Elements of Play for Cognitive, Physical and Social Health in Older Adults

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Abstract. An increasingly older demographic emphasizes the need to deal with a likewise increasing number of people with cognitive disabilities like dementia or Alzheimer's disease. While no cure exists the preventive potential of activities in the areas of reminiscence, cognitive, social and physical activity has been recognized. This paper looks at the possibilities of technological interventions in this field from a game design perspective. The paper follows the core research question "Which elements of play can be used in a playful holistic application combining reminiscence, cognitive, social and physical activities to prevent or postpone the development of cognitive disabilities such as dementia for older adults?" Examples are qualitatively analysed and lead to the identification of the elements auto-biographical play, musical play, kinaesthetic play, object-based play, adaptive play, collaborative play and role playing. The list of these elements is expendable and lays the foundation for a holistic design space.

Keywords: aging well, play, game elements, dementia prevention, serious games, reminiscence

1   Introduction

Due to steady advances in both disease prevention and treatment our society benefits from a longer life expectancy but also faces new challenges [1]. There is a growing demographic of older adults who despite of the advances made in other fields, still face the risk of cognitive disabilities such as dementia or Alzheimer's disease. The ever growing number of people who have one of these disabilities puts a great strain on care institutions who have trouble accommodating more and more patients. The exploding costs of care expenses demand new approaches for therapy and especially prevention. This demographic shift is accompanied by a change of the understanding of health and health care. Movements like the quantified self use technology to inte-

grate personal health, data feedback and consequently self reflection of one's health into everyday life. Governments try to encourage self responsibility of patients, hospitals discharge people into outpatient care earlier. It can be observed that there is a shift from a care society to a participation society, which empowers patients and encourages people to take on more responsibility for their well being.

This paper looks at how to support people with their goal to age well, in particular taking account of the three major challenges accompanying aging: cognitive loss; physical decline; and social isolation. These challenges are not discrete but closely interrelated. Cognitive disabilities cannot be prevented entirely but their onset can be postponed and their progression can be slowed by engaging in beneficial behaviour, thus enabling a longer prosperous life. For example, as also summarised in Grosinger et al [2]: low levels of social connections and infrequent participation in social activities affects the risk of cognitive decline [3]; and physical activity helps to improve cognitive performance [4], is particularly key to promoting health and well being among older people [5] and "regular physical activity is a key component of successful aging" and "may also slow down the course of Alzheimer's disease" ([6], pp.401) but physical activities typically decrease with age [7]. Beneficial behaviour therefore includes a mixture of cognitive, physical and social exercises. Also the values of reminiscence to promote well aging in older adults need to be taken into account, including identity-forming and self-continuity, enhancing meaning in life and coherence, preserving a sense of mastery, and promoting acceptance and reconciliation [8].

The starting premise of this paper is that games can provide a platform to combine all dimensions of these exercises to make them more engaging and to sustain these activities long term and so contribute to a prolonged independent life and also a lessened strain on care facilities. It seems promising to take a holistic approach and combine the four areas into one intervention. However, while there are a number of games that focus on one or more of these areas, there are no principled approaches to doing so nor an understanding of key elements of play that can support these. The aim of this paper is to identify elements of play to combine these diverse areas, to increase motivation and to sustain long term engagement. This leads to the following research question:

"Which elements of play can be used in a playful holistic application combining reminiscence, cognitive, social and physical activities to prevent or postpone the development of cognitive disabilities such as dementia for older adults?"

The goal of this paper is to open up the design space for possible technological interventions in this context. We will identify holistic and playful concepts across the areas of reminiscence, social activity, cognitive activity and physical activity, which are beneficial to delay or avoid the development of cognitive disabilities. This will be achieved through relating literature review of the current state of the art with a theoretical analysis of qualitative examples.

2   Research Approach

This paper builds on existing literature on games and dementia as well as a review of selected serious game examples to answer the above question. Based on the concepts of reminiscence, cognitive, social and physical activity discussed in the literature review we make a selection of games and serious toys, which are then qualitatively analysed. Relevant elements of play to prevent cognitive disabilities are extracted, discussed and are then interpreted in the context of a holistic application.

This paper is written in the context of the project Lebensnetz, a playful approach to prevent the development of cognitive disabilities. The paper's findings are informed by preliminary insights from four focus groups held as part of the project. The focus groups were comprised of 8-10 persons each and were held between October and November 2012 in Vienna, Austria. The first focus group involved experts from academia, health and care institutions, the second was held with members of the older adults target audience, the third with the families of older adults and the fourth was attended by care personnel. The focus groups were audio-recorded, transcribed and thematically analysed and will be the focus of another publication (under preparation). While not the core focus here, we will still draw on insights from the focus groups, and relate them to the findings of this paper. The key contribution of the paper is the identification of elements of play supporting holistic activities and directed at an older adults target audience.

The elements of play are identified through a qualitative analysis of the four selected game examples. The resulting differentiation of play elements in a holistic context and relating them with the current state of the art forms the core research result of this paper.

3   Literature Review

In this section we first elaborate on adult play and discuss the use of games and game elements in technological interventions targeted at older adults. We then move on to individually identify how reminiscence, social, cognitive and physical activity can support aging well.

3.1   Older Adults & Play

When designing games for older adults, age related changes have to be taken into account [9]. Some abilities tend to decline as people get older, including short-time memory, speed, executive functions and visual perception [10]. Barriers can for example be created by using too little contrasts or colours that are hard to discriminate. In this context, thinking about accessibility is of great importance [11]. McLaughlin et al. [12] also raise the issue of stereotype threat. Stereotype threat is the fear of failing at something because of stereotypes about the group a person belongs to, for example, "computer games are made for kids".

These changes can be addressed by carefully choosing physical interaction methods, feedback systems, an accessible interface and adaptive difficulty of the gameplay. Older adults tend to have less experience using computers than younger people. To facilitate learning a game Whitlock et al. [13] propose training support before getting started and during the learning process.

Quandt et al. [14] explored the experiences of older gamers and found that most of them got into playing as part of their jobs, were introduced by the children's generation or because of life-changing events like illnesses. They found that gaming impacts social acceptance of older gamers, creating frustration or resignation on their partner's side, but building a common ground for the interaction between different generations.

Concentrating on the interests of older gamers Pearce [15] conducted a study consisting of an online survey, interviews and discussion groups. She concluded that the PC is the platform of choice for older gamers (though Grosinger et al. [2] found a reluctance to spend too much time at the PC and instead found good acceptance among older people for using tablet computers; Murata et al. [16] also argue that a tablet computer tends to have fewer age-related usability issues for pointing tasks). They favour single-player games but are interested in mature companionships with other gamers. The older generation of gamers leans towards intellectually challenging games over speed and reflex-oriented games and are less interested in levelling and skill acquisition but just want to have fun.

The insights on adult play from the focus groups only partially overlap with Pearce's study. While many say they play in various contexts (e.g. with their grandchildren), most deny playing games (although they do play card and board games) and explicitly say they do not play digital games and many even avoid using a PC all together. It was also a common statement in the older adults focus group that they don't like to play alone but rather like to play together with their peers. Most said that the aspect of gaming they enjoy most is to play in a social context which fosters togetherness and spawns discussions. While Pearce [15] found that old adults play for fun rather than to hone skills and to overcome challenges focus group members were very conscious about the need to train their cognitive skills and regarded games as a possible means to do so.

Overall, the insights on adult play lead to the assumption that play can provide a motivating context for a technological intervention but that using a classic videogame might turn away many. For a project that is meant to encourage various beneficial activities the concept of gamifying these activities instead of making a full game out of them thus is tempting. Standard gamification techniques such as giving out awards, badges and points come into play here and can form an important part of a system's feedback [17]. For a meaningful system that sustains engagement in the long term it is necessary to move beyond these techniques though. In this context game elements are understood not only as a score and feedback layer but as mechanics, which further meaningful interaction or engagement with a cause [18]. Consequently we understand elements of play as ways users can interact with these game elements.

Especially in the context of health it is necessary that approaches do more than just reward the right kind of behaviour. If positive results receive positive feedback this conversely also means that if players make no progress they are penalized. This is not

desirable because it might not be the patient's or user's fault that he or she has taken some steps backward and even then these kind of players need to be encouraged even more. Referring to Bartle's [19] distinction of player types this means that game elements should not only appeal to the success oriented "achievers" and "killers" who focus on rewards, scores and competitive play but also to the "explorers" and "socialites" who play less goal oriented. This opens up the spectrum between intrinsic and extrinsic motivation. External rewards might lead to more immediate engagement with a system but the more powerful intrinsic motivation can only be triggered through a deeper embedding of game mechanics where the game enables players to interact with the desired cause in a meaningful way. The term "gameful design" is used to describe such approaches (see [20] and [21]). For a project that should encourage beneficial activities across a wide range of areas, this means that these activities should not only be rewarded in a game-like sense but that the activities themselves shall be designed from a game design perspective to make them engaging and playful.

3.2 Physical Activity

Digital games, especially designed for older adults and for the benefit of their health, are becoming increasingly popular [22]. These games are often designed as exergames which require bodily interaction to play the game [23]. In their paper they define and compare Sony PlayStation Move, Nintendo Wii, and Microsoft Xbox 360 Kinect as the three major solutions for these kind of games.

Especially Microsoft's Kinect is used in games for preventative health care or rehabilitation as no handheld devices are needed and the tracking is not limited to certain body parts or specific gestures [24]. However, the full-body effort needed with Kinect can also be a disadvantage for people in wheelchairs and older adults who might not be able to move a lot. In any case it is important to clarify whether the primary purpose of an exergame is the training or rehabilitation of particular body parts or if the physical interface is mainly used as a game controller with the intention to increase physical activity.

3.3 Cognitive Acitivity

In his book about play Stuart Brown ([25], p.34) sees important parts of cognition related to playing as "discriminating relevant from irrelevant information, monitoring and organizing our own thoughts and feelings, and planning for the future". Playing games without doubt requires concentration and, depending on the genre, uses cognitive abilities to various degrees. A higher amount of cognitive activity is needed in genres like puzzle or adventure games. There is mixed evidence though about whether playing these kinds of games can help delay or stop cognitive decline in older adults. Nouchi et al. [26] has shown positive short term effects in cognition and executive function for an audience with an average age of 69 using a commercial brain training game. Likewise Brem et al. [27] also used a commercial brain training game to evaluate if cognitive decline after hip surgery is slowed in people with an average age of

45. They found that the use of a video game can stop cognitive decline during prolonged hospital stays but could not substantiate positive effects on memory. Stern et al. [28] used a custom made game to train cognitive function and basic motor ability. While a training effect in cognitive functions could be observed it could not be fully isolated from the preconditions and training effects of motor abilities. Basak et al. [29] could show that using a commercial real time strategy game which involves complex tasks and decisions positively influences executive functions like task switching, working memory, visual short-term memory, and reasoning in the short term.

Overall the studies cited show some potential of games to be used to train cognitive abilities in older adults. All the discussed studies were conducted using short terms ranging from 4 to 12 weeks and thus only short term effects can be confirmed while long term effects and potential are unknown. However, there are enough positive reports from off-the-shelf games to suggest that game activities are a good means of cognitive training.

Reminiscence. Reminiscence is a cognitive activity that is used to remember and relive one's past. A playful approach to reminiscence can hold great value to older adults because it stimulates their cognitive functions while being entertaining. Various definitions of reminiscence exist emphasizing different aspects of the process of recalling past experiences. Parker ([30], p.517) distils the essence as "a selective process in which memories are evoked and reconstructed, probably with varying degrees of intensity and emotional involvement". Reminiscence can take place in a silent interpersonal or an oral intrapersonal setting, both of which are caused by conscious or intentional as well as non-conscious or spontaneous triggers [31].

There are different ways to look at reminiscence and its purpose. Bluck et al. [32] describe the directive, self, and social functions that reminiscence serves. The directive function can help dealing with the present and future by remembering the past. It can facilitate processes like problem-solving and predicting an outcome. The self function helps create and preserve a sense of self. Social functions work towards interacting and engaging with others, sharing memories, empathizing and building relationships. Wong and Watt [33] define six types of reminiscence: integrative, instrumental, transmissive, narrative, escapist, and obsessive reminiscence. Of these six categories, only integrative and instrumental reminiscence support successful aging by achieving a sense of self-worth, self-continuity and mastery.

Reminiscence therapy is used in people with dementia ([34], [35], [36], [37], [38]). People who suffer from dementia show short-time memory loss that makes participation in social activities and interaction increasingly difficult. Concentrating on a person's long-term memory can potentially facilitate communication and social interaction and lead to an improved integration into the community and well-being. [35]

Some studies [39] point out that the effectiveness of reminiscence for the prevention and treatment of dementia has not been proven. Several other studies ([30], [31], [32], [33], [34]) indicate that reminiscence can have a positive effect on cognitive functions and hence has positive implications for people with dementia. Parker ([30], p.523) suggests that "decline in short- and long-term memory leads to an increased

reliance upon remote memory systems" and that "increased use of remote memory in older adults improves general cognitive functioning". Lai et al. [34] conducted a study in nursing home residents with dementia trying to detect impacts of reminiscence on their well-being. They concluded that reminiscence helps to improve the psychosocial well-being of the participants. Wang [36] found that cognitive functions of participants increase while depressive symptoms are reduced as a result of using group reminiscence therapy.

3.4 Social Activity

Older adults need to feel that activities they engage in offer benefits to be interesting [12]. Video games provide social opportunities that are seen as important in the lives of seniors or as Hirsch et al. ([40], p.74) put it "An elder's quality of life is dependent on a rich set of social relationships among a variety of individuals." Games improve interaction with friends, family and younger generations, but also with people from other social circles and decrease social distance [41]. Games can not only be played together, but also discussed in hindsight and used as conversation starters.

Koster [42] presented a collection of social mechanics that can be found in games. He named helping, status, handicapping, roles, trust, community and teamwork among his list of 40+ social mechanics. Helping takes on an important role in playful interaction. Users can work together in a team, or can show one another what they already know. Status can be derived from helping others or succeeding in a difficult task. Handicapping is a tool to balance knowledge and capabilities of players in order to provide a pleasurable gaming experience for everyone. If a player is extremely experienced and the other doesn't know the game, the experienced player gets a handicap, making the game harder for him/her while favouring the inexperienced player. Playing can build up trust between the players out of a need for them to work together and overcome challenges.

Games create a safe environment to take on different roles in a social surrounding. Players can try out the roles of comrades as well as enemies and change between roles during a game [43]. The change of roles in social activities can be seen as empowering people. They can take control and steer the game in a direction they want to go in or take on roles they see themselves in.

Research ([44], [2]) indicates that the social factor of games constitutes a motivating and engaging environment. Competition and team building as well as personal and social involvement are rewarding and create a sense of accomplishment.

4 Qualitative Examples

Based on the four areas of reminiscence, cognitive, social and physical activity, interesting examples are chosen which predominantly build on one of these areas each. Most examples overlap into other areas as well. The analysis of the examples shall help us in learning about how features can come together in a holistic application. In this chapter we first introduce each example and describe the elements directed at

hindering cognitive disabilities. In the following discussion chapter we then pull together and interpret the possible use and meaning of these elements in a holistic context.

4.1 Example 1 (Reminiscence): Music Memory Box

The Music Memory Box (created by [45]) is a collection of personal objects in a box whose placement triggers the box to play different songs. The project was chosen for analysis because it constitutes an unusual and art-based approach, which also is highly personalized. The objects carry RFID chips and were either selected or designed and crafted in a user-centered design process by Meineck together with her user Barbara (see the below picture). Each object represents a certain family member. The songs triggered by the objects were selected by Barbara as well. This makes the Music Memory Box a very personal object and allows Barbara to directly relate to it. As she triggers the playback of individual songs the combination of objects and music also helps her to trigger associated memories.

Fig. 1. The Music Memory Box filled with objects, which represent a family tree

While the Music Memory Box is not a game but a serious toy, it nonetheless invites playful exploration of its contents both in a tangible (by using objects) and digital (through triggering music playback) way. The elements of play in this case are the objects which allow access to the music and in a metaphorical sense to the player's memories. Each of the objects in the box was made to represent and to trigger memories of a member of Barbara's family tree. Studies show that music is useful in coping with dementia ([46], [47]), that music is preserved longer than other memories in people with dementia [48] and thus can be a good anchor point to access memories.

4.2 Example 2 (Physical Acitivity): Wii Fit

Nintendo's Wii Fit is a collection of exergames that are played with the whole body using (1) the Wii balance board, a floorboard that measures the movement of the whole body, (2) the Wiimote, a wireless movement controller operated by hand, and (3) the Nunchuck, an extension of the Wiimote to play with both hands. We have chosen this as an example because first, since its introduction in 2006 Nintendo's Wii became a popular, easy-to-play and low-cost game environment that older people can

use. Use of the Wii in care homes has been documented in [44]. The purposes of the games from a health perspective are muscle building, yoga positions, aerobics and balance. Especially the latter have been used for balance training with old adults and furthermore evaluated [49]. In the study they have used basic step, soccer heading, ski slalom, and table tilt, letting the participants 3 times per week, 30 minutes each session over a period of 3 months. All games are intended to exercise static and dynamic balance, motor response and give visual and auditory feedback.

Fig. 2. Wii Fit helps old adults with balance

The study revealed that the participants "enjoyed playing and found the games motivating" ([49], p.165). Furthermore the authors observed a general improvement regarding the balance of the participants. However, the authors suggest a close supervision and guidance for a better progress and a reduction of the risk of an injury. Apart from that the majority of all participants reported they were playing the games also together with their grandchildren which indicates additional social benefits and increase of motivation.

The underlying study shows the suitability of a gaming approach to support health and improve well-being of old adults. The importance of specific aspects are identified which are important when the players are old adults and are usually negligible with young people. These are body and health-related issues on the one hand, and the need of supervision on the other hand.

4.3   Example 3 (Cognitive Acitivity): Eldergames

An example of a game to support cognitive activity is Eldergames. The Eldergames project ([50], [51]) was chosen because it focuses on furthering cognitive activity but embeds it in a social context. It is a table installation with a screen surface. Up to four players can sit around the table and play together but it can also be played alone or with remote players. The interface is controlled with a pen which is tracked through four cameras, each mounted to a metal bar in the four corners of the table. Game-play centres around a memory game. Mistakes in the memory game can be compensated by short minigames which focus on training isolated cognitive aspects like reasoning

or divided as well as selective attention. Another module of the project allows monitoring performance of the target audience.

Fig. 3. A test group playing the memory game module of the Eldergames project

Acceptance and usability evaluations [52] showed a good overall response but pointed out individual areas for improvement like better feedback and instructions as well as a more balanced and adjustable difficulty level.

In Eldergames augmented reality [53] is used to bridge digital games with physical objects. The physical nature of the project not only helps in lowering the technological barrier of entry but the table setup also naturally facilitates social contact and social play. The project also showed that rather simple games can still help further cognitive engagement. It also showed that a bridge to known analogue games (like memory) is helpful in making the game accessible.

4.4 Example 4 (Social Activity): DanceAlong

The DanceAlong project [54] is an augmented dancing environment aimed at older adults. It is introduced as an example for encouraging social activity among large groups of players. DanceAlong was developed to provide entertaining means of exercise and social engagement to the target group. Participants can choose from a list of song clips of old movies and dance along with the actors. The setup consists of a dedicated dancing area and two big screens with the projection of the movie scene in the front and the back of the dance floor. Participants dance along mirroring the dance moves they see on screen.

The game is designed to promote positive social interaction. Interviews conducted by the authors showed that older people tend to interact within a set group of acquaintances and seldom leave their social circle. They also found that dancing is mentioned as a desired activity by many older people but hindered by various factors like the lack of a partner, no space to dance or a lack of dance events. DanceAlong is a group activity with no need for one particular dancing partner and encourages interac-

tion beyond social circles using memories of a shared past. It doesn't only focus on socializing but also involves reminiscence and physical components in the game-play, both of which are relevant for the context of this paper.

5   Identifying Elements Of Play

The four examples, though chosen for their particular focus on either reminiscence, social, cognitive or physical activity, are interesting because they all overlap into some of the other areas. These overlaps and the elements of play, which manage to bring different areas together, are what we are most interested in. We think that a holistic approach, which combines all four of the mentioned areas, holds potential to increase the preventive effect of such an application. The following interpretation of the analysis describes elements of play directed at a older adults target audience and puts them in a holistic context. We identify a series of elements of play as we go through the four qualitative examples again.

Autobiographical play happens when games trigger memories and let players relive moments of their past. The Music Memory Box' focus is on reminiscence and what can be learnt from this project is to make use of the even stronger relation people have with personal objects. It also shows that it is beneficial to have assistance with collecting materials and making selections. Similar systems can be designed to facilitate collaborative use, to enable families and friends to interact with the system together and to contribute content. Thus autobiographical play allows reminiscence to be combined with social activity. In the focus groups we also learned that at care homes personnel fills out a biography sheet together with older patients to be able to better relate to them. A system focused on autobiographical play for example could use these sheets to enter data. Another possibility brought up during the focus groups is to combine autobiographical and make-believe play by using a game to create part real part imaginary biographies. Langer ([55], p.158) describes the potential of recalling the past: "Perhaps older memories are more meaningful to the elderly; this type of information was worthy of encoding in the past and is worthy of retrieval in the present."

Musical play, as opposed to music making, describes playful interaction with musical contents [56]. Both the Music Memory Box and DanceAlong revolve around musical play. The before cited studies show music helps remembering things and can be used as a preventive measure. Research in reminiscence [31] shows that reminiscence can be triggered by various cues, such as music. In the Music Memory Box musical play triggers reminiscence and supports social activity because the box can be played and listened to together and can be used as a starting point to share memories. DanceAlong encourages reminiscence and physical activity through music contents.

Collaborative play happens when two or more players play together and try to reach a common goal. DanceAlong tries to provide the means for collaborative play for a broad audience of participants. Everyone willing to dance along can be included. This approach is beneficial for the use of the game at big events where it acts as conversation starter and entertainment and motivates interaction and mingling. In the focus groups we also found that weekly singing is a very popular social activity at

care homes. The game could be filled with any kind of content, but choosing songs from the players pasts is a powerful tool. Collaborative play was also found to be a beneficial factor in the above cited study on Wii Fit.

One of the functions of reminiscence is the social function as described by Bluck et al. [32] which facilitates the sharing of memories and, moreover, engaging in and building of relationships. This function is particularly used to achieve the goal of DanceAlong to act as a nexus to connect different social circles. The process of reminiscence is also amplified by the social context of the game. Stories and conversations among the participants can lead to additional memories of the individual.

Role play has players take on a different roles or perspectives than their own. This can also mean going back to past experiences. Another effect of reminiscence according to Bluck et al. [32] is the self function. Playing the game and remembering the past is a role play activity. Players are put in the roles of celebrities of their youth and might get a sense of self that they might not have had in a long time. This might lead to a feeling of renewed youth and empowerment. Connecting to memories and experiences on a deeply individual level is a personal benefit that serves as an additional complement for the otherwise social game. A similar correlation between reminiscing and role playing can also be attributed to the Music Memory Box.

Kinaesthetic play [57] means that physical bodily interaction is used to control a game rather than a controller interface. This can make the game more immersive for players and at the same time makes gameplay easier to grasp for observers. Kinaesthetic play also adds another sensory layer to a holistic concept. Dancing is a physical activity and not always easy to do alone as was mentioned in interviews conducted for the DanceAlong project. Establishing a social, open environment for players to participate in, is the goal of DanceAlong. The game designers decided on letting the players just mirror the dance moves on the screen in contrast to letting them use controllers, track their movements or give feedback on the correctness of the movements. This design decision is beneficial for the target group and the interaction with each other and the game. The dance floor is open for as little or as many dancers as want to join in. Participants are not restrained by possible mistakes and players with physical restrictions are not excluded from the activity. Thus DanceAlong serves as a strong example for connecting the areas of reminiscence and social activity with physical activity.

Wii Fit's focus is physical activity and aninteresting aspect of the above described study is that participants occasionally played together with their grandchildren when they had no official guidance of the study-team, instead of playing alone as intended by the study design. This tendency to willingly play within a social context should be considered when designing games mainly addressed at old adults. Involving relatives or other possible players might be an important part of the game-play. Additionally such co-players can even assist and take care of old adults playing games if there are any health-related issues to be aware of. Similarly to the DanceAlong project, the use of kinaesthetic play seems to encourage others to take part and thus bridges physical with social activity. Additionally kinaesthetic play can be tightly intertwined with cognitive activity. Games in particular often prompt players to correctly recall and reproduce certain moves, like dance moves in DanceAlong or exercises in WiiFit.

Object-based play is interacting with a game through the use of dedicated physical objects. In the Eldergames project a tangible interface facilitates social activity by

prompting four players to sit around a table to play together. Play itself centers on small cognitive activities. The interface acts as a bridge between these activities and the social context. The use of a table and its acceptance by test users points to the use of objects rather than using screens and classic interfaces like keyboard and mouse. The focus groups showed insecurity towards PC technology as well and thus building a dedicated play object like in Eldergames might help overcome this barrier of entry. The Music Memory Box also strongly relies on the use of objects which shall trigger music and associated memories and also facilitate to play with the box together. Object-based play and tangible interaction can help to better identify with a technological solution and also ease entry. It is helpful in a social context because it makes other players' actions easier to trace and comprehend. Focus groups interviews also showed a conscience among older adults that they need to train their cognitive abilities and they do so by e.g. solving crosswords or playing Sudoku. Thus a system that comes close to these analogue activities should be well accepted.

