

Toward Ludic Gerontechnology: a Review of Games for Dementia Care

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ABSTRACT

Due to the increase of the older population, dementia has become a growing societal problem. This has led to an increased interest in digital games to support dementia care, such as cognitive rehabilitation or reminiscence games. To facilitate the design of games for dementia and set a research agenda in this domain, we carried out a literature review of games designed more specifically for dementia. The review brought out a number of design issues and highlighted limitations of on-going development. Beyond cognitive rehabilitation, we should turn to affective game design as many emotional issues stem from the dementia condition. Finally, we advocate stepping out of the functionalistic approach taken in this domain to design enjoyable, emotional and fun game experiences.

Keywords

Dementia, review, digital games, cognitive rehabilitation, reminiscence, affect, aging

INTRODUCTION

Digital games are now ubiquitous, and their value has been substantiated in many domains from education to health. Besides entertainment, games have been accepted as a powerful vehicle to enhance learning. They have been developed to tackle societal problems, support cognitive learning and address emotional issues such as empathy or depression. From an initial focus on teens, games are being played and designed increasingly for older adults. Indeed, playing digital games has been associated with successful aging (Allaire et al. 2013). Digital games, with easy gameplay have been found to create positive feelings and enjoyment, boosting the self-confidence of senior citizens. Exergames, which provide a combination of fun, social and physical activity, are used as an incentive for older adults to stay active (Gerling et al. 2011.). As the population ages, so called “brain games” are becoming quite popular as players hope to slow cognitive decline related to aging or even to delay the onset of dementia.

With an increase in lifespan, dementia has become more prevalent in countries such as US or Europe as well as Japan and China. As numbers continue to grow, dementia is becoming a societal problem, and digital games can be used as a tool in the fight against dementia. McCallum and Boletsis (2013) reviewed in detail mostly commercial games tested with People Living with Dementia (PLWD) or people with mild cognitive impairment. The games fall broadly into two main categories: brain games and exergames. Perhaps the most important point coming out of their review is that despite

Proceedings of 1st International Joint Conference of DiGRA and FDG

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cognitive impairment, PLWD were able to play such games. Digital games designed specifically for this context have also slowly emerged.

As we are starting to develop games around dementia care, we wanted to gather more specific knowledge about this domain and develop a new research agenda. Thus, we carried out a review of games specifically designed for dementia care. To guide our research and game design, we aimed to identify key concepts and issues, as well as determine trends and gaps. In this paper, we first discuss games centred on PLWD as cognitive rehabilitation and reminiscence games. We then examine issues around user-centred design and outline the limitations of on-going developments: are we really designing the right games?

We aim to facilitate the design of games for people living with dementia; games that respond to the full spectrum of dementia problems, not just cognition, but also address socio-emotional issues. To celebrate the person within and facilitate laughter and joy, we recommend stepping out of a functionalist approach to game and dementia, and develop games for fun and entertainment.

BACKGROUND ON DEMENTIA

Dementia is a degeneration of brain function that occurs, except for early onset, when people are over 65. The older people get, the more common this condition is. Dementia is an umbrella term for different pathologies: the most common form is Alzheimer's disease, followed by Lewy Body and Frontotemporal Dementia.

Mild Cognitive Impairment (MCI) is characterized by a cognitive decline greater than expected for normal aging, but which does not interfere with the activities of daily life. MCI can be temporary and reversible if triggered by specific health conditions, or it can be a sign of 'pre-dementia' (if the disease is already established). People with MCI have an increased risk of developing dementia. Dementia is characterised by cognitive impairments affecting executive functions (e.g. memory, planning, or problem solving), visual perception and orientation, as well as language. Common symptoms include difficulty in performing familiar tasks, impaired judgement, language deterioration and mood changes.

Dementia is a progressive condition often described through three stages: early, moderate and severe. In the early stage, people start to have communication problems but are still capable of expressing basic ideas. They have difficulty in performing daily activities (such as getting dressed and making tea) but can still do most of these activities alone and if not, with assistance. At this stage, the deterioration of cognitive ability varies greatly from one person to another. In the moderate stage, people lose the ability to perform daily activities. Their memories deteriorate further, people become unable to recognise close relatives and long-term memory is impaired. At the severe stage, people are totally dependent on carers, with little language left (Balasi et al. 2014). Dementia is to this day incurable and a terminal condition.

