PLAYING FOR A REAL BONUS: VIDEOGAMES TO EMPOWER ELDERLY PEOPLE

Luciano Gamberini,1 Mariano Alcaniz,2 Giacinto Barresi,1 Malena Fabregat,3 Lisa Prontu,1 Bruno Seraglia1?

This paper offers an overview of recent game-based applications for therapy and rehabilitation of elderly people. Information and Communication Technologies represent a viable solution to meet the various physical and psychological needs of a population growing at an incredibly fast rate. In particular, videogames have proven to improve elderly people's cognitive abilities and take care of psychological problems accompanying illnesses and social isolation. We will present several examples of videogames adopted within training programs for elderly people, and tested through scientific procedures. We will include both old-fashioned games and recent ones. Characterized by a higher naturalness in the input system, the latter rely on already established usage practices with non-digital tools (a pen, a bowling ball, etc) that make the interface more accessible. Finally, we will describe a current European project that aligns with these efforts towards natural interfaces and aims at developing a mixed reality game for cognitive training and sociability of elderly users.

Introduction: Technologies in an ageing society

The Department of Economic and Social Affairs of the United Nations released the 2006 revision of the World Population Prospects, highlighting “an unprecedented transformation brought about by the transition from a regime of high mortality and high fertility to one of low mortality and low fertility” (Population Division of the Department of Economic and Social Affairs DESA of the United Nations Secretariat, 2007, p.1). According to the UN document, compared to the other continents “the population of Europe is today the oldest, with a median age of 39 years. It is followed by the population of Northern America, with a median age of 36 years and then by Oceania whose median age is 32 years. The population of Asia has a median age slightly lower than 28 years and that of Latin America and the Caribbean is 26 years. Only Africa’s population still has a median age below 20” (Population Division of the Department of Economic and Social Affairs DESA of the United Nations Secretariat, 2007, p.1). A main effect of this transformation is the fast increasing percentage of older adults. By 2025 there will be 1.2 billion people aged 60 and over, double the same population in 2000 (World Health Organization, 2002).

A similar expansion of the senior population constitutes an important social and economical issue, since aging is also accompanied by limitations in carrying out everyday activities (Nehmer, Karshmer, Becker, & Lamm, 2006) or by physical and mental impairments that have to be taken care of. On one hand, this has been addressed by initiatives to facilitate successful aging, where older people's involvement in physical, cognitive, and social activities is encouraged.
"Active aging", for instance, is a multidisciplinary field focusing on the possible ways to ensure that elderly people's habits meet good life quality standards (e.g. World Health Organization, 2002). On the other hand, assistive and clinical needs are pressing the elderly population and the oldest portion, namely people aged 80 or over, who "will likely increase more than four-fold, from 88 million in 2005 to 402 million in 2050" (Population Division of the Department of Economic and Social Affairs DESA of the United Nations Secretariat, 2007). Many of these individuals require long-term medical, social, psychological and personal care, which calls for effective strategies, possibly taking advantage of the opportunities of Information and Communication Technology (ICT). This means not only adapting already existing tools to the needs of older users (Gamberini, Alcañiz, Fabergat, Seraglia, Gómez, & M ontesa, 2007), but also developing tools especially devoted to prevent or treat their precise impairments and diseases.

Several technological solutions have appeared aimed at ameliorating the quality of life of older people, paying particular attention to their cognitive, social and health needs (Burdick & Kwon, 2004). Some scholars warn against too much optimism, arguing that no evidence of a positive impact of computers and technology on the well-being of elderly people has been properly collected (Dickinson, & Gregor, 2006). However, information and communication technologies offer a solution to reduce the costs and complexity of intervention; through the constant acquisition of data regarding psychological, cognitive and neuropsychological behaviors, and by communicating at a distance, they offer the potential to reach and improve the well-being of a larger number of elderly people (Weiner et al., 2003). Since technology improves in efficiency and usability as its costs decrease, ICT's are conveying accessible and valuable environments to treat many different psychological and behavioral diseases such as anxiety, addiction disorders, depression and phobias (Wiederhold & Wiederhold, 2004; 2006). Therapeutic and rehabilitative procedures carried out with computer technologies are constantly being developed and evaluated (Rizzo & Kim, 2005; Rizzo, Schultheis, Kerns, & M ateer, 2004) side-by-side with more traditional ones (LoPresti, M ialidis, & Kirsch, 2004).

Games offer complex scenarios that can stimulate discussion, collaboration and imagination, or train skills such as hand-eye coordination, strategic abilities and problem solving (Gaggioli, Gorini, & Riva, 2007; Young, 2004; Barr, Noble & Biddle, 2007). Cognitive scientists consider videogames, in which objects move faster than usual and multiple items have to be monitored at the same time, as stimulating the peripheral processing. Experimental studies have registered an improvement of some cognitive and perceptual capacities (e.g. spatial abilities and reaction time; Lager & Bremberg, 2005) in gamers compared to non-gamers (Green & Bavelier, 2006, 2007). Computer games also seem to be able to affect neurocognitive functions (also neurochemical levels, Koepp et al., 1998), thereby showing a high potential for rehabilitation (Cameirao, Bermúdez i Badia, Duarte Oller, Zimmerli & Verschure, 2007). While cognitive improvements would appear insignificant to most people, to a sub-set of the population such as elderly people, stroke patients or military personnel, they would be extremely beneficial.

