Cognition and theory of flow for elders: can digital games help?

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In this communication, we are going to investigate the impact of digital games on older adult cognitive abilities. After identifying the effect of age on cognitive processes, we present the potential impacts of video games on cognitive skills. Also, we will present a conceptual framework to explain these impacts, based on the theory of flow and on the definition of learning into the theory of activity. We will finally conclude with specific studies, which illustrate the framework and the perspectives for our ongoing research.

1. Elders and cognitive processes

Aging populations are increasing worldwide. The proportion of people who are 60 and over is growing faster than any other age group and is predicted to grow to two billion by 2050 (Aalbers et al., 2011). In 2010, almost five million Canadians were over 64 years of age; by 2036 there will be more than 10 million (HRSDC, 2011). Keeping a high quality lifestyle can be challenging, especially for institutionalized older adults who are victim of unfavorable health conditions such as dementia or other brain disorders (Chen et al., 2012). To improve the quality of life among older adults, we must understand the problems associated with ageing, especially the cognitive slowness experienced amongst them.

There are age-related cognitive deficiencies among older adult age 50 and above and these deficiencies are detrimental to this age cohort (Hedden & Gabrieli, 2004). Some of these deficiencies were noticed in working memory (Bopp & Verhaeghen, 2005), engaged in a list of shopping for instance, reasoning (Schaie, 1996) and in episodic memory of events and experiences (Salthouse, 2003). Furthermore, research shows that the decrease in working memory capacity and the inability to engage in activities involving problem solving can also contribute to the decline in cognition among older adults (Salthouse & Miles, 2002; Marsiske & Willis, 1995). Therefore, ageing can be positively linked with cognitive decline (Salthouse & Miles, 2002; Basak et al, 2008). Moreover, age-related cognitive declines include dementia, which is a severe loss of capacity in memory, attention, language, and problem solving (Salthouse, 2009).

While earlier-life factors such as education and income help to determine higher functioning in later life (Lupien & Wan, 2004), many studies provide evidence that training can maintain and enhance cognitive, emotional, and social functions for seniors. The study of Ball et al. (2002) demonstrated that specific training could produce significant improvements in reasoning or in memory and visual speed of processing that persisted for two years with limited booster training. Green and Bavelier's (2008) review of human brain plasticity research cites numerous

studies showing improved task abilities after laboratory training, again without transfer. Older adults should be given new and innovative activities to engage in because it raises their awareness and also encourages cognitive health (Friedland et al., 2001). Therefore, it is beneficial to the physical and mental health of older adults to engage in novel and innovative activities such as, playing video games, which could be specifically developed to reduce neurodegenerative disorders and increase cognitive abilities of older adults.

2. Potential of videos games

A study by Groves and Slack (1994) found that the use of technology among older adults resulted in increased autonomy and higher engagement in social activities. The term "Third Age University is used often to refer to volunteer organizations that are promoting learning for personal development and satisfaction, in particular to senior citizens" (Juznic, Blazic, Mercun, Plestenjak & Majcenovic, 2006, p. 335). We can then suppose that video games increase cognitive abilities, but there are several issues linked to this public that must be considered before engaging it into an activity of video game, like stereotypes and ergonomics.

In choosing video games for older adults, Schulz (2006) stated that video game developers and researchers should be wary about stereotype threat. Stereotype threat can be defined as the exhaustion of mental resources which resulted in failure caused by the stereotype of group membership (Schulz, 2006). McLaughlin, Gandy and Whitlock, (2012, p.17) affirmed that "avoiding stereotype threat could be essential for older players to employ their full abilities and to reduce early demotivating failures that create a downward spiral of belief in ability and performance". It means that older adults should be told beforehand the advantages of playing video games: Telling them the advantages of playing digital games will reduce prior stereotype they may hold against playing video games.

Cognitive ergonomics of interface are directly linked to cognitive processes. Among older adults who play digital games, it is crucial to use digital games that are user-friendly, easy to navigate and which do not cause cognitive overload for the gamers. In digital games, cognitive ergonomics is concerned with games quality to maximize the physical and mental effort of the gamers (Hollnagel, 1997). Fisk, Rogers, Charmess, Czaja and Sharti (2004) found that 50% of their participants who were older adults reported difficulty in usability as the main problem when playing digital games. Video games do not need to be too much usable, because the difficulty of the game is linked to the fun process. Koster (2005) defines "fun" as a neurophysiologic activity related to a loop between eyes and hand: the hand acts and causes a visual feed-back for the next action of the hand. In the game, we manage a pattern and the increase of difficulties into the pattern develops the fun. In fact, a game is fun when we can learn gradually how to manage its procedural pattern. Here, the notion of pattern is really important to understand: it is what is needed to accomplish within the game, what movements

and schemes we have to complete, for instance: catch the object; go ahead moving right or left, etc. During the game, the fun is linked to this increase of the pattern difficulties and ergonomics, which must be gradual: if the pattern is too easy, or if the pattern is too complicated, we do not learn and there is no fun. And it is what is learned: the management of the pattern. So it is important to find a pattern adapted to older adults, linked to a continuum of ergonomics complexity into the game play: if ergonomics is too simple, there is no fun, as well as if ergonomics is too complex. This shows that a game needs a good ergonomic distance to keep older adults interested.

For older adults, the new cognitive skills learned can also be maintained for years if they regularly rehearse their skills (Peretz, Korczyn, Shatil, Aharonson, Birnboim & Giladi 2011). In another study it was noted that the longer the time of playing video games, which are ergonomically viable, the higher the degree of use of sophisticated techniques (Harley, Fitzpatrick, Axelrod, White and McAllister 2010). This means that older adults can experience increased cognitive competence as they spend more time playing digital games which are created ergonomically for them. Moreover, a study shows that older adults who were given innovative and new challenges outperformed their colleagues who played traditional games such as card games (Friedland, Fritsch, Smyth, Koss, Lerner, Chen, and Debanne 2001).

How do older adults learn through video games? What do they learn that increases cognitive processes and how can we maintain interest for a video game? The theory of flow brings us some elements of answer.

3. Learning activity into the flow

The theory of flow is really useful in understanding how to maintain interest in a video game, especially for an elder public. Flow can be defined as the state of total absorption in any activity comprising noticeable challenges, well-defined goals and direct feedback on progress made during the activity (Csikszentmihalyi, 1988). Flow in digital games can also be defined as the state of total immersion in an enjoyable playing associate to features that encourages different states such as providing rich immediate feedbacks to player actions, enjoyment, playfulness and appealing to players' attention and these characters are inclined to arouse players' flow experience (Chang et al., 2008). To experience flow in any activity, it is expected that its complexity depends on the gradient of challenges it can provide and, consequently, on the level of difficulty of the required skills (Csikszentmihalyi, 1988). This conclusion came about to Takatalo, Hakkinen, Kaisteinen and Nyman (2011) by realizing that to experience flow in the digital world, older adults are expected to experience cognitive evaluation such as, challenge and competence as well as, emotional outcomes such as, playfulness, control and enjoyment.

For older adults to experience flow, it is advisable to play digital games, which will provide a balance between individual skills and the challenges introduced by the game (Sharek & Wiebe, 2011). Similarly, O'Brien and Tom (2008) found that it is possible to experience flow within a game play among older adults, with reduced boredom and frustration recorded by the participants, if a balance between game play and challenge can be achieved. The level of engagement during game play is essential because it reveals the level of involvement in playing video game. Concentration, enjoyment and perceived control (Kowaris, 2002) are characteristics needed to enjoy game play among older adults. This definition is directly linked to the necessity to have adapted ergonomics into the game play to maintain fun.

To understand what older adults learn as cognitive abilities during a video game activity, we can refer to the Theory of Activity. This theory, proposed by Léontiev (1981) and explored by Engeström (1996) in ergonomics, takes its roots into the work of Vygotski (1997) which could be summarized into the concept of proximal development zone. Learning is an internalization of problem solving. The problem defined into the activity needs to be in the proximal development zone. If the problem is too complex, the student will abandon trying to solve it, as well as if the problem is too simple. This is exactly what happens with fun and with the ergonomics complexity into video games for older adults. We have tried to represent a model of flow in figure1.

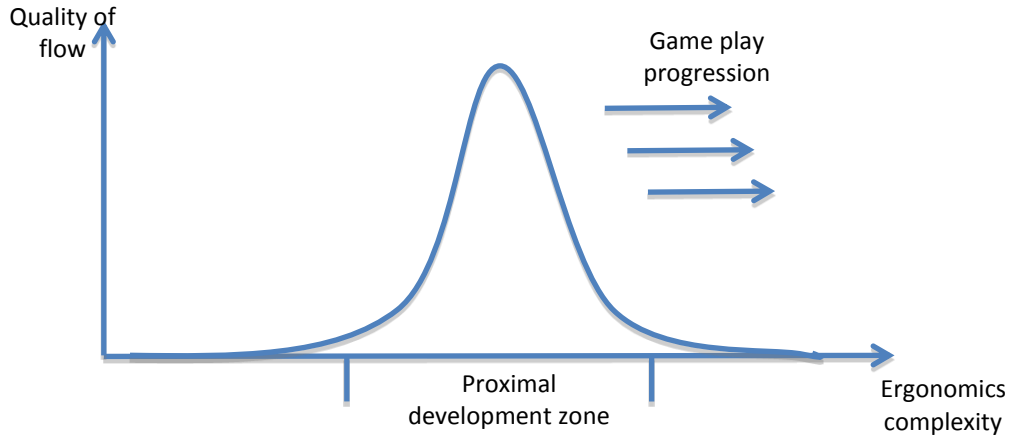

Figure 1: Quality of flow and ergonomics complexity in the game play progression.

If ergonomics are too complex, elder player will abandon the challenge, as well as if it is too simple. We would need video games with specific ergonomics for elder, in order to maintain learning at the interface, and by the way, to maintain the flow. The quality of flow is dependent on a correspondence of ergonomics challenges and computer skills of players.

4. Example of games and perspectives

The experimentation of Whitlock, Collins McLaughlin and Allaire (2012) predicted to improve cognitive abilities, particularly multitasking and special cognition, using the video game World of Warcraft. They observed changes in attention control, social orientation, mental rotation, recognition memory and reasoning. This game can also improve cognitive abilities of older adults. Moreover, they found a relationship between initial ability level and ability change: lower-ability older adults may stand to benefit more from cognitive training. The sample was however composed of higher-ability participants: the lower-high can benefit more than the higher-high. Authors mentioned that future studies should include more measures of individual differences (daily activities, etc.).

In another experiment, Anguera et al. (2013) customized the game "NeuroRacer" in multitasking training mode: older adult players had to pilot a car and, at the same time, they had to identify symbols to react to. Several groups were trained, with each separate task or with both. Participants had cognitive tests about attention, working memory and electroencephalography to localize the effects of training. Results show that older adults with multitasking training mode reduced multitasking costs attaining levels beyond those achieved by untrained 20-year-old participants, with gains persisting for 6 months. Results highlight the robust plasticity of prefrontal cognitive control system in the ageing brain, and provide the first evidence, to our knowledge, of how a custom-designed video game can be used to assess cognitive abilities across lifespan and can serve as a powerful tool for cognitive enhancement.

In conclusion, cognitive training with video games, under certain circumstances and for certain individuals, has the potential to improve cognitive abilities and possibly daily life of older adults. Our research will focus on exploring individual differences in cognitive training with digital games. We will also explore the link between social and cognitive training into the flow. A last perspective is to take a look at the imaginary dimension and its link to the flow, which has never been studied in previous research.

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