Adaptive play helps to establish a level playing field. The older adults demographic is very heterogeneous and diverse. Thus for cognitive tasks the difficulty level will always be an issue. What is easy for one person might be too difficult for another. Especially in a social play context difficulty must be adjusted to keep the game motivating for all who participate. Both the level of difficulty and/or the complexity of tasks should challenge a player to make the game satisfying while at the same time they should be low enough not to trigger feelings of anxiety or being overwhelmed. A digital solution can us adaptive difficulty to help level the playing field in a social context and thus act as a second way to bridge cognitive and social activity. For example the game can be made easier for some players so that they don't fall behind. In the focus groups it was mentioned that when playing board games together in the care home people often change the rules slightly to help each other during the course of the game.

Table 1. Elements of play and their function to bridge activities in a holistic context.

Element of play	Found in	Reminis-cence	Social act.	Cognitive act.	Physical act.
auto-biographical play	Music Memory Box	X	X		
musical play	Music Memory Box, DanceAlong	X	X		X
collaborative play	DanceAlong, Wii Fit	X	X		
role play	DanceAlong, Mu-sic Memory Box	X		X	
kinaesthetic play	DanceAlong, Wii Fit		X	X	X
object-based play	Eldergames, Music Memory Box	X	X	X	
adaptive play	Eldergames		X	X	

6 Conclusion

In this paper we identify several elements of play and describe them with respect to their use to establish a holistic context across the areas of reminiscence, social activi-ty, cognitive activity and physical activity.

This paper first gives an overview of using game elements as motivating compo-nents in applications for older adults which support one or more of the above activi-ties. By studying examples we identify a series of elements of play which act as bridges between different activities (see Table 1). Aside from these particular ele-ments of play, the main contribution of this paper is to open up the design space and subsequently study further examples of holistic elements of play.

In the focus groups we found that digital games might not always be accepted by an older demographic but we could find evidence that play still is attractive to them. Hence we suggest that a playful application which uses elements of play to engage people increases the acceptance of an application aimed at our target audience.

The elements of play we extract from the four analysed examples are auto-biographical play, musical play, kinaesthetic play, object-based play, adaptive play, collaborative play and role playing. All of them serve an important purpose in bridg-ing two or more of the areas of reminiscence, cognitive, social and physical activity. These elements of play are not mutually exclusive and can be used together to estab-lish a holistic context for applications with the purpose of preventing cognitive disa-bilities. In this paper we derive the described elements of play from a qualitative anal-

ysis and from literature. The next step would be an evaluation of the elements with users.

Future work will also include finding more of these elements and designing a system which manages to engage people across all four areas. We think that a playful and holistic approach can result in higher acceptance than a game or focused intervention in this context. Furthermore such an approach can have preventive effects against cognitive disabilities. These assumptions need to be evaluated through studies after such a system has been designed. This paper provides a foundation for a holistic design space as well as a set of elements of play that can be used in different play contexts.

List of images

Figure 1: Music Memory Box, http://www.chloemeineck.co.uk
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References

1 WHO World Health Organisation (2002) Active Ageing: A Policy Framework. Available from: http://whqlibdoc.who.int/hq/2002/WHO_NMH_NPH_02.8.pdf [Accessed 12 Dec, 2012]

2 Grosinger, J., Vetere, F, Fitzpatrick, G. 2012. Agile Life: addressing knowledge and social motivations for active aging. In *Proceedings of OzCHI2012*.

3 Zunzunegui, M.-V.,Alvarado, B.E., Del Ser, T. & Otero, A., 2003. Social Networks, Social Integration, and Social Engagement Determine Cognitive Decline in Community-Dwelling Spanish Older Adults. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 58, 2, pp. 93-100.

4 Voelcker-Rehage, C., Godde, B., & Staudinger, U.M., 2011. Cardiovascular and coordination training differentially improve cognitive performance and neural processing in older adults. *Frontiers in Human Neuroscience*, 5, 26, pp. 17-26.

5 Brassington, G.S., Atienza, A.A., Perczek, R.E., DiLorenzo, T. M. & King, A.C., 2002. Intervention-related cognitive versus social mediators of exercise adherence in the elderly, *AJPM* 23, 2, pp.80–86.

6 Rolland, Y., Abellan van Kan, G. & Vellas, B., 2008. Physical activity and Alzheimer's disease: from prevention to therapeutic perspectives. *Journal of the American Medical Directors Association*, 9(6), pp.390–405.

7 Schutzer, K.A., Graves, B.S., 2004. Barriers and motivations to exercise in older adults. *Preventive medicine*. 39, 1056–1061.

8 Bohlmeijer, E., Roemer, M., Cuijpers, P., & Smit, F., 2007. The effects of reminiscence on psychological well-being in older adults: a meta-analysis. *Aging & mental health*, 11(3), pp.71–89.

9 Holzinger, A., Searle, G., Nischelwitzer, A., 2007. On some Aspects of Improving Mobile Applications for the Elderly. In: Stephanidis, C. (ed.) *Coping with Diversity in Universal Access, Research and Development Methods in Universal Access, Lecture Notes in Computer Science* (LNCS 4554), pp. 923-932. Springer, Berlin, Heidelberg, New York.

10 Whitlock, L.A., McLaughlin, A.C. & Allaire, J.C., 2011. Video Game Design for Older Adults: Usability Observations from an Intervention Study. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 55(1), pp.187–191.

11 Miesenberger, K., Ossmann, R., Archambault, D., Searle, G. & Holzinger, A. 2008. More Than Just a Game: Accessibility in Computer Games. *HCI and Usability for Education and Work*. Springer Berlin Heidelberg,pp. 247-260.

12 McLaughlin, A., Gandy M., Allaire, J., & Whitlock, L., 2012. Putting Fun into Video Games for Older Adults. *Ergonomics in Design: The Quarterly of Human Factors Applications*, 20(2), pp.13–22.

13 Whitlock, L. a., McLaughlin, a. C. & Allaire, J.C., 2010. Training Requirements of a Video Game-Based Cognitive Intervention for Older Adults: Lessons Learned. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 54(27), pp.2343–2346.

14 Quandt, T., Grueninger, H. & Wimmer, J., 2008. The Gray Haired Gaming Generation: Findings From an Explorative Interview Study on Older Computer Gamers. *Games and Culture*, 4(1), pp.27–46.

15 Pearce, C., 2008. The Truth About Baby Boomer Gamers: A Study of Over-Forty Computer Game Players. *Games and Culture*, 3(2), pp.142–174.

16 Murata, A. & Iwase, H., 2005. Usability of touch-panel interfaces for older adults. *Human Factors*, 47(4) pp.767–776.

17 Schell, J., 2010. Design outside the box. *Presentation at Design Innovate Communicate Entertain Summit*, p.4.

18 Deterding, S., Sicart, M., Nacke, L., O'Hara, K. & Dixon, D., 2011. Gamification. using game-design elements in non-gaming contexts. In *Proceedings of the 2011 annual conference extended abstracts on Human factors in computing systems*. ACM, pp. 2425–2428.

19 Bartle, R., 1996. Hearts, clubs, diamonds, spades: Players who suit MUDs. *Journal of MUD research*, 1(1), p.19.

20 McGonigal, J., 2011. *Reality is broken: Why games make us better and how they can change the world*, Penguin Press HC.

21 Deterding, S., Dixon, D., Khaled, R. & Nacke, L., 2011. From game design elements to gamefulness: defining gamification. In *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments*. ACM, pp. 9–15.

22 Gerling, K.M., Schulte, F.P. & Masuch, M., 2011. Designing and evaluating digital games for frail elderly persons. In *Proceedings of the 8th International Conference on Advances in Computer Entertainment Technology - ACE '11*. New York, New York, USA: ACM Press, pp. 62:1–8.

23 Tanaka, K., Parker, J., Baradoy, G., Sheehan, D., Holash, J., Katz, L. 2012. A Comparison of Exergaming Interfaces for Use in Rehabilitation Programs and Research. *Canadian Game Studies Association*, 6(9), pp.69–81.

24 Boulos, M.N.K., 2012. Xbox 360 Kinect Exergames for Health. *Games for Health Journal*, 1(5), pp.326–330.

25 Brown, S.L. & Vaughan, C.C., 2009. *Play: How it shapes the brain, opens the imagination, and invigorates the soul*, Avery Publishing Group.

26 Nouchi, R., Taki, Y., Takeuchi, H., Hashizume, H., Akitsuki, Y., Shigemune, Y., Sekiguchi, A., Kotozaki, Y., Tsukiura, T & Yomogida, Y, 2012. Brain training game improves executive functions and processing speed in the elderly: A randomized controlled trial. *PloS one*, 7(1), p.e29676.

27 Brem, M., Lehrl, S., Rein, A., Massute, S., Schulz-Drost, S., Gelse, K., Schlechtweg, P., Hennig, F., Olk, A. & Jacob, H., 2009. Stop of loss of cognitive performance during reha-

bilitation after total hip arthroplasty—Prospective controlled study. *Significance*, 60, pp.0–19.

28 Stern, Y., Blumen, H., Rich, L., Richards, A., Herzberg, G. & Gopher, D., 2011. Space Fortress game training and executive control in older adults: a pilot intervention. *Aging, Neuropsychology, and Cognition*, 18(6), pp.653–677.

29 Basak, C., Boot, W., Voss, M. & Kramer, A., 2008. Can training in a real-time strategy video game attenuate cognitive decline in older adults? *Psychology and aging*, 23(4), pp.765–77.

30 Parker, R.G., 1995. Reminiscence: A Continuity Theory Framework. *The gerontologist*, 35(4), pp.515–525.

31 Webster, J.D., Bohlmeijer, E.T. & Westerhof, G.J., 2010. Mapping the Future of Reminiscence: A Conceptual Guide for Research and Practice. *Research on Aging*, 32(4), pp.527–564.

32 Bluck, S., Alea, N., Habermas & T., Rubin, D.C., 2005. A Tale Of Three Functions: The Self-Reported Uses Of Autobiographic Memory. *Social Cognition*, 23(1), pp.91–117.

33 Wong, P.T. & Watt, L.M., 1991. What types of reminiscence are associated with successful aging? *Psychology and aging*, 6(2), pp.272–9.

34 Lai, C.K.Y., Chi, I. & Kayser-Jones, J., 2004. A randomized controlled trial of a specific reminiscence approach to promote the well-being of nursing home residents with dementia. *International Psychogeriatrics*, 16(1), pp.33–49.

35 Alm, N., Dye, R., Gowans, G., Campbell, J., Astrell, A., Ellis, M., 2007. A Communication Support System for Older People with Dementia. Computer , 40(5), pp.35–41.

36 Wang, J., 2007. Group reminiscence therapy for cognitive and affective function of demented elderly in Taiwan. *International Journal of Geriatric Psychiatry,* 22(12), pp.1235–1240.

37 Bornat, J., 2001. Reminiscence and oral history: parallel universes or shared endeavour? *Ageing and Society*. 22(2). pp.219-241.

38 Flood, M. & Phillips, K.D., 2007. Creativity in older adults: a plethora of possibilities. *Issues in mental health nursing*, 28(4), pp.389–411.

39 Thorgrimsen, L.,Schweitzer, P. & Orrell, M., 2002. Evaluating reminiscence for people with dementia : a pilot study. *The Arts in Psychotherapy*, 29, pp.93–97.

40 Hirsch, T., Forlizzi, J., Hyder, E., Goetz, J., Kurtz, C. & Stroback, J. 2000. The ELDer project: social, emotional, and environmental factors in the design of eldercare technologies. In *Proceedings on the 2000 conference on Universal Usability*. pp. 72–79.

41 Ijsselsteijn, W., Nap, H., De Kort, Y. & Poels, K., 2007. Digital game design for elderly users. *Proceedings of the 2007 conference on Future Play - Future Play '07*, p.17.

42 Koster, R., 2011. Social Mechanics, The Engines Behind Everything Multiplayer. In *Slides presented at the Game Developers Conference, San Francisco, California*.

43 Salen, K. & Zimmerman, E., 2003. *Rules of Play: Game Design Fundamentals*, The MIT Press.

44 Harley, D., Fitzpatrick, G., Axelrod, L., White, G., & McAllister, G. 2010. Making the Wii at home: game play by older people in sheltered housing. In *Proceedings of the 6th international conference on HCI in work and learning, life and leisure: workgroup human-computer interaction and usability engineering* (USAB'10), Gerhard Leitner, Martin Hitz, and Andreas Holzinger (Eds.). Springer-Verlag, Berlin, Heidelberg, 156-176.

45 Meineck, C., 2012. Music Memory Box, http://www.chloemeineck.co.uk [Accessed 12 Dec, 2012]

46 Clark, M.E., Lipe, A.W. & Bilbrey, M., 1998. Use of music to decrease aggressive behaviors in people with dementia. *Journal of gerontological nursing*, 24(7), pp.10–17.

47 Sung, H. & Chang, A.M., 2005. Use of preferred music to decrease agitated behaviours in older people with dementia: a review of the literature. *Journal of clinical nursing*, 14(9), pp.1133–1140.

48 Cuddy, L.L. & Duffin, J., 2005. Music, memory, and Alzheimer's disease: is music recognition spared in dementia, and how can it be assessed? *Medical hypotheses*, 64(2), pp.229–235.

49 Agmon, M., Perry, C.K., Phelan, E., Demiris, G. & Nguyen, H.Q., 2011. A pilot study of Wii Fit exergames to improve balance in older adults. *Journal of Geriatric Physical Therapy*, 34(4), pp.161–167.

50 Gamberini, L., Alcaniz, M., Barresi, G., Fabregat, M., Ibanez, F. & Prontu, L., 2006. Cognition, technology and games for the elderly: An introduction to ELDERGAMES Project. *PsychNology Journal*, 4(3), pp.285–308.

51 Gamberini, L., Fabregat, M., Spagnolli, A., Prontu, L., Seraglia, B., Alcaniz, M., Zimmerman, A., Rontti, T., Grant, J. & Jensen, R., 2008. Eldergames: videogames for empowering, training and monitoring elderly cognitive capabilities. *Gerontechnology*, 7(2), p.111.

52 Gamberini, L., Martino, F., Seraglia, B., Spagnolli, A., Fabregat, M., Ibanez, F., Alcaniz, M. & Andrés, J., 2009. Eldergames project: An innovative mixed reality table-top solution to preserve cognitive functions in elderly people. In *Human System Interactions, 2009. HSI'09. 2nd Conference on*. IEEE, pp. 164–169.

53 Alcañiz Raya, M.L., Gòmez, J.A., Gamberini, L., Martinelli, M., Prontu, L., Seraglia, B. & Varotto, D., 2008. Design and development of a mixed reality solution for gerontechnology applications. *Gerontechnology*, 7(2), p.66.

54 Keyani, P., Hsieh, G., Mutlu, B., Easterday, M. & Forlizzi, J. 2005. DanceAlong : Supporting Positive Social Exchange and Exercise for the Elderly Through Dance. *CHI'05 extended abstracts on Human factors in computing systems*, pp.1541–1544.

55 Langer, E., 2009. *Counterclockwise: Mindful Health and the Power of Possibility*, Ballantine Books.

56 Kayali, F., & Pichlmair, M. 2008. Playing Music, Playing Games - Simulation vs. Gameplay in Music-based Games. Paper presented at the *Vienna Games Conference 2008 'Future and Reality of Gaming'* (FROG).

57 Westecott, E., 2008. Bringing the Body back into Play'. In *The [player] conference proceedings, Copenhagen, Denmark*.