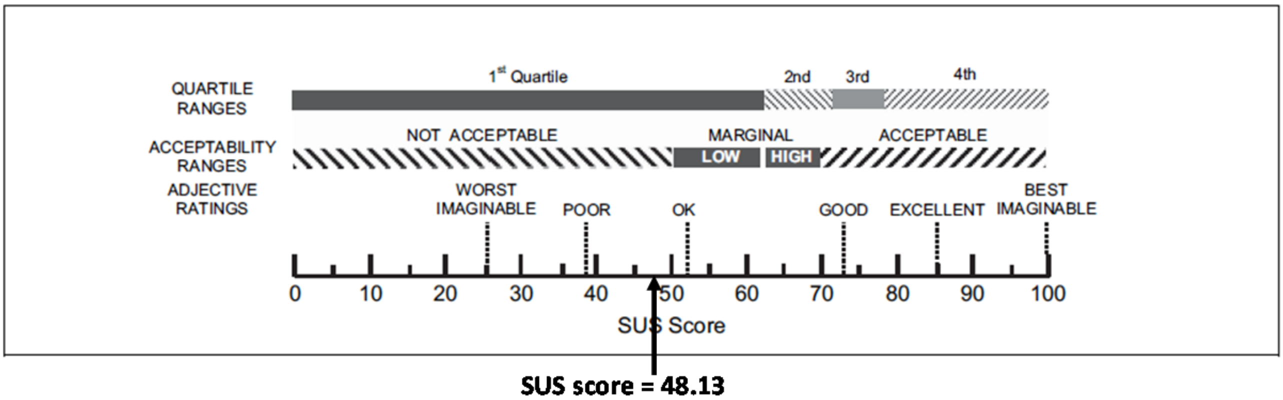
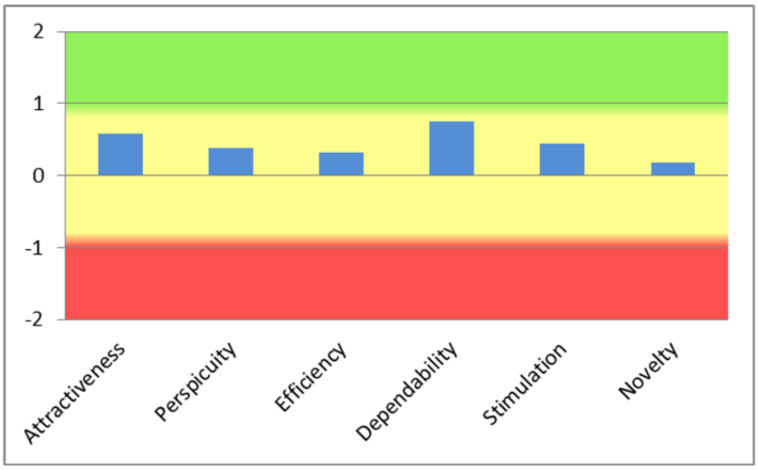


Fig 6. Dashboard application SUS Score

Due to the weak return rate of completed questionnaires for the dashboard further analyses with respect to subgroups like age or gender would not be appropriate. However, during the interviews, participants provided some more detailed insights with respect to their attitudes and perspectives on the dashboard application.

User experience: Participants rated the attractiveness of the dashboard application with a mean value of .58. With respect to pragmatic quality participants evaluated the dashboard application with an average score of .48. The hedonic quality was rated with a mean value of .31. Figure 7 illustrates the mean values for each UEQ scale.



UEQ Scales	
Attractiveness	0,583
Perspicuity	0,375
Efficiency	0,313
Dependability	0,750
Stimulation	0,438
Novelty	0,188

Fig 7. UEQ scales for the dashboard

Interviews: During the interviews participants provided some insights, which help to understand the weak return rate. Many participants did not use the app frequently. Some of them just opened it once and stopped right after: „*Well, I opened it once, just to see what is inside, but that's it.*" (TN25, male, years 76). It seemed that participants didn't perceive an added value by using the dashboard application: „*I cant see the benefit here [using the dashboard]. It [the dashboard] shows me some values but I don't understand them. I need to put the value into perspective, for instance with a reference value to assess whether I am doing fine or not*" (TN25, male, years 76).

In addition to the interview material, the poor user experience and usability scores can be explained in more detail by results of our usability tests in section 4.1.1, which shows some essential problems that lead to user frustration while using the app.

4.2.2 My-AHA Cognitive game

We received 21 completed SUS questionnaires and 16 UEQ questionnaires for the cognitive games. During the last months, participants frequently used the cognitive games and therefore may provide relevant and meaningful feedback on usability and user experience.

Usability: Participants rated the usability of the cognitive games with an average score of 58.69 (see fig 8).

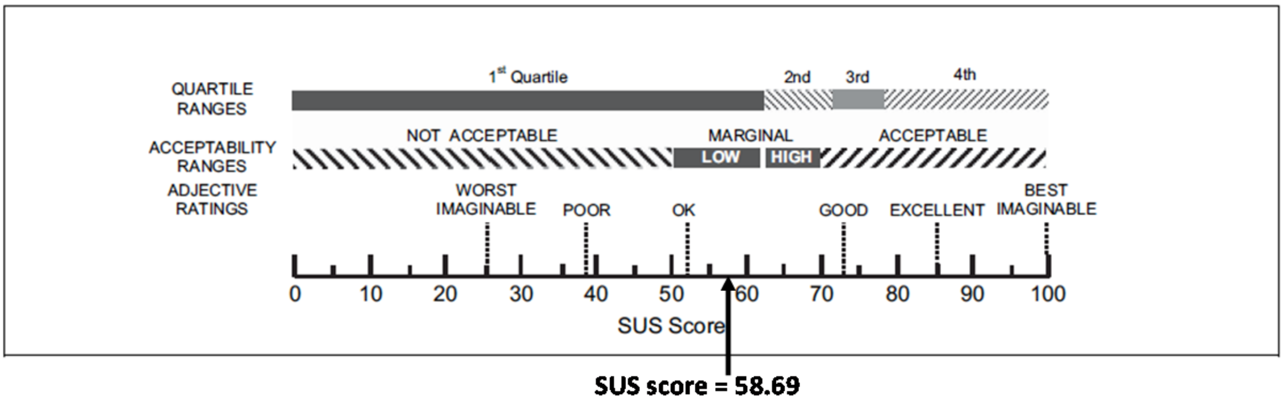


Fig 8. Cognitive games SUS score

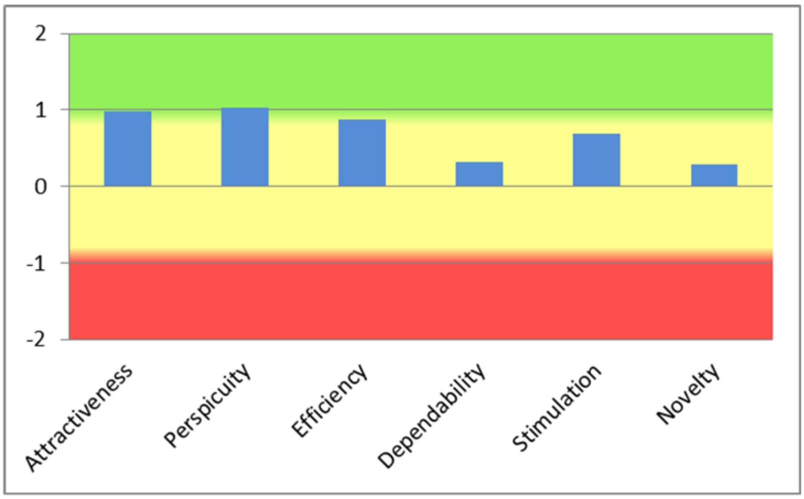
With respect to the subgroup gender, results indicate that female participants perceived the usability of the cognitive games more positive than their male counterparts. While male participants (n = 13) rated the cognitive games with an average score of 56.35, female participants (n = 8) assessed the games with an average score of 62.5. In terms of age, we split participants into the groups < 71 years and > 71 years. Participants younger than 71 years (n = 10) evaluated the cognitive games with an average score of 56.25, while participants older than 71 years (n = 11) evaluated the games with an average score of 60.9.

Interviews: As participants used the cognitive games frequently during the last months, interviews with them provided meaningful and detailed insight to draw a more complete picture of older adults' attitudes and perspectives on usability and user experience with respect to the cognitive games.

Especially at the beginning, participants had some general problems, to use the game and to understand all given information in the right way which led to a negative impact on the usability: *„As I said before, it was hard to understand what the application wanted me to do. I did not understand some terms, for instance cognitive. What does it mean? I dont know how to proceed here, as I dont understand the meaning of the word.“* (TN24, male, years 66). In addition to the wording which was partly confusing, participants had problems to understand the overall game play of the C.B.M. game: „*Actually, I need to press the button when I see the second of two identical figures. However, when I press the button after the third figure appears, it turns green again. I struggle a bit with that game to be honest.*" (TN29, female, years 79). In this context, the instruction videos provided insufficient gameplay explanation to support the users: „*I totally did not understand the whole back three, back four, back two story. And then there were the instructions and I thought now I will understand it after listening to them. Well…They [instructions] were so fast that I could not even read everything. That was really poorly designed.*“ (TN33, female, years

71). In this context, participants did not understand the functionality of stopping the instruction video and therefore perceived the usability of the system as poor: „*You need to tell that to people first [That you can pause the instruction video]. I did not know that, I am completely new to that technology.*“ (TN33, female, years 71). Especially one old male participant mentioned that he was overwhelmed by the games and didn’t see any value by playing this one: „*I think I played it once. It overwhelmed me to be honest. And then I also didn’t see the benefit in playing it.*“ (TN41, male, years 84).

User experience: Overall, participants rated the attractiveness of the cognitive games with a mean score of .98. With respect to the pragmatic quality, participants evaluated the games with an average value of .74. The hedonic quality of the games was rated with a mean score of .48. Figure 9 illustrates the mean values for each UEQ scale.



UEQ Scales	
Attractiveness	0,979
Perspicuity	1,031
Efficiency	0,875
Dependability	0,313
Stimulation	0,688
Novelty	0,281

Fig 9. UEQ scales for the cognitive games

With respect to gender, male participants (n = 10) evaluated the attractiveness of the cognitive games with an average score of .52. Their female counterparts (n = 6) evaluated the attractiveness of the system with a mean value of 1.75. Regarding the pragmatic quality, male participants evaluated the games with a mean score of .74, while female participants evaluated the games with a mean score of 1.19. In terms of hedonic quality, male participants rated the cognitive games with an average score of .48. Their female counterparts assessed the hedonic quality of the games with a mean value of 1.06.

Splitting participants into the age groups < 71 and > 71 years, older adults aged 71 years and above (n = 8) evaluated the attractiveness of the cognitive games with an average score of 1.38, while their younger counterparts rated the games with an average score of .58. In terms of pragmatic quality participants above 71 years assessed the games with a mean value of 1.17, while participants below 71 years assessed the cognitive games with a mean value of 0.31. Finally, older adults aged 71 years and above rated the hedonic quality of the system with an average score of 0.61, while older adults aged below 71 years rated the hedonic quality of the games with an average score of .36.

Interviews: The analysis of qualitative interview material helped to elucidate the meanings behind the quantitative results described above. In general, the interview statements matched with the general positive feedback on the user experience. Especially the female participants mentioned the fun and the challenge they experienced by playing the cognitive games: „*It is fun and I realize that it [the games] motivates me to play it again. I notice that it is beneficial for me to play it and I want to perform better each time I play it.*“ (TN29, female, years 79). Despite the fact that some games seemed to be boring at first, participants changed their view by after playing the games on a regular basis: „*At first I found the games rather boring. But after some time I understood the meaning and sense behind the games, that you train concentration and speed.*“ (TN33, female, years 71).

In contrast, playing the games over a longer period seemed to decrease the challenge for many participants, especially when participants reached a point in the game where they cannot improve themselves anymore: „*I am tempted to play if I have the possibility to progress further. But if I play when I am tired and still win every time, that is where it gets boring for me.*” (TN29, female, years 79).

4.2.3 My-AHA Nutrition Application

In terms of the nutrition application, eight participants completed the SUS questionnaire and seven participants completed the UEQ questionnaires. Similar to the cognitive games, the nutrition application was frequently used by our participants during the last months.

Usability: Participants rates the usability of the nutrition application with an average score of 51.25. Figure 10 puts the SUS score into perspective.

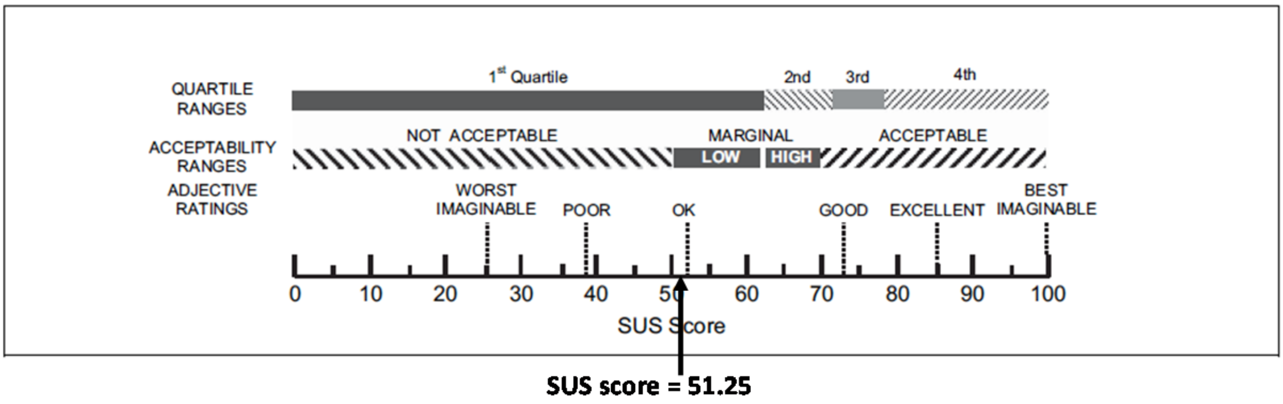
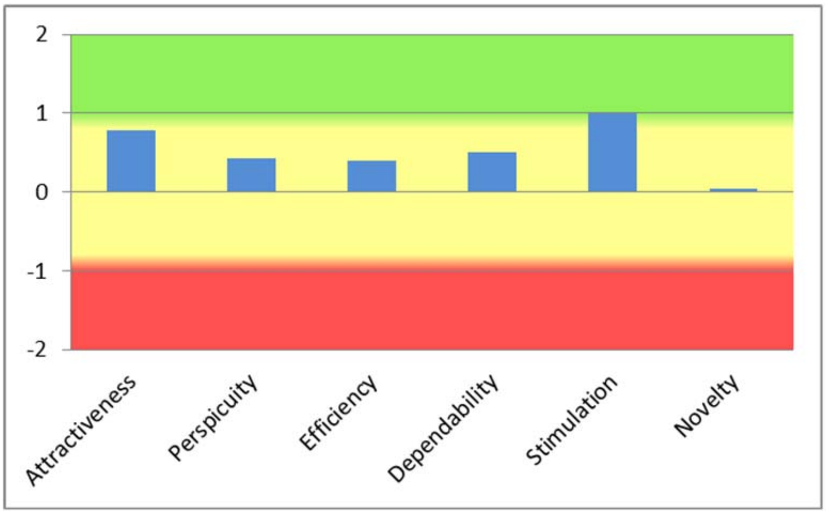


Fig 10. Nutrition application SUS score

User experience: With respect to the attractiveness, participants evaluated the nutrition application with an average score of .79. Pragmatic quality was rated by participants with a mean value of .44. In terms of hedonic quality, participants assessed the nutrition application with an average score of .52. Figure 11 illustrates the mean scores for the UEQ scales.



UEQ Scales	
Attractiveness	0,786
Perspicuity	0,429
Efficiency	0,393
Dependability	0,500
Stimulation	1,000
Novelty	0,036

Fig 11. UEQ scales for the nutrition application

As the return rate of questionnaires was rather low for the nutrition application, further subgroup analyses would not provide any reliable data here. However, during our interviews we were able to reveal different attitudes and perspectives towards the nutrition application that seem to be related to age and gender differences.

Interviews: The interviews implied that especially male participants were interested in the functionalities of the nutritional app: "*I am very keen to use the nutrition app.*" (TN25, male, years 76). Another male participants mentioned that his increased weight was a fundamental reason for him to use the app: „*I just wanted to know how much I really eat, as I tell myself again and again that I do not eat so much, but without such an app I can't tell for sure.*" (TN30, male, years 61).

Although some women were also interested in the opportunity to monitor their weight, most of them did not use the app: „*For me, this is not interesting. It is too complicated and it goes on my nerves. And on top of that, I don't even want to lose weight. I also take care of a healthy food intake myself.*" (TN26, female, years 72)

Although most participants were willing to use the app, the uncomfortable and inefficient usage reduced the usability and the use experience. One participant mentioned that she didn't understand how to use the app in the right way: „*I don't manage. I have to be honest. I need instructions how to use the application*" (TN33, female, years 71). Other participants complain about confusing information: „*After I entered my lunch, the appl told me that I would eat 5000 kcal, which just cannot be true. The app somehow changed to a dutch measure and thus the increased kcal. Very confusing and annoying.*" (TN30, male, years 61).

A high negative effect on the pragmatic quality of the nutrition app was reached through the inefficient and obstructive interaction which could explain the low score of the pragmatic quality value regarding the UEQ questionnaire. Especially the high effort required from participants to enter their meals impaired joy of use: "Entering the meals into the app is tedious. *IT just takes too long if I need to enter a lot of data via that small digital keyboard. I need to focus then and I frequently mistype and need to delelte and start over again. This just takes too long for me.*" (TN25, male, years 76).

4.2.4 Original platforms

We received completed questionnaires for iStoppFalls, which was implemented into My-AHA as an original platform. In total, participants returned 18 completed SUS and 17 completed UEQ questionnaires. During the last months, iStoppFalls was used by participants on a regular basis.

Usability: Overall, participants rated the usability of iStoppFalls with an average score of 60.14. Figure 12 puts the SUS score for iStoppFalls into perspective.

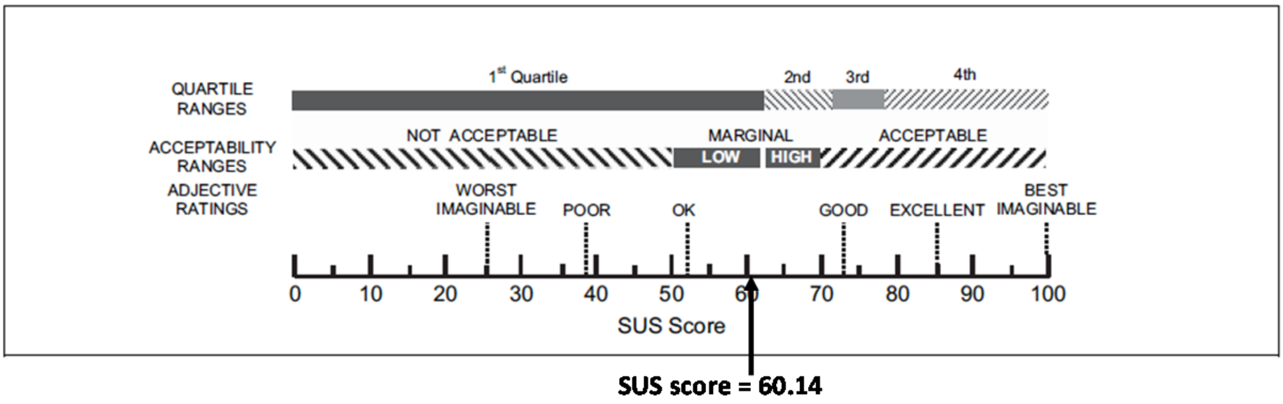
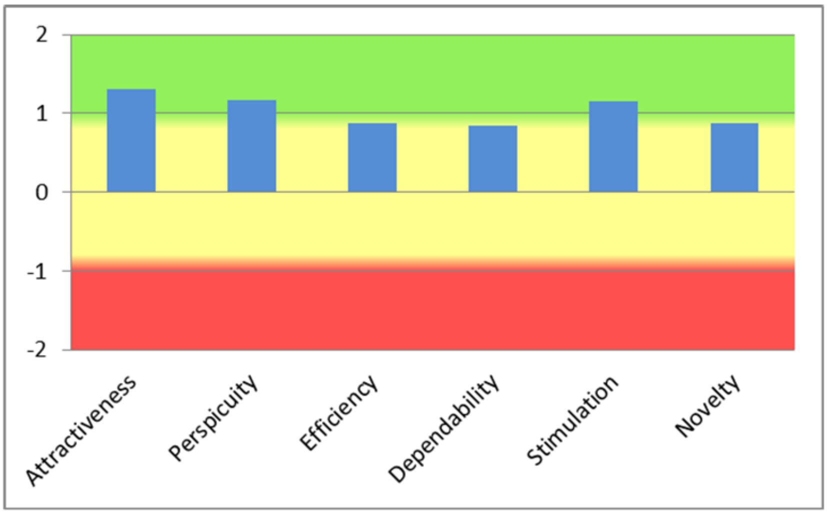


Fig 12. iStoppFalls SUS score

With respect to gender, our analyses showed that male participants (n = 11) evaluated iStoppFalls with an average score of 62.95, while their female counterparts (n = 7) assessed iStoppFalls with an average score of 55.71. The analyses also showed that participants aged above the mean age of 71 years (n = 11) rated iStoppFalls with a mean value of 64.32, while participants with an age below 71 years (n = 7) evaluated iStoppFalls with an average score of 53.57.

User experience: Participants rated the attractiveness of iStoppFalls with an average value of 1.31. In terms of pragmatic quality, participants evaluated iStoppFalls with a mean score of .96. Hedonic quality was rated by participants with an average score of 1.01. Figure 13 illustrates the mean values of the UEQ scales for iStoppFalls.



UEQ Scales	
Attractiveness	**1,314**
Perspicuity	**1,176**
Efficiency	**0,868**
Dependability	**0,838**
Stimulation	**1,147**
Novelty	**0,868**

Fig 13. UEQ scales for iStoppFalls

Our analyses showed minor differences of participants' user experience with respect to gender. In this context male participants (n = 10) rated the attractiveness of iStoppFalls with an average score of 1.27, while female participants rated iStoppFalls with an average score of 1.38. Regarding pragmatic quality male participants evaluated iStoppFalls with an average score of .98

(female mean score = .94). Finally, the hedonic quality was rated by male participants with an average score of 1.04 (female mean score = .96).

With respect to age, the analyses revealed considerable differences. While older adults below the mean age of 71 (n = 6) rated the attractiveness of iStoppFalls with a mean score of .72, their older counterparts (n = 11) assessed iStoppFalls with an average core of 1.64. In terms of pragmatic quality, older adults aged below 71 years rated iStoppFalls with an average value of .58 (mean score of older adults aged above 71 years = 1.17). At last, participants aged below 71 years evaluated the hedonic quality of iStoppFalls with a mean score of .79, compared to a mean score of 1.13 of their older counterparts.

Interviews: Conducted interviews with participants provided meaning to the quantitative results described above. In this context we learned that most of the participant had fun by plaining the game and were willing to spend their time with the system: *„Yes of course, if it woudnt make such fun [playing iStoppFalls] I definitely would not spend so much time with it.“* (TN32, male, years 75). Another participant said: *„Yes, in winter season I played it almost every day for an hour.“* (TN33, female, years 71). These statements coincide with the positive feedback from the questionnaire regarding the attractiveness and the hedonic value. Despite that positive impression it seemed that the stimulation and attractiveness of the game mitigated by a constant and long term use: „*Well, if you play it [iStoppFalls] over a longer period it becomes a little boring.*“ (TN32, male, years 75). In this context, participants also mentioned that the challenge is gone after reaching the highest level: „After you reach the highest level, you are stuck there and cannot progress any further. It becomes boring then.” (TN33, female, years 71). Here, participants explicitly mentioned challenge as an important aspect: „*Yes I could use some more challenge here to be honest.*“ (TN33, female, years 71)

Regarding the average usabiliy score of 60.14 the interviews gave some explanations why the score is in a marginal and not in an acceptable area. Especially at the beginning, the system had some errors that led to increased user frustration: *„I had the impression that the system is not well-engineered. There were some bugs and malfunctions.”*. (TN28, male, years 66).

4.3 Primary stakeholder perspectives

4.3.1 Combination of exercise group classes and home based training

With respect to the study group in Bad Berleburg, who additionally participated in group exercise classes on a regular basis, we learned that the convergence of social activities, such as aforementioned group exercise classes, and ICT-based technologies for AHA support seems to be an important aspect that older adults welcomed very much. In this context, participants emphasized that such convergence supports them to maintain continuity in their healthy lifestyle, for instance in form of physical activity. Here, one participant said „*Well, participating in the group exercise classes once a week for one hour showed me that this is not enough to improve your health. Having the possibility to continue training at home with the system and devices was a very good supplement to the group exercise classes. I know I would not have done so much exercise without having these systems and devices at hand (PN32, male, years 75).* Another participant stated that continuous participation in group exercises and technology supported physical activity at home helped to improve physical condition: "*yes, this [continuous exercise in group and at home] really helped a lot. I remember stumbling around in the beginning and after 12 sessions I felt much more confident and safe. I have to say, the training was very efficient." (PN33, female, years 71)*

4.3.2 Risk visualizations

In order to explore how older adults perceive and comprehend the risk visualizations displayed in the my-AHA application, we conducted two workshops. The first workshop took place with healthy community dwelling seniors living at home in rural and urban areas. The second workshop took place in an elderly care home with seniors in need of geriatric care services. In the workshops, several options for risk visualizations have been evaluated with the participants. We first report on results concerning with visualizations for a single risk factor, for instance fall risk. Subsequently, we will illustrate workshop results that focused on visualizations for multiple risk domains, for instance physical, social and cognitive risk.

Single risk factor visualizations: Firstly, we showed participants a risk visualization that is already implemented in the MY-AHA application (see fig 14). It shows the probability of having a certain disease on the vertical pivot and the age on the horizontal pivot. The blue curve is showing the average risk of a specific age group to develop a certain disease. The red point is indicating the individual risk of one person, based on the available calculated data from that person.

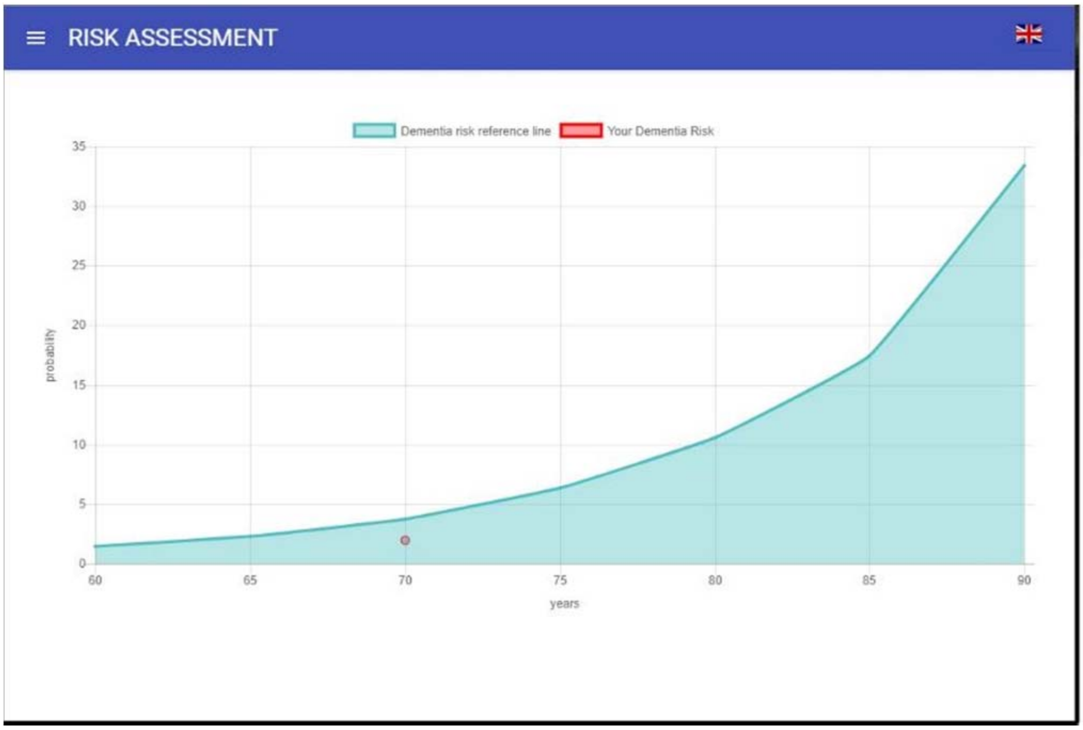


Fig 14. Already implemented risk visualization

For the seniors in both workshops, the information presented in this visualization were not completely comprehensible to them. For instance, they were not able to interpret the meaning of the illustrated value for their personal risk in relation to a reference value. Participants said that the possibility for interpretation would be key for them to perceive value in such visualizations. Furthermore the presented visualization had a maximum age of 90 years, whereas many members of elderly care homes are over 90 years old.

Secondly, we presented a new design of a possible risk visualization to participants (see fig 15). The visualization shows the risk level on the vertical pivot and the age on the horizontal pivot. The level of risk is marked with colors. The light blue part represents the average risk of a person. The colors above (yellow, rose, red and purple) are showing an advanced risk level. The colors below (rose, yellow, green and blue) show a reduced risk to the reference range. The red point is again showing the personal risk level.

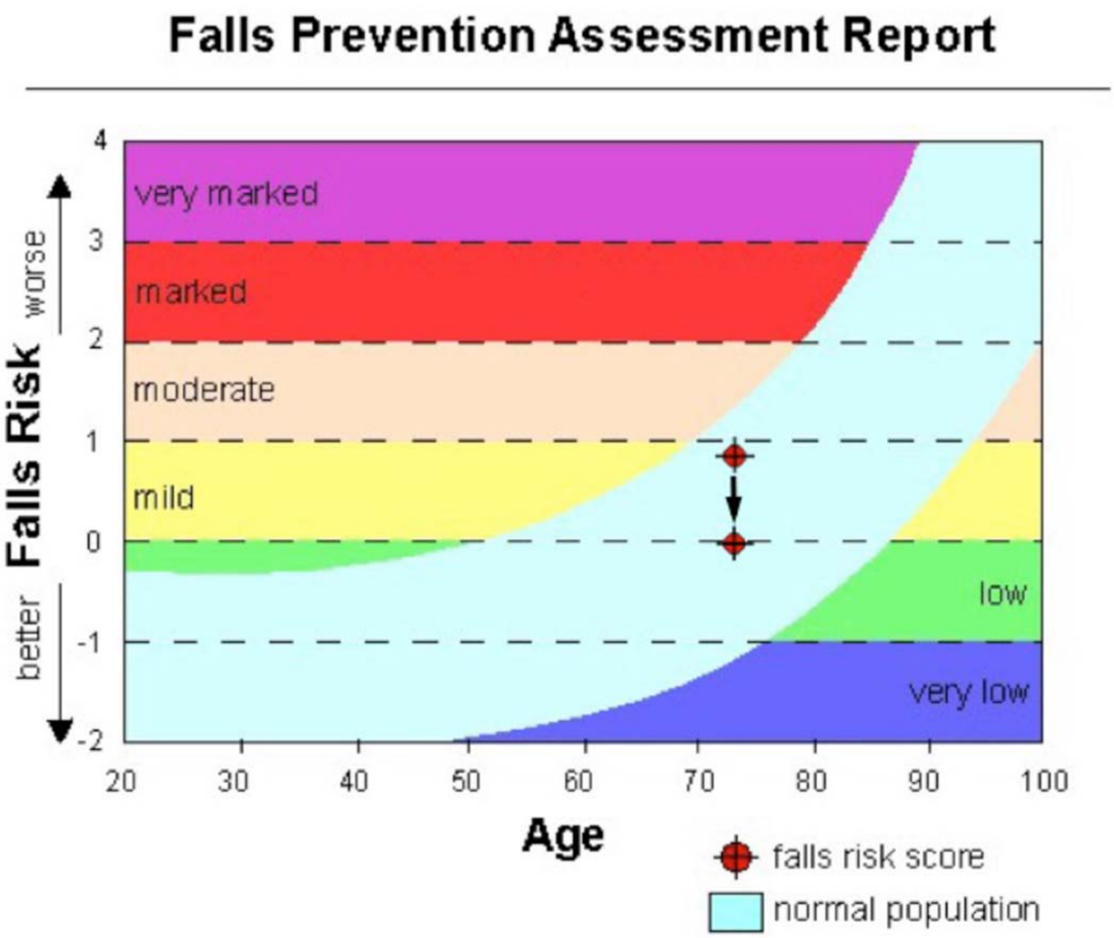


Fig 15. Risk corridor visualization

Seniors preferred this visualization, as it put their own risk into perspective. This feature helped them to understand their personal risk level and gave them an information about how urgent it is to reduce their personal risk. In contrast, for participants from senior care home facilities the visualization was too complex. It was difficult for them to understand all the presented information which and they wished to have a less complicated visualization.

As a third option, we provided high level risk visualizations in form of smileys to participants (see fig 16). Here, a green smiley indicates a low risk, while a yellow and red smiley indicate a medium and advanced risk respectively.

Fig 16. Risk visualizations with smileys

In general, most participants mentioned that they perceive this kind of visualization as too basic and think that it does not provide them with enough information about their health risk.

Finally, we showed participants a fourth option for risk visualization (see fig 17). It illustrates the risk in a semicircle and indicates the risk levels with numbers and colors. The needle is indicating the individual risk level.

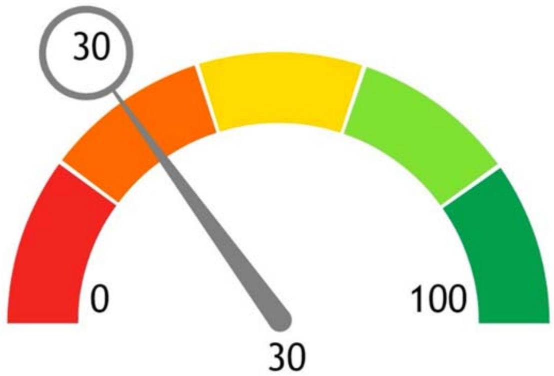


Fig 17. Tachometer risk visualization

This visualization has been well received by participants. Especially participants in elderly care home facilities mentioned that this visualization is easy to understand and it remembered them of a tachometer in a car and thus looks familiar to them. Here, the fact that this visualization is not putting their own risk in perspective to a reference risk value did not concern them. On the question, if they would like to know how their risk is in comparison a reference value, they responded that every person is different and a comparison therefore did not matter to them.

Multiple risk factor visualizations: With respect to visualizations that illustrate the risk for multiple health domains, we first discussed the current risk assessment screen already implemented in the MY-AHA application (see fig 18). It shows an icon for each health domain and below a number indicating the risk for each domain. The risk value is calculated based on the six different parameters participants may enter below.

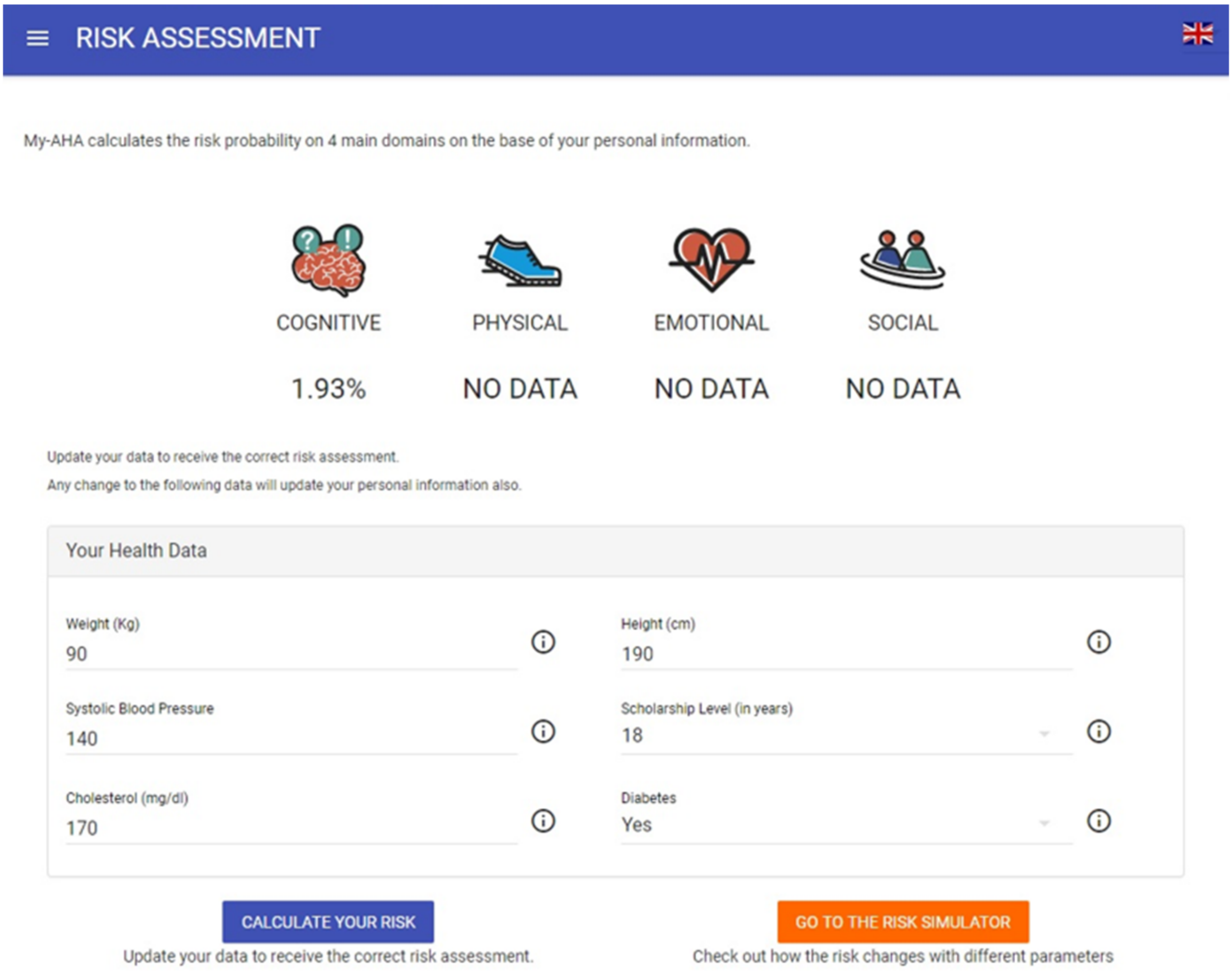


Fig 18. Risk assessment screen in MY-AHA

We found distinctive differences in the perception of the current risk assessment screen in the group of community dwelling older adults and older adults living in care home facilities.

Community dwelling older adults in general were not keen on this visualization. For them it was not clear how the risk value was calculated and they would prefer an explicit explanation on how their individual risk is calculated. For instance, it was not clear to them that all six parameters affected the risk value. Further, it was unclear to them whether all parameters had the same relevance and importance for the risk calculation or for instance, education was inferior to height. All participants questioned the value and advantage of providing decimal numbers in the risk level. They preferred to have absolute numbers here. A major point for discussion was the scholarship level. Participants did not accept that value to be a valid parameter for risk calculation, since it only considered the years of school or university education but no other education, for instance advanced training or education in health competence, physical activity or nutrition. They would prefer a system which is more differentiated about such aspects. Most participants were familiar with the concept of Body Mass Index (BMI) and they asked why the BMI is not displayed when they enter their height and weight. They would expect the system to provide such measures to them. In this context, an additional major issue concerned with the cholesterol parameter. There are different numbers (and metrics in different countries) which are indicating the cholesterol level. The system however, only allows one value. Participants would like to have the opportunity to choose which value they can use (HDL, LDL for example), as they are not familiar with the value provided by the system. With the current version of My-AHA, they do not know which Cholesterol measure to enter. Finally, all community dwelling older adults agreed that the reference to scientific research have not been useful for them. The main reason here concerned with problems in understanding the referenced articles, regardless of the language. They demanded only easy to understand explanations and texts.

In contrast to community dwelling older adults, we learned that members of care home facilities preferred the dashboard screen with icons and %-values as shown in fig X. According to their statements and discussions, the icons helped them to understand which risk was addressed. However, they agree that absolute numbers should be provided instead of decimal numbers.

The second visualization we showed to participants illustrated the individual risk in bubbles (see fig 19). The size of a bubble is determined by the level of risk a certain domain has.

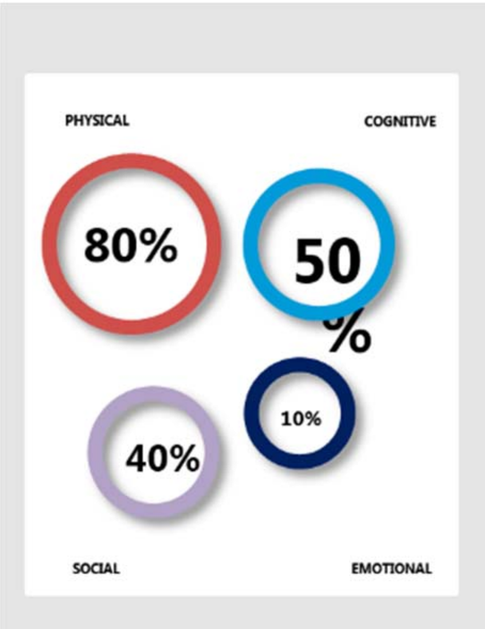


Fig 19. Risk visualization with bubbles

This visualization was preferred by community dwelling older adults. For them it has been a clear overview that provided appropriate information. Older adults in care home facilities did not articulate any positive or negative feedback on this visualization. However they made it clear that they preferred the overview page with the icons (see fig 18).

Finally, we presented a third visualization that illustrated multi-domain risks of a person in a radar graph (see fig 20). From the inside out, an increased risk for each domain is indicated by a value closer to the outer boarder of the radar. A bigger surface (see orange area in fig 20) is therefore indicating a high risk level in several domains. Also there is a reference value plot (age dependent norm value range) below in blue color.

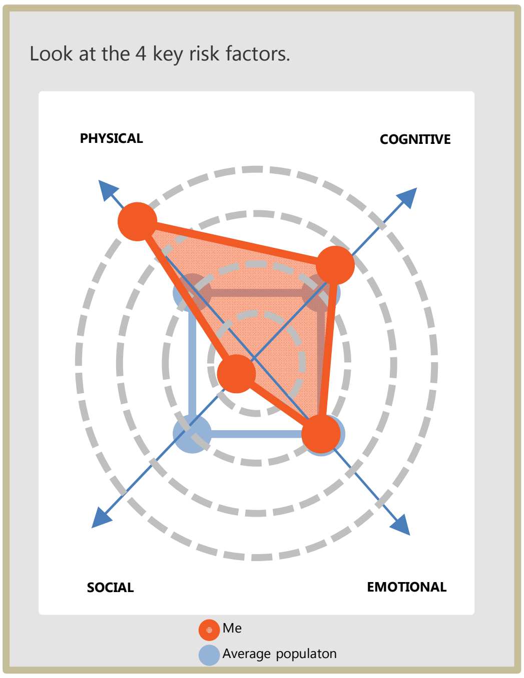


Fig 20. Risk visualization with a radar

Community dwelling older adults appreciated this visualization for its high level of information. Even though they remarked that this visualization alone would be too complicated, they would prefer it in combination with the bubbles (see fig 19) and the single risk factor visualizations (see fig 15 as an example). They mentioned that this visualization would provide them with more detailed information than the bubble visualization, and they would like to have the opportunity to change to this visualization in case they needed more details about their risks.

In contrast, participants living in care home facilities perceived this visualization as too complicated. They believed that this visualization would be better suited for younger seniors than for them.

However, both groups agree on the fact that there is a strong need to label all axes and values correctly and provide smart information, for instance tooltips behind small icons, etc.

4.4 Secondary stakeholder perspectives

4.4.1 Acceptance

The acceptance of wearables is rather high for certain parts of the secondary Stakeholders. *„ […] when I think of those health-bracelets […] I think it is so. That's one of the […] coolest gadgets that [have been] developed." (Caregiver 3).* There's a huge potential that those devices accustom current users to health-technology which would reduce the inhibition level of use in old age. *"If I would have worn those in youth because they're in or fashionable or because they have been of use to me personally. When I use that in order to stay healthy in youth it's no problem to use such a devise in old age as well even under another aspect." (Caregiver).* However, the opinion of this being for the baby-boomer generation is not shared by everyone and rather reduced to the younger generation. *"Either the users already work out, then they possess such pedometer-watches too, then they already bothered with such things beforehand, but I'd say that most of my patients are at an age, where computers and technology are disconcerting." (Physiotherapist 4).* On the other hand, this opinion is also not shared by all of the stakeholders. *„ […] just bring blood pressure devices with you and look around in the group, whether there are 20-year olds or 80 year olds, it does not matter at all. I bet in the end everyone there has had his blood pressure measured." (social association 3).*

Health technology is also seen as addition to the program of the care providers and has an advantage with this especially when an alternative is sought because of spatial, personal or financial reasons.

"I think it's reasonable, because- [if] it's used at home […] it's a regular exercise, because we can only meet each other once a week and that's not enough." (physiotherapist 4).

There are also doubts, that the wearables don't motivate the users to work out more than what they already would do at other sportive obligations. *„If someone has such fitness trackers, they also have to use it themselves. Whether I would go on a walk because of those is probably the same question I ask myself, whether I should go to the fitness center in the evening or not. One has to conquer one's weaker self. Whether I play soccer, work out or go on a walk. It's true that the tracker would remind myself more often, but after 3 months I probably wouldn't care anymore." (social association 3).* This opinion is also shared by the private health insurances. *„I really doubt that this is possible. Even though I know that we're just at the beginning of a process. But as I already mentioned there are often people that handle their health indifferent no matter what you offer them, like for example some devices or gross messages on cigarette boxes […] But you won't be able to break their habit of smoking with your devices. Except for those, that are already willing to find a* *way out of their habit. "(private health insurance 2).* Even if those technological possibilities are used, it' mandatory to find the appropriate relation to them. It's impossible for technology alone to promote. *„ […] they also forget their own preventive behavior and too much technology should also not be the solution then. It's important to keep the balance […]. Getting active themselves by getting up and doing something good for their bodies and technology might be a good aid but it's certainly not the measure of all things." (statutory health insurance 2).* Furthermore, the technology has to be designed to be usable by all kinds of user groups and therefore be intuitive, its visuals have to be easy to understand and the data has to be secured. *"[…] we would rather say that the requirements should be directed to offers and devices or whatever someone thinks about: wearables, patient records etc to such products. That they are usable, easy to use by anyone and without possibilities to make mistakes while using it. That the data security is given etc. Therefore, requirements towards the offers instead of the insured persons." (statutory health insurance 1).* If those key points are kept there's a good chance of success using those devices. One of the interviewed private health insurances already had good experiences with a diabetes app used by elder people. *"[… We're offering afflicted persons to manage their blood glucose levels online. Doctors, diabetologists or diabetes advisors are able to take a look at them if the customer wishes for it by the way. […] The customer itself has to decide whether he wants someone to have access to the data. […] Interestingly a lot of elder people like to do this, to our surprise. Those that first had their doubts, since they are not technophiles. Because they say, "I just have a very old computer at home" but due to the very good coaching of the call agents we were able to build a resonance or willingness to use it online and now after two years […] it's noticeable that it's very well received. That's something we'll pursue for sure. (private health insurance 1).* Apart from that they also see lots of possibilities with technology for their insurance persons. However always under the premise of the patient being the owner of their data and that all processes are handled transparent.

„There are definitely advantages if the elder people agree to the offer. They know that themselves especially with that boom in the development regarding only the mobile phone. That they struggle at the beginning, but if it's possible to design the technology as easy as possible, then I think that there are advantages for sure. A disadvantage is the gathering of data. With that I mean the data security: Where does my data go? Who sends it? Who's able look at it? How does it get transmitted? Is it used for some analyses I don't even want? Are they published somewhere I don't even want? Those are… I wouldn't say disadvantages but doubts of elder people that have to be taken serious here. Because younger people handle that more loosely, however being watched all over all the time is an experience that elder people are suffering from and which is the reason why they first say: "I don't need that right now. Someone does not need to know everything and where I

am at which time and how I move." On the other hand, if you carefully show them due to learning by doing something really useful that they are able to try, when they have the possibility to get that step, then you are able to convince them to use other technological support options." (private health insurance 1).

Still health technology cannot replace a doctor. It can be used to support the patients in their treatment and prevention and might serve as some kind of early-warning mechanism though. But the final diagnose has to be given by the intended personal. *„ […] it's not possible to replace an actual examination. It can describe symptoms at best and just possible explanations for those symptoms or even suggest treatment possibilities. […] Supporting telemedicine for sure, where there's just a transmission of body parameters to an appropriately qualified officem that works as some kind of early-warning mechanism. Be it in the cardiac area, […] that one says, okay that patient is at risk of heart attacks, we'll gather data to cover the situation in case […] he collapses and cannot be found. That's an important example. That's what we think! What we think is really reckless though is a tutorial […] to do physiotherapeutic exercises via video. That's what we think is really problematic especially for elder insured person, as there's no one that adjusts their position at physiotherapeutic exercises. […] That means that they're able to harm their health, if they are not doing to 1-on-1 at a place where a therapist does the exercise with the patient or is nearby and able to interrupt. […] That's what we think is critical. However, it's probably not unimaginable on the long run. That's because we have more and more areas in the federal republic that are underserved when it comes to doctors and therapists." (private health insurance 1).*

4.4.2 Usage

The secondary stakeholders don't always think that the technology is useful. That's why a conversation about the eating habits is prefered at nutrition counseling. *"No, […] we get to know about that during conversations." (nutrition counseling).* That might be the case because the area is not covered sufficiently with technology which is why in accordance not many persons do research. *"Yes, I did have 1-2 patients here, that told me something about an app. But it's rare […]" (nutrition counseling).* That's different for the physiotherapists and it's possible to see remarkable successes that can be lead back to health technology. *"[…] I have the feeling that they are more active. They also sometimes compare their watches. How many steps do you have today and yes… they compare. Who has done more by now?" (physiotherapist 4).* That can also be applied to the rehabilitation of the patients. *"When they are discharged from the clinic, they get a camera with MS Connect and appropriate software for the support of the physiotherapy at home. That spares them having to drive around and they have a good and monitored mobility at home in the meantime." (IT* *company).* This usage of eHealth applications is actively supported from the statutory health insurances with own offers.

"[…] if you visit our homepage, I can just repeat again and again that you are going to find one app or another for eating habits, movement habits, relaxation habits and so on […]" (statutory health insurance 2). The support of those offers is limited though. The legislator gives the health insurances still relatively strict guidelines about what they are allowed to do with the new technologies at the moment. *"[…] a big topic for us are also wearables, yes it has to be taken a note of the big number of people that are measuring their jogging kilometers or calories and those are all processes we have to recognize and that's where we're also under a certain expectation pressure […] to offer our customers what they would like to have and that's why we demand to have much more lawful freedom. We're not allowed to do so many things we'd like to offer nowadays and that's what disturbs us, as we're afraid that our business is taken over by Amazon or Alpabet then and we in Germany, the statutory health insurances, are kept away from such processes." (statutory health insurance 1).*

The goal of this insurance is to use new possibilities as fast as possible, as long as they are validated. *"[…] The goal naturally consists of always offering the current technological progress to our insured persons, as long as it is deemed reasonable and appropriately tested. In order, not to lag behind." (statutory health insurance 1).* However, there are also doubts that the new possibilities indirectly stress the patients and could therefore cause negative effects in the aftermath.

"Let's take this smartphone for example […] one always thinks they might have missed something which unconsciously builds up stress too. […] And that's effecting the sleep quality and thus the health, I think that's scientifically proven enough." (social association 3).

4.4.3 Expectations

The demands towards the health technology are naturally high. That's why it is expected that the technology proves its usefulness and shows users and wearers that it makes sense to use them.

"[…] in the evidence that technology also has economic effects on the payers. […] That means in the relation between payers, doctors and caregivers and naturally the […] patients. That has to be proven. "(Caregiver 3).

But chances are also seen. Especially if you cannot trust the provided information of the patients the technology is seen as chance to get valid data.

"If you are then […] able to recognize clearly what happens there. Especially when people get dementia and do not provide correct information anymore. If there was a sensor technology that

would measure objective data, then that would be a huge step forward, wouldn't it. Then that would be a blessing as long as it's handled correctly […]." (Caregiver 3).

As well as recording this data. *„That one […] gets an appeal. If I go on a walk, then I now have written evidence afterwards […], how much I walked." (Physiotherapist 4).*

It is also understood as an opportunity to match up the preventive health services individually to the patients.

"That would be interesting of course insofar that […] it can be adjusted to one person's weak points." (Physiotherapist 4).

The goal of this recording of data would be to understand the patient in the end in order to meet his need accordingly.

"We want to know based on certain data which prevention would make the most sense for a certain group." (IT company).

However, the autonomy of the human must not be harmed due to the diversity of options that might possible with the health technology.

"Just like with other diseases it's questionable whether one should be allowed to intrude that far into the self-determination of a human. I don't think that this is future-oriented. At least not in Germany and not at the statutory [insurances]. (IT company).

Or lead to a price discrimination. At which insured persons get a discount if they use health technology. At least that's how the GKV sees it.

"[…] this must always remain voluntary and no one should be allowed to discriminate someone that says for some reason: "I don't want to do that now." This must also be the case and there should not exist different contribution models or something similar that give false incentives. But we would like to support the positive motivation to use it." (statutory health insurance 1).

Partially it's even assumed that health technology will make use of robots that could replace caregivers in the future.

> *"Surely there are domains that aren't subsequent but surely there are also many domains where such technologies […] could replace caregivers occasionally. We already have care robots from japan where relationships are formed, between the older people and the computers, the robots. […] They are not alone, they hold conversations, even with only a computer. But, I do think so, that the future lies there. And not only in Japan." (social association 3).*

The stakeholders of the insurance industry are a little more hesitant in comparison and, at least for the near future, see different cases of application that they want to further develop.

„ […] will also be a possibility in the future to set even stronger emphasis in the domain, particularly when it comes to the topic of the psyche, when it even comes to the topic of management in case of illness, from the medical condition in the morning until the recovery, to develop chains that, helped by technical support make sense by all means […].” (GKV 2).

The interviewees share the consensus that this technological progress is an endeavor they have to face.

„ […] naturally there’s enormous challenges the leading technology which is justifiably talked about everywhere is the internet of things and we likewise must contemplate in medicine in the basic supply, no question.” (GKV 1).

There might be possible prospects specifically for older people. The challenges they face in their everyday life could be cushioned by technology.

„It can definitely also support, be it with everyday helpers now when you think of the older insured parties. In their own living quarters. That you would simply offer assistance options. That they feel animated to stay autonomous there […]. But also through respective, there’s also more and more older insured people that know their way around a smartphone, that simply can use the respective apps for themselves.” (PKV 1).

However, there is also worry that the collected data might not be correct and erroneous data could arise due to improper usage or badly developed technology.

„The risk I see in this is that many could feel competent to play in this métier but cannot just guarantee the quality that has to be warranted for a sustainable and substantial service. […] I am greatly worried about the sensor technology that is purchasable in Media Markt, that is connected via plug and play and where people get promised it will all work. That still has to be proved as a start.” (Caregiver 3).

This erronous development could then also lead to persons not feeling stressed enough about the findings and therefore causing the opposite of what is attempted to be accomplished.

„If you delve into yourself too much, which you have never done before and […] got through the day healthy, and now always have it, always my high, I have to feel this again, I have to look at that again, is everything in order. Then I could be inclined to be a hypochondriac and challenge everything.” (social association 3).

4.4.4 Structural problem due to urbanization and skill shortage

Another problem is of structural nature and promotes eHealth applications. The supply in rural areas is getting harder and harder because of the increasing urbanization of the population.

„ Because we have more and more areas in the federal republic that are doctor and therapist wise underserved. I think of Mecklenburg-Hither Pomerania and Brandenburg, there are areas where you won't find a doctor or physiotherapy office far and wide and I think you should see how that can be regulated better." (PKV 1).

Moreover, the caregiving has the problem that less and less people are cared for at home and at the same time there are not enough professionals on the job market to provide for them.

"Because it's known that there is less and less household care, kinsman care. That these people therefore rely on professional help frequently etc. we also have a job market problem there. Who is supposed to do all that in the future? In this sense the technological devices, I'd say, that act as fall prevention or controlling of the nutrition basics etc., extremely important, yes, and you can only welcome the research being carried on." (GKV 1).

On the scale of things there are less and less employed people that have to carry the financial responsibility for more and more seniors.

„Naturally we also have to deal with the demographic progression. We'll obviously have less employed people in proportion to older people who will then have special medical needs, that is a central topic of the future […]". (GKV 1).

4.4.5 Incentive systems

By now incentive systems are used by some health insurance companies. In most cases they serve the purpose of rewarding a health beneficial behavior.

With the interviewed health insurance companies, there is no classical incentive system in place which sets financial inducement to care for your own health. However, Ms. Siegel told about a different system with a similar effect (partial refunding of payment). The clients get a fixed amount as a refund at the end of the year of contribution if they have not made use of any services that is defined by the health insurance company. This peculiarity is suspended for preventive medical checkups and the clients can get the refund although they made use of reimbursable services.

„Well you don't get anything back but […] who goes in for a regular dentist appointment per year, those costs are refunded but they don't count as a service in the sense that the client would lose their right for the refunding of their contribution […]." (Frau S. – PKV)

Mr. Wolf of the statutory health insurance company has a generally positive outlook on incentive systems. For him it is important however that there is no discrimination and that an insurant is not urged because of a financial incentive.

„ […] when you have the motivation, we want to encourage you with offers accordingly. […] But you certainly need to add that this should always be voluntary and […] there shouldn't be

any wrong incentives with differing contribution models or anything like that. But we would like to encourange this positive motivation to do it." (Herr W. – GKV).

His employer already provides such an offering accordingly.

„We already make incentive schemes with bonus programs to show healthy behavior and when you collect enough points you simply get something nice." (Herr W. – GKV).

But for this to be, not all available data should be part of the system. *„ […] in my eyes, some things should be incentisized with bonus points but that should not be in place for the whole offering […]." (Herr W. – GKV).*

Mr. Birke, who is of the statutory health insurance company as well has a different opinion about it. According to him the health of a person should be viewed as a whole and progress should generally be rewarded. *„ […] health is generally rewarded. On all accounts. "(Herr B. – GKV).*

That the bonus programs would have impact is something Mr. Bayer from the social association doubts. For him the incentive is too small.

„ […] many health insurance companies already do it, that they offer a sort of bonus when you can attest that you're in a sports club, that you do this or that, […] if that really enhances health potential or if health is improved, I dare to say I doubt it. […] just because I refund 50 Euro in contribution, it will also […] be unrewarding, […] to care for your health. "(Herr Z. – social association).

His colleague Mr. Grieß thinks of bonus systems as unfair, because healthy people are given an advantage and sick people are at a disadvantage.

„The one who is fit is being rewarded because he was lucky and the other, for whatever reason he got sick, […] is being disadvantaged." (Herr G. – social association).

Furthermore, there is a big risk that too much data would get transmitted to the health insurace company. Because this could lead to a selection of clients in the long run.

„Das should not happen. […] where everything is disclosed, the health insurance companies would now and again say: 'What do we get out of it.' […] would maybe develop a second-class party again. Right? Maybe not at the doctor's, but at the health insurance company, […] because one would be more important to me than two or three others that cost me countless thousands of Euro per year. I wouldn't run the care of this member as strongly when the data is going to the [health insurance] company. That would be of big detriment." (Herr Z. – Sozialverband).

5 Implications for Re-Design

5.1.1 My-AHA Dashboard

First and foremost, it has to be focused on finishing the key features of the app that did not work properly during the usability tests. Using the app as of now does not give the participants any advantages and therefore lead to questions what the app actually is good for. It's difficult to redeem the first impression of an app, if users already characterized it as useless. Therefore, it's important to show the users remarkable changes and provide them with a user-friendly interface, when all features are implemented and the bugs mentioned before, have been fixed. This includes fully translating the app into a certain language as the users think they are unable to use the app as it's in a foreign language. Since the participants overlooked the flag option to change language it would make more sense to set a language directly during the registration process.

In order to improve the interaction flow it's possible to simplify the process of logging in by staying logged in right after the registration. A few participants mentioned that beside themselves no one would use their device which is why it would be more comfortable to stay logged in. Especially one participant is highly annoyed by the amount of passwords he has to use. Another way of improving the interface is staying close to the users' natural expectation and common guidelines for interfaces. Hence when a new site is getting displayed it should start at the top of the page like the reading direction. Concerning the unclickable navigation bar during the registration process they could either make it more obvious that it's not clickable by greying it out more or instead make it clickable for real to fulfill the built affordances. Furthermore, they could add a progress bar with indicators what information is exactly missing. To countermeasure, having to delete a wrong value first before being able to add a new one, it might help to mark the whole value if you tap on it once. A double tap would enable the participants to edit the value. This would allow the participants to just write over the old value without having to delete every digit.

The wording of the app should focus more on their target user group, which implies that it should be kept as simple and self-explanatory as possible. Unit's should be displayed next to the input field to enable a fast interaction. That's also the reason why technical terms such as i.e. "cognition" should either be replaced or explained better. The participants also struggled with terms like "systolic blood pressure" wherefore there should be at least description of the term as well as the format in which the participants have to input it. Ideally it should link to a manual how it's possible to measure the value. As a few participants were doubtful during the usability tests to reveal those data to the application it would also be wise to explain why the values are needed, which evaluations might be possible with them and what kind of benefits they could have.

It's also important to use symbols the participants already know from the real world or logos they have already gotten used to. Therefore, it would be easier to understand how to improve a certain value if the logo of the app they have to use for that were displayed over the value instead of a symbol that tries to embody the use for that app.

Furthermore, in order to avoid uncertainty due to misinterpreted affordances it would help to follow the basic guidelines and conventions of interfaces. Input fields should be visible and recognizable as such accordingly. When providing additional information it should not be hidden behind an icon and rather have a small information icon next to the item that needs further explanation. It's also more common for participant's to tap on icons for information rather than text. As the symbol (brain) in the app does not serve any other purpose, it might be wise to make it clickable too. When the participants wanted to change their password the display showed a password of much longer length. This might be a security measure in order to hide the true length of the password, however it ended up also confusing the participants as they thought they made a mistake setting the password.

Last but not least the interface should be developed more dynamically and for more devices as participant also tries to look at the app via Browser and Smartphone.

5.1.2 My-AHA Cognitive game

The solution suggestions for the N-Back games focus mainly on the manual and explanation of the game logic. A few participants mentioned that they understood the game better after having it explained by someone. It might be possible to improve the understanding by adding audio to the manual as it's an additional option that might help to remember the game logic. Another suggestion would be to scratch the video format and replace it with a presentation-like format, where the participants are able to click on continue once they are done reading and understanding a step. It might also help to start with a tutorial level that shows the users in small steps what they have just read in the manual.

It was confusing to some of the participants to have started with level 2, therefore it might also help to start with level 1. The participants also often did not realize they are in a new level with higher difficulty as they did not see the n-Back title on top of the game board. Therefore, having the "n-Back" displayed in the middle before a new round starts and then moving onto the top could help them realize how many steps back they have to remember. The "n-Back" in particular confused the participants as they are not able to understand English, and mixed up the "Back" with the German "backen". It might help to translate the "Back" to "Zurück".

To counter the problem of not knowing where to tap in the n-Back game it's possible to implement a button (and still making the screen completely clickable to make sure). The traffic light has become better understood when it was explained in the manual. It might not be that bad that it is at the side, as it also does not disturb the users with a prominent sign that could distract them in their trails of thought. As for the CBM training it has only been suggested to reduce the time or to raise the difficulty due to levels like in the N-Back trainings. In higher levels there could be i.e. more point options.

5.1.3 My-AHA Nutrition Application

As the main issues of the nutrition consisted in the inconvenient and time-consuming entry of ingredients the solutions to improve the app will focus on this factor. Typing in the names of the ingredients disturbed the participants since the majority are still new to tablets or smartphones which is the reason why they are not able to type fast as they sometimes need to search for the letters on the keyboard. Therefore, an alternative might be voice commands or being able to directly scan the barcode of an ingredient. By scanning the barcode the users also wouldn't make mistakes of using an abbreviation or different name for a product.

Another factor was having to input a meal each day anew. Hence an option of setting a constant meal for i.e. breakfast would be handy and would save time. The participants could be asked each day whether they really ate it and have the chance to edit it if that was not the case. A further way of shortening the process might be the system suggesting dishes that the user adds more often for a certain meal a day. It has also been wished for having the option of editing a meal on the page itself in order to change small ingredients (i.e. a spoon of sugar to coffee) without having to add those ingredients extra.

Additionally, the participants would like to have an overview option that lets them filter after contents such as fat or carbohydrates. This would enable to see which ingredient has a lot of those contents and which they should avoid. A traffic light like indicator has been suggested for an easy way of understanding. Such an option was deemed a valuable option to a nutrition app and should not be amiss. The participants have also been disappointed in the tips on the landing page as all of them were very general and not individualized after their eating habits.

5.1.4 Original platforms

Special requirements might be needed for the care home facility Marienheim. As the majority of the participants of that group are unable to stand safe for the duration of an I Stopp Falls game, they mainly play while sitting. However, the speed of the Ski-game is increased while sitting which influences the difficulty. Therefore, an option to switch the speed of standing and sitting might be an option. Another problem consisted in them having struggles to reach with their hands for the solutions of the working memory exercises (calculations, memorization) while skiing. The options are too close to each other which is why they end up choosing a wrong option on the way of reaching for the right option. A few are also unable to reach high enough, which is why they hold up a tinkered hand on a stick. It could help them if the options would be placed like in the graphic below.

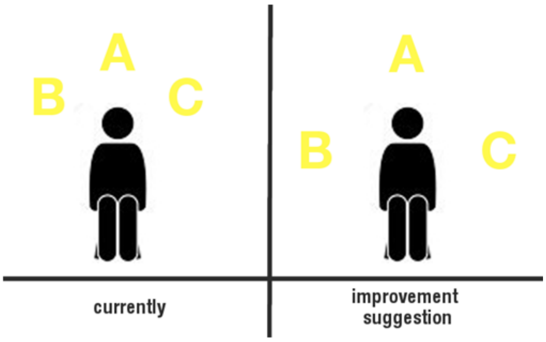


Fig 21. Choice Selection via Kinect Gestures

Additionally, it might be a good use of loading time during the launch of ISF to provide the user with tips on what clothing they should wear for a good Kinect recognition and how to recalibrate the Kinect in case it has a bad recognition.

Pls. see also chapter 4.3.1 referring to the social context of such technology based interventions.

5.1.5 Risk visualizations

Single risk factor visualizations: The risk visualization currently in place is not the preferred visualization of participants in our study. Pre-frail community dwelling older adults preferred the corridor visualization showing the average development (see chapter 4.3.2). An important feature here was that participants were able to put their risk value into perspective and evaluate their own risk compared to a reference value. In contrast, frail older adults living in a care home facility preferred the tachometer visualization. The colors helped them to understand the meaning of the risk value. Further, the tachometer form was familiar to them as it resembled a tachometer in a car. Therefore, the results suggest that further development of My-AHA should focus on these two visualizations.

Multiple risk factor visualizations: The dashboard overview page, as it is implemented now suffices the requirements of frail older adults living in care home facilities. Nonetheless, community dwelling older adults perceive the dashboard overview as too simple in the sense that it does not provide enough information. They rather preferred the bubbles and the radar, as the design and messages were easier to understand. However, community dwelling older adults wish for additional opportunities to individualize the visualization of their health data.

Therefore, our study suggests that MY-AHA should implement two dashboard alternatives, an "easy" and an "advanced" mode. The "easy" mode would display the graphs in a simple design and only provide simple information, while the "advanced" mode would use graphs with higher complexity and a deeper level of information.

6 New Use Cases

6.1 Stepping Game

To reduce the burden of falls in older adults effective fall prevention programs need to be developed and implemented worldwide. Targeting deficits in movement velocity as well as foot placement accuracy are likely to represent an effective strategy to optimize balance ability and reduce the risk of falls and related injuries in older people. Therefore we developed a novel, group-based stepping training program aiming to improve motor, cognitive and psychological fall-risk factors in older adults.

The initial feasibility, pilot-study comprised two training sessions per week (60 min each), for 9 weeks. Participants were 20 healthy older adults (aged 60 or older) without severe mobility impairments and health conditions.

In order to evaluate aspects of enjoyment, perceived effectiveness, intention to recommend, intention to further use as well as evaluation of frequency, intensity and duration of the exercise program, the subjects were asked to fill in a self-developed questionnaire after the last training session. Eleven of the total 12 statements could be answered with a 5-point Likert scale and one was a yes/no question. At the end of the document, participants were given the option to give additional feedback (overall impressions and further comments) about the training program in their own words. The questionnaire was translated in English and is attached to the annex of this deliverable. The following paragraphs report on the results of returned and completed questionnaires.

Results: There was one drop-out after the 12th training session due to personal reasons. The rest of the participants (n=19) participants completed the intervention (17 sessions in 9 weeks) and no data were missing. No participant indicated any former theoretical or practical experience with such square-stepping exercise. No participants reported any pain or discomfort after the stepping training. The mean training compliance was 86.7 ± 8.5 %.

Frequency (2 sessions/week) and duration (60min/session) of the training sessions were perceived as exactly right by the majority of the participants (84% and 95% respectively on Fig. 21 and Fig. 22). Most of the participants perceived the training's intensity to be high or rather high. (Fig.23)

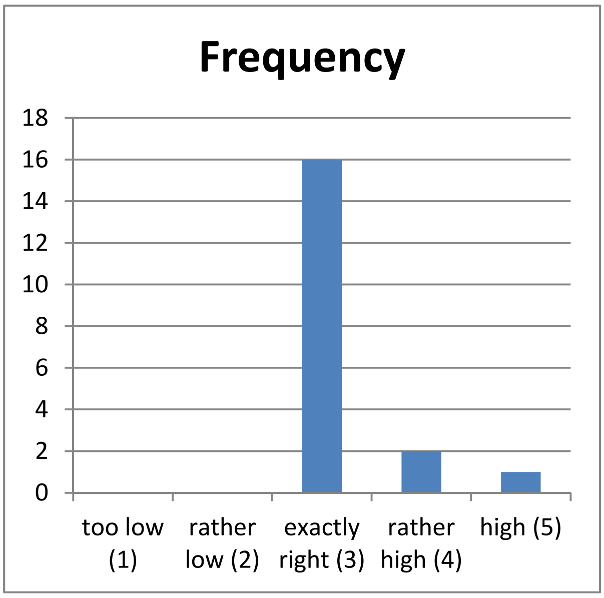


Fig 22. Subjective rating of training frequency

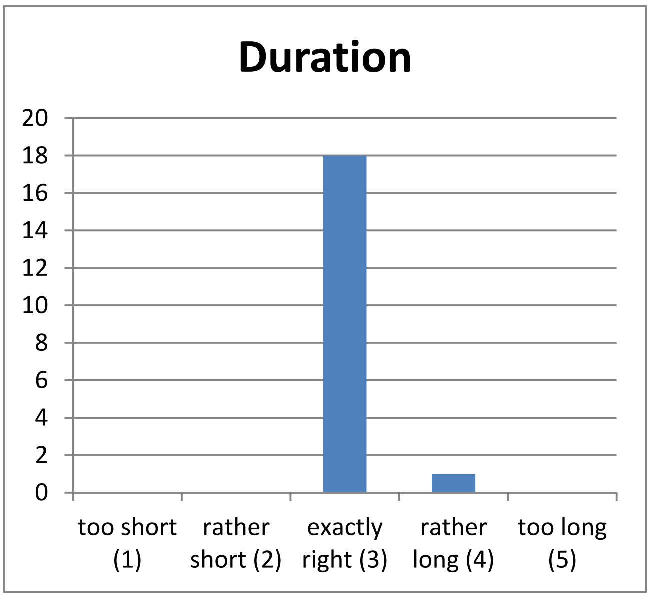


Fig 23. Subjective rating of training duration

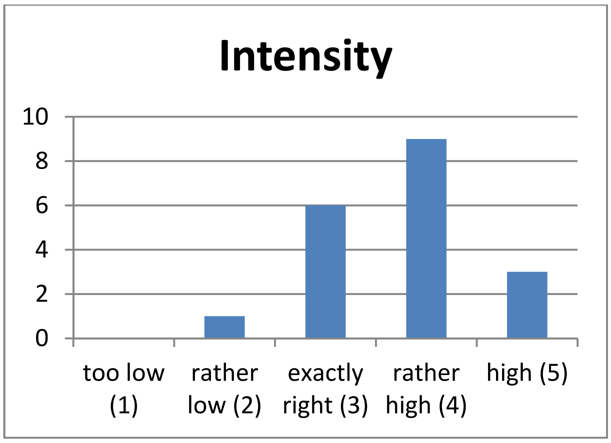


Fig 24. Subjective rating of training intensity

Almost all (95%) participants would recommend this stepping training to people with motor coordination issues (Fig. 24) and somewhat less to people with memory issues (Fig. 25). However, most participants said that they would recommend this stepping training to anyone (Fig. 26).

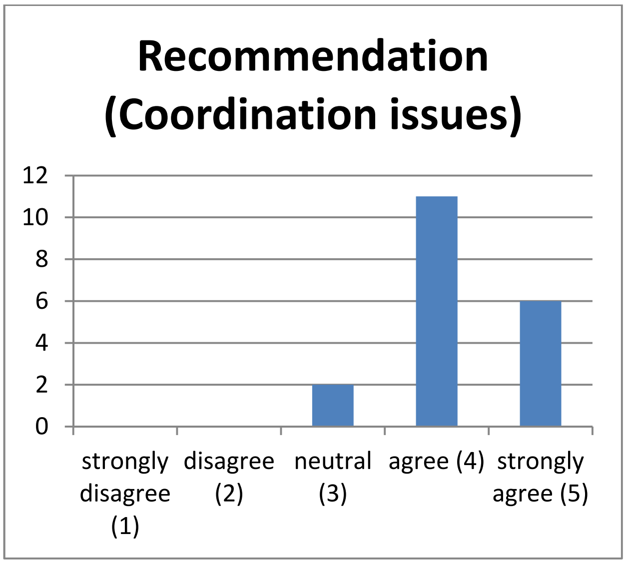


Fig 25. Intention to recommend this training program to people with coordination issues

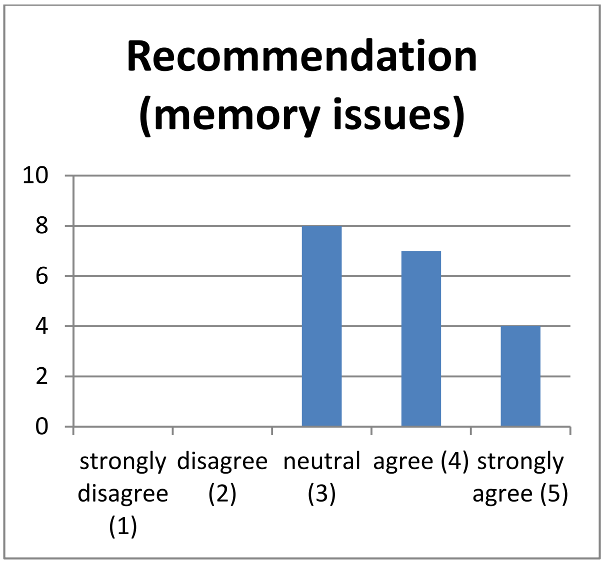


Fig 26. Intention to recommend this training program to people with memory issues

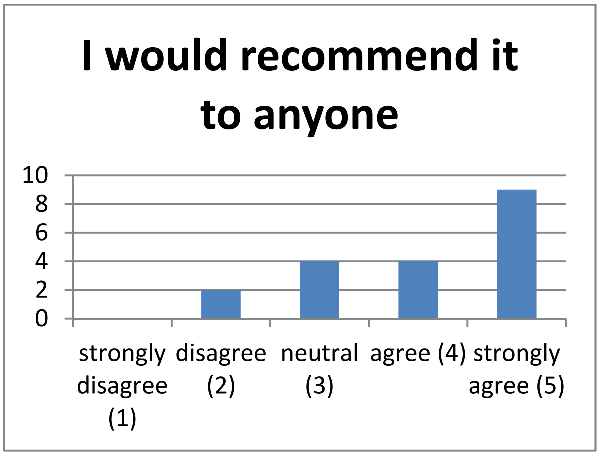


Fig 27. Intention to recommend this training program to anyone

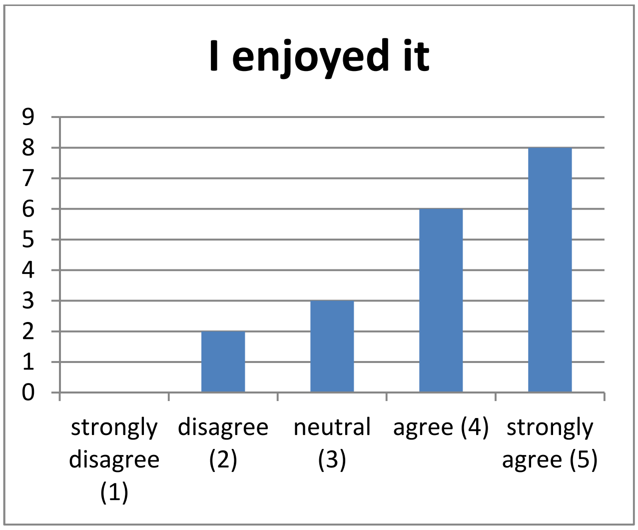


Fig 28. Subjective rating of enjoyment

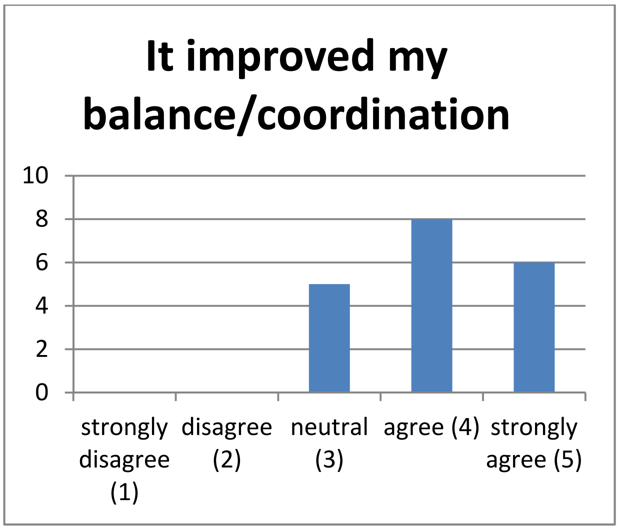


Fig 29. Self-perceived improvement of balance/coordination

Although satisfaction/enjoyment about training overall was not too high (Fig. 27), most of the participants (74%) reported self-perceived improvement of their motor coordination/balance ability, as well as overall positive effects (74%).

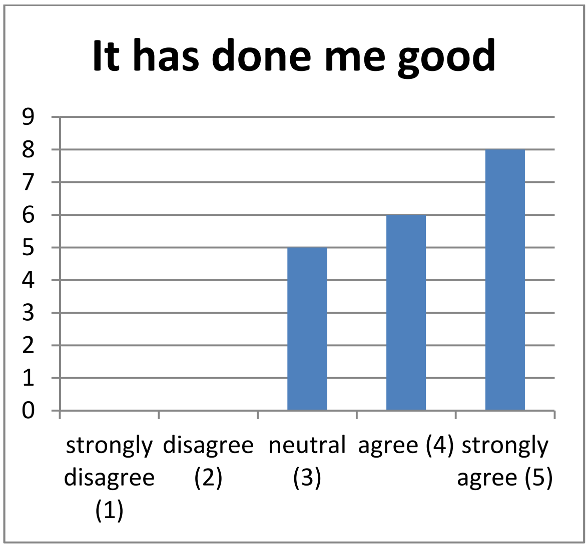


Fig 30. Self-perceived feeling of satisfaction

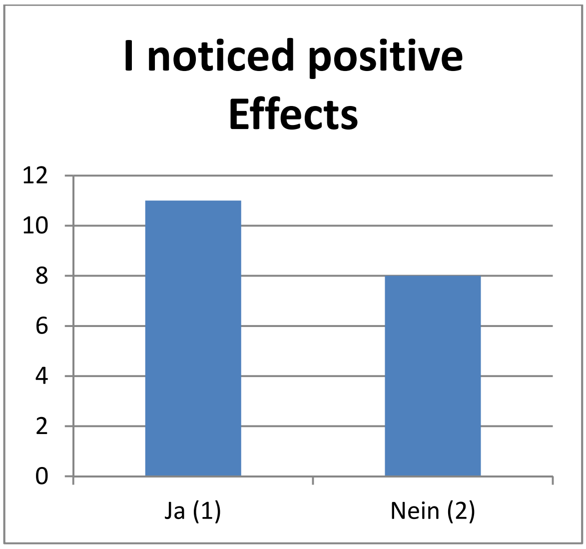


Fig 31. Self-reported positive effects

Training in the sports hall did not enable personally tailored adjustment of the training's intensity; many participants perceived training intensity to be high. As a result, their intention to continue following this group-based training program was rather low (Fig. 31). However, providing this training in form of an exergame would enable personalization of the training's intensity as well as flexible training hours. This is possibly the reason why participants expressed here a higher intention to use a stepping exergame (Fig. 32) rather than a group-based exercise program.

Taking into consideration the participants' feedback our next step will be to provide this exercise program as an exergame using a sensor floor (see text below).

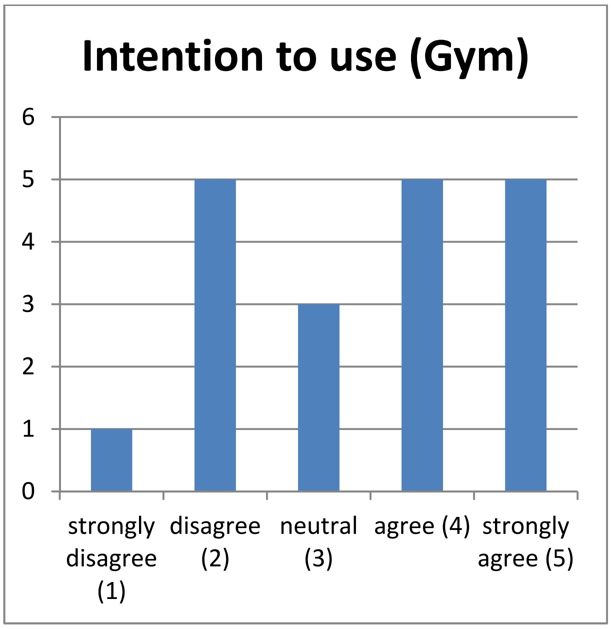


Fig 32. Intention to continue training in a Sports hall

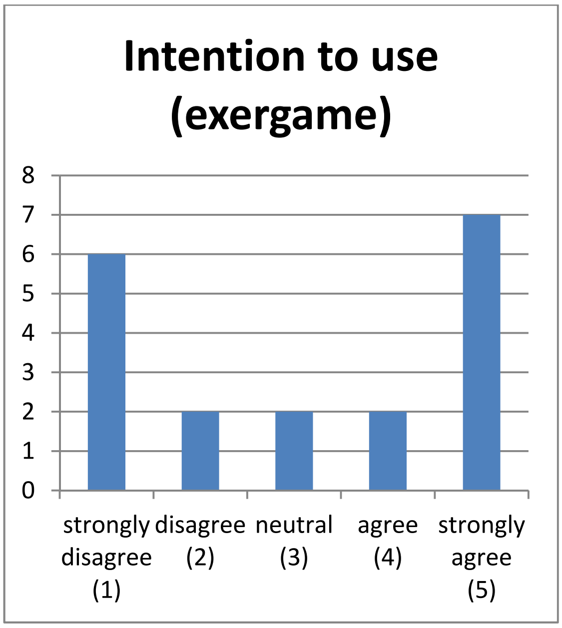


Fig 33. Intention to continue training at home

The SensFloor system from the SME Future-Shape in Germany (see http://future-shape.com/en/system/) provides detailed information for a gait analysis (Future-Shape) which may be used together with the inputs from a newly designed stepping game from my-AHA partners DSHS and USI to derive further insights into the physical (and cognitive) frailty domain.

6.2 SmartFeet

Complementary to iStoppFalls, MY-AHA will provide a new use case with the SmartFeet Platform from Fraunhofer Portugal, which delivers ICT-based physical interventions. The user interacts with the SmartFeet application through their smartphone, which is used as a sensor pointer to control game UI. Alternatively, other sensors such as Kinect, Force Platform or EMG may be used to control the game UI. SmartFeet delivers following exercises:

- Warm up (stepping exercise)
- Lower limb strength (sit to stand exercise)
- Posture (Upper limb elevation exercise)
- Balance (Slow weight shift & One leg standing)

All exercises are embedded in exergames that provide competitive and cooperative modes. Figure 33 depicts an exemplarily exergame (stepping exercise).

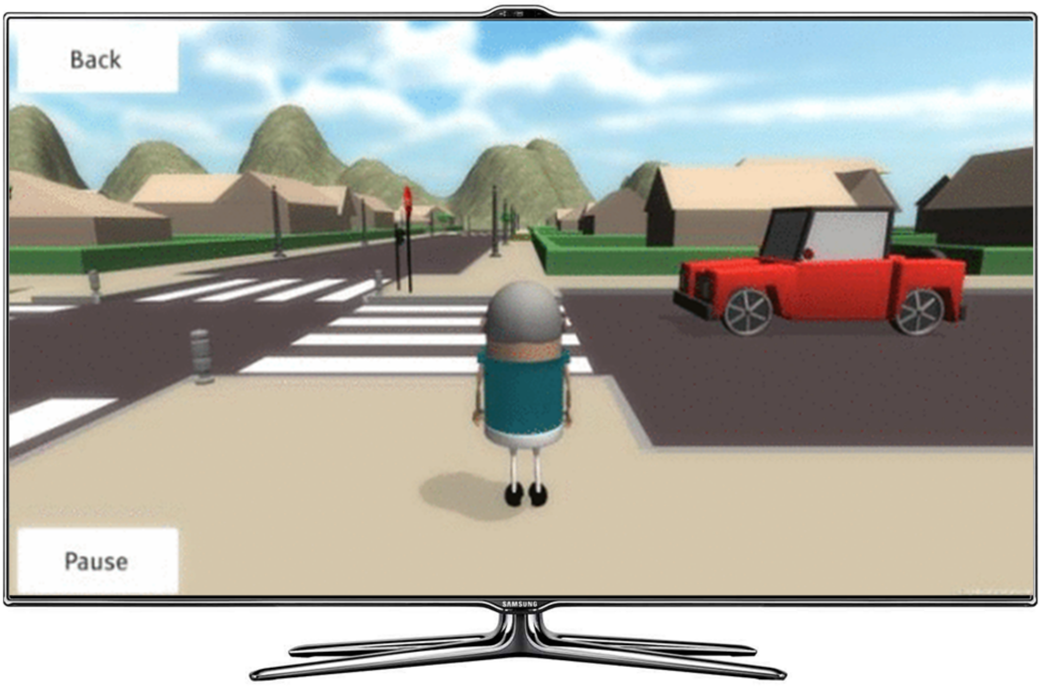


Fig 34. SmartFeet stepping game

6.3 Recipe Recommendations

This new use case is based on end-user feed-back from the living labs. The idea is that all users from different countries, regions and languages are providing own recipes into the MY-AHA database system to be displayed via the nutrition app to all users of a specific language/country. This may trigger social interactions, for instance information exchange about recipes, and further may establish a foundation for social cooking classes, where older adults meet to prepare specific recipes.

6.4 Voice commands

Based on the end user feed-back from the living labs we suggest to add up a voice control function for the nutrition app (selection of food ingredients). We learned in our observations and interviews that entering ingredients via smartphone or tablet keyboard can be tedious and frustrating to older adults. Voice command libraries are available, for instance by google, and implementation may be possible with manageable effort. Therefore, further development of MY-AHA should explore the feasibility of voice command.

6.5 My-AHA Tutorial

Based on the end user feed-back from the living labs we suggest to add up a tutorial explaining the whole my-AHA system and concept (could be easily done by Axure websites but would need a lot of translations).

7 Conclusions

The my-AHA living labs commenced with technical problems and content related aspects. Therefore, the first phase of the study was not only characterized by the participant’s technical learning and related difficulties to using the various system components but can also conclude by a good deal of frustration relating to technical problems hindering the potential smooth operating of the system. Still, it can be concluded from these first living lab experiences that the system was in overall approved by the target audience. Wherever the system was working properly, participants reported to be in favor of the system.

Summing up the design implications that have been presented in this report, three larger topics have emerged. One of them is the technical use of system components. Secondly, we see the design implications to focus on the language and choice of words implemented: the correct, labelling of items is important to ensure an easy use and engagement of the system. The third aspect relates to the contents, looking at aspects that enhance the user experience and/ or support and increase training and use motivation.

As participants were aware of the fact that they were testing the my-AHA system at an early stage of its development, they were contributing new ideas for additional games and were providing their experiences of using the system in detail. Here again, a strong link to the participants respective everyday lives and experiences could be observed, e.g. when themes such as hiking were suggested to form a game concept.

The next step to take for the my-AHA living lab studies will be to conduct further testing of the system with the new demonstrator entering the upcoming RCT. Here, unresolved questions regarding the long-term use in everyday life and more intercultural aspects will be tested with predominantly qualitative methods, incl. also secondary stekeholders from different countries.

The formerly mentioned new use cases comprise a set of factors that have been identified during the Living Lab period to be crucial for achieving a sustainable experience for older adult users over a longer period of time, i.e. a tutorial, new exergames, external partners and vendors, etc.

Addressing these factors and thereby difficulties that had been identified over the course of the RCT and the Living Lab phases II (until M36) and III (until M48) which will be conducted in parallel, should provide a basis for a sustainable future exploitation of the my-AHA system after the project end.

Annex

Annex 1: Questionnaire Stepping Game study

Feedback to the Stepping-Training

1. I enjoyed doing the stepping-training.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

2. I believe that the stepping training contributed to the improvement of my coordination/balance ability.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

3. I believe that the stepping training has done me good.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

4. I noticed positive effects after the stepping training

   Yes No

   If so, what exactly?

5. I would recommend this stepping training to people with motor coordination problems.

Strongly agree | Agree | Neutral | Disagree | Strongly disagree

6. I would recommend this training to people with memory problems.
   Strongly agree | Agree | Neutral | Disagree | Strongly disagree

7. I would recommend this training to people in general (i.e also to people without any motor coordination or memory problems)
   Strongly agree | Agree | Neutral | Disagree | Strongly disagree

8. I would be interested in continuing the stepping training in a group in the gym.
   Strongly agree | Agree | Neutral | Disagree | Strongly disagree

9. I would be interested in doing the stepping training at home using my TV i fit was an exergame.
   Strongly agree | Agree | Neutral | Disagree | Strongly disagree

10. How would you rate the intensity of the training?
    Too low | Rather low | Exactly right | Rather High | High

11. How would you rate the frequency of the training? (2/week)

Too low Rather low Exactly right Rather High High

12. How would you rate the duration of each training session (60min/session)?
    Too short Short Exactly right Rather long Too long

13. Space for additional impressions/comments:

Thank you very much for participating!
Please bring this questionnaire filled out at your last testing appointment

Annex 2: System usability scale and user experience questionnaire

Dear Participants,

The following pages will contain different questionnaires. These questionnaires help us to learn about your opinion and attitude with respect to usability and user experience of the different systems and applications. During the last months, you were asked to use following systems and applications:

- Cognitive games
- Nutrition application
- iStoppFalls (Fall prevention)
- my-AHA Dashboard (Risk models)
- Moodscore application

It is likely that you did not use all of these systems and applications. Hence, we kindly ask you to complete the questionnaires that refer to systems and applications you frequently used during the last months.

Before we begin with the questionnaires, we kindly ask you to provide some information about you, by filling out the following form. After that, the questionnaires will be on the next pages.

On behalf of all project members, we thank you for your participation!

1. Are you…
   - ☐ female?
   - ☐ male?

2. How old are you?
Please write your age in the box ☐

3. What is your highest level of education? (only one answer)
   - ☐ Elementary or secondary school leaving
   - ☐ O-levels; comprehensive school leaving certificate
   - ☐ A-levels; general or subject-specific higher education entrance level qualification
   - ☐ University/college degree
   - ☐ A different qualification, namely: ____________________

4. What is/was your occupation? (one answer only)
   - ☐ Farmer/agriculturalist
   - ☐ Independent professional (e.g. doctor, lawyer)
   - ☐ Self-employed
   - ☐ Civil servant/public official
   - ☐ Employee
   - ☐ Manual worker
   - ☐ Different occupation, namely: ____________________

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5. Would you be prepared to pay a **monthly** fee for using the My-AHA application? If so, how much would you be prepared to pay? (One answer only)
   - ☐ less than 5 Euros
   - ☐ less than 10 Euros
   - ☐ more than 10 Euros
   - ☐ I would not be prepared to pay a monthly fee to use

6. Would you be prepared to pay a **one-off** fee for using the My-AHA application? If so, how much would you be prepared to pay? (One answer only)
   - ☐ less than 5 Euros
   - ☐ less than 10 Euros
   - ☐ more than 10 Euros
   - ☐ I would not be prepared to pay a one-off fee to use the application

7. Would you buy the My-AHA application if it were partially financed by your health insurance fund?
   - ☐ Yes
   - ☐ No

PART I

Usability

*The following section relates to your **feelings and thoughts** that may rise while using the **cognitive games**. Please circle one in each of the following statements, the number that reflects your impressions.*

There is only one answer possible.

Statement	strongly disagree	⟷			strongly agree
1. I think that I would like to use the system more often.	1	2	3	4	5
2. I found the system unnecessarily complex.	1	2	3	4	5
3. I found the system was easily to handle.	1	2	3	4	5
4. I think I would need the help of a technical person to be able to use the system.	1	2	3	4	5
5. I found the different functions in the system were well integrated.	1	2	3	4	5
6. I think the system were too instable.	1	2	3	4	5
7. I can imagine that most of the people can easily learn to handle the system very quickly.	1	2	3	4	5
8. I found the system very uncomfortable to use.	1	2	3	4	5
9. I felt very safe while using the system.	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system.	1	2	3	4	5

*The following section relates to your **feelings and thoughts** that may rise while using the **nutrition application**. Please circle one in each of the following statements, the number that reflects your impressions.*

There is only one answer possible.

Statement	strongly disagree		⟷		strongly agree
1. I think that I would like to use the system more often.	1	2	3	4	5
2. I found the system unnecessarily complex.	1	2	3	4	5
3. I found the system was easily to handle.	1	2	3	4	5
4. I think I would need the help of a technical person to be able to use the system.	1	2	3	4	5
5. I found the different functions in the system were well integrated.	1	2	3	4	5
6. I think the system were too instable.	1	2	3	4	5
7. I can imagine that most of the people can easily learn to handle the system very quickly.	1	2	3	4	5
8. I found the system very uncomfortable to use.	1	2	3	4	5
9. I felt very safe while using the system.	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system.	1	2	3	4	5

*The following section relates to your **feelings and thoughts** that may rise while using the **iStoppFalls System**. Please circle one in each of the following statements, the number that reflects your impressions.*

There is only one answer possible.

Statement	strongly disagree		⟷		strongly agree
1. I think that I would like to use the system more often.	1	2	3	4	5
2. I found the system unnecessarily complex.	1	2	3	4	5
3. I found the system was easily to handle.	1	2	3	4	5
4. I think I would need the help of a technical person to be able to use the system.	1	2	3	4	5
5. I found the different functions in the system were well integrated.	1	2	3	4	5
6. I think the system were too instable.	1	2	3	4	5
7. I can imagine that most of the people can easily learn to handle the system very quickly.	1	2	3	4	5
8. I found the system very uncomfortable to use.	1	2	3	4	5
9. I felt very safe while using the system.	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system.	1	2	3	4	5

*The following section relates to your **feelings and thoughts** that may rise while using the **my-AHA dashboard application**. Please circle one in each of the following statements, the number that reflects your impressions.*

There is only one answer possible.

Statement	strongly disagree	⟷		strongly agree	
1. I think that I would like to use the system more often.	1	2	3	4	5
2. I found the system unnecessarily complex.	1	2	3	4	5
3. I found the system was easily to handle.	1	2	3	4	5
4. I think I would need the help of a technical person to be able to use the system.	1	2	3	4	5
5. I found the different functions in the system were well integrated.	1	2	3	4	5
6. I think the system were too instable.	1	2	3	4	5
7. I can imagine that most of the people can easily learn to handle the system very quickly.	1	2	3	4	5
8. I found the system very uncomfortable to use.	1	2	3	4	5
9. I felt very safe while using the system.	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system.	1	2	3	4	5

*The following section relates to your **feelings and thoughts** that may rise while using the **moodscore application**. Please circle one in each of the following statements, the number that reflects your impressions.*

There is only one answer possible.

Statement	strongly disagree	⟷			strongly agree
1. I think that I would like to use the system more often.	1	2	3	4	5
2. I found the system unnecessarily complex.	1	2	3	4	5
3. I found the system was easily to handle.	1	2	3	4	5
4. I think I would need the help of a technical person to be able to use the system.	1	2	3	4	5
5. I found the different functions in the system were well integrated.	1	2	3	4	5
6. I think the system were too instable.	1	2	3	4	5
7. I can imagine that most of the people can easily learn to handle the system very quickly.	1	2	3	4	5
8. I found the system very uncomfortable to use.	1	2	3	4	5
9. I felt very safe while using the system.	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system.	1	2	3	4	5

PART II

User experience

Please make your evaluation now.

For the assessment of the systems and applications, please fill out the following questionnaire. The questionnaire consists of pairs of contrasting attributes that may apply to the used systems and applications. The circles between the attributes represent gradations between the opposites. You can express your agreement with the attributes by ticking the circle that most closely reflects your impression.

Example:

attractive	○	⊗	○	○	○	○	○	unattractive

This response would mean that you rate the application as more attractive than unattractive.

Please decide spontaneously. Don’t think too long about your decision to make sure that you convey your original impression.

Sometimes you may not be completely sure about your agreement with a particular attribute or you may find that the attribute does not apply completely to the systems and applications. Nevertheless, please tick a circle in every line.

It is your personal opinion that counts. Please remember: there is no wrong or right answer!

Please assess the **cognitive games** now by ticking one circle per line.

	1	2	3	4	5	6	7		
annoying	○	○	○	○	○	○	○	enjoyable	1
not understandable	○	○	○	○	○	○	○	understandable	2
creative	○	○	○	○	○	○	○	dull	3
easy to learn	○	○	○	○	○	○	○	difficult to learn	4
valuable	○	○	○	○	○	○	○	inferior	5
boring	○	○	○	○	○	○	○	exciting	6
not interesting	○	○	○	○	○	○	○	interesting	7
unpredictable	○	○	○	○	○	○	○	predictable	8
fast	○	○	○	○	○	○	○	slow	9
inventive	○	○	○	○	○	○	○	conventional	10
obstructive	○	○	○	○	○	○	○	supportive	11
good	○	○	○	○	○	○	○	bad	12
complicated	○	○	○	○	○	○	○	easy	13
unlikable	○	○	○	○	○	○	○	pleasing	14
usual	○	○	○	○	○	○	○	leading edge	15
unpleasant	○	○	○	○	○	○	○	pleasant	16
secure	○	○	○	○	○	○	○	not secure	17
motivating	○	○	○	○	○	○	○	demotivating	18
meets expectations	○	○	○	○	○	○	○	does not meet expectations	19
inefficient	○	○	○	○	○	○	○	efficient	20
clear	○	○	○	○	○	○	○	confusing	21
impractical	○	○	○	○	○	○	○	practical	22
organized	○	○	○	○	○	○	○	cluttered	23

attractive	○	○	○	○	○	○	○	unattractive	24
friendly	○	○	○	○	○	○	○	unfriendly	25
conservative	○	○	○	○	○	○	○	innovative	26

Please assess the **nutrition application** now by ticking one circle per line.

	1	2	3	4	5	6	7		
annoying	○	○	○	○	○	○	○	enjoyable	1
not understandable	○	○	○	○	○	○	○	understandable	2
creative	○	○	○	○	○	○	○	dull	3
easy to learn	○	○	○	○	○	○	○	difficult to learn	4
valuable	○	○	○	○	○	○	○	inferior	5
boring	○	○	○	○	○	○	○	exciting	6
not interesting	○	○	○	○	○	○	○	interesting	7
unpredictable	○	○	○	○	○	○	○	predictable	8
fast	○	○	○	○	○	○	○	slow	9
inventive	○	○	○	○	○	○	○	conventional	10
obstructive	○	○	○	○	○	○	○	supportive	11
good	○	○	○	○	○	○	○	bad	12
complicated	○	○	○	○	○	○	○	easy	13
unlikable	○	○	○	○	○	○	○	pleasing	14
usual	○	○	○	○	○	○	○	leading edge	15
unpleasant	○	○	○	○	○	○	○	pleasant	16
secure	○	○	○	○	○	○	○	not secure	17
motivating	○	○	○	○	○	○	○	demotivating	18
meets expectations	○	○	○	○	○	○	○	does not meet expectations	19
inefficient	○	○	○	○	○	○	○	efficient	20
clear	○	○	○	○	○	○	○	confusing	21
impractical	○	○	○	○	○	○	○	practical	22
organized	○	○	○	○	○	○	○	cluttered	23

attractive	○	○	○	○	○	○	○	unattractive	24
friendly	○	○	○	○	○	○	○	unfriendly	25
conservative	○	○	○	○	○	○	○	innovative	26

Please assess the **iStoppFalls system** now by ticking one circle per line.

	1	2	3	4	5	6	7		
annoying	○	○	○	○	○	○	○	enjoyable	1
not understandable	○	○	○	○	○	○	○	understandable	2
creative	○	○	○	○	○	○	○	dull	3
easy to learn	○	○	○	○	○	○	○	difficult to learn	4
valuable	○	○	○	○	○	○	○	inferior	5
boring	○	○	○	○	○	○	○	exciting	6
not interesting	○	○	○	○	○	○	○	interesting	7
unpredictable	○	○	○	○	○	○	○	predictable	8
fast	○	○	○	○	○	○	○	slow	9
inventive	○	○	○	○	○	○	○	conventional	10
obstructive	○	○	○	○	○	○	○	supportive	11
good	○	○	○	○	○	○	○	bad	12
complicated	○	○	○	○	○	○	○	easy	13
unlikable	○	○	○	○	○	○	○	pleasing	14
usual	○	○	○	○	○	○	○	leading edge	15
unpleasant	○	○	○	○	○	○	○	pleasant	16
secure	○	○	○	○	○	○	○	not secure	17
motivating	○	○	○	○	○	○	○	demotivating	18
meets expectations	○	○	○	○	○	○	○	does not meet expectations	19
inefficient	○	○	○	○	○	○	○	efficient	20
clear	○	○	○	○	○	○	○	confusing	21
impractical	○	○	○	○	○	○	○	practical	22
organized	○	○	○	○	○	○	○	cluttered	23
attractive	○	○	○	○	○	○	○	unattractive	24

friendly	○	○	○	○	○	○	○	unfriendly	25
conservative	○	○	○	○	○	○	○	innovative	26

Please assess the **my-AHA dashboard application** now by ticking one circle per line.

	1	2	3	4	5	6	7		
annoying	○	○	○	○	○	○	○	enjoyable	1
not understandable	○	○	○	○	○	○	○	understandable	2
creative	○	○	○	○	○	○	○	dull	3
easy to learn	○	○	○	○	○	○	○	difficult to learn	4
valuable	○	○	○	○	○	○	○	inferior	5
boring	○	○	○	○	○	○	○	exciting	6
not interesting	○	○	○	○	○	○	○	interesting	7
unpredictable	○	○	○	○	○	○	○	predictable	8
fast	○	○	○	○	○	○	○	slow	9
inventive	○	○	○	○	○	○	○	conventional	10
obstructive	○	○	○	○	○	○	○	supportive	11
good	○	○	○	○	○	○	○	bad	12
complicated	○	○	○	○	○	○	○	easy	13
unlikable	○	○	○	○	○	○	○	pleasing	14
usual	○	○	○	○	○	○	○	leading edge	15
unpleasant	○	○	○	○	○	○	○	pleasant	16
secure	○	○	○	○	○	○	○	not secure	17
motivating	○	○	○	○	○	○	○	demotivating	18
meets expectations	○	○	○	○	○	○	○	does not meet expectations	19
inefficient	○	○	○	○	○	○	○	efficient	20
clear	○	○	○	○	○	○	○	confusing	21
impractical	○	○	○	○	○	○	○	practical	22
organized	○	○	○	○	○	○	○	cluttered	23

attractive	○	○	○	○	○	○	○	unattractive	24
friendly	○	○	○	○	○	○	○	unfriendly	25
conservative	○	○	○	○	○	○	○	innovative	26

Please assess the **moodscore application** now by ticking one circle per line.

	1	2	3	4	5	6	7		
annoying	○	○	○	○	○	○	○	enjoyable	1
not understandable	○	○	○	○	○	○	○	understandable	2
creative	○	○	○	○	○	○	○	dull	3
easy to learn	○	○	○	○	○	○	○	difficult to learn	4
valuable	○	○	○	○	○	○	○	inferior	5
boring	○	○	○	○	○	○	○	exciting	6
not interesting	○	○	○	○	○	○	○	interesting	7
unpredictable	○	○	○	○	○	○	○	predictable	8
fast	○	○	○	○	○	○	○	slow	9
inventive	○	○	○	○	○	○	○	conventional	10
obstructive	○	○	○	○	○	○	○	supportive	11
good	○	○	○	○	○	○	○	bad	12
complicated	○	○	○	○	○	○	○	easy	13
unlikable	○	○	○	○	○	○	○	pleasing	14
usual	○	○	○	○	○	○	○	leading edge	15
unpleasant	○	○	○	○	○	○	○	pleasant	16
secure	○	○	○	○	○	○	○	not secure	17
motivating	○	○	○	○	○	○	○	demotivating	18
meets expectations	○	○	○	○	○	○	○	does not meet expectations	19
inefficient	○	○	○	○	○	○	○	efficient	20
clear	○	○	○	○	○	○	○	confusing	21
impractical	○	○	○	○	○	○	○	practical	22
organized	○	○	○	○	○	○	○	cluttered	23

attractive	○	○	○	○	○	○	○	unattractive	24
friendly	○	○	○	○	○	○	○	unfriendly	25
conservative	○	○	○	○	○	○	○	innovative	26

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