Less commonly discussed in popular literature is the psychological and behavioural symptoms related to dementia, such as anxiety, depression, apathy or agitation. Dementia influences a person's emotions and their ability to control them. Cognitive deterioration, as can be understood, generates a number of negative emotions including frustration, anxiety or anger. Depression is quite common in older people with dementia. Depressive symptoms include hopelessness and feelings of low self-esteem, lack of energy and

interest, and difficulty in concentrating. The presence of depression in dementia is associated with worse outcomes. It leads to a more rapid loss of skills, including accelerated cognitive decline and increased isolation, (Potter and Steffen 2007).

GAMES AND DEMENTIA

To build a full picture of the development of digital games in the context of dementia and to set a new research agenda in this domain, we collected game papers from a variety of well-established academic databases, including those from the Association for Computing Machinery (ACM), the Institute of Electrical and Electronics Engineers (IEEE) and the PubMed database, and we are continuing to do so. We searched for “game”, and “dementia” or “Alzheimer”. After initial searches, a better control of search parameters led to fewer than 30 results per database. After screening, most papers did not contain both search criteria and thus were removed. We tried to be as inclusive as possible in papers reviewed to map out key concepts and issues. Nevertheless, following the goal of our review, we excluded (commercial) games only tested with PLWD but not designed for dementia care. More generally, the papers are very heterogeneous, in quality and length. There are important variations regarding game development that should be outlined: some authors present conceptual designs while others discussed early prototypes or more functional games.

Games and People Living with Dementia

One of the most fundamental questions concerning games and dementia, is in regard to the ability of people living with dementia to play at all using computer or game platforms and then, to play games independently (i.e. without caregiver help). Øyvind (2011) investigated these very questions, exploring whether players with dementia could interact with a tablet using a simple quiz. They found that people living with dementia could and seemed to prefer playing independently. However, their results were mitigated and some caution is needed. Not knowing how to answer quiz questions, for example, led to great confusion that prevented PLWD from continuing play.

Astell (2014) demonstrated that older adults with dementia could learn to interact with and play with digital media and games independently. The use of commercial games is increasingly popular for dementia as shown by McCallum and Boletsis (2013)a. Cutler et al. (2016) have conducted a number of play sessions with digital gaming technology for PLWD (including DS and Wii games). They found that games promote computer literacy and life-long learning. Moreover, successfully playing games challenged caregivers’ assumptions about PLWD capabilities and increased PLWD self-confidence.

Although it seems that people living with dementia can use technology and play games independently, but in which respect and conditions remain to be investigated in more depth, especially with regard to commercial games. As Bouwhuis (2003) stated, because of their cognitive impairment, many games and leisure products are unfit for people with dementia. They advocate developing a range of leisure products that fit PLWD needs and skills. Imbeault et al. (2011) criticised commercial brain games and their uses in dementia, as these games do not sufficiently accommodate for aging or for disabilities (including cognitive impairment). Indeed, traditional game design for cognitively impaired players is often too challenging (Fua et al. 2013). More generally, many criticisms advanced by Imbeault et al. can be applied to most commercial games. Apparent discrepancies as to what people living with dementia can play (or do) should be further investigated. These inconsistencies might be explained by differences in user groups and variables such as the level of cognitive impairment, misdiagnosis,

demographics, or computer literacy. Understandably, due to their profound cognitive impairment, digital games are neither developed nor suitable for people at the severe stage of dementia. Thus, technological solutions are focussed elsewhere to support their needs (e.g. multi-sensory immersive environments, playware or robotics).

Cognitive Rehabilitation and Dementia

Kazmi et al. (2014), reviewed applications designed in the context of dementia and aging centred on cognitive rehabilitation, which included games such as *Food Stamp* and *Kimentia*. Indeed, a number of games connected to cognitive rehabilitation have been developed on a variety of platforms, with different design strategies based on activities of daily living or brain games. First, clarification is needed. We use cognitive rehabilitation as a generic term for cognitive games although some authors employed terms such as; cognitive training, cognitive stimulation or cognitive maintenance. Furthermore, cognitive rehabilitation is often used for an application or service that enhances or restores normal cognitive functioning. Such is not the case in the context of dementia. While dementia is a degenerative condition, studies have shown that at least in the early stages, the brain is still able to learn and change. Thus stimulating cognitive functions and increasing brain activity may have a protective effect, which would slow cognitive deterioration (Zelinski and Reyes 2009). Cognitive rehabilitation games address a range of cognitive functions associated with dementia, including working memory planning or language skills.

From Activity of Daily Living to Brain games

Unlike commercial games, most dementia games designed for cognitive rehabilitation have adopted a more realistic frame in which games tasks are grounded in activities that PLWD carry out during their daily life.

SmartAgeing is a 3D serious game aiming at the detection of MCI and assessment of PLWD cognitive impairment (Tost et al. 2014). Such games are designed to replace standard cognitive tests, which are not very motivating and lead to a great deal of frustration and anxiety. In *SmartAgeing*, players interact with a 3D house via a touch screen. Game tasks are structured sequentially, for example, users have to find a telephone number, memorize and then dial it and finally remember to turn the television off. Game tasks have been developed to assess different executive functions, thus performance within the game should give an indication of users' cognitive performance. Validation of the game as a testing tool, by comparing game data to performance in cognitive tests, as well as further development for rehabilitation, is still on-going.

Bouchard et al. (2012) discuss a game prototype implemented as a point and click game. The game, derived from the Cognitive Naturalistic Action Test, used cooking activities such as making tea and toast. As the paper focuses on the description of the AI module, not enough was included about the game design. Two key features of their game system are the inclusion of a player's cognitive profile and adapting the game to player performance. In this tablet game, *Kitchen and Cooking* (Manera 2015), a player interacts with simple cooking scenarios such as making a pizza by following a number of steps in the right order and choosing the right ingredients. Game tasks are developed to use different skills and cognitive functions such as object recognition, planning and spatial abilities. An interesting feature of the paper is the data collected for the small evaluation. It included game data (time spent playing, errors, number of scenarios completed) and measures of players' cognitive impairment, as well as a questionnaire about game

experience. Results of the evaluation showed that the game was acceptable, motivating and enjoyable for all.

Lopez-Martinez et al. (2011) developed a game of gifts purchase for people with mild cognitive impairment (to early dementia) that addresses executive functions like abilities to plan and meet goals. Players had to buy gifts for imaginary relatives based on some criteria from a number of available shops and stay within budget. Performances were assessed, for example, by comparing players' gifts against initial lists. Results from a pilot study show that cognitive tests were correlated with results obtained from the game performance. Chang et al. (2013) designed a game system for MCI to exercise memory and problem solving abilities to prevent further deterioration and postpone dementia. In the game module, players are shopkeepers attending to customers buying different food stuffs paid with food stamps (used in China from the 50s -80s). Players have to remember what the client ordered and calculate the invoice. All older players had some measure of success with the game, although there were quite large variations between them. Players liked the game, which sparked some reminiscence around the food stamps. Further evaluation is needed with MCI participants, as well as more generally with people at the early stage of dementia.

The next two games are centred on language skills. *CogStim* Game (Kim et al. 2011) aimed to stimulate memory and language through various fun mental exercises such as a name-face matching game, as forgetting people's names is a common occurrence in dementia. Further scenarios based on activities of daily living are planned. Breton et al. (2012) developed a Kinect platform, *Kimentia*, for cognitive rehabilitation to improve language areas. Players have then to go through a series of small games including recognition and naming of objects found in stores or completing word games. Key features of the platform are the game analytics and the provision of different levels of difficulties according to users' mental conditions.

Unlike others, the two following games are based on simple card mechanics. However, they present unusual features. Garcia et al. (2014) developed a platform that supports intergenerational gameplay. For now, their prototype is based on a matching pair card game that can be played individually or against an opponent. The level of complexity is increased by using more cards or decreasing the time that cards are visible. Players at the early stage of dementia were able to play on their own in both modes, while the more severely impaired needed assistance to play. The two players' version was only tried with people at the early stage of dementia and seemed to have enhanced players' motivation to play and concentration. De la Gula et al (2013) developed *Alzgame* using a computer screen and picture cards containing tags that could be read by mobile phones. Their focus was not on the game design, but on studying tangible interaction, thus little information is included about the game itself. Indeed tangible interface could be more advantageous for older users (80+) and those moving toward the moderate stage of dementia, less familiar with or unable to use digital media. Various technological mixes including physical or digital objects should be further investigated to support gameplay.

For the stimulation of cognitive functions, Balasi et al. (2014) discussed the design of a brain game grounded in dementia pathology. They designed a series of casual games called *Fight Alzheimer* for mobile phones, inspired by traditional cognitive training and brain game mechanics. Players have, for example, to sort letters and numbers, find hidden words or reconstruct proverbs. Expert evaluation was first carried out followed by a small study with participants with brain issues. Participants found the games easy to use and

enjoyable. A larger study or clinical trial is needed with people living with dementia (i.e. Alzheimer's in this case), as for all cognitive rehabilitation games.

Design of Cognitive Rehabilitation Games

Current games for cognitive rehabilitation seem to address memory stimulation, planning and calculus, as well as language. We should establish more precisely, which cognitive functions do games currently deal with, as well as areas that are missing or not covered sufficiently to support PLWD. Are there issues within specific forms of dementia that are not addressed at all? Ultimately, what are cognitive games best at in this domain, i.e. memory or language training? What are the best design strategies? What kinds of game mechanics do these games use (or should use) or what is the most effective gameplay?

Most games developed for cognitive rehabilitation in this context are grounded in activities of daily living, especially cooking and purchasing. The rationale for this choice can be explained in complementary ways. As stated by Bouchard et al. (2012), using a familiar environment makes players more comfortable with the game and diminishes confusion and time needed to learn it. As games simulate mechanisms of real activities, the more times an activity is performed, the more chance that players retain it. Thus, would simulation games be the best design strategies for cognitive rehabilitation in this context? *Food stamp* has been criticized by Kazmi et al. (2014) for being awkward as the Chinese elderly have not used the stamps for a while. However, using an historical period and drawing on the long term memory strength of PLWD seems to have been quite engaging, triggering reminiscences around the game. Thus, could a simulation game also take place in a different setting or would a natural environment still be best? Could elements of roleplay and storytelling increase the motivation to play and appeal of such games? Cooking games are quite popular; could some elements or game mechanics of these games be added to simulation games to make them more appealing and playful?

We have found one game for dementia centred on brain games. Older people are quite familiar with Sudoku, card games, dominos and crosswords, etc. Should we thus develop more brain games specifically for this context as advanced by Balasi et al. or tailored commercial games more appropriately for dementia? However, the effectiveness of brain games is still not clear. As discussed by Butcher (2008), improvements following play sessions are highly specialised. Training in memory will not enhance processing speed or reasoning. Trials, to show the efficacy of brain games especially in this context, are still to come.

Instead of brain games, could there be other approaches to the design of games for cognitive rehabilitation? Could we find other design strategies and game genres that are suitable as well as enjoyable for the development of cognitive rehabilitation games? After all, playing computer games can enhance problem solving, decision making and visual processing, etc. As shooting games are well known to improve visual concentration, Mader et al. (2012) discuss the transposition of a game shooter mechanic into shooting photographs. The premise of the proposed game is to ensure that a village becomes classified as a natural reserve, by sending players on quests like shooting bird photographs, etc. *XTORP*, a game being developed for the Kinect, is based on a submarine scenario, in which players fight ships and complete missions (Sacco et al. 2014).

Due to cognitive impairment, what kind of game mechanics should we avoid? Fua et al. (2013) examined more particularly how cognitive impairments impact gameplay

mechanics. For example, they discussed visual-spatial abilities at the early stage of dementia, comparing *Tetris* (List 1984) object strategies to the more complex projectile trajectories from *Angry Birds* (Rovio Mobile 2009). But then what kind of game mechanics can we use for cognitive rehabilitation? What are the fundamental building blocks or design patterns for such games (e.g. matching, sorting, shooting, etc.)?

To better comprehend the design of cognitive rehabilitation games and compare different design strategies, we recommend developing a detailed cognitive map for games linking cognitive functions to game tasks and game mechanics.

Reminiscence, Games and Dementia

Reminiscence is seen as the process of remembering and recalling events and memories from the past. It can happen spontaneously in response to multi-sensory stimuli such as a smell, image or sound (in particular music) but can also be triggered intentionally. With dementia, while memory of recent events becomes impaired, memories from years ago remain intact much longer. Thus, a major feature of reminiscence games is to trigger conversation about events that are meaningful.

Games themselves, especially those that people played in childhood, can be used for reminiscence. However, specific reminiscence board games have been developed for people living with dementia and distributed by the Alzheimer's Society and similar organisations. For example, *Anecdote* (2015) is a simple board game divided around four life periods "childhood, adolescence, adult life and life in general". To progress in the games, players have to tell a story related to the appropriate theme. To stimulate further reminiscences, players are also given objects to touch and feel, or even to taste. Reminiscence games seem to operate on two bases: personal memories (or life story), and social memory based on sociocultural events. Important aspects of board game designs are their visual aesthetic, multisensory elements and conversational prompts. "*A board game with objects that can be handled such as cards and a dice is better at providing more sensory stimulation*" (Schmid, 2009). Furthermore, the board and its components serve as visual stimulus. To optimise reminiscence, conversational prompts are often integrated to the games (e.g. quiz questions, reminders, etc.). Such games can inform the design of digital games, especially augmented board games.

Digital games based on reminiscing start to emerge; most of the following examples are based on personal reminiscence. *Memoir Monopoly* (2014) is the closest we found to board games. The game used four iPad synching and sharing screens to simulate the board game; tangible round tokens were utilised for interaction. The games include different ways of reminiscing through music, photos and also quiz like games, etc. Besides local content, players' personal materials are used to populate the game content, and thus the game needs to be customized for each group session. A small pilot study showed that participants were actively engaged in the game and willing to share their stories. However, to resolve some usability issues with the iPad setup, the game has been redesigned with a more standard user interface but seems to have lost some of the conviviality of the board game setup.

The prototype *What remains?* developed by Cadamuro and Visch (2013) is more like a gamified storytelling tool for caregivers aiming at facilitating transition from home to care home. Thus, it is used with people with more advanced dementia than is usual for these games. After gathering life story elements, twenty pictures are pre-selected for specific reminiscing sessions. Users are first asked to move, connect, and group pictures,

and then prompted to reminisce and tell stories about them. During the prototype evaluation, players combined the same pictures over and over trying to communicate specific needs or wishes. Such a tool can be used to enhance communication and moods but also to personalise care. Luckner et al. (2013), have developed a series of conceptual designs for digital games and playful interaction. The core component of the sketches relates to different ways of representing and accessing biographical content. Thus, they proposed the use of the *Snakes and Ladders* board game to organize personal content starting from the present and going back in time on a journey of discovery. In another sketch, players are represented by a tree containing different fragments of memories and thus players can meander and explore the forest together. Another design consisted of 3D rooms with specific themes where users could add memory objects.

To stimulate reminiscing and social interaction, van Rijn et al. (2009) developed a situated game centred on digitised old media objects including a telephone, radio, and television as well as a treasure box. The different media objects are used to trigger reminiscence through old archived programmes. The *Chitchatters* installation was tested with a small number of participants and showed that PLWD could interact with the objects although they needed triggers (to know what objects to activate) as well as prompts for doing so. The benefits of game interventions were as important for players as for caregivers, as they provided moments of delightful and meaningful interaction for all.

Another playful approach to reminiscence worth noting is *Theater Memories*. It is based on a 3D reconstruction of a Taiwan cinema. 3D technology was used to enhance the sensory and immersive quality of the user experience. Based on users' nostalgic recollection of cinema and films from the fifties, Lee and Chou (2015) aimed to support elderly people's wellbeing, incidentally decreasing depression. Usability testing is still on-going and the use of 3D technology could create specific problems for that population.

Social interaction, Emotion and Reminiscing

Reminiscing is an activity that people living with dementia can still enjoy until the severe stage. Unlike cognitive rehabilitation games, most reminiscence games such as *Chitchatters*, *Memoir Monopoly*, and of course all the board games are played in small groups to stimulate social interaction. Another strong element of reminiscence games is their multi-sensory component. Multi-sensory stimulation is designed through different board game objects, and through the multi-sensory media in digital games. The addition of multi-sensory objects to provide more diversity to trigger reminiscence is one of the main advantages of digital games over board games.

Reminiscence games have a number of socio-emotional functions. They are used to create an enjoyable and positive experience to alleviate boredom and depression. Reminiscence games also help senior citizens to maintain a sense of identity, building connections between past and present. They can thus enhance self-esteem and confidence. It is also important to stress the social functions of the game. In a care home, reminiscing can enhance the relation between caregiver and PLWD, as the caregiver gets to know the person and interact with them in a pleasant and relaxed context (van Rijn, et al. 2009). Reminiscing at family events or within couples also supports intimacy and social bonding.

Both approaches to reminiscence based on collective memory or biographical content have different strengths and weaknesses. Personal reminiscing can trigger more engagement and responses as people are familiar and more emotionally involved with the

stimuli but it can also generate more frustration and negative feelings as PLWD struggle to recollect what the stimuli are or mean, and fail to do so. Reminiscing based on social events can enhance socialisation and lead to rich collective stories as memories are shared but it can be less meaningful for some participants (e.g. minority groups). Innovative mechanisms that support reminiscing and socio-emotional experiences should be further explored. Would a game format like *Game of Life* (Hasbro 2014) or a game show prove more engaging? Could you immerse players back in the past through the eyes of historical persona or as celebrities of their youth as Kayali et al. (2013) suggest? They further discussed different types of play for older adults, could kinaesthetic play (using the body) also be used for reminiscence in this context? What kind of game mechanics, such as social or cooperative ones, would make these games more stimulating and engaging? Further research should also look into the best platform for these games e.g. table top games, iPad or mixed forms of physical and digital artefacts.

Games as Leisure and Entertainment

As Astell (2014) noted, there is not much assistive technology dedicated to leisure that is developed for people living with dementia, so it seems for games. Although designed as a reminiscence game, the Chitchatter's goal was to develop a game for leisure and entertainment. *Cat vs. Mouse* is a simple casual game played on the iPad (Sirkka and Koivisto 2015). Players must collect as many cheese chunks as possible by tilting the tablet. As the player progresses, the game difficulty increased by introducing cats that chase the mouse. Astell et al. (2014) developed a range of casual games and activities to provide engaging and stimulating pastimes. Through a process of iterative design, they developed a number of concepts ranging from a 3D botanical garden, creative arts (e.g. painting a vase) to games. Games included funfair games (e.g. shooting gallery), sport (e.g. a penalty game) and fun games (e.g. blowing bubbles). Astell et al. highlighted the potential of game playing as a shared social activity for families and caregivers.

DISCUSSION

To advance the design of games around dementia care, technical features and user-centred design issues highlighted by several authors should be presented here. We need to look more particularly at issues connected to evaluation. Most games designed in this domain were situated in two main areas: cognitive rehabilitation and reminiscence. Thus as the use of games for dementia care continues to grow, we should query the types of games developed in this context.

What Purpose Can Technology Serve?

Regardless of the game platform, the most important feature for cognitive rehabilitation games is game analytics. Robert et al. (2014) and Bouchard et al. (2012) recommend keeping tracks of patients' cognitive abilities, as well as providing adaptation or customisation. Using game analytics, players' performances can be observed over time and any changes noted and analysed. Furthermore, once a game validity is established, the cognitive profile and dementia stage of the player can be monitored through game analytics. Adaptability or the system capability to dynamically adapt game difficulty to players is an important feature of these games. Variations in the cognitive profile of the player can occur in short period of time (e.g. due to changes in health conditions or to specific dementia pathologies). Moreover, people living with dementia have different profiles, socio-demographics and abilities. Thus, adaptability (and customisation) helps to provide the right challenge so that games stimulate players but are not too easy or too difficult. For reminiscence, especially those based on biographical content, customisation

for each player is also an important platform's attribute. User preferences and responses to different stimuli can then be monitored to enhance impact.

Reverse Engineering the Design of Games for PLWD?

A number of user-centred design issues have been examined by authors developing games for PLWD such as van Rijn, et al. (2009), Imbeault et al. (2011), Øyvind (2011), and Astell et al. (2014). According to Bouchard et al. (2012) and Gerling et al. (2011), games for the elderly and PLWD need to be very straightforward and easy to learn. As we are designing for impaired and older players, it is imperative to design games according to accessibility guidelines (Lopez-Martinez et al. 2011). Imbeault et al. (2011) describe a series of guidelines for the design of games in this context, grouped around cognitive challenge (providing help and adaptation), and user interface design (e.g. legibility and contrast). Most games are designed for touch screens to avoid motor problems with the mouse. Moreover, the use of a stylus has been recommended for iPad games. Games must have simple instructions and intuitive interfaces to enable users to understand what they need to do without being buried in information they cannot use straightaway (Astell 2009; Fua 2013). Several authors highlight the need for designing clear questions, feedback, instruction and prompts (Astell 2009; Øyvind 2011, etc.). Indeed, PLWD need simple guidance on what is expected and immediate feedback on the appropriateness of their response. Specific guidelines for dementia might need to be derived, formalised and added to game accessibility guidelines.

Flow is another aspect of game design that can be quite problematic to achieve with PLWD. Challenge vs. skills is a very sensitive issue that should be considered carefully. As with other players, PLWD need sufficient challenges and they need ways to progress and improve over time in order to stay interested in a game (Astell 2014). Some players even seem to enjoy an element of competition to be at the top of the leader board (Merilampi et al. 2014). However, something too challenging leading to failure can have devastating effects. As noted, an inability to apprehend or perform game tasks can lead to confusion, which can stop the game progress. Dementia is too often characterized as a condition with negative consequences: diminishing capacities or skills, failure to function and communicate, etc. Thus, exposing players' deficits through failure can have quite detrimental consequences. So, game mechanics should strive to provide a more positive and rewarding "can do" experience in order to encourage players. Thus future research should establish what set of game mechanics and design patterns are more effective in this context.

Games for PLWD could benefit from more playful and stronger aesthetics, aspects seldom discussed within these games. Alvarez and Djaouti (2008) highlighted the importance of keeping a gameful or playful aspect to serious games. Serious games for dementia should have a good balance between their utilitarian aspects and engagement to motivate play. *Rayman Raving Rabbids* (Ubisoft 2007) has been tried with the elderly (Mader 2012). Although perhaps not completely appropriate for PLWD, the game has strong engaging features. The game uses a forceful design with a sense of humour, for example, the rabbits are just hilarious. The game incorporates various fun mini games such as *Bunny Hunt*, and sports (including throwing cows), as well as mini games with multi-sensory gameplay (e.g. *Shake your Booty!* dancing and disco). What design strategies are thus needed to maintain cognitive engagement and support reminiscence in stimulating ways especially over a long period of time? Would storytelling elements increase motivation to play and the efficiency of such games? What role can humour

play? More generally, what is the role of multi-sensory design and aesthetics in this context?

Emotion vs. Cognition: Are we Developing the Right Games?

Dementia implies cognitive impairment through cognitive decline, thus naturally games for cognitive rehabilitation became a priority in the fight against dementia. This trend was strengthened with the advent of brain games, as dementia can be seen as a growing niche market for these games. But is it the best approach for games and dementia? Are we designing the right games? Could we get inspirations from indie games to design games in this context?

After carrying out a SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats) in the development of games for Alzheimer's disease, Robert et al. (2014) reported participants' suggestions for games that not only address cognitive impairment but also games that attend to a range of socio-emotional problems. Games should help to reduce fears associated with the condition of dementia. They should be designed to support communication as well as increase sharing and social interaction and finally to have fun. Reminiscence games are designed to stimulate social interaction and can alleviate boredom and enhance self-esteem. To increase motivation to play through social interaction, Garcia et al. (2014), developed a simple intergenerational game. The importance of developing games that are socially inclusive and thus can be played with people of different cognitive abilities should be stressed here. It can allow friendships to continue between PLWD and old friends, or strengthen family ties through playful interaction. Such games can be very empowering, boosting self-confidence in PLWD and breaking social isolation. Thus research is needed to more fully develop intergenerational and socio-cultural games in this context. We might also want to look at cultural differences and assess if the needs of diverse minorities are met by existing games, especially reminiscence games.

Despite the emergence of games dedicated to the affective domain (Hromek and Roffey, 2009), we have not found any games for PLWD that are designed to attend to specific emotional issues. As highlighted in the background, beside and because of cognitive impairment, dementia leads to mood disturbances such as depression. Dementia criteria also include a decline in emotional control, or the ability to manage the generation and expression of emotions. Frontotemporal Dementia engenders a profound alteration of personality, and behaviours associated with social misconduct. Should the focus of digital games in this context shift then to the affective domain to address these problems and increase ability to cope with dementia?

Findings from studies show that, in general, playing video games can lead to changes in an individual's pleasure, alertness, dominance and therefore in the state of experienced well-being (Sirkka 2015). Games are well known for creating rich emotional experiences. Should we then develop games that stimulate different types of emotional experiences for PLWD? Games such as *Flowers* (Thatgamecompany, 2009) are meant to stimulate positive emotions in players. Accompanied by music and flowing petals, *Flower's* players fly through a natural landscape, triggering renewal through brightly coloured landscapes. Once the suitability of game mechanics, ease of use, and emotional reactions have been established, could we develop more games like *Flowers*? Beside reminiscence and multi-sensory stimulation, Anderiesen (2015) discussed suitable play experiences for the early stage Alzheimer's disease as exploration, relaxation, friendship and caring. What kind of game concepts then could we use and develop in this context: Zen games,

music and Karaoke games? Indeed, music provides a strong and lasting multi-sensory stimulation for people living with dementia. Lazzaro (2009) discusses different types of fun, as Hard Fun (a moment personal triumph over adversity), Easy Fun (curiosity), Serious Fun (relaxation and excitement) and People Fun (Amusement). How can we reinterpret these in a dementia context?

Evaluation Criteria

As most games are still in development, most games evaluations were quite limited in scope, carried out as part of the game design iterative process, or as pilot studies before larger scale evaluations. Thus, games have not yet been fully evaluated nor have they undergone full clinical trial (i.e. cognitive rehabilitation). Besides difficulty in assessing the impact of games, another problem stemming out of these evaluations is the heterogeneous nature of the data reported (procedure, parameters and variables used). Variations in dementia and cognitive impairment, socio-demographics and factors such as computer literacy or gameplay experience can affect game performance and thus confound results.

Dementia is an umbrella term for different pathologies leading to different kinds of cognitive impairment. For example, memory is less affected in the early stage of Lewy Body and Frontotemporal Dementia. Misdiagnosis, difficulties in assessing transition between stages (especially between MCI and early dementia), or large variations in abilities at the early stage can affect results. Thus, for quantitative evaluation of cognitive rehabilitation games, we need to establish players' cognitive profiles, testing players' abilities or impairment for the cognitive functions evaluated (e.g. before /after). With qualitative evaluation, such as with reminiscence and leisure games, the dementia stage (early vs. more moderate) and even types of dementia should be carefully considered and included in the evaluation. Understandably, differences in cognitive impairment or dementia stage can have severe impacts on usability issues, game performance, and emotional reactions.

Apart from the dementia profile, we might want to consider socio-demographic factors such as age, gender or education, as well as factors such as computer literacy and gameplay experience. Gerling et al. (2011) highlighted how older people lack of game experience influenced their comprehension of gameplay. Being 70 or 90 does make a difference in frailty and impairment due to aging (visual, hearing, or motors, etc.). Moreover, differences between generations such as with the silent generation, baby boomers, or Gen X is likely to influence preferences for leisure, acceptance of technology and likelihood to have played computer games before the onset of dementia. Again, those factors in turn will impact usability, the socio-emotional evaluation and game results. Thus to assess the benefits and effectiveness, short-term and long term, of games for dementia more thoroughly, we need to look more closely at current methodological issues regarding evaluation. We might have to establish a benchmark for the user profile and game evaluation with harmonised procedures and standardised variables.

Taxonomy of Games around Dementia

Within this context, the use of the term "game" is quite divergent and used from the computerized version of cognitive tests, to brain games and persuasive story telling games. Besides clarifying nomenclature like, if using a game platform like the Wii is enough to make an application a video game (e.g. *MINWii*, Benveniste et al. 2014), we might want to establish a classification scheme for these games. Such classification would enable us to better understand the effectiveness of games properties within this

context as well as to compare games relative to one another. Using as a starting point a games-for-health taxonomy, McCallum and Boletsis (2013)b, classified games for dementia care as for raising awareness, for testing or, as preventative, rehabilitative, or educative. Kazmi et al. (2014) distinguished between assessment, predictive and rehabilitative games. We find the use of “predictive /preventative” highly debatable in this context. There is not yet a reliable way of predicting dementia, especially a non-medical one. Preventative is also highly unlikely. As Chang (2013) and Breton (2012) discussed, games can help MCI players in maintaining cognitive functions and at best lower the risk or postpone dementia. As McCallum and Boletsis anchored their classification in serious games, the category games for leisure and entertainment is missing. We should perhaps reframe the taxonomy for all games and distinguish between therapeutic (including assessment), educational and entertainment aspects. Future research will need to establish the validity of the different categories. Besides high-level descriptions, low level criteria such as game platform, game interface (2D/3D), game genre, game mechanics, etc. should also be provided. A clear taxonomy of games around dementia will stand as a design tool and support a research agenda in this domain.

CONCLUSION

Dementia is a growing societal problem, thus games have been used and developed to support people living with it. As we are starting to develop games in this domain, we aimed to gather more specific design knowledge related to those games and develop a new research agenda. Thus, we carried a review of games specifically designed for dementia care to identify good practice as well as weaknesses and ascertain development trends and gaps.

Games developed for PLWD are situated into two major areas: cognitive rehabilitation and reminiscence. We outlined a number of issues and areas for further studies related to user-centred design and game design. We discussed some of the limitations of on-going development, highlighting strengths and weaknesses. We need to establish a program for games and dementia that better relates to pathologies and the needs of people living with dementia. We propose first to develop serious games related to the affective domain as many emotional issues stem from the dementia condition. Then, we advocate moving out of the functionalistic approach taken with games and dementia to provide enjoyable, emotional and pleasurable game experiences. One of the drawbacks of dementia is that PLWD and their carers live in a closed world regulated by the condition itself and coping with activities of daily living. We should therefore explore in greater depth with what types of digital games, PLWD and carers may play and enjoy. As game designers, we also have a unique opportunity to open a window and develop a world of games, which is joyful, adventurous and stimulating.

There were limitations to the review such as to the depth of what could be discussed within the scope of this paper. The focus of this paper on games for PLWD originated from the articles that we found. Despite the fact that many carers suffer from burn out, poor health or depression, we have not found any games developed for this group. Notwithstanding existing practices in the use of games in healthcare, we only came across two games being developed for professional caregivers: *EHPAD PANIC* (2015) and *Hazel Court* (Anja et al. 2013) focusing on problem solving in residential care. Nevertheless, a program of research for games and dementia care should include all concerned parties and look at needs and opportunities in this context.

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