In this paper, we will focus on game-based applications for therapy and rehabilitation of older people. First, we will explore the opportunities for cognitive training offered by classic and recent videogames. Then, we will focus on the treatment of psychological problems accompanying illnesses and social isolation. Finally, we will describe a current European project that fits the scenario depicted in the previous paragraphs and aims at developing a mixed reality game for elderly people to facilitate their cognitive training and sociability.

**Videogames for Cognitive Training and Rehabilitation**

Cognitive training is a set of procedures to help people re-acquire a useful level of performance in everyday tasks for different functions (e.g. attention, memory, reasoning). For instance, the ACTIVE (Advanced Cognitive Training for Independent and Vital Elderly; Jobe et al., 2001) program is focused on memory training (remembering lists of words, sequences of items), reasoning training (solving problems after pattern presentation), and speed of processing training...
The efficacy of these training programs has been shown in several studies; cognitive training has improved episodic memory in people affected by mild cognitive impairment (MCI) and healthy elderly people (Belleville, Gilbert, Fontaine, Gagnon, Ménard & Gauthier 2006). Inductive reasoning trainings were more predictive of subsequent mental status than spatial orientation trainings (Boron, Willis & Schaie, 2007). Willis et al. (2006) found long-term effects of reasoning training on everyday performances for the elderly, reducing their natural functional decline.

Everyday problem-solving in healthy older adults is more complex, flexible and emotionally balanced than is usually supposed: elderly people are able to take actions directed toward the source of the problem while at the same time controlling their emotions to manage psychological stress (Blanchard-Fields, 2007). This suggests the opportunity to exploit everyday engagement and tasks to support cognitive functioning. Stine-Morrow, Parisi, Morrow, Greene & Park (2007) developed a team-based program of creative problem-solving, named Senior Odyssey, to test the engagement hypothesis, i.e. that social and intellectual engagement can buffer cognitive senescence (Schooler, Mulatu & Oates, 1999 in Stine-Morrow, Paris, Morrow, Greene & Park, 2007). Game-based trainings, possibly integrated with existing activities and habits, also work as educative interventions and preventive tools for mental deficiency, cognitive deterioration and dementia (Mórales-Sanchez, Arias-Merino, Díaz-Garcia, Cabrera-Pivaral & M. Aynard-Gomez, 2007). Wang et al. (2006) showed that a board game like Mahjong could reduce the risk of cognitive impairment in older adults, whereas television constituted a factor enhancing the risk of age related deficits within a group of the same cohort.

Even physical activity can improve the cognitive function of healthy but sedentary elder people: according to a meta-analysis of Colcombe and Kramer (2003), fitness produces strong but selective enhancements of cognition (in particular, for executive-control processes), mostly depending on factors such as gender or type and temporal length of task and training. Colcombe, Erickson, Scalf, Kim, Prakash, McAuley, et al. (2006) found that cardiovascular fitness can increases brain volume in elderly people. These findings confirm the presence of cognitive and neural plasticity along the life span. Fabre, Chamari, Mucci, Masse-Biron and Prefaut (2002) observed that the combination of fitness training and cognitive training is able to enhance memory performance more than the each training alone. The cognitive training obtained from carrying out everyday operations, social entertainment and physical activity can be easily provided by specially designed videogames, both classic non-immersive ones and innovative augmented technologies (Van Noorden, 2006), as described in the next two sections.

First Generation Games

Several “first generation games” of the past century inspired researchers who started using them as tools for cognitive rehabilitation of older adults. For instance, Clark, Lanphear and Riddick (1987, in Green & Bavelier, 2006) had an experimental group of elderly people playing with either ‘Pac Man’ and ‘Donkey Kong’ two hours a week for seven weeks, and observed a reduction of their reaction time. The reaction time test was conducted with a special device, composed of two buttons and two lights (each button was positioned under one of the lights); when one light emitted a flash, the participants pressed a button: the button under the flashing light (compatible condition) or the button under the off light (incompatible condition). Participants improved in both conditions, contrary to a control group with no videogame training. In another study, elderly people playing ‘Crystal Castle’ one hour a week for two months improved their manual dexterity, hand-eye coordination, verbal and non-verbal intelligence measured by WAIS-R (Drew & Waters, 1986 in Green & Bavelier, 2006).

In the study of Goldstein, Cajko, Michielsen, VanHouten and Salverda (1997), a group of non-institutionalized elderly people (aged 69 to 90) was positively affected in terms of reaction time (Sternberg Test) and emotional being (self-
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Innovative Games

The advances in information and communication technology have made available new, enticing videogame interfaces. The VividGroup's Gesture Xtreme™ (GX) VR is a system to create an interactive image of the user in a simulated environment, thanks to a vision-based tracking system (IREX - www.irexonline.com). This entertainment tool is able to augment the mediated experience without the use of a Head Mounted Display (HMD), and it has been adapted to cognitive rehabilitation aims, although the high price of the GX™ VR limits its usage. A cheaper option to a similar end is the Sony PlayStation II EyeToy® (www.eyetoy.com; Rand, Kizony & Weiss, 2004). This device displays real-time images of the user on the monitor, where s/he can see him/herself surrounded by the virtual environment; the user can play with active movements individually (e.g., painting), or in multiplayer modality (e.g., boxing). The elderly healthy subjects participating in the study played Wishy-Washy, Kung-Foo and Keep-Ups and enjoyed using the tool, as the usability questionnaire indicated. Acute stroke patients showed interest and involvement, but also frustration because of their left-side impairment with sensory, cognitive, language and hand deficits; in this case, therapists are necessary in order to help patients. These games seem more powerful as treatment tools for mild stroke or chronic patients, and EyeToy is an ideal tool for home autonomous rehabilitation, involving active movement of the body, attention and quick reactions (Rand, Kizony & Weiss, 2004). The environments implemented for this tool cannot be graded according to low functioning patients or for specific therapies. TheraGames is another video capture VR system to enhance interaction of elderly people with rehabilitative systems thanks to highly motivating game setting (Kizony, Weiss, Shahar & Rand, 2006).

An unusual interactive system is also offered by two commercial platforms, Nintendo DS® and Nintendo Wii® (http://www.touchgenerations.com), which permits the manipulation of virtual objects displayed on the screen thanks to intuitive gestures performed with a physical tool (a pen in the former, a remote control in the latter). Several training programs exploit the properties of these interfaces. The DS is also a portable platform, permitting users to perform cognitive training tasks designed according to scientific results from neuroscience anywhere (Kawashima et al., 2005). A study by Korczyn, Peretz, Aharonson & Giladi (2007) on another commercial product for computer-based cognitive training, called MindFit™, shows that the training can improve cognitive performance more than classic computer games.

The PositScience Corporation (http://www.positscience.com) offers a computer-based Brain Fitness Program™ and provides scientific support to the exercises proposed, like the study by Mahncke et al. (2006). The study reports that intensive plasticity-engaging training can improve memory in healthy older adults. A web-based, game-like training program called Lumosity™ (http://www.lumosity.org) has been used in two studies, involving different tasks for different functions (visual attention in Scanlon, Drescher & Sarkar, 2007; working memory in Sarkar, Drescher & Scanlon, 2007). The evidence collected suggests that specific experimental and clinical tasks can be implemented in games to accomplish function-specific trainings. For instance, Green and Bavelier (2007) observed that action games seem to be able to alter the spatial resolution of vision, enhancing visual acuity.
Finally, the design and usability issues of these technologies are not less important than their direct training functions (Gamberini, Alcaniz, Barresi, Fabregat, Ibanez, & Prontu, 2006). Whitcomb (1990) reviewed several games to find the issues limiting elderly people's use of electronic entertainment and identified the small dimensions of visual objects, the requests of low reaction times, inappropriate sound effects as responsible for diminishing the satisfaction and involvement of older adults. Åstrand (2006) adopted an iterative design cycle approach to develop ACTIONPET, a network word game for older people (based on the ACTION project for healthcare (Assisting Carers using Telematics Interventions to meet Older persons' Needs). The users were involved during the design process. Khoo and Cheok (2006) introduced a mixed-reality system named "Age Invaders" as a context for intergenerational gaming between grandparents and kids, with remote monitoring by the parents. Age Invaders is a social, physical, family videogame derived from the famous Space Invader arcade game (www.spaceinvader.de) that uses a 3D online virtual interface. The system consists of a platform for real-time playing, with wireless tools and an unconventional floor display. Players have to move following a predetermined path; the tracking system gives the input for the synchronization of the real and virtual scene to create the shared real time scenario. Design solutions to meet the specific needs of elderly users, which should be a constant concern (Heller, Jorge, & Guedj, 2001; Jorge, 2001), are included: the game's parameters of difficulty and speed adjust to the age of the participant so that the potential disadvantages of elderly people is compensated; for example, rockets of grandparents are faster, in order to compensate for possible motor disadvantages.

**Dealing With Affective and Social Diseases**

As a consequence of health problems related to aging, some psychological and social problems can emerge as well. When cognitive and physical deficits confine elderly people at home, they also start to feel isolated from their relatives, companions and public life. Assistive Technologies could intervene to facilitate contact with caregivers and family. We will concentrate on the so-called Comfort Systems (Nehmer, Karshmer, Becker, & Lamm, 2006), namely those technologies that are designed to increase physical and social well being of older adults. They can be used as an alternative or as an integration of more conventional treatments of many psychological diseases, such as phobias or depression. We selected some examples, where technologies offer a means to deal with psychological aspects of physical diseases, or with social isolation.

**Physical Diseases And Their Psychological Consequences**

The first example refers to breast cancer and tries to relieve patients from some of the psychological consequences of chemotherapy. Breast cancer affects 180,000 women each year, 84% being older women. Schneider, Ellis, Coombs, Shonkwiler and Folsom (2003) assessed the potential of virtual reality as a means to distract patients from the stress generated by chemotherapy. