Interaction Techniques for Tablet Games that Benefit Cognitive Abilities of People with Dementia

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Declaration

I hereby declare and confirm that this thesis is entirely the result of my own original work. Where other sources of information have been used, they have been indicated as such and properly acknowledged. I further declare that this or similar work has not been submitted for credit elsewhere.

Hagenberg, September 26, 2016

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Contents

Kurzfassung

Die vorliegende Arbeit befasst sich mit geeigneten Interaktionstechniken im Bereich von Tablet-Spielen für Demenz. Serious Games für Demenz ist ein gut erforschter Bereich, jedoch gibt es wenig Wissen über die Durchführung von Gesten und Interaktionen auf Tablet-Computern von Benutzern mit Demenz. Da diese Anwender bereits viele Einschränkungen mit sich bringen, wie der Verlust des Kurzzeitgedächtnisses, birgt die Bedienung von Touch-Oberflächen ein weiteres Hindernis. Tablet-Spiele verlangen oft die Ausführung verschiedenster Interaktionen, wie einfaches Tippen, Swipen oder Drag and Drop. Eine geeignete Implementierung von Interaktionstechniken könnte die Anwender bei der selbständigen Benutzung solcher Anwendungen unterstützen. Als Proof of Concept dient ein im Rahmen dieser Arbeit erstellter Prototyp eines Tablet-Spiels. Der Zweck dieses Tablet-Spiels ist es, Menschen mit Demenz im Früh- und Mittelstadium, die intuitive und effiziente Benutzung von Gesten zu ermöglichen. In einer angeleiteten Feldstudie mit Demenzpatienten wurde die Benutzung von Gesten im Kontext der App untersucht. Die Auswertung dieser Daten zeigt interessante Ergebnisse über die Interaktionstechniken von Tablets. Abschließend werden Anforderungen von Serious Games für Demenzleidende diskutiert und mit dem aktuellen Stand der Forschung verglichen.

Abstract

This thesis discusses applicable interaction techniques in the field of tablet games for dementia. Serious games in the dementia context is a well-researched topic. However, there is very little knowledge about performing gestures and interactions on tablet computers by users suffering from dementia. Since they already encounter many restrictions, such as loss of short-term memory, using a touch interface might be another obstacle. Tablet games often require different kinds of interactions, such as single tap, swipe, or drag and drop. An efficient appliance of interaction techniques could support a more independent usage of applications on tablets. A developed prototype tablet game *Mindtraining* serves as proof-of-concept in this thesis. The purpose of the tablet game is to facilitate an intuitive and efficient usage of gestures for people with early- and middle-stage dementia aged over 65 years. In a conducted field study with dementia patients, performed gestures and amount of support for operating the application, were investigated. The evaluation reveals interesting results regarding interaction techniques for tablet devices. Finally, requirements for serious games for dementia are discussed and compared to state-of-the-art research.

Chapter 1

Introduction

The number of people with dementia, especially Alzheimer's disease (AD), is increasing and no cure has yet been found [59]. In addition to medicine-based therapies, also non-medicine-based therapies exist to slow down the progress of the disease. These methods consist of therapies such as cognitive training, playing games, listening to music or biographical work. With help of technology in this context, non-medicine-based therapies could be more accessible for dementia patients.

1.1 Motivation

Recent research shows many advantages to introduce mobile technology into therapy [15, 35, 36, 50, 51, 56]. Tablet games for dementia have received a great interest in research as they have the potential to stimulate dementia patients with help of cognitive training applications [26, 27]. The aquisition costs of mobile devices, such as tablets, are low and touchscreen devices are easier to handle in comparison to conventional computers with mouse and keyboard. Furthermore mobile devices are capable of utilizing assistive technologies to benefit people, who have visual and/or hearing impairments. High-contrast color schemes, scalable fonts and auditory enhancement of visuals could assist elderly people, who have bad eyesight. Subtitles, captions and visual cues for sound effects could support people with hearing problems.

An application, which is adapted to the special needs of people with dementia, could compensate the shortcomings and train the remaining resources. This might lead to a more autonomous usage of new technology. Caretakers would benefit from this, as they cannot afford the time to provide technical support and training for every single patient. Already a small amount of additional workload for nurses can be an obstacle for using a beneficial serious game in a nursing home.

1.2 Problem Statement

One major barrier is the complexity of available mobile applications. Most applications are not designed for people who have cognitive disabilities and therefore make operating the device very difficult. Playing mobile games often requires different gestures, such as tap, swipe, and drag and drop, which need to be learned by novel users. Interactions have to be simple or alternatively be explained in a tutorial-like style. As dementia patients tend to have almost no short-term memory, they might need a tutorial every time they use the application.

These applications need to fulfill special requirements to ease the usage for people who are cognitively impaired. Basically, designing for dementia patients means moving back in time and thinking of events that happened in the past of one individual and the respective generation [27]. Metaphors, which are frequently used in mobile applications, have to tie in with the level of knowledge, the experiences and the cultural background of earlier years. Research projects in the dementia context already give many recommendations for designing serious games. Yet, there seems to be an absence of best-practice approaches for interaction techniques on tablet devices.

1.3 Research Objectives

The aim of this thesis is to explore interaction techniques for therapeutic tablet games, which are suited for people with early- and middle-stage dementia aged over 65 years. Interaction techniques are investigated in terms of ease of use and how good dementia patients are able to remember different kinds of gestures. Requirements for serious games for dementia are analysed and limitations of previous research are discussed. A developed tablet game prototype, called *Mindtraining*, which facilitates an intuitive and efficient usage, is used to conduct a field study with dementia patients and get a deeper understanding of the matter. These findings are used to gather further information for suitable interaction techniques adapted for dementia disease. Intuitive interaction techniques could support a more independent usage of applications on tablets by people with dementia.

1.4 Document Structure

This chapter described the motivational background and problem description of the topic. Chapter 2 discusses state-of-the-art research work in the dementia context. An overview of the limitations of dementia and how technology could help with those is explained. In addition, multiple serious games and their input methods, which were tested with dementia patients, are examined.

Chapter 3 describes the process of establishing requirements for a serious game in the dementia context. The content is about getting to know the users and their needs. The given recommendations are categorized into three aspects: Interface design, game design and prompting. All these findings are used for developing the proposed application *Mindtraining*. Its concept is introduced in chapter 4. The main idea behind is an interactive photo book which content consists of photos, trivia games and music. Sketches and screenshots illustrate the development of the prototype game.

Details about the implementation of *Mindtraining* are presented in chapter 5. An overview of the system architecture, development challenges and the logging module is shown. The development of the prototype game followed an iterative process of analyse, design, implement and evaluate. A summary of the iterations is also described in this chapter.

Chapter 6 is devoted to evaluating the prototype game *Mindtraining*. First, the methods used, to examine interactions the proposed application Mindtraining, are explained. Next, the results – supported by diagrams of the quantitative data – are shown and analysed. The discussion in the end summarizes the found observations and compares them to current research.

Chapter 7 finally concludes this thesis. The first section focusses on the research objective and discusses the accomplished findings. Contributions and limitations are described in the next sections. The last section states future plans and potential improvements for the prototype tablet game *Mindtraining*.

Chapter 2

Related Work

Current studies present a meaningful integration of tablet computers, such as iPads, into the therapy context with the aim of benefiting cognitive abilities or acting as trigger for the patient [15, 35, 36, 50, 51, 56]. Particularly mobile games show great potential to stimulate dementia patients [26, 27]. Many commercial games (such as *Nintendo's Big Brain Academy*, *Lumosity*, *BrainHQ*, *Complete Brain Workout*, *Wii Sports*, *Wii Fit*, and *Smartbrain Games*) have been evaluated for usage in dementia therapy [36]. Although most of those games were developed for entertainment purposes, they are also beeing used for health reasons. The content varies from memory games to random puzzles with the aim to improve your brain performance. Those games often don't meet the perceptual and interaction needs of people suffering from dementia. For example, they don't provide in-game assistance and their interaction methods seem not natural. Nevertheless, those games are widely used amongst elderly and cognitive impaired patients. Even though they cannot fully fulfill the needs of people suffering from dementia [4, 36]. Studies often choose children games and educational games for evaluation in the dementia context [27, 35]. These type of games may seem to be easy to use, but they still often require too complex interactions or result in a cognitive overload.

Games for dementia provide different strategies to either slow down the process of the disease or to improve the living standards for these groups of users. An overview of the major health restrictions of people with early- and middle-stage dementia is given in the next section.

2.1 The Role of Technology in the Dementia Context

Dementia is not specific disease, it can cause problems in multiple areas, such as cognitive, behavioral and physical disfunctions [16]. Due to aging, people with dementia are also subject to visual and hearing constraints. In this section, research projects are presented, which suggest approaches to help with these problems.

A dementia disease can affect multiple cognitive abilites, such as memory, attention, language, reasoning, judgement, reading, and writing [16]. Recent research shows that video games, which enhance cognitive functions, have the potential of delaying the cognitive decline [15, 26, 27]. Zaccarelli et al. [56] performed a computer-based training with 348 participants suffering from dementia to measure the respective effect on memory and executive function. In their trial they confirm that computer-based cognitive training is a promising area of intervention. The treatment group, who performed cognitive exercises, improved the cognitive status with significant evidence in comparison to the not intervention control group.

Kawashima et al. [23] presented a training program for reading aloud and arithmetic problems. The authors examined that these tasks can be used for cognitive rehabilitation of dementia patients. In their study they used two tests which are widely used to diagnose dementia: the Frontal Assessment Battery (FAB) and the Mini-Mental State Examination (MMSE). After a 6-months training, people of the experimental group could improve their FAB score and maintained their MMSE score. They also observed that people restored their communication and independence due to the training.

Due to the cognitive decline, it is hard to store and manage new information and perform tasks in parallel. A tablet game made for dementia patients has to tie in with the cognitive abilities. Therefore a special focus on usability heuristics should be taken into account to reduce the cognitive overload [42]. Especially adaptability is noted as a very important feature in serious games, as every patient with cognitive impairment has different needs [27, 50].

To help with memory and organization, cueing systems can assist people with cognitive impairments to remind someone to perform a task at the right time or provide a series of prompts in order to perform multiple steps [31]. A study shows that automated task guidance compared to written cues, allows people with memory impairment to perform tasks with reduced occurrence of errors [24].

People with dementia suffer from various behavioral problems leading to emotional distress. Cognitive impairment may limit the ability to communicate effectively, which has a strong negative influence on the patient's well-being [22]. Common negative effects are depression, anxiety, aggression, wandering and sleep difficulties [16]. A patient who is scared and overwhelmed by feelings of confusion can be calmed down by showing pictures or videos of familiar television shows [27, 54]. Benveniste et al. proposed a video game-based music therapy platform *MINWii* to improve patients' self-image to reduce behavioural symptoms [3]. In their study they show that music has the potential to reduce the anxiety levels of dementia patients.

User limitations	Adaptions
Cognitive	Visibility of system status, match between system and the real world, user control and freedom, consistency and standards, error prevention, recognition rather than recall, flexibility and efficiency of use, aesthetic and minimalist design, help users recover from errors, help and documentation.
Behavioural	Show pictures of family or favourite things, turn on favourite music songs, show videos.
Visual	High-contrast color schemes, scalable fonts, the option to zoom in, auditory enhancement of visuals.
Hearing	Use of subtitles, captions, visual cues for sound effects

Table 2.1: Limitations of dementia patients and possible adaptions for tablet games.

Research has shown that there is a powerful connection between music and memory, even when having severe dementia [8]. Music enriches one individuals life as shown in the project *Alive Inside*, in which dementia patients have been listening to their favourite music with iPods [64].

In another research project, a mobile music app with a special focus on usability, was developed [41]. The application offers listening to personalized music based on the patient's life.

Music and photos also played an important role in a pilot study, where tablets were used in dementia therapy for over three months [27]. In this study, they proposed listening and singing to music or watching photos (animals, patients themselves, family, children, babies, etc.) and videos as initiating and ending practice in therapy. This inspires communication and affects the patient's mood in a positive way. Especially the first visual signal in a game has to give a positive impulse, as the patient might not know what to do and therefore feel unconfident and anxious. In the same study they mentioned that the caretaker had to give continuous positive feedback, especially at the end of the tablet therapy to motivate and encourage the patient. Games, which integrate continious positive feedback and encouragement, would relieve the caretaker [27]. The authors also proposed that the feedback system could also be expanded with questions about the current condition, such as if the patient is thirsty, hungry or doesn't feel well.

Concerning the age of dementia patients, other problems, such as visual and hearing impairments, may occur. To make a mobile game accessible, different tested and approved strategies exist [55]. Features, such as high-

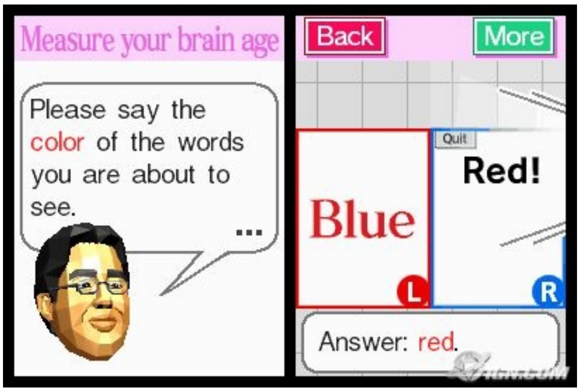


Figure 2.1: Stroop test in Brain training for Nintendo DS [19].

contrast color schemes, scalable fonts, the ability to zoom in or auditory enhancement of visuals, are commonly used in commercial available games to enable playing for people with a bad eyesight, color blind people or blind people [45]. McGook et al. proposed five guidelines for touch screen accessibility targeting visually impaired users [37]. To make games accessible for hearing impaired players, audio is converted into visuals (use of subtitles, captions or visual cues for sound effects and music) [55].

Table 2.1 summarizes the described limitations of dementia patients and lists possible adaptions for software targeting people with dementia. Aforementioned, especially tablet games seem to be suitable in dementia therapy. But not all type of games are suitable for dementia patients. The next section gives an overview of different kinds of games, which have been evaluated in research projects and appear to be most popular in the dementia context.

2.2 Serious Games and Dementia

McCallum et al. notes that a serious game for dementia patients might perform more than one health function and also serve more than one health purpose simultaneously [35]. A game might cover cognitive, physical and social, emotional areas and can be categorized as preventative, rehabilitative, educative and/or assessing game.

Many commercial games with the aim to improve your cognitive abilities have been evaluated in research [19, 35, 36]. Those games let players test their intelligence level with word puzzles, mathematical exercises or trivia, which involve attentional and memory processes (such as the Stroop test, see Fig. 2.1).

In another dementia study, salient features of a list of iPad apps were determined [26]. It was found that the most popular applications incorporated

Table 2.2: Commercial dementia-related games, which have been evaluated in research.

Game	Description	Input Method	Studies
Big Brain Academy	Puzzle game for Nintendo Wii, testing mental activity	Wiimote Controller	[1, 13]
Lumosity	Brain training game for Web and Mobile	Mouse/Keyboard or Touch	[9, 15]
BrainHQ	Cognitive training gaming software for PC	Mouse/Keyboard	[2, 60]
Complete Brain Workout	Cognitive brain games for PC to stimulate and exercise the brain	Mouse/Keyboard	[48]
Wii Sports	Physical sport games for Nintendo Wii, including baseball, golf, bowling, tennis and boxing	Wii Balance Board, Wiimote Controller	[12, 30, 53]
Wii Fit	Training game for Nintendo Wii, including balance games, aerobics, yoga and strength training	Wii Balance Board, Wiimote Controller	[43]
Smartbrain Games	Interactive multimedia tool for PC with different stimulation programs across the domains of attention, calculation, language, memory and orientation	Mouse/Keyboard	[63, 49]

simple mathematics, letter descrambling and activities similar to existing group activities. The less successful applications were characterized by preset time limits, confusing directions and difficult vocabulary.

Table 2.2 presents an extract of serious games, which are commercial available and have been evaluated in dementia therapy. Their input methods vary from gesture recognition controllers (Wiimote), type and click with mouse and keyboard, to touch input with your finger or with a stylus. Different research projects focussed on the usage of mobile applications in the dementia context. In one research project thirteen tablet applications were tested and evaluated for dementia therapy [27]. A trivia game and a world scramble game were the most popular applications for the patients. Yet,

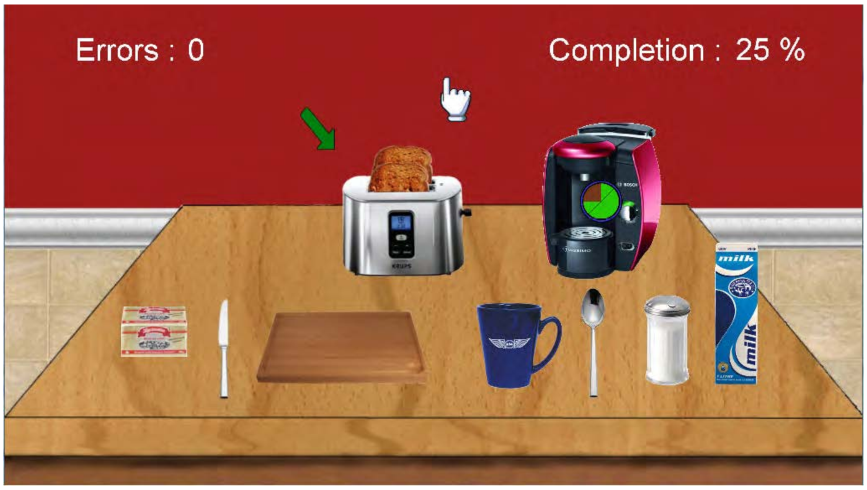


Figure 2.2: Serious game prototype for AD patient's cognitive training [20].

there remained some problems when using these applications, such as: too small fonts and visuals, missing visuals, too touch-sensitive displays, complicated graphics (needless shadows and perspectives) and fast transitions.

Recent research shows, which type of games seem to be popular amongst people with dementia. One interesting part of those popular games is how users interact with them. Operating a game can be a complex process and might be an unbearable obstacle for a person with dementia. As the presented games are developed for different devices, also the input methods vary. These techniques are discussed in the next section.

2.3 Interaction Techniques of Dementia Games

Bouchard et al. proposed a set of guidelines for designing and implementing effective serious games for AD, covering the following aspects: (i) choosing right in-game challenges, (ii) designing appropriate interaction mechanisms for cognitively impaired people, (iii) implementing artificial intelligence (AI) for providing adequate assistive prompting and dynamic difficulty adjustments, (iv) producing effective visual and auditory assets to maximize cognitive training[4]. In their prototype game the user has to prepare meals in a virtual kitchen, see Fig. 2.2. This game also allows an in-game estimation of the patient's cognitive performance. The game was developed with the Unity 3D game engine and the interactions are based on point and click.

One research group developed a tablet application *MyLife* to support people suffering from dementia in daily life as well as to relieve the caretakers [18, 52]. The app offers a calendar with daily reminders, an interactive photo book, a radio for listening to music, newspaper articles and a tool for sending messages to family members. During the project phase, they developed several design guidelines in regards to cognition and accessibility: enable gradual simplification, enable direct manipulation, offer alternative modalities, simplify the language, make visualisations relevant, enable alternative presentation styles, model real world artefacts and their behaviour, make it easy to start from the beginning, acknowledge external communication and let the users be users.

They gathered data about using the application in two phases, each around eight-weeks with 53 participants in total. The radio application seemed to be really popular among the participants and watching photos encouraged communication. Although the developers had a special focus on usability to encourage autonomous usage, one result showed that around half of the participants needed continuous assistance from their caretakers when they used the application.

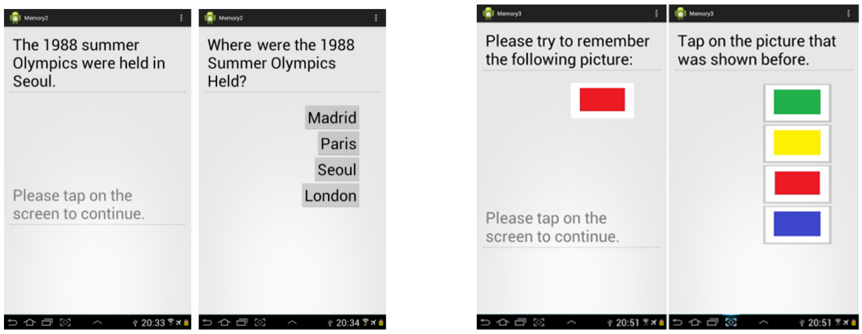
The *eMotiva project* was developed as a tool to keep dementia patients motivated at all times and also to detect behavior patterns in order to recognize disorders in routines [39, 46]. The tool consists of a collection of cognitive games with the aim to help staff at Nursing Homes to alleviate the cognitive decline of dementia patients. For their tool they decided to use an All-in-one PC with a touch screen interface, which provides a more natural interaction than the use of keyboard and mouse.

MINWii is a music therapy game which was developed as a renarcissization tool for dementia patients [5]. It allows the player to play predefined songs by pointing at a virtual keyboard with a Wiimote Pistol. They observed that the usage of the pistol-shaped controller was very intuitive as every participant quickly understood what to do with it. Nevertheless, most participants judged the controller as slightly too heavy for holding it longer than ten minutes in a row.

In a case study about games for dementia, researchers assessed the level of independence while playing the tablet game *Masterquiz* [34]. As care givers are extremely time poor, they wanted to develop a game which could be played independently. They observed that the majority was able to play the tablet game without any assistance.

One research project compared the use of mouse interaction and ecological interactions with a Wiimote in the context of a serious game adapted to AD patients [6]. The authors findings indicate that the use of ecological gestures may increase the immersion level in a game as there is a significant reduction of the learning time.

Zmily et al. observed that people with early stage AD could successfully use mobile devices without any prior experience in using such devices [57]. In their research project they developed an Android application *ADcope* that includes several modules to target people with AD. As part of their research they compared a text-based scenario and a graphic-based approach



(a) (b)

Figure 2.3: Different scenarios in the application ADcope: text-based approach (a) and graphic-based approach (b) [57].

for a question and answer game see Fig. 2.3. They conducted a study with 10 participants with early stages of AD and observed that the participants had a better performance, less workload, and better response time for the graphic-based scenario.

Breton et al. presents the Microsoft Kinect-based game *Kimentia* in their study, which promises a physical and cognitive stimulation for people with dementia [7]. The proposed system allows the user to interact with the computer without any controller, which accomodates people with physical disabilities, see Fig. 2.4. In the authors opinion, controllers are more difficult to handle when accurate movements should be performed on a device. The main advantages are that the user will engage with its own body – which seems more natural – and that the user does not have to memorize complex button systems.

In another research project, students developed multiple mobile applications for people with AD and dementia and assessed their effectiveness [54]. During the trials in an adult care center, they observed many usability problems. The greatest challenge was the accuracy of the touchscreen interface. The participants tended to touch the screen with their fingernails, which has no effect on capacitive touchscreen panels. The students proposed to change the sensitivity on Android tablets and additionally provide a vibration feedback when the screen is touched. Other problems were that buttons were located too close to the taskbar, which got therefore accidentally hit several times. The students observed that the continuous occurrence of these problems within a trial led to frustration and confusion of the patients. To address the difficulties with holding the devices (accidentally touches at the border of the screen), the students suggested to use a rubber case with adjustable stands.

Games for dementia integrate different interaction techniques. In conclusion, all prototypes of research projects tried to find a simple and natural

Figure 2.4: Kimentia provides controller-less interaction with the game: The Pose Recognition System detects the raised right hand [7].

way to interact with the respective system to reduce the cognitive overload for people with dementia. Either touch interaction or ecological gestures seemed to be the most successful interaction paradigms. These do not require any external controller, such as a mouse or keyboard. In a study with mobile games and elderly people, the participants reported that it is much easier to touch the objects on the screen with their finger than using a mouse [10]. Learning how to interact with a software system is a complex task, in particular for users, who never used computer systems before. Yet, studies have shown that elderly people with dementia are willing to learn new technologies [29, 32]. In another study with dementia patients, half of the participants had never used a mobile device before. However, all of them indicated that they would like to see more technology and believed they could benefit from it [26]. Moreover, tablets cover many positive features like high-quality responsiveness multi-touch screen, mobility, accessibility and ease of aquition [50].

2.4 Conclusion

Dementia has been an interesting topic in research for a couple of years. But only a few video games were developed for the target group dementia patients in mind, addressing their specific health restrictions described in Sec. 2.1. Recent research focusses mainly on the effect of games on people with dementia and how to counteract health restrictions of the disease with help of technology. It seems that games, which enhance cognitive functions are already widely spread – commercial games as well as prototypes of research projects. Research projects show that the usage of tablet devices in dementia therapy offer a great alternative to conventional devices like a PC or a video console. Touch input seems easier and more natural than using external controllers. Although there are already many recommendations available for developing a game for dementia [4, 50], there seems to be a lack of guidelines for interaction techniques on touch interfaces. Senior people might not have any prior knowledge of operating touch devices. Hence, performing different and multiple gestures in an application might be already too complex for people with dementia. To examine which gestures on a tablet device are best suited for this target group, we developed a prototype for a tablet game.

In conclusion, tablet games have the potential to support dementia therapy. There are a few applications available, which target dementia disease rising the need for developing new and innovative games that can truly capture the users and help them overcome (some) of their needs. It seems that developing a tablet game for this target group encounters several obstacles, as it is difficult to adress cognitive impairment through technology applications [33]. Current research has already documented many of these obstacles and gives recommendations how to design a serious game for dementia patients [4, 27, 50]. But there are almost no experiences, how a mobile application specifically designed for dementia could improve the ease of use in comparison to a general application. The suggested requirements of previous research work on dementia games were used to build a prototype tablet game with dementia patients as target group. The concept of this prototype is described in the next chapter.

Chapter 3

Designing Games for Dementia

This chapter describes the establishment of requirements for a prototype tablet game for dementia patients. The objective of the application is to examine, how people with dementia cope with different gestures in a mobile application. On the one hand it is interesting to find out, how good people can remember gestures and how intuitive they are. On the other hand it is relevant to know, if one of the gestures might be easier to perform than another one for the same task. Before requirements can be identified, the designer needs to get to know the target audience. Understanding the user work and needs is an important part in the context of interaction design and user experience (UX) [17]. It is specified as the first activity in the UX lifecylce, which consists of four activities: *analyse, design, implement and evaluate* [17]. This chapter summarizes the steps of the first activity – Analyse – which content is about getting to know the user, analyse data, construct design-informing models and identify requirements.

The proposed application *Mindtraining* serves as an interactive photo book with a playful integration of interactive games. The purpose of the games is to target the cognitive functions of people suffering from dementia. Elderly people are more motivated to play, if the purpose of a digital game is to exercise your mind or trains any other health functions [10]. It seems that they engage better with activities, which help to overcome or prevent some limitations that occur with old age. A game, which is not primarily designed for entertainment, but to achieve some change in the player, is generally known under the term “serious game” [44]. This change could refer to the domains of education, health or mental well-being [34]. Serious games have become very popular amongst all generations, which is also shown by the emergence of organizations and conferences dedicated to this topic [44].

In this chapter the requirements for developing a game for dementia are described. In particular, the authors observations about the users needs are listed, as well as recommendations how to meet those needs. The recommendations are based on current research projects, which documented their findings and stated guidelines of how to design a serious game for dementia. All these findings are used for developing the proposed application *Mindtraining*.

3.1 User Modelling

Knowing the target audience for a serious game, which serves for health intervention, is very critical for designing the game experience [47]. When designing a game for dementia, the designers need to take advantage of different strategies, to get to know the user. In the beginning the demographics of the audience need to be defined, when creating a game, which is meant to be enjoyed by a vast number of users, [47]. To focus on a narrow demographic in a project, gives the advantage to tailor the cognitive, emotional, or physical needs of the users and therefore increases the experience [34]. A broad audience makes it harder, to design the experience and measure the effect of the intervention.

Creating a game for an audience you have never been part of, requires imagination what it is like to be them, spending time with your audience, talking with them and observing them [47]. Examining research and reading books about dementia aids to learn about the health restrictions people are facing suffering from dementia. A more practical way to learn about the daily life of a person with dementia is to visit a nursing home or care-taking facility and observe the activities and relations in the facility. Interviewing caretakers and close family members of patients gives an insight about current therapy work in the facility and at home. As dementia disease affects long-term memories at last, it is useful to get to know the life of the early years of the patient. Interviewing people of the respective generation is helpful to learn about events of their past, popular television shows they watched and their favourite music they listened to.

For the developed prototype, which serves as proof-of concept, the demographics are defined as followed: Female and male people with early- or middle-stage dementia with 65 years or older in age. In these stages of dementia, a person is still able to perform most of the functions in daily life without or with little help. Symptoms of early-stage dementia are mild forgetfulness and communication difficulties, such as finding the right word and following a conversation [16]. Due to these changing abilities, a person also might become frustrated, depressed and/or anxious. For patients with middle-stage dementia, it has to be considered that the short-term memory is already seriously impaired and it is difficult to remember anything new [16]. The vast majority of people with dementia is beyond the age of 65, but the age statistics vary with the region of occurence: in Europe and the Americas peak incidence is among those aged 80–89 years, in Asia it is among those aged 75–84, and in Africa among those aged 65–74 [59]. In the user modelling process, concepts, such as persona, work roles and/or usage models, help, to define your users [17]. Based on parts of the collected interview data, observations and examined research, specific characteristics influenced the development of the persona for the developed prototype (see Appendix A). A persona describes a specific person in a specific role who has a name, a photo a life and a personality [17]. Defining the target group for a product already hints what the needs of these users are and which obstacles they could face using the product.

3.2 Results of User Observations

Introducing technology into a health care system might raise individual requirements for the respective health situation of the audience. To get to know the target audience, a small day-care facility for people with dementia was visited a couple of times. In the facility 2–3 people care for 5–12 people with dementia, from 08.00 am to 16:00 pm, three times a week. Observing the actions and relations of people in the facility and talking to the care takers led to a deeper understanding of limitations of dementia disease and how technology could support people with dementia. Two main issues have been noticed. One problem is that care takers in nursing homes are extremely time poor. They cannot afford the time to provide technical support and training for every single patient. Already a small amount of additional workload for nurses can be an obstacle for using a beneficial game in a nursing home. Also family members are often very time poor as they might need to go to work, manage the household and in addition care for the person with dementia. No time remains for tutoring a technical application, which might be necessary multiple times if the user with dementia forgets how to use the application from one time to the next time. The caretakers in the visited day-care facility noted another concern that family members might not have the technical know-how to handle a tablet device, thus don't want to engage with unknown technology. A game for dementia patients therefore has to provide the highest possible level of self-explaining play. One research project addressed exactly this problem and focussed on the development of a tablet-based quiz game that could be played independently [34]. In the authors opinion, autonomous executed tasks from people with dementia have positive effects on their self-esteem and well-being. Technical aids, which benefit the feeling of independence or even counteract the emotional distress of patients and relatives might lead to less hospitalization [34]. The investment in technical aids would be rather small in comparison to the costs of hospitalization [11]. Therefore an intuitive integration of gestures would be also very important.

The second main issue, which has been noticed, is that it is sometimes difficult that a person with dementia engages in an activity or conversation. A person with dementia often relates current events to similar past events. Since long-term memory often stays intact, even in late stages of the disease, a person is able to take part in activities, which recalls events and interests of earlier years with the effect of enhancing peace of mind and autonomy [16]. For example, reading the daily newspaper gives some good entry points for a conversation. Talking about a newspaper topic of nowadays gets people thinking how this topic would have been handled in the past. These circumstances also play a major role, if you want a person with dementia to engage in your game. Designing for a person with dementia means to move back in time and capture what happened in the person's earlier years [27]. The short-term memory might already have been vanished due to dementia, so it is important to integrate positive metaphors of the respective generation in a game. The authors observations at a day-care facility for dementia revealed that showing famous pictures, reading newspapers and magazines and singing songs, which a person learned at school, leads to a high engagement of a person with dementia.

Gathering the user's needs and problems one of the basic steps in the process of designing your product [17]. Before explicating the requirements, a product designer needs to know, who the users are and what their goals are in using the application. After analysing the target audience for the prototype tablet game, design-informing models, such as personas, have been created. Combined with the knowledge of conducted research in the dementia context, requirements were identified. The found requirements for the tablet game are documented in the next section.

3.3 Requirements for a Dementia Game

The established requirements for the tablet game are based on several research studies within the dementia context and the author's analysis of the target audience. They are divided into three categories: Interface design, game concept and prompting. These categories were found as a useful classification for the proposed tablet game. The design of the interface and prompting strategy have a great influence on the user interaction with the tablet device. The separate section for game design was chosen as it influences the players motivation to play and should therefore considered as a focus category.

3.3.1 Interface Design

The interface of an application for elderly people should minimize the load on declined functions, such as demands on spatial memory, working memory, visual functions or motor ability [19]. For the developed tablet game, the following recommendations for interface design were found as most important:

- The design has to be simple and intuitive and the used elements have to provide an appropriate affordance [19, 27].
- Designing for dementia means going back in time and thinking of events that happened in the past of one individual and the respective generation [27]. The visual design should anticipate memory engrams of a person, which are the traces of long term memories.
- Small targets and moving interface elements should best be avoided as they are known to be difficult for older people [19].
- Hide unnecessary information on the screen, so that the player is able to find the correct object immediately [4]. Visually complex scenes might discourage the player as difficulties in finding objects might occur.
- The first visual signal should arouse a positive optical stimulus to reduce insecurity with handling the tablet [27].

3.3.2 Game Design

While playing a game, a person with dementia can have fun and at the same time might also be doing an activity, which aims to slow down the cognitive decline. To get the player motivated and to engage in the game, it should meet the following requirements:

- A game has to match the mental model with the conceptional model to make it easier to understand for senior people, who are novel users [19]. Use real world models and the behaviour of real objects to reduce the difficulties operating new technology [18].
- A game needs to be aligned with the capacity of perception of people with dementia and also with their personal interests and preferences [27].
- To target long term memories, a game could integrate pictures of movies, culture, politics, sports and daily life of the early years of the patient. Also a game might incorporate significant events of the past, famous faces or idols, or popular songs of the elderly generation [27].
- The game should enhance communication, social interaction with other people and integrate a playful cognitive training. Transfer of knowledge is not a priority [27].
- Failure-free gameplay: People with dementia often don't have enough confidence and therefore might be scared of performing new tasks. The game should be designed in a way that it is impossible to fail [3].
- Provide a cognitive challenge, which makes the player proud of his/her ability [10].

- Recreate a well-known environment and reflect actions of the patient's everyday life [4]. Placing the player in a familiar concept will smooth the learning curve and lead to less frustration and a more enjoyable game experience.
- Predefined time limits should best be avoided [27].
- As every player is different, adaption of the game – regarding difficulty, player's interest and/or visualization – is highly recommended [4]. Aligning the game to a player's profile could also lead to an increased engagement.

3.3.3 Prompting

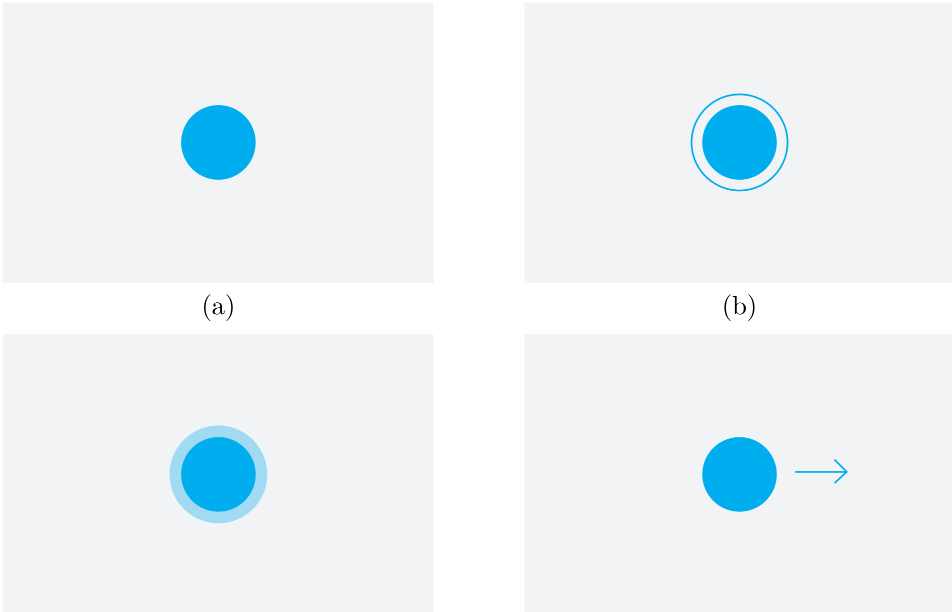
In addition to the cognitive limitations of dementia disease, a person also might suffer from age-related constraints like sensory and hearing troubles. Prompting is a method, to assist the user with using new technology and/or overcome those problems [28]. For example, prompts in a game could be used to instruct the player what to do next and therefore reduce the cognitive overload. As tablet devices offer multiple output modes, a prompt might appear visually, acoustically or physically as vibration. The following recommendations regarding prompting on mobile devices for people with dementia have been found as most useful:

- As elderly people suffer from visual and/or hearing problems, it is helpful to provide redundant information through multiple modalities [18, 19].
- Give motivational messages and positive feedback when achieving a goal or making a mistake [27].
- Provide information about the benefits of using the application, such as training your cognitive abilities [10].
- In order to simplify the language, find as simple and short expressions as possible, without losing any information [18]. This should be considered for visualized text, as well as for speech output.

3.4 Guidelines for Interaction Techniques

Interacting with a touchscreen is very natural, as no external controller is needed. Nevertheless, novel users have to be taught, which gestures can be done with their fingers. Figure 3.1 shows different touch mechanics for mobile devices and in Table 3.1 their actions and use cases are described.

Companies, such as Google or Apple, provide several guidelines for interacting with controls on a touch screen [58, 61]. For example: Google specifies that touch targets should be at least 48×48 dots per inch, which results in a physical size of about 9 mm. This recommendation shall allow users with lower motor dexterity to tap the correct target in the application.



(a) (b) (c) (d)

Figure 3.1: Touch mechanics refer to what the user's fingers do on the screen [62]: touch (a), double touch (b), long press (c), drag or swipe (d).

Table 3.1: Touch mechanics according to Google's design guidelines [62].

Touch mechanic	Actions	Use Cases
Touch	One-finger press, lift	Activates a screen element, like a button
Double-touch	One-finger press, lift, one-finger press, lift	Zoom in/out
Long press	One-finger press, wait, move, lift	Pick up and move, select multiple items
Paging swipe	One-finger press, move, lift	Reveals related off-screen content
Drag	One-finger press, move, lift	Maintains contact with an element and moves it to another position

Although recommendations exist, how a user should interact with certain controls (such as touch on a button), there is no general rule, which gestures are most suitable for people with cognitive declines. The prototype tablet game integrates multiple gestures in order to investigate how good people can execute those gestures. Another considerable aspect is, how good people with dementia can remember the gesture from one task to the next task. A game, which integrates gestures in different sequences, might already be a useful cognitive training for a person suffering from dementia.

3.5 Summary

This chapter summarizes the most important recommendations for dementia games, regarding interface design, game concept and prompting. These recommendations had a great influence in the development of a prototype tablet game for people with dementia. The game also integrates the previously listed gestures and will investigate the usability of those. The concept of the game is described in the next chapter.

Chapter 4

Game Prototype Mindtraining

Based on the established requirements, a prototype game for tablet devices was developed. The purpose of the tablet game is to facilitate an intuitive and efficient usage of gestures for people with early- and middle-stage dementia aged over 65 years. The investigation captures how people with dementia perform different gestures and how much help they need each time they use the application.

The underlying idea of the developed prototype *Mindtraining* is an interactive photo book with a playful integration of cognitive games. A photo book is an item, which is also known from the earlier years of nowadays dementia patients, hence it should present a good mental model for the players. The visualization concept of the prototype game takes an original photo book of earlier year as a basis, see Fig. 4.1. Visual aids, especially photos, can stimulate the memories and are furthermore a proofed concept in dementia therapy [27].

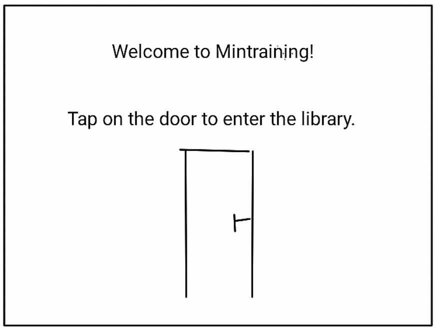
To target individual interests of every user, each user is able to create a personal photo book. The personal photo book consists of a photo of the person, the name of the person, and the individual interests (such as animals, travelling, nature, cars, flowers). The photo of the person can be captured with the camera of the tablet device. The photo book for one individual is created once with help of the carer and then stored persistently on the device. The main view of the application is called "The Library", where all created photo books are shown. Displaying the photo and the name of the user should provide a familiar environment and emphasise selecting its own photo book. Before entering the library view, an introduction view with a welcoming text and a door is displayed. The user is asked to open the door with a tap to enter the library. The first sketches of these views are shown in Fig. 4.2. Opening the door should represent a positive welcoming gesture, asking the user to enter the virtual world. It is the first visual signal in the

(a)

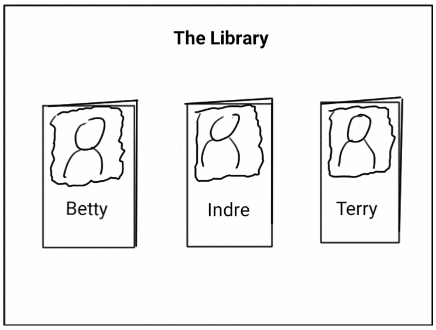
(b)

Figure 4.1: The inner surface of the interactive photo book (b) is based on an original photo book of a married couple born between 1940 and 1950 (a).

game with the aim to introduce the tablet device with its touchscreen to a novel user. With the first tap on the door, the door will open up with an animation and a door-opening sound. This serves as a tutorial as the player will understand that the device reacts to touches. When the users select their own photo book, the selected photo book is enlarged and the pages can be flipped to see the inner content of the photo book. All actions are



(a)



(b)

Figure 4.2: Created sketches for the tablet game showing the welcome screen (a) and the library screen (b).

accompanied with sound effects. The next sections describes the detailed concept of the photo book.

4.1 Content of the Photo Book

The content of the photo book can be created very flexible and leaves lots of space for future extensions. For the prototype game, a focus on three different areas was chosen: Watching photos of the person's interest, playing a trivia game and listening to old songs with a radio. For each double page of the photo book another content is shown, alternating photos, trivia and music. On the first double page, the users are asked about their current mood, see Fig. 4.3.

Observing the person's mood might contribute to the analysis of the usage of the application. A person, who is in a bad mood, might interact different with the device, than a happy person. Also using the application might affect a person's mood later on. One research study showed that in lots of cases the participant's behaviour was affected in a positive way after playing on the tablet [27]. It was also observed that the participants satisfaction increased with playing tablet games, although they had a obvious bad general health condition.

After the first double page, pages of the mentioned three focus areas follow: Photos, trivia and music.

4.1.1 Mindtraining: Photos

Photo books are also used in conventional therapy to exercise a persons mind. At a day-care center for dementia the following activity was observed: The carers provide cards of famous sightseeing places in Austria and ask the patients, if they are able to remember the name of the place and in which city

Figure 4.3: Screenshot of the first double page of the photo book, asking the user's mood. The users have to touch the smiley face, which suits best to their current mood.

it is located. In one of the research studies, the researchers found showing photos of cute animals a very useful method to start with a technological therapy intervention [27]. It enhanced motivation and communication and took away the anxiousness of using the tablet device.

In the first version of the prototype game, photos of the users interests (such as flowers) are shown, combined with matching background sound and a textual description. The text might also be a question such as "Do you know the name of this place?" with the aim to get the person thinking. The first view shows a small photo with an instruction to tap on it to show it larger (see Fig. 4.1(b)).

4.1.2 Mindtraining: Trivia

Trivia exercises your mind and is a conventional method in dementia therapy to counteract the cognitive decline [15, 26, 27]. In one research study with dementia patients, the participants found playing a quiz game “Who wants to be a millionaire” as their favourite game on a tablet device [27]. Playing the game increased the participants self-esteem as it made them feel proud to accomplish earning virtual money with their knowledge. It also increased communication between the present patients who almost never talked with each other before. At a day-care center for dementia, it was observed that activities like completing sayings and word scrambling games are very popular amongst the patients. Wordplays, including sayings, are widely used

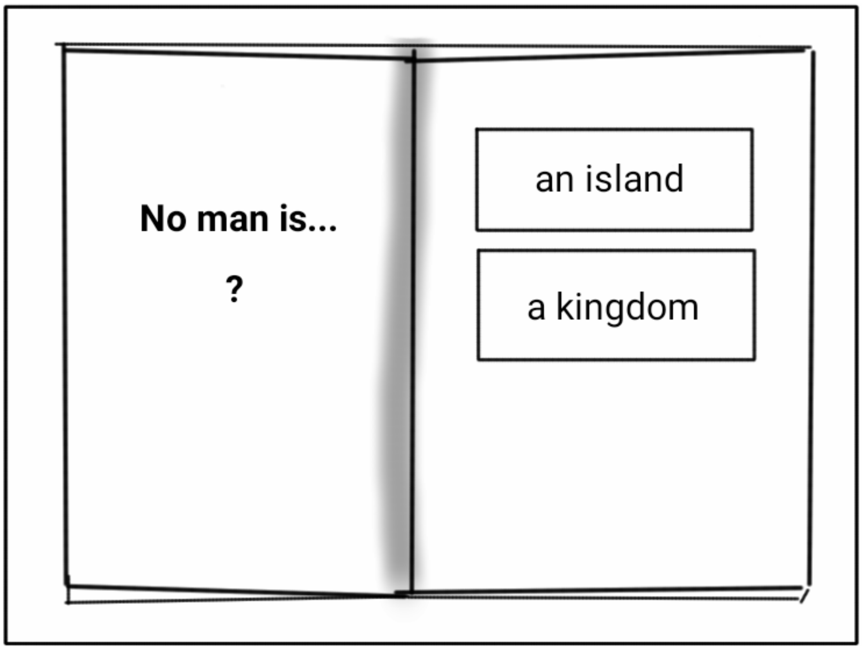


Figure 4.4: Sketch for trivia game: For completing the saying the player has to select the correct answer.

in mind training therapies for dementia patients to exercise their mind. In Austria and Germany lots of old sayings exist, which are very well known by the elderly generation. Based on those observations a game with Austrian sayings is integrated in the photo book, see Fig. 4.4.

The player sees the first part of the saying and gets multiple suggestions for completing the shown saying. If the player selects the right answer, a success sound plays and and a congratulation message pops up. If the player selects the wrong answer, the answer changes to a red color for a few seconds and the player has the chance to guess the right answer again.

4.1.3 Mindtraining: Music

Singing and listening to music has the potential to affect people with dementia in a positive way [8]. Observations at a day-care facility for people with dementia showed that singing songs together (as a group activity) acts as a trigger for most of the participants. If it is a favourite song of the person, the fun and motivation to sing increases. The most liked songs for the people in the facility are either songs they learned at school or popular songs of their earlier years. Although these observations are valid for most of the patients at this facility, there are also exceptions as each person favours a different style of music.

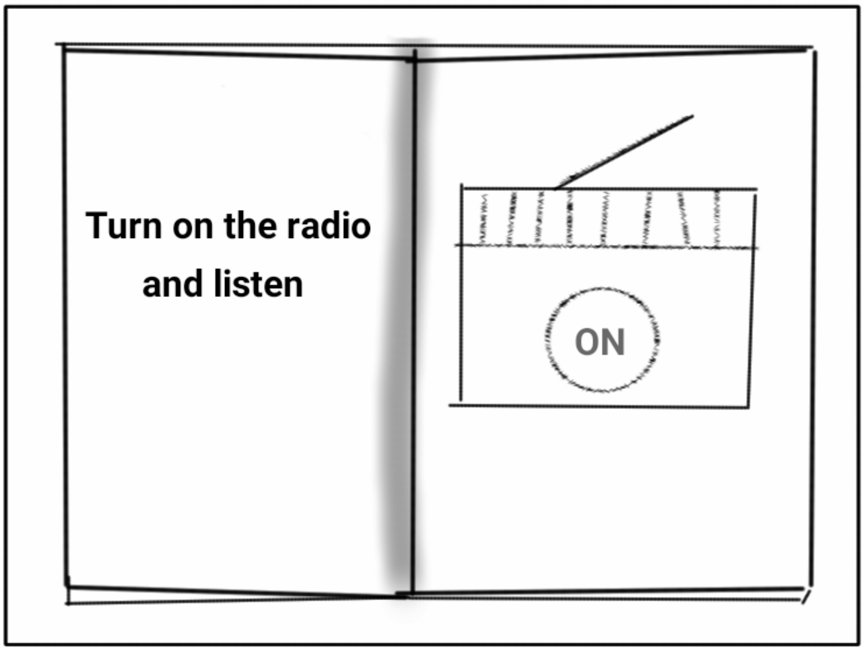
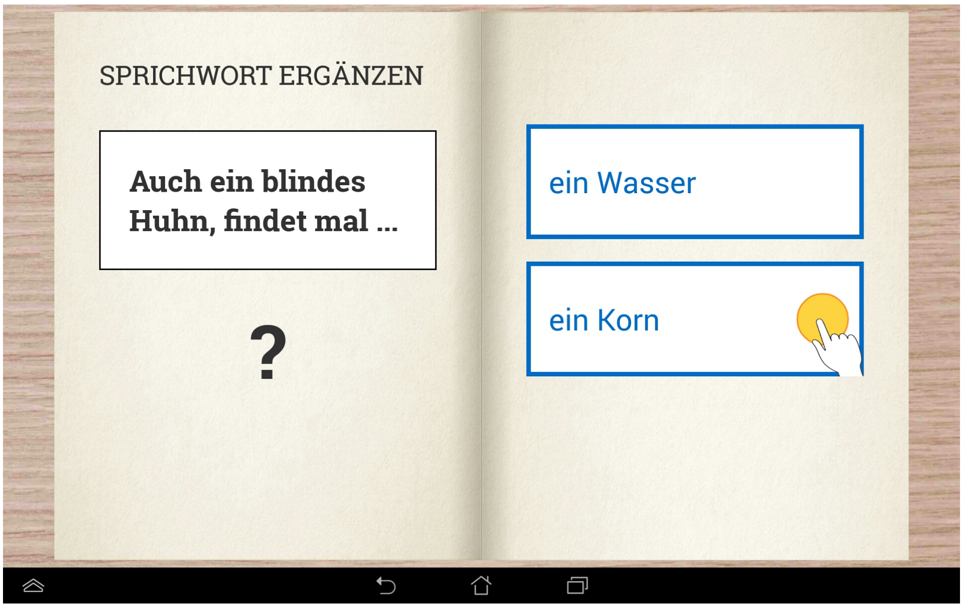


Figure 4.5: Sketch for the interactive radio: The user is asked to turn the radio on.

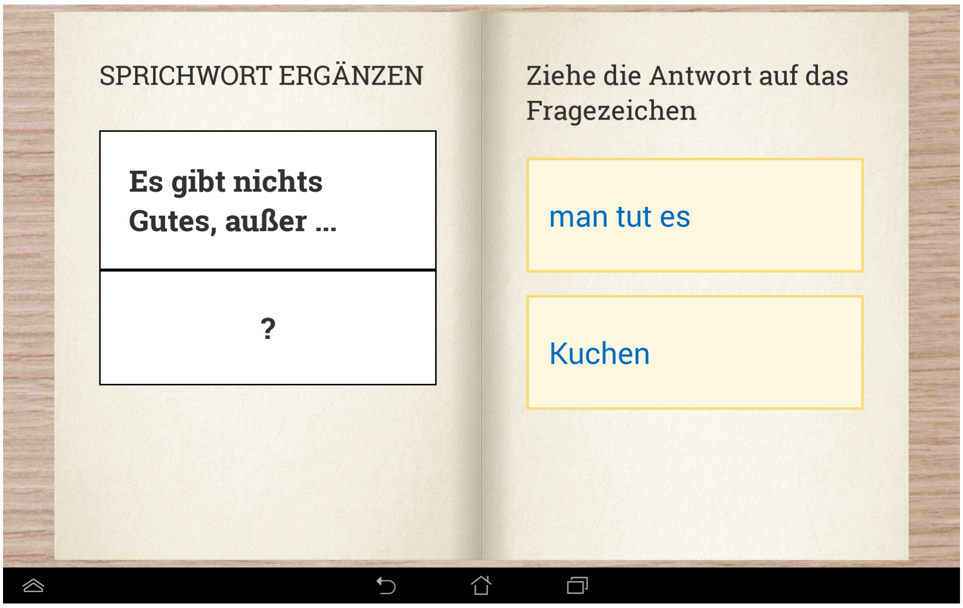
In the initial prototype game an interactive radio is part of the photo book, see Fig. 4.5. One page of the book displays a vintage radio as it was used in the earlier years of nowadays dementia patients. The user is asked to turn the radio on with the radio power button. The radio plays a song from a little selection of songs, which were popular between the years of 1940 to 1960. The radio should serve as alternate stimulation for the user.

4.2 Integration of Gestures

Playing the tablet game requires different gestures and interaction techniques. In the album you have to swipe through the pages, tap on photos to see them in full screen and use tap for turning on and off a music radio. The trivia game with completion of sayings is implemented on multiple pages with two different scenarios: (1) tapping on the right answer, (2) dragging the right answer to a target location.



(a)



(b)

Figure 4.6: Different scenarios within the application: In (a), you have to touch the right answer and in (b) you need to drag the right answer to the box with the questionmark.

Chapter 5

Implementation

This chapter describes implementation details about the proposed tablet game *Mindtraining*, described in chapter 4. An overview about the system modules and the technical aspects of the application are given. As the aim of the game is to gather information about the performed interactions of the users, the logging module, which tracks this information is described in more detail. Non-trivial implementation issues are also discussed in this chapter. The development of the tablet game required multiple cycles of analyse, design, implement and evaluate. Before the first field test took place, the application had been tested multiple times by elderly adults and also five times by dementia patients. The results of the pre-tests were used to optimize the application and eradicate remaining usability problems of the tablet game *Mindtraining*. The iterations of the development phase are described at the end of this chapter.

5.1 Technical Aspects

The application is developed for Android tablets and optimized for displays with at least 10 in of size. For testing, a 10.1 in sized ASUS MeMO Pad 10 Android tablet was used. The application was developed in Java, using Android Studio as development environment. The application targets a minium Android API of 18, which means every Android device with a minium Android system version of 4.3 is capable to run it.

The application is generally structured into two main parts: The application module and the logic module (see Fig. 5.1). While the application module handles all Android specific code, the logic module provides an interface to manage all data of the interactive photo book. The application module consists of four Android activities: Welcome view, library view, view for adding a new book and the book view. Each activity uses an instance of the Android *TextToSpeech* engine, to speak aloud all shown text phrases in the application.

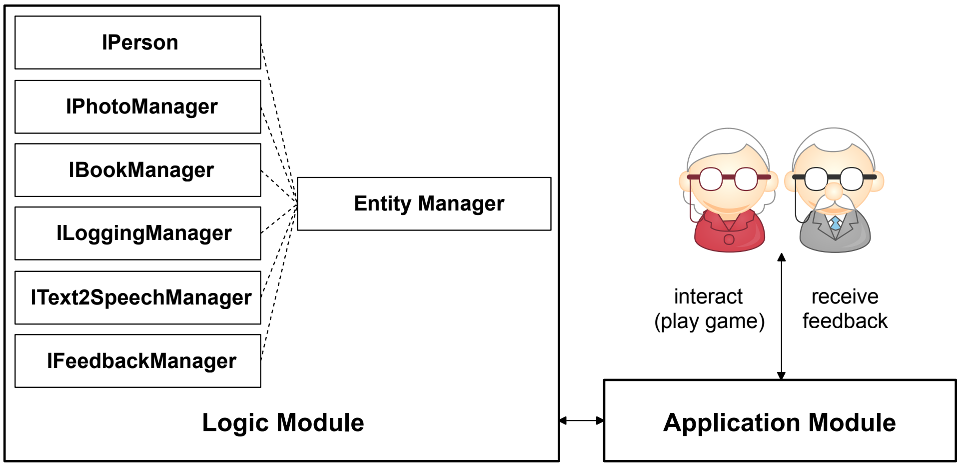


Figure 5.1: The system consists fo the application module and the logic module, which implements various interfaces.

For showing the photos in photo book, a data pool of 30 photos with text and sound is created in the application. The photos are organized into the following categories: Animals, flowers, sightseeing, nature, cars. The photos are randomly displayed. For the sayings game, 36 sayings with each three false and one correct answers, are created in the application. The sayings are randomly chosen from this data pool. For the interactive radio, 13 songs, which were famous in the earlier years of nowadays dementia patients, are prepared to be played.

There are two additional libraries for various features used. *ActiveAndroid* is an active style object relational wrapper, which simplifies managing data in databases[1]. This wrapper was used, to persistently save the person's data of each photo book (name, photo, favourite categories) onto the device.

A native Android library, *Android Propose*, helped to implement the concept of the interactive photo book[2]. Basically, the library provides creating a book with several pages, which are managed by a page manager. It also provides the implementation for flipping the pages.

5.2 Logging Module

To examine, which gestures on a tablet device are best suited for this target group, an automatic logging module was integrated in the final prototype. The logging module tracks, how a user interacts with visible elements on the screen. Tracked touch mechanics are: single tap, double tap, long press,

[1] https://github.com/pardom/ActiveAndroid
[2] https://github.com/JaeWoongOh/Propose

swipe from left to right and vice versa, swipe from top to bottom and vice versa. For this purpose, a listener for touch events is set recursively to each view:

```
public void setListenerRecursively(ViewGroup parent){
  for (int i = 0; i < parent.getChildCount(); i++) {
    View child = parent.getChildAt(i);
    if (child instanceof ViewGroup) {
      setListenerRecursively((ViewGroup) child);
    } else if (child != null) {
      if (child.getTag() != null && (child instanceof ImageButton ||
    child instanceof TextView || child instanceof Button)) {
        child.setOnTouchListener(this);
      }
    }
  }
}
```

Within the photo book the recursive approach was not possible, as there are too many helper views for providing the flipping animation. In the photo book, the listener was therefore attached manually to each view of interest.

In detail, the touched view, the performed touch mechanic, the position of the finger and a timestamp get logged, when the user touches the screen. The data is stored in a log-file in jSON-format onto the device. A typical extraction of the log-file looks as following:


```
{
  "name":"BookPage_Photo",
  "durationMs":"32581",
  "person":{
    "id":"4",
    "name":"Igrid"
  },
  "interactions":[{
    "interactionType":"LongPress",
    "viewName":"100_page4_imageview",
    "startX":"449.0",
    "startY":"428.0",
    "endX":"450.0",
    "endY":"424.0",
    "date":"Wed May 11 09:31:33 MESZ 2016"
  }]
}
```


With each start of the application, a new log-file is created. For analysing the gathered data, all log-files were converted to comma-separated values and imported in a spreadsheet calculation program.

5.3 Development Challenges

The concept of a photo book was complex to implement. A fluent animation of flipping the page from one side to the other with your finger was unexpected complex, to realize with native Android code. The research in this matter took a great part of time in the development phase. In Android, CustomView is needed, to apply animations to it. But using CustomView has several disadvantages, as it is not reusable and also limited with using multiple animations. Research and deployment of similar open-source projects confirmed those problems, as the animations never seemed fluently. A stuttering animation would be a huge obstacle, when using the application. After several trial and errors, a new open-source project was found on GitHub, which accomplished animations on views with a new approach[3]. The library uses Android Property Animation, which allows combinations of translation and rotation in a fluent way. It provides several examples of animations and one project of a ready-to-use storybook, which was used for *Mindtraining*.

Also providing animations for gestures took a lot of effort to implement and test in Android. Each time, position and object has to be configured manually without preview of the animation. For example, the animation, which shows, how to flip the page, is implemented as follows (see Fig. 5.2):

```
anim_right2left = new TranslateAnimation(circle1.getRight(),  circle1.
     getRight() - bookWidth, cursor.getTop(), cursor.getTop());
anim_right2left.setDuration(3000);
anim_right2left.setStartOffset(1000);
anim_right2left.setRepeatCount(Animation.INFINITE);
anim_right2left.setRepeatMode(Animation.RESTART);

android.os.Handler handler = new android.os.Handler();
handler.postDelayed(new Runnable() {
  @Override
  public void run() {
    cursor.startAnimation(anim_right2left);
  }
},0);
```

Although all requirements were accomplished with native Android code in the end, it might be easier to develop a mobile game including animations with a suitable game development environment, such as Unity[4]. Handling animations in 2D and 3D could probably be accomplished more efficient using Unity's integrated services.

5.4 Iterative Testing of the Prototype

Testing the game by your target audience is crucial, to be able to predict what they are going to enjoy [47]. Thinking about the player is useful, but even more useful is watching them play your game.

[3] https://github.com/JaeWoongOh/Propose

[4] https://unity3d.com/

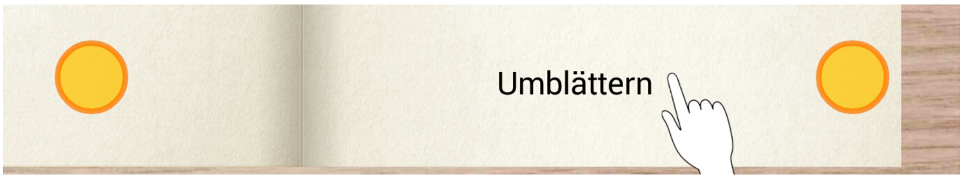


Figure 5.2: The system consists fo the application module and the logic module, which implements various interfaces.

Before conducting the field test, the application was tested by eight participants (age: 56–90, gender: 3 male, 5 female). Three of the participants have early-stage dementia, one has middle-stage dementia, the others don't have dementia. The results of these tests were used to find and eliminate usability problems. The device used was a 10.1 in sized ASUS MeMO Pad 10 Android tablet. A protection case covered the back of the device, which firstly gave additional grip and secondly provided a stable base to position it on a table in the right angle.

In total, four main iterations, each included planning, implementing, testing and evaluation, took place. Besides adapting sizes for fonts and graphics, two important issues were optimized during these iterations. At first people were instructed which gestures had to be performed, such as tapping on a photo or swiping for flipping a page. When it came to dementia patients, switching between the different gestures caused problems. As they had learned that swiping from right to left resulted in the intended outcome, they also tried swiping on photos and buttons. To solve the cognitive overload of switching between different gestures, simple animations for tapping and swiping were implemented at the desired positions to provide a visual instruction how to perform the gesture on the element. Figure 5.2 shows the visualization of the animation for flipping the pages. This optimization showed that dementia patients needed fewer instructions from the caretaker on how to interact with the different elements.

The second main usability problem, which had been observed, is that a single tap is often difficult to perform by elderly people including dementia patients. The main issues are sideslipping of the finger and the duration of the tap. Also the user sometimes touches the screen with the fingernails, which has no effect on a capacitive display. With Android's standard functionality of clickable elements the action is only executed when performing a single tap on the element. To solve this issue, Android's standard functionality for clickable elements was extended in a way that these elements also react to gestures, such as swipe, double tap and long press. The logging module tracks, which gesture has been performed on an element. This will allow an analysis of the usage of gestures afterwards. Due to the single tap problem, the scenario with dragging the right answer to a target location in the sayings game, could be performed much faster and more fluently than single tapping on the right answer. But after implementing the extension of clickable elements, selecting the answer worked much better compared to dragging.

Chapter 6

Methods and Results

To analyse the interaction methods in the prototype tablet game, a field test with three participants with early-stage dementia was conducted. The test took place in a small day-care facility where dementia patients get cared for three times a week. Additional to the implemented logging module, an observation protocol served as a documentation of qualitative data during the field test. The limited number of participants in this study doesn't give significant results, but the captured quantitative data supports the results of the qualitative observations. A focus on qualitative research was chosen, as there could not be recruited a greater number of participants, with early- or middle-stage dementia, in a timely and cost-efficient manner.

First, this chapter describes the methods used, to examine interactions in the proposed application *Mindtraining*. This includes the description of the participants, who attended the field study, and the procedure of the field study. Next, the results – supported by diagrams of the quantitative data – are shown and analysed. The discussion in the end summarizes the found observations compared to state-of-the-art research. A list of recommendations for interaction techniques in a serious game for dementia, based on the conducted field test, is given.

6.1 Participants

Three participants, with 75–90 years in age, agreed to undertake the field test. Two of them are male, one is female. All participants usually visit a day-care facility on a regular basis every week. During the test phase, exceptions with all of the participants occurred as they didn't visit the facility for 2–3 weeks in a row, either due to sickness or hospital stays. One participant suffers from beginning senile dementia, the other two participants are diagnosed with early stage dementia, with first signs of transitioning into middle stage dementia. All of them stated that they use technology, such as a mobile phone, but the frequency of usage differed from every couple

Figure 6.1: Typical setting of the the field tests: Subject playing the game, a carer sitting next to her and supporting her when questions arise and the observer in the background, taking notes.

of months to daily. Two of them said, they mostly felt very confident when using technology and one said that he seldom feels confident when using technology. The type of games, they are interested in, vary a lot, although all of them have a high interest in games for training their minds. When the participants were asked about their common general interests, they all stated that they like music and nature. Other interests of the individuals were movies, animals, cars, technology and travelling.

6.2 Procedure

The field test was conducted in a day-care facility for people with dementia. The facility consists of a large communal space with multiple tables, chairs and couches. During the field tests, the number of people in the room varied from six to twelve people (including care takers). Due to this, the noise level often was very high in the communal space. Also the participants got easily distracted, as other activities just happened next to them at the same time. Most of the time, the participants tested the tablet game in the morning, between 09:00 to 10:30 o'clock. People were more concentrated and motivated to participate the first half of the day. After breakfast, they always read the newspaper together and talk about the articles before they start with another activity, such as gymnastics, around 10:30 o'clock. The participants were asked if they want to play the tablet game and most of the time they agreed to. When they didn't feel so well that day or were tired, the participants rejected to play. Before the participant started playing, the application was introduced to the participant by the instructor. During the field test, the instructor helped the participant whenever it was needed (see Fig. 6.1). The observer watched the field test and filled out an observation protocol for each test. When they reached the final view of the application, the participants were asked how they liked the application, what they liked best and if they want to play it again. After the test the participants were thanked and complemented that they undertook the field test.

Before the field tests took place, the participants were introduced to the study project and got a general information sheet to read. In the information sheet it is clearly stated that all data of the participants will be handled anonymously. Then they were handed out an informed consent, which they signed. Two out of the three participants agreed that pictures can be taken during the field test. A questionnaire was also filled out by the participants in order to help with the interpretation of the collected data. Besides demographic data, such as age or gender, questions about personal interests, technological skills and level of education were conducted by this questionnaire. The carers in the facility, who helped with the study, gave an orally agreement to participate and have their data used in this thesis.

The tablet game was tested completely twelve times by three participants within a duration of 78 days. One participant tested the tablet game six times, the other two each three times. Completely in this context means, that the participant used the application from the welcome view to the final page of the interactive book. It happened several times that the participant didn't play until the final page of the application. Reasons for that were that either the participants got tired or they were distracted by group activities, which they preferred to join. The data of these uncompleted test sessions is not being used for the quantitative evaluation as it is to few data for comparison. When conducting the field tests, it was an important factor that the participants do not get harmed. Not knowing the answers in the sayings game could influence the participant's self-esteem and dignity in a negative way. During the field test, a special consideration was shown, to respect the participants abilities during testing.

6.3 Results

With iterative testing of the prototype during the development phase, it was observed that it is difficult for the patients to perform single taps on interactive elements (describend in Sec. 5.4). As this is an interesting issue, a great part of the evaluation is focused on the touch mechanics on interactive elements. The implemented logging module recorded each touch

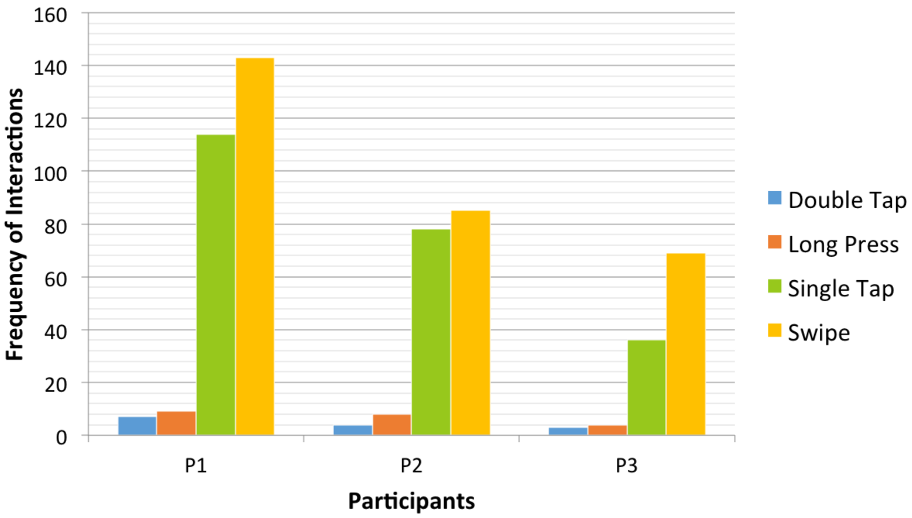


Figure 6.2: Performed touch mechanics of each participant on single tap elements. Swipe is most frequently used by each participant.

of the elements in the application. With the gathered data it can be confirmed that single taps on touchable elements, such as buttons, are difficult to perform by the target audience. Figure 6.2 shows the performed touch mechanics of each participant on elements, which usually require a single tap. These elements include: welcome door, photo on right page, photo on left page, smiley button to select mood, sayings answer text, sayings repeat button, radio on button and radio off button. The diagram shows that the participants most frequently perform a swipe on elements. Although these elements would require just a single tap, the mechanic single tap is not the most frequently performed interaction. Occasional usage of long presses and double taps also occurred for these elements. Similar issues occured in the study of Kobayashi et al., as participants wanted to perform a tap, but the action resulted in a swipe [25]. As it was already observed during the iterative testing phase, reasons for that are either sideslipping of the finger or the difficulty to switch between different gestures. Swiping is needed, to flip the pages of the book and it already seemed like a cognitive training when the patients had to alternate between swiping the pages and tapping the buttons and images. Problems with slipping and drifting has also been observed with older users as well as with users with motor impairments, using pen- or mouse-based target acquisition [14, 38]. The proposed solution of the authors is enhancing the area of the target to reduce the precision needed to position the cursor. This strategy is comparable to the approach in *Mindtraining*, though the area is not expanded, but the spectrum of touch mechanics is enhanced. With this strategy a tap on the screen, with slipping the finger before lifting it up again, is still recognized as a click on the element. Kobayashi et al. observed that elderly users try different gestures as error correction [25]. Their participants tried to vary the speed and pressure by slowing down or speeding up their finger movements, if they failed to tap the target on the first attempt. This often resulted in different touch mechanics, such as swipe or long presses. This can be confirmed with the observations in the field tests of *Mindtraining*. When a participant missed a target, the participant used a different finger movement with the next attempt.

The analysis of the gathered data shows that more than 50% of the users interactions on single tap elements could not have been performed with Android's standard functionality of clickable elements (such as buttons). The implemented extension in the prototype, allows other forms of touch mechanics on clickable elements and therefore offers the user a more flexible way of interaction. The experience of repetitively not responding elements could lead to demotivation and frustration and should best be avoided.

Part of this research is, to examine an intuitive and efficient usage of interaction techniques. It was observed that as long there are clear instructions for the user, any gesture can be performed. Even though an interface is carefully designed and seems intuitive, participants need to be instructed how to perform a gesture. This issue was also observed in the study of Kobayashi et al., when the participants complained about missing instructions how to perform gestures [25]. For example, flipping the pages of the photo book requires to swipe the page from one side to the other side. Without the animation (two points and a sliding finger from one side to the other, see Fig. 5.2), the users had to be instructed by the caretaker each time. After the animation was implemented on the pages of the photo book, the users could execute the gesture without any further instructions.

The analysis shows, that single taps are difficult to perform. This was also observed by Kobayashi et al., as tapping (especially on small targets) was a difficult operation for elderly users [25]. In their study, they assumed that tapping on a touchscreen is the easiest gesture to perform. Referring to the results, they had to reject this hypothesis. It seems that a combination of the touch mechanics single tap and swipe would be the most efficient interaction technique for clickable elements. This combination covers 93.75% of the performed interactions on single tap elements in our field tests (confirmed in Fig. 6.2. The occurrence of double taps and long presses is vanishing small. Intuitive usage of the elements in the application was measured by the ratio of selected non-clickable and clickable elements. Non-clickable elements are text views and images in the application, which result in no further action, when the user selects them. The application consists of nine text views and two images, which are not clickable. Figure 6.3 shows the performed touch mechanics on non-clickable elements per participant.

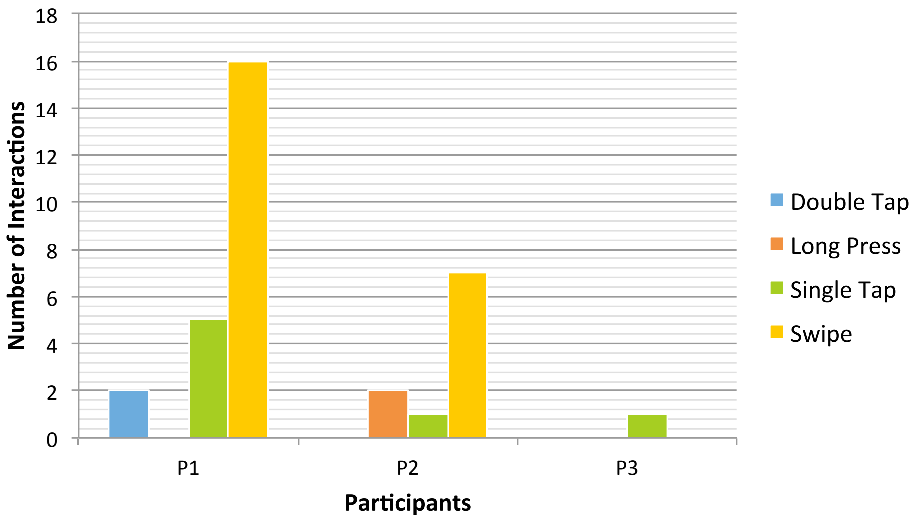
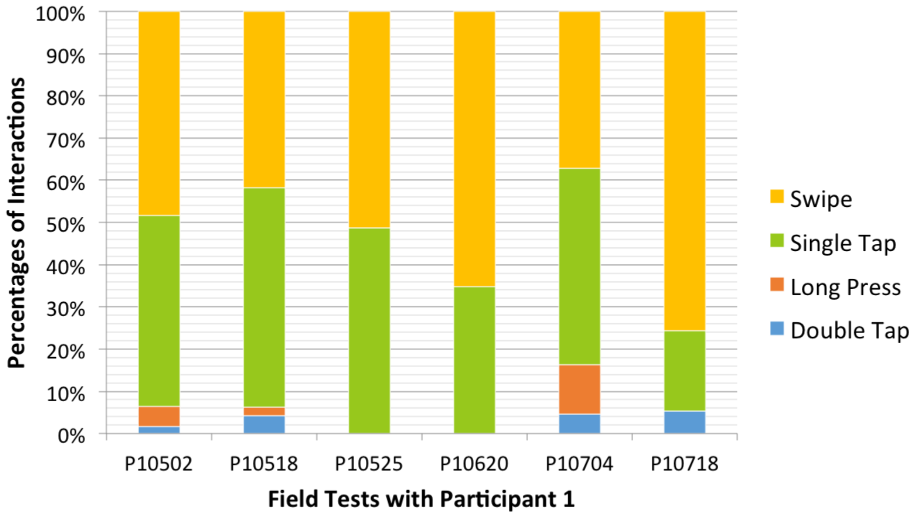


Figure 6.3: Performed touch mechanics of each participant on non-clickable elements.

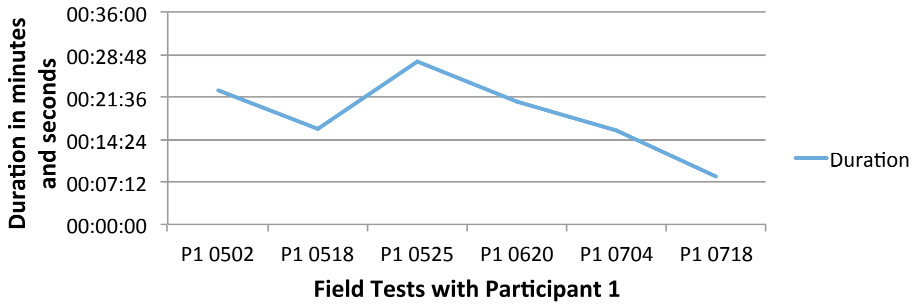
Table 6.1: Ratio of interactions on non-clickable elements performed by participants $P1$, $P2$ and $P3$.

	$P1$	$P2$	$P3$
Double Tap	22%	0%	0%
Long Press	0%	20%	0%
Single Tap	4%	1%	3%
Swipe	10%	8%	0%
Total Ratio	8%	5%	1%

Table 6.1 shows the ratio of selected non-clickable elements in comparison to all interactions. It can be seen that less than ten percent of all interactions were performed on non-clickable elements ($P1$: 8%, $P2$: 5%, $P3$: 1%). Intuitive usage is about the affordance of elements. A good affordance means, that an object is designed in a way, that users know, how to interact with it. If an element has a good affordance, the user would recognize, if it is clickable or not. The data results show that also text and non-clickable images in the application were selected, but with vanishingly low occurrence.



(a)



(b)

Figure 6.4: Performed touch mechanics of participant $P1$ on single tap elements (a) and visualization of the duration of the tests (b). The field tests are chronically ordered from left to right.

6.3.1 Recall of the Application

Another interesting matter is, how good people with dementia remember, how to interact with various elements from one test to another. Figure 6.4(a) shows the partitioning of touch mechanics of all six conducted field tests of the first participant $P1$. The average time between each of the six tests was 15.4 days. The assumption was that the correct usage of gestures would increase, after a couple of times using the application. This cannot be confirmed by the gathered data about touch mechanics on single tap elements. The diagram doesn't show any pattern that would confirm an increase of single taps on single tap elements with passing test rounds.

Before each test round, the patients were asked, if they remember playing with the tablet device, which all of them denied. Except for one time, when the device was shown to $P3$ two days after he used the device, he nodded that he already used it before. In a three-months tablet study, in a nursing home for dementia, they observed that dementia patients remember the tablet applications, when they use it on a regular basis, such as two to three times a week [27]. Hence, after a three months pause, nobody remembered using the tablet before. But when they started using the tablet after the three months pause again, it was noticed that they could almost use it as independently as at the end of the three-months study (only a short tutorial in the beginning was needed).

In *Mindtraining*, each time, when the patients saw their picture in the library view (except for $P3$, who didn't want to have a picture taken of him), they were slightly surprised and delighted to see themselves. Although the participants denied knowing the application, it was observed that they speeded up and needed less time for flipping through the photo book with passing field tests. This is also confirmed with the logged time data, shown in 6.4(b). $P1$ needed – except for the second field test – less time for each following field test. In a three-months study in Berlin, four participants with dementia tested tablet applications on a regular basis and the time for each test varied for each participant [27]. As for two of them, twenty minutes was already enough, the other two participant often spent two hours with the tablet. Lim et al. examined the usability of tablet computers within the early-stage dementia context as a source of leisure for people with dementia [32]. The majority of the participants (38.10%) spent more than 40 minutes per day using the iPad accompanied by a supervisor. One third of the participants spent 30 – 40 minutes per day and the remaining $28,57\%$ of the participants spent less than 30 minutes per day with the iPad. It seems like the duration of usage varies depending on the interest of the individual and the respective application used. None of the related research studies reported an increase of speed with passing field tests. Due to the low number of participants this would need a further investigation.

In Fig. 6.4(a), it also can be seen that the touch mechanics vary slightly with every test round, as two out of six times the frequency of single taps outweighs the frequency of swipes. With analysing the observation protocol, this circumstance might relate to the mood and well-being of the patient on the particular days. At some days of the test rounds the patients were more tired and less concentrated due to reasons such as weather conditions, medicine or insomnia. This also has been observed in a three-months tablet activiation in a nursing home for dementia [27]. The disease influences the performance of the patients, which could reveal different results with every field test. To have a better comparison, a detailed analysis of the patients well-being would need to be documented before conducting each test. Jenkins et al. investigated administering cognitive tests for touchscreen devices

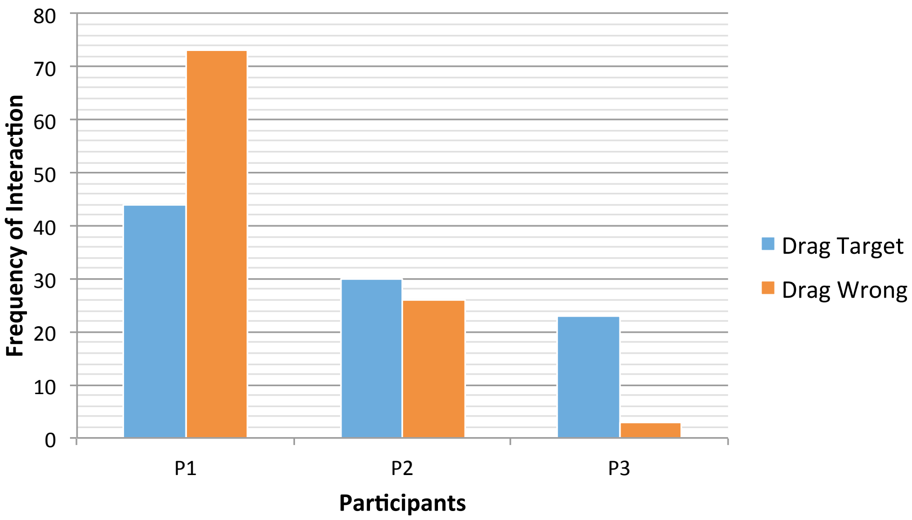


Figure 6.5: Performed drags of each participant in the sayings completion game, divided int drags to the target location (Drag Target) and drags to an incorrect location (Drag Wrong).

and noted that the disease status of a dementia patient has a large influence on the test results [21].

6.3.2 Mindtraining: Sayings Game

Observing the patients playing the sayings completion game yielded some interesting results. Two different scenarios are implemented in the game. The first scenario (S-Tap) requires tapping on the right answer (an animation in the game shows, how this should be done). The second scenario (S-Drag) requires dragging the right answer to a target location (a textual instruction explains, how this should be done). S-Tap is the first scenario to be done in the current book compilation. During the field tests, the players needed very few instructions, how to tap on the right answer and the concentration still was very high. S-Drag is positioned at the middle-end of the current book compilation and it was observed that at the end of playing S-Drag, concentration already was decreased. Also the textual instruction, how to perform the drag, was not that effective, as a visual animation. The players needed increased support to perform the drag action. With the first question, the caretaker always had to give instructions, how this drag needs to be performed. The correct execution of drags of the remaining questions with S-Drag varied with each participant. Figure 6.5 shows all performed drags, separated by each participant. A drag is classified as wrong, when the element got moved by the user, but not dragged to the target loca-

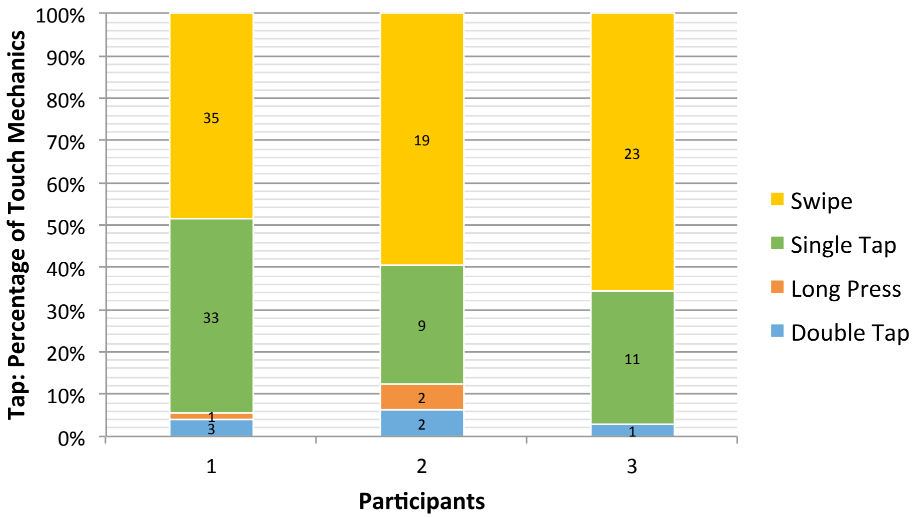
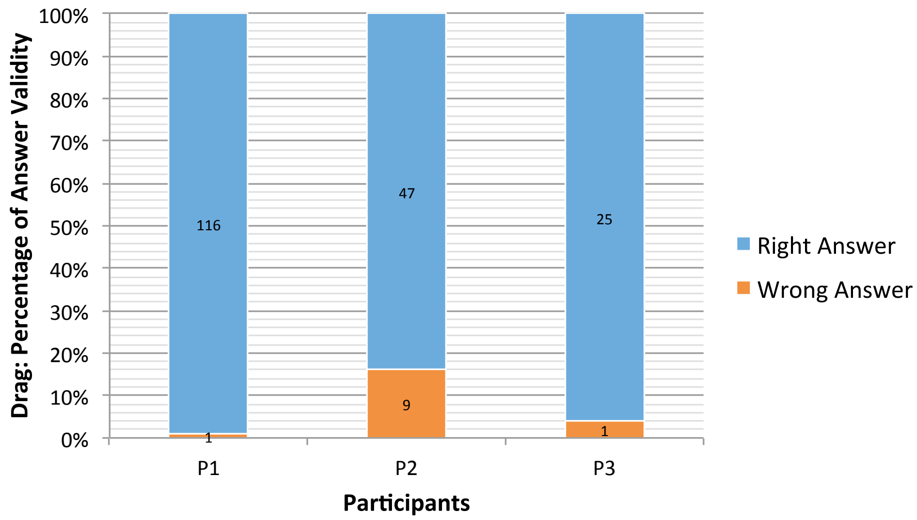


Figure 6.6: Sayings game (S-Tap): Performed touch mechanics of each participant on answers of the sayings game.

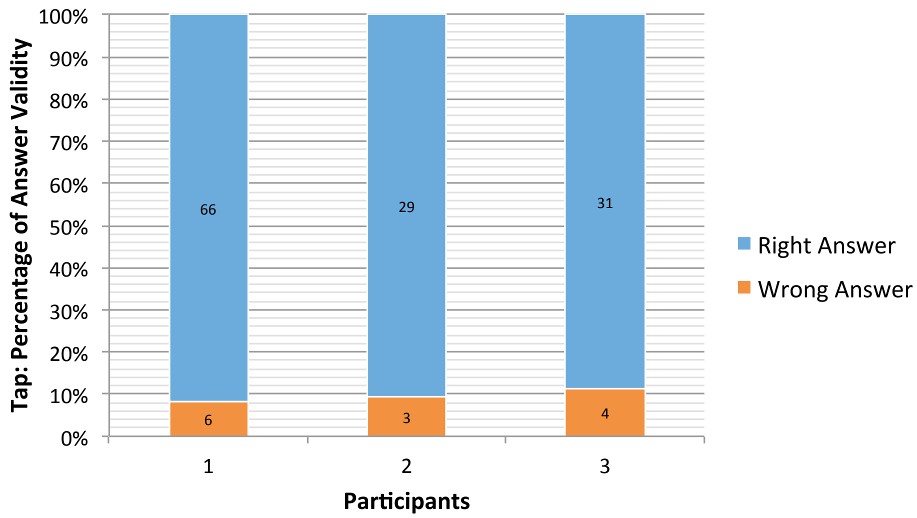
tion. The gathered data shows that $P1$ had the most problems to drag the answers, $P2$ has almost the same amount of correct drags as wrong drags and for $P3$, dragging the answers seemed to be no problem at all. It could be generally observed that $P3$ was very fast with grasping how to use the application. Although, at the beginning of each field test, it seemed that $P3$ is unchallenged with using the application, $P3$ also had problems with switching between gestures at the end of the tests. Lowering the accuracy requirements could improve the accessibility of the drag scenario. Motti et al. [40] investigated the usage of drag gestures with elderly people (aged 65 to 86 years old) and found lowering the accuracy requirement for positioning targets on touchscreens a successful method.

In the study of Kobayashi et al., the subjective opinion of the participants was that drag and drop is the preferred gesture and easier to perform compared to tapping [25]. Figure 6.6 shows the touch mechanics used in S-Tap. Without the extension of clickable elements in the prototype *Mindtraining*, more than 50% of the answer selection in the sayings game could not have been performed. Comparing the touch mechanic single tap in Fig. 6.6 to dragging right and wrong in Fig. 6.5, dragging seems to have a slightly better performance than single tapping. Hence, with the extension of clickable elements, S-Tap is the better scenario compared to S-Drag.

Although dragging the answer was difficult for two out of three participants, it had no influence on choosing the correct answer. The diagrams in Fig. 6.7 show, that all participants knew almost all correct answers for completing the sayings. The game contains one saying, which is completely



(a)



(b)

Figure 6.7: Relation of correct and incorrect answers of each participant when dragging (a), and tapping (b) the answer.

unknown to the patients of the facility. When this one saying was shown, the participants either asked the caretaker for the correct answer or they guessed it. The dementia patients could never remember the correct answer to this one special saying. Not even, if it randomly popped up twice in the same sayings game (which is possible, as the sayings are chosen randomly from a data pool).

Figure 6.8: Success message on the right page of the book and completed saying on the left side of the book. The repeat button is accompanied with an animation which shows how to tap.

When the player selects the correct answer on the right side of the book, the saying gets completed with a short transition on the left side. At the same time a striking success animation, accompanied with sound, pops up at the right side of the book, see Fig. 6.8. A typical flow, when people with dementia tested the application, was the following: The player focusses on the success animation, but often overlooks the sayings repeat button at the bottom of the page. Instead the player's focus switches to the left side again and the completed saying gets read again by the player. After that, the player searches what to do next and recognizes the tap animation at the sayings repeat button on the right side and selects it. With increased time in a field test, it got more difficult and required more time for the player to select the repeat button. Observations also showed, that tapping on the repeat button was especially difficult with S-Drag, as it required instant switching between drag and tap with every question. An automatic switching to the next question might help the player in this situation.

Another observation is that the sayings game gets people to speak the question out loud. This circumstance had two side effects: Firstly, a good group dynamic emerged as other patients started guessing the answer. Secondly, due to increased talking of the participant, the caretaker had to remind the participant to drink some water in-between. This could be a future requirement that drinking reminders are already integrated in such games.

6.4 Discussion

The results show interesting aspects of the application *Mindtraining* and the used interactions techniques. Though the application was only tested by three participants with dementia, the field tests revealed many useful results regarding interactions techniques. Different gestures are required to use the application in order to investigate how intuitive and effective they are. Switching between gestures (flip a page via swipe before tap on a photo) is already a task, which can be demanding for people with dementia. It seems that using a single gesture (just taps; just swipes) in the entire application could ease the usage of an application. But when discussing this issue with the care taker, who was involved in the study, another point of view was noted: Operating the touchscreen with different gestures is already a good cognitive training for people with dementia. Nevertheless, building the application with diverse gestures, requires support for the user, to know which gestures are possible within the respective view of the application.

One main topic, which was further investigated, is the touch mechanic on interactive elements. With the gathered study data, it can be confirmed that single taps are difficult to perform by the target audience. This is due to reasons of sideslipping of the finger (which results in a swipe and not a tap), or intentional swiping (not knowing, how to perform a tap). A similar problem has also been observed with pen- or mouse-based target acquisition [14, 38] and in a study, which investigates touchscreen interactin with elderly [25]. A combination of single tap and swipe covered 93.75% of the performed interactions on single tap elements in the field tests of *Mindtraining*. It seems that implementing this combination would result in the most efficient interaction technique for clickable elements.

Touches on text views and images, which are not clickable, occurred less than 10% of all interactions. Having this percentage as low as possible improves the intuitiveness of the application.

The application was not remembered by the patients before each test round. The average time of 15.4 days between each of the six tests seems to be to high to remember the application by people with dementia. In another research project people could remember using the tablet device, but they used it two to three times a week [27].

Time used for each field test decreased over time. This would need further investigation as none of the related research studies reports an increase of speed with passing field tests. What has been observed and also confirmed in other studies that the performance of a person with dementia is mainly depending on the current disease status and well-being [21, 27].

The sayings game is implemented with two scenarios: Tapping on the correct answer and dragging the correct answer to a target location. Dragging revealed more difficulties for dementia patients than tapping. Lowering the accuracy requirement for positioning targets might ease the use of dragging [40]. Kobayashi et al. observed that drag and drop is easier to perform than single taps by elderly people [25]. With the implemented extension of clickable elements in *Mindtraining*, this cannot be confirmed, as the scenario with tap was easier to perform for dementia patients.

Based on the conducted logging data, the qualitative observations during the field tests and an expert interview with the involved care taker, the following recommendations regarding a serious game for dementia and its interactions techniques were found:

- Usage of different gestures is a good cognitive training and should be encouraged in an application.
- Instructional support for performing a gesture is needed. For example: Animations at the respective location are well understood.
- Animations have to be carefully integrated as they might be interpreted differently by each person. A further investigation, which animations work best for touch mechanics, such as touch, swipe, drag and drop, would be needed.
- Touch points in the animation indicating where to touch the screen are very useful. They should be highlighted from the background.
- Animations need to be integrated repeatedly, so that the user has enough time to watch it, and think, how to perform the gesture.
- Interactive elements need to be spatially separated from each other, so that missing a target does not trigger another target. For example, before the field test took place, flipping the page in the photo book was implemented on the entire page of the book. When the user missed a button, it sometimes happened that the user flipped the page instead.
- Visual language needs to be tested and re-implemented in multiple iterations, as it is prone to misinterpretations. For example in *Mindtraining*, a button with an arrow pointing to the left is shown, to close a photo, when it gets enlarged (see Fig. 6.9). But the arrow pointing left was often interpreted as swiping from right to left.
- Tasks to perform should rather be implemented sequentially than parallel to reduce the cognitive overload. In *Mindtraining*, the user can choose to either enlarge the photo or flip the page. The participants sometimes tapped on the animation to flip the page, although they wanted to enlarge the photo.
- If the tablet application is mainly used in a community room of a nursing home, distractions (due to activities of the other patients) may occur during the usage of the application. To get the user's attention again, the application should provide a prompting method after one minute of inactivity.
- With time passing in each field test, the participants needed increased support, to use the application. When the application was used by

Figure 6.9: A button is shown, when a photo gets enlarged in the photo book. By triggering the button, the photo gets minimized again.

elderly people without dementia, the opposite effect was observed. The learning curve increased in a way that people without dementia could use the application more independently with time passing. But with dementia, it seems like the cognitive effort outweighs the learning curve. To give one example: When concentration decreased, the participants sometimes enlarged the same photo over and over again until the care taker told them to flip the page. A step by step instruction or an automated navigation in the application would release the cognitive effort.

- *Mindtraining* consists of three main parts: Trivia game, music and photos. But everyone liked something else better. Two participants preferred playing the game and the third one preferred watching photos. One of them did not like watching photos at all. The interactive radio appeared as least popular by the participants. As all users of *Mindtraining* have their own photo book, individual settings could be applied easily. This will be considered in future developments.

This list of recommendation should be considered in developing a serious game for dementia. Nonetheless, as these recommendations are based on the findings of a small study with few participants, some of the findings would need a further investigation. This chapter described the methods and results of a field study with a tablet prototype game for dementia patients. The next chapter summarizes the thesis and limitations and contributions of the project are noted.

Chapter 7

Conclusions

7.1 Limitations

A limitation of this research is that only three participants undertook the field study. Due to this, the focus was set on qualitative research via observation data and interview data. With a greater number of participants, significant results could be gathered. Conclusions about age, gender and stage of dementia were also not incorporated in the evaluation, as it is not convincing with this low number of participants.

Another issue is the lack of documentation of the participants well-being before each test. The mental and physical status of a patient with dementia disease (which can vary from one day to another) has a large influence on the performance during the test. An analysis before each test would be needed, to correlate the test results to the disease status.

Also the noise level and activities in the room, where the field tests took place, might have influenced the concentration of the participants. Viewed in a different way, this might not be a limitation, as with included distraction, the study setting is more similar to a real-life setting.

The study data might also be different, if another time interval between each test would have been chosen. The average days between each test were 15.4 days and all participants noted that they do not remember the tablet device anymore. In another study with an interval of two to three days, the participants remembered using the device [27]. Applying different time intervals between each test might lead to different results.

7.2 Future work

Future research should focus on the interaction design of tablet applications, with designing for dementia patients in mind. It has been observed that people with dementia need support to operate a touch device, particularly when concentration decreases with passing time. Animations with visual cues, which show, how to perform gestures, are a useful method to provide this support. But these animations for gestures would need further investigation, as they are easily misinterpreted by elderly people.

Personal adaption of the photo book is a future requirement, as some users favor photos over games, music over games, or games over photos. This would increase the motivation to play as the users only see their preferred topics in the photo book.

7.3 Summary

Research of serious games in the dementia context played an essential role, when designing a novel serious game for dementia: *Mindtraining*, a tablet game, which serves as an playful photo book. State-of-the-art projects confirm that tablet games have the potential to support dementia therapy. The aim of this thesis is to gather findings of intuitive and effective interaction techniques of tablet games for people with dementia. The concept of the prototype game *Mindtraining* is based on recommendations of several research studies in the dementia context, as well as on observations of the target audience. The application was used to undertake a field study with dementia patients to gather information about how much help is needed each time using the application and how good different kinds of gestures are remembered. The findings reveal some interesting results, which should be considered in designing serious games for dementia in the future. The results show that dementia patients needed a lot of help performing swipes and taps. This support was sometimes provided by another person, who helped the participants, and it also was provided by animations, which displayed the respective gestures. One interesting fact is that single taps are difficult to perform by people with dementia and often result in a swipe due to sideslipping or forgetting how to perform a single tap. In *Mindtraining*, a novel approach is introduced, which allows any kind of gestures to click interactive elements, such as swipes or long presses on buttons. With this approach, over 90% of the interactions could be performed successful.

Recall of the application by the participants was non-existent. This might change, if dementia patients use the application on a regular basis. But for usage at a non-regular basis, it seems that an application needs to give a tutorial of how to perform gestures, each time the application is used. All findings of interaction techniques for dementia are discussed in Sec. 6.4 and should inform further research on this matter.

In conclusion, the tablet game was well appreciated by the participants and they enjoyed operating the touchscreen. Nonetheless, it should be noted that a tablet application might not cure the patients disease, but it can be seen as a tool to achieve greater autonomy in daily life and encourage social interactions.

Appendix A

Personas

Betty Barns

72 years old

Former occupation: teacher

Betty was born in 1943 and worked as a teacher until her retirement in 1998. She lives in a house with her daughter and her daughter's husband, who take care of her. Five years ago, she got the diagnose of having Alzheimer's disease. Most of the time her daughter, who has a part time job and sometimes works from home, takes care of her except for 2 days in the week, where Betty stays in a day caretaking facility. Betty likes to remember her childhood, when she grew up with her four sisters and brothers. They had a little farm with chicken, goats, cats and a dog and she always tells about how they played with the dog. Her brothers and sisters already died, but she doesn't remember that and always gets really sad when somebody tells her. Listening to music of the 60's cheers her up, when she is in a sad mood. She also likes to be outside in the garden, but since a few months she needs a wheelchair, which took the flexibility from her to go to the garden whenever she wants. Betty always was a curious person and still shows lots of interest when you tell her something new. The bad thing is she forgets almost everything and you can tell her the same new story the next day again. Considering her age, she still has really good eyes and just needs reading glasses when she wants to read the small texts in the newspapers.

Quotes

"Sometimes when I'm in the garden, I see everything like it was when I grew up. Although this dog here is much smaller than the one we had."

"We children really liked to dance and sing together, it was a lot of fun. When I was 12, we got our first radio at home. Then we danced to the songs from the radio."

Key attributes

- curious
- doesn't remember everything of previous day
- caring about her family
- animal-loving
- feels incommodiousness when she can't go outside for a day
- loves music from the 60's
- good eye sight

Figure A.1: Persona 1.

Indre Lack

68 years old

Former occupation: farmer

Indre was born in 1947 and grew up on her parent's farm with her six brothers and sisters. She had to help a lot on the farm and in the household. With 19 she married a young man from the neighbourhood and they overtook his parents large farm after ten years. She was used to work hard and always was kind of restless. With the age of 64 she got the diagnosis having Alzheimer's. Indre lives in a caretaking facility now, because she was too restless at home and also got aggressive sometimes, that her husband became unable to cope with her disease. He visits her everyday, but sometimes she is in a bad mood and doesn't want to speak to him. On other days she wants to go home with him, because she thinks that she needs to help on the farm. She sometimes forgets that they sold the farm a couple of years ago. In the caretaking facility she is a great help in all belongings. She sometimes describes herself more as a staff member than a patient. The other patients like her company a lot: she talks with them or plays card games or ludo with them. She also helps with cooking and with the household in the facility and always needs to tidy up something. When she doesn't have any task to do, she gets restless and a little bit aggressive as she insults other patients. The caretakers found out that they can calm her down with showing her pictures from former times, from the farm and from cute animals. Then she begins telling her entertaining stories from her past or makes funny jokes. Sometimes the caretakers find it hard to calm her down, because she has a very bad hearing and doesn't always hear what others are saying to her. Also sometimes they got the feeling that she just doesn't want to hear it.

Quotes

"When I was young, we were the only household in the whole neighbourhood, who owned a TV. Anyways, there was no time for watching TV. Just for the big skiing races all neighbours came to our parlour to watch it together."

"I like helping here in this facility and talking to the people. What else should I do the whole day?"

Key attributes

- restless
- still remembers most of the past
- able to talk for hours
- distinct sense of order
- likes to play games with others
- funny
- bad hearing

Figure A.2: Persona 2.

Terry Reese

65 years old

Former occupation: musician and shoemaker

Hans was born in 1950 and worked as a shoemaker until his car accident six years ago. Additionally to his impairments due to the accident he got diagnosed with Alzheimer's two years ago. Due to the accident he is suffering a little muscle tremor and also seldom feels appetite or thirst. Since the accident, he is living in a caretaking facility. Besides his shoemaking career he also often had musical shows with his old friends, where he played the saxophone. They often travelled to other countries for their shows. Unfortunately he can't play the saxophone anymore due to his muscle tremor. Ever when music is playing in the facility, he is starting to swing and sway to the music. He isn't that much of a talker and prefers sitting alone at the table. The caretakers always need to ask him lots of questions to find out how he is feeling and what he would like. He often seems sad and engrossed in thought. Hans is able to spend hours at the artistic corner in the facility, where some mandala drawings are provided. He has a talent for drawing beautiful mandalas and when he finishes one, it gets hung up on the wall, which makes him really proud and happy. When they are reading the newspaper together or talking about famous locations in the facility he always acknowledges with a nod, as he knew exactly what it is about. He shows interest in the current world affairs and sometimes corrects someone, when the person says something that is not true. These are the only moments, when he starts talking by himself and explains, why something is not true. The people around him respect him and think of him as a person with a very good general knowledge.

Quotes

"I'm fine. Just let me rest a little bit more. I don't want to participate in the therapy."

"It's not exactly true what you are saying. I can tell you why,.."

Key attributes

- reserved
- still remembers most of the past
- loves music
- very good general knowledge
- doesn't like false statements
- artistically talented

Figure A.3: Persona 3.

Laura Peter

35 years old

Occupation: caretaker

Laura works in a caretaking facility for dementia patients. The facility accomodates permanent residents with early-, middle- and advanced-stage dementia and a few day care guests who are in the facility two or three times a week from 08:00 to 16:00 o'clock. In the morning she helps with preparing the breakfast before she wakes up the patients. After all people had their breakfast, she is taking care of the day care guests. She prepares different occupational therapies for the morning activities. She can do more pretentious activities in the morning, because people are far more concentrated. A few of her day care patients often ask for mind and memory exercises as they are concious about their current disease situtation. Exercises, which she prepares, are playing word games, reading backwards, reading newspaper articles aloud and calculating numbers. Before she starts with the exercises, she always invites her patients to sit in a circle and sing a song together, listen to a song or just hum to a song, which she is playing on the guitar. With this procedure the patients are often more willing to participate with the therapy. There are also often patients who doesn't want to participate or are too tired or even fall asleep during the exercises. That's no problem at all, Laura just lets a person sleep when the person wants to. After lunch, which they sometimes also cook together, most of the patients want to rest a little bit. In the afternoon, there is another occupational therapy session. As concentration is less than in the morning, Laura prepares some simple activities. Sometimes she shows pictures of famous places and asks if somebody knows them, they just sing a few songs together, they play some card games or they play Ludo. When playing games most of the time she doesn't have to explain any rules as every patients remembers the rules from the past (although they differ a lot from time to time). The most important thing she is doing in dementia therapy is motivating her patients. Even if somebody gets something wrong in a game, she gives positive feedback or responds with a funny saying. On some patients she has to focus more than on others as it's very hard to bring somebody out of her or his shell sometimes. Some of the female patients are also knitting or crocheting in the afternoon sessions.

Quotes

"You look like you need a hug today."

"You have done a very good job. What would we do without you?"

Key attributes

- all time motivating
- observing patients mood
- giving positive feedback
- knows lots of funny sayings
- medical experience

Figure A.4: Persona 4.

Appendix B

Content of the DVD

B.1 Thesis

Pfad: /

Hackner_Elisabeth_2016.pdf Master thesis

B.2 Literature

Pfad: /Literature

*.pdf . . . . Copies of the used literature documents
literatur.bib . . . . Database of all reference-list entries

Pfad: /Online

*.pdf . . . . Copies of the used web pages documents

B.3 Project

Pfad: /Project

readme.txt . . . . Instructions how to use the project
Source/ . . . . Source code of the project

B.4 Study Data

Pfad: /Study

*.pdf . . . . Forms for the field test
*.xlsx . . . . Data of the field test
*.jpg . . . . Pictures of the field test

B.5 Images

Pfad: /Images

*.ai	Original Adobe Illustrator Ffles
*.jpg, *.png	Original images
*.pdf	Vectorgraphics

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Höhe = 50 mm

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