Digital Game Design for Elderly Users

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ABSTRACT
The current paper reviews and discusses digital game design for elderly users. The aim of the paper is to look beyond the traditional perspective of usability requirements imposed by age-related functional limitations, towards the design opportunities that exist to create digital games that will offer engaging content combined with an interface that seniors can easily and pleasurably use.

Categories and Subject Descriptors
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General Terms
Design, Human Factors

Keywords
Digital game design, elderly users, social and cognitive benefits of games, review.

1. INTRODUCTION

"I´m growing older, but not up." - Jimmy Buffett

There are compelling social and financial reasons why game developers should think seriously about making their games interesting and accessible to elderly users. Digital games hold a significant promise for enhancing the lives of seniors, potentially improving their mental and physical wellbeing, enhancing their social connectedness, and generally offering an enjoyable way of spending time. From a commercial point of view, elderly users are potentially a very large customer base. Worldwide, the population is ageing rapidly, and this is particularly true for Europe, where the proportion of seniors is dramatically on the rise [33]. However, the growing 65+ demographic is currently not well served by the majority of commercial games on the market, creating a significant potential niche market for game developers.

In this paper, we discuss a number of demographic characteristics and age-related sensory, cognitive and motor properties that may influence the senior's experience of interacting with digital games. To date, the interface design community has focused primarily on the design requirements that make interactive applications, including digital games, usable for elderly users. Indeed, usability is a sine qua non, and usability issues can be a serious showstopper to user acceptance. However, usability in itself is not a sufficient motivation to use software. What is important to realize is that game design for elderly users should not only focus on usability issues, but should also seriously investigate the motivations of seniors to engage with new technology. A perceived lack of benefits may be more detrimental to the adoption of digital games, than perceived costs associated with usability problems. We need to design for rich and rewarding experiences, combining low-threshold interaction styles with content that will directly speak to and engage elderly users.

2. ELDERLY GAMERS

By the year 2020, one in four of the European population will be aged over 60, and the largest increase is expected in the oldest age groups (75+). Although quite a bit of demographic data is available on gamers below 65 years of age, relatively little is known for people over 65. Recent research, commissioned by the BBC, shows that people over 65 watch more TV than other age groups, and are also the most likely to cite TV viewing as their favorite activity. Of all age groups they are least likely to be using the internet. If they do use it, it is mostly for practical purposes - travel, finance, education and shopping. However, over a third of pensioners state that they like to keep up with new technology.

It is hard to find reliable numbers that adequately characterize the adoption and use of digital games amongst seniors. A review of

pioneering research in this area [35] showed that a majority of elderly users were interested to engage in playing digital games when they were offered the opportunity through organizational stimulation or study programs, and that such gameplay could yield several benefits, ranging from improvements in perceptual-motor speed to social and educational enrichment. However, it was also found that many of the games were either not enjoyable or were unsuitable because of a challenging interface (e.g., small size of the objects on the screen, rapid movements or reactions required).

Although not addressing the 65+ demographic, Pratchett, Harris, Taylor and Woolard [30] report that approximately one in five (18%) of the 51-65 year olds in their sample of UK participants played digital games, two thirds of whom play at least once a week. These findings may not be homogeneous across Europe, though. For example, a recent Finnish consumer study performed by VTT as part of the Exergames project (1,489 respondents between 13 and 76 years) found that every second (52%) pensioner (over 65 years old) stated to play computer games, and every fifth (22%) pensioner stated to play games on a daily basis However, almost all pensioners (93%) spent less than an hour playing at a time [18]. In the US, the Entertainment Software Association (ESA) reports on data from almost 1500 respondents in their 'Essential facts about the computer and video game industry' publication. They found that 19% of Americans over the age of 50 played video games in 2004, an increase from 9% in 1999. In 2005, this number rose to 25% [10; 11].

Overall, it is clear that seniors play digital games to a lesser degree than younger aged groups, but this cannot be attributed to a lack of openness or interest. Despite the fact that interacting with computer technology can be challenging for seniors, the literature suggests that older people are generally quite receptive to using new technology. In a detailed study of technology adoption behavior by elderly users, Melenhorst [25] found that older individuals are motivated to invest in new communication technology provided they perceive enough benefit for their purposes. The perception of a lack of benefits, irrespective of perceived costs, is reason enough to reject a new technology. In line with these findings, Eggermont, Vandebosch, and Steyaert [9] report that, in general, elderly are proponents of technological advancement, which may provide valuable opportunities for them, but not at any price. For example, they do not want technology that replaces face-to-face contacts, but are interested in technology that supports additional social contacts, connecting people with similar interests (e.g., clubs), or helping them to stay in touch when immobile.

3. AGE RELATED CHANGES AND DIGITAL GAME DESIGN

Although seniors are quite diverse in abilities and experience, older age is generally associated with a number of well-documented changes in sensory-perceptual processes, motor abilities, response speed and cognitive processes, all of which impose requirements on interfaces that are to be pleasurably used by the growing elderly population. We will briefly summarise some of the main issues here. For a more detailed treatment, we refer to Czaja and Lee [4], and Fisk, Rogers, Charness, Czaja and Sharit [12].

With increased age, there is a loss in static and dynamic visual acuity, as well as a reduction in the range of visual accommodation, a loss of contrast sensitivity, decreases in dark adaptation, declines in colour sensitivity, and a heightened susceptibility to problems with glare. Such visual decrements may make it harder for elderly people to perceive small elements on a display (e.g., single soldiers in a real-time strategy game), to read small print instructions or captions, or to locate information on complex screens. Allowing the user easy control of font, color and contrast setting, as well as window resizing, scroll rate and zooming, is generally recommended. These adjustments should not exceed appropriate boundaries for the playability of a game on a system, e.g., a 200 point-size font on a portable game device will not increase readability. At any moment in time, the user should be able to directly undo the adjustments by means of a single click.

Ageing is also related to declines in auditory acuity, in particular sensitivity for pure tones, and high frequency tones. Problems may occur in localizing sound, through problems in binocular hearing. Older people may find it hard to understand synthetic speech, because it is often somewhat distorted. For non-speech audio signals, lower frequency tones (in the 500-1000 Hz range) are easier for elderly users to hear than higher pitched sounds. In general, it is advisable to provide redundant information through multiple modalities. For example, if an in-game sound effect delivers vital information, tactile (vibration) feedback through a rumblepad or force-feedback joystick would be helpful as well. Moreover, online social play should support both headsets (voice) and text messaging (keyboard) for communication.

Motor impairments are diverse in their nature and cause, and have varying degrees of impact on the user experience. Generally though, senior users may experience changes in motor skills, including slower response times, declines in ability to maintain continuous movements, disruptions in coordination and balance, loss of flexibility, and greater variability in movement [32]. Thus, it may become a challenge to be steady with the mouse, or any other control device. Small targets and moving interface elements are known to be difficult for older people, and should best be avoided.

Age-related changes in cognition are also likely to affect the requirements of interface design. Cognitive processes that decline with age include attention processes, working memory, discourse comprehension, problem solving and reasoning, and memory encoding and retrieval. Apparently easy computer tasks may put quite a stringent demand on many of the processes mentioned here. For example, remembering information from one screen to another could be difficult because of limits in attention (see [5]) and working memory. From the point of view of interface design, the focus has to be on simplicity and intuitiveness, providing

appropriate affordances and overview, thus keeping the load on memory and cognitive processing to a minimum.

In addition to functional limitations, the current generation of seniors has not been exposed to the same level of computer technology as the younger generation. In fact, many pensioners have retired without needing or having used computers or the internet at all during their working lives. Thus, this lack of exposure may result in seniors not having an accurate mental representation or conceptual model of how computer technology works, what it can and cannot do. There is very little published literature available on the potential differences in the way mental models are built up by seniors as compared to the young. Van Hees [15] suggested that elderly users must unlearn some of their accumulated knowledge if it does not fit with the properties of new technologies. Docampo Rama [6] has demonstrated that in addition to an age effect (i.e., decline of function over age) there is also an independent effect of technology generation, that is, the dominant user interface experienced during the formative period in life. When confronted with a layered interface, there Docampo Rama found a pronounced discontinuity in the number of error between people from the 'electro-mechanical generation' (born before 1960) and those from the 'software generation' (born after 1960), suggesting a generational effect. Time on task, on the other hand, increased linearly with age, indicating a more continuous cognitive change. In addition, elderly users appear to use somewhat different strategies in handling novel interfaces, taking a more reflective approach, rather than a trial-and-error one [6].

The functional limitations and ICT experience of seniors could have an impact on seniors' confidence level in playing, or starting to play, digital games. Within the ICT domain, seniors are less confident in their ability to perform than the young, which is related to poorer, computer-related, global self-efficacy beliefs [22]. Czaja, Charness, Fisk, Hertzog, Nair, Rogers, and Sharit [3] found that computer self-efficacy is an important predictor of computer anxiety. So, to decrease computer anxiety it is important that seniors receive encouraging feedback and experience some level of success (see [3]). Within the games industry there already is a lot of (heuristic) knowledge about how to provide effective positive feedback that increases the self-efficacy or mastery of gamers. To support inexperienced elderly users in overcoming their anxiety it is recommended to design games that provide enough time to learn basic necessary skills, and provide encouraging feedback from the start (e.g., provide positive feedback in a strategy game after having build a town centre, instead of providing feedback after having conquered Europe). In this context, it is generally beneficial to emphasize and provide feedback on learning goals rather than performance goals, especially when the senior's confidence in his or her present abilities is low [8]. By presenting learning goals, there is a focus on progress and mastery, rather than ability judgments, which will likely increase the senior's motivation and persistence to engage in a task that is initially perceived as challenging.

In a quantitative study of web usability, Nielsen [29] compared the performance (tasks completed, time on task, number of errors) and subjective ratings of elderly users with that of younger users, and found that overall, seniors experience more than twice the usability problems than do younger users. He also found a strong positive correlation between successful performance on the various tasks, and subjective preference (r=0.78), indicating a strong preference for those websites that are easiest to use. In short, seniors are hurt more by bad design, and increasing usability will significantly increase their satisfaction.

Although the discourse of 'disengagement' and an age-related digital divide has dominated discussions on the effects of old age on ICT use, it should be noted that certainly not all seniors face difficulties when interacting with computers. The larger part consists of mentally and physically healthy autonomous adults between 55 and 75 years of age [1]. Most seniors are very well capable of acquiring computer skills, learning how to use the web (see, e.g., [27]), or learning how to use PDA's [23].

Moreover, retirement can also be considered as a time for further exploration in life, rather than withdrawing from it. Digital games may offer elderly users with new and exciting ways to be entertained, stimulating mental abilities, and supporting existing and emerging social networks, both within and across generations. The accumulation of knowledge and wisdom, heterogeneity of experiences, and changing social and societal roles that come with age also bear relevance to the design of digital games. Perhaps the most important design requirement we can formulate is to offer seniors the kind of content they will appreciate and engage with, even if this requirement is perhaps not as easily and unambiguously specified and will be more idiosyncratic. As the work of Melenhorst [25] has shown, it is not so much the cost of having to learn a new interface that elderly users find prohibitive, but a lack of perceived benefits. Thus, if a user-friendly interface only provides access to games that are uninteresting for the elderly user, he or she is not likely to engage with the content. To put it differently, *Counterstrike* with adjustable font size may not be the "killer application" for elderly users.

4. BENEFITS OF PLAYING DIGITAL GAMES

Although little is known about senior adults' perceived benefits of digital games, there is a small but growing body of research evidence in support of the notion that digital games can have a significant positive impact on the older person's mental and physical health and wellbeing (see [14] for a brief review). In one of the earliest studies in this area, Weisman [34] suggested that digital games can play a positive role in meeting seniors' need for fun and mental stimulation, while also heightening their self-esteem. He reported that moderate physical and mental impairments did not prevent the nursing home patients in his study to participate, using four games specifically designed for this population.

Hollander and Plummer [16] reported on a study involving a senior community in Rockville, MD, who were asked to play video games over a three week period. Results indicated that thought-provoking games (*Trivia* and *Hangman*) were found to be the most stimulating and attention-grabbing. Therapeutic effects were reported in a greater constructive use of leisure time, and in participants' increased feelings of success and achievement.

McGuire [24] studied the effectiveness of digital games in improving self-esteem among elderly long-term care residents. Elderly residents in one wing of the institution were offered video

games for a period of eight weeks, whereas residents of a second wing did not have the opportunity to play video games. Results demonstrated that the elderly that played video games had an improvement in self-esteem. Similarly, Goldstein et al. [13] found that playing digital games for five hours per week for five weeks improved reaction times, self-esteem and sense of well-being for the elderly participants in his study. It did not, however, have a significant effect on cognitive performance when compared to controls.

Drew and Waters [7] have argued for the use of video games for improving hand-eye coordination, or for slowing deterioration, with age. A decline in perceptual-motor functions has serious consequences which affects a range of activities of daily living. The use of video games may ameliorate this situation for large numbers of (non-institutionalized) seniors. Finally, Miller [26] recently reported on a trial of 95 healthy older adults with an average age of 80. Those who played *HiFi*, a game designed to boost the function of the ageing brain, on a regular basis, improved their scores on tests of memory and attention.

Although these studies indicate the potential benefits of digital gaming in older age, especially on self-esteem and mental stimulation, it should be noted that this research is still in its infancy, and also some contradictory findings have been reported (e.g., with regard to emotions; see [31]). Moreover, most studies to date employed specially designed games, rather than games that were already commercially available. Most commercially available games today require such rapid and complex responses that they are not easily accessible for seniors, who may find the required eye-hand coordination and cognitive processing prohibitive. Nevertheless, it is fair to say that digital games have potential that goes beyond their primary recreational functions, and may include therapeutic effects, as well as 'spin-off' effects in terms of increased computer literacy and improved self-efficacy in relation to other modern technologies.

5. DESIGN OPPORTUNITIES

Seniors have a variety of preferences, interests, tastes, abilities and experiences which make them as heterogeneous a group as any other. No empirical data are available as to what a typology or categorization of senior gamers may look like and how this would map onto potential game content. Although some of the functional limitations described earlier may fuel a tendency to focus on usability guidelines as an overarching design focus for this group, we have argued that it is the perceived benefits rather than the costs that will be decisive in the acceptance or rejection of digital game design.

With this in mind, we see four main areas in which we feel there are significant design opportunities. First, and perhaps most basically, is the use of digital games for relaxation and entertainment. Of all possible problems seniors may encounter in their homes, those related to leisure time are among the least solved ones. Although many seek problem-focused strategies for problems such as housekeeping and personal care, often involving the use of technology or social support, these types of solutions are typically not sought when enjoyable leisure activities are frustrated [20]. Instead, in over 60 percent of reported cases, seniors gave up on their favorite pastime. The most pressing barriers for the adoption of technology in the service of goal attainment are their availability and seniors' perceived self-efficacy to use these [21]. Digital gaming applications present a widely available class of technologies, serving a wide variety of tastes, for which perceived self-efficacy can be increased through accessible design and thoughtfully integrated feedback. Gaming technology thus has significant potential to contribute positively to seniors' leisure time, as a viable alternative to television viewing.

Secondly, many elderly enjoy games (especially of the non-digital sort) as a means of socializing with others within and outside their social network. Games provide a rich set of enjoyable topics of conversation (e.g., *Trivia*), as well as a common activity that can serve as a way of decreasing social distance (e.g., *Bingo*). Although many digital games can be played alone, digital gaming has become an increasingly social activity. A 2005 Nielsen research report commissioned by the Interactive Software Federation of Europe (ISFE) details that two-thirds of the gamers they sampled (N=2000, with equal proportions from Spain, Germany, Italy, the UK and France) play video games with other people for at least an hour a week. Moreover, when probed for their motivations to play, the number one motivation, supported by 60% of the gamers, is the social component, i.e., "being able to play with friends" [28]. The social interaction underlying games is thus a crucial motivator to engage in digital gaming, and this is only expected to increase in importance as one grows older. Digital games may also connect different age groups together while enjoying a common activity (e.g., grandparents and grandchildren). Such games will need to meet requirements of multiple user groups at the same time, which is an interesting challenge from both a game and interface design point of view, and one that recent intergenerational gaming projects are starting to address [2].

Third, games can be played with the explicit motivation of sharpening one's mind. The evidence presented earlier in this paper provides tentative support that challenging mental activities, such as puzzles and quizzes, may indeed be beneficial for stimulating memory and attentional abilities. Moreover, the sense of accomplishment and perceived self-efficacy after mastering a certain game can provide a significant boost to one's self-esteem. Echoing this sentiment, Nintendo has recently launched an active and successful marketing campaign focusing on elderly as a serious consumer segment. For the Nintendo DS platform they introduced their '*Dr Kawashima's Brain Training: How Old Is Your Brain?*', software which puts players on a daily regimen of number games, word puzzles and reading exercises. It also lets players test their intelligence levels ('brain age') through quizzes that involve attentional and memory processes (such as the Stroop test; see Figure 1). It saves the results so progress can be tracked or compared with others, introducing a social component as well.

Finally, with the advent of new interaction technologies, digital games now afford new ways of interacting that are both more natural in terms of affordances and engage the whole body. Examples of such embodied interaction devices include the Sony EyeToy (using computer vision) and the Nintendo Wii (using position and acceleration sensing), both of which allow for an embodied, physically active way of engaging with the game content. Such interaction styles can be employed for engaging the

user in a virtual fitness programme, providing guidance and coaching that can be tailored to the individual, especially if such software is coupled to biometrics data, such as heart rate (see, e.g., [17]). In such a context, digital games can be regarded as persuasive technologies that provide an additional incentive to engage in healthy behaviour [19]. Indeed, the Nintendo Wii has been successfully introduced in some old people's homes, where they are being used to keep physically fit, as well as socially engaged with one another. As an example, Wii is now the latest rage at the Sedgebrook retirement community in Lincolnshire, where the average age is 77. In particular, the Wii Bowling component of Wii Sports has members of this particular retirement community hooked on playing the Wii installed inside the Sedgebrooks's clubhouse lounge.

6. CONCLUSION

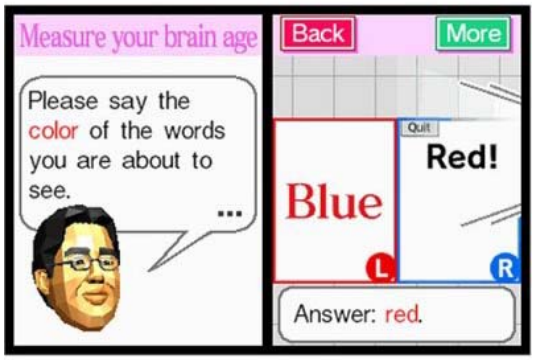

Figure 1. Dr Kawashima's Brain Training for Nintendo DS

Digital games hold significant positive potential for elderly users – one that has hardly been tapped to date. In addition to entertainment value, there can be substantial therapeutic value in playing digital games. Moreover, digital games allow elderly people, like other users, to bond socially, both with online or physically co-located others, thereby enhancing their social connectedness and potentially enlarging their social support structure. Despite this potential, seniors are at present proportionally underrepresented as consumers of digital games, creating a significant and largely untapped market opportunity. One of the reasons for this state of affairs has been the focus of game developer studios to develop games primarily for adolescent users – games which do not usually resonate well with the interests, needs, abilities and limitations of elderly users.

As a consequence of both functional limitations and a simple lack of technological experience, seniors are hurt more by usability problems than younger users. Most game developers are still very much unaware of basic game accessibility guidelines, which could benefit a range of users, including seniors. This situation can and should be drastically improved through extensive user testing with elderly users and the use of design guidelines that are specifically tailored to an elderly population. There is a substantial body of literature focusing on the elderly ICT user which details a number of specific interface design guidelines that could also be usefully applied to game design (e.g,, [4]). Two general design recommendations can be distilled from this literature, which are particular to the needs of the senior population. First, interface design for elderly users should minimize the burden on functions that may have suffered decline, such as demands on spatial memory, working memory, visual functions or motor ability. Second, interfaces should be adaptable to compensate for particular functional limitations (sensory, motor or cognitive) of elderly users.

However, in this paper, we have argued that in addition to ensuring usability of games for seniors, we need to make sure that there are substantial perceived benefits for elderly users so that they are willing to invest their valuable time and energy in what could potentially be a rich and rewarding experience. To explore and understand the needs and motivations of elderly gamers, there is a great need for a substantial research effort, which includes focus group studies, interviews, surveys and general market segmentation research. In addition, further well-controlled studies are required to establish unambiguously the effects of different genres of digital games on different types of elderly gamers, putting the various hypothesized benefits to a much more detailed test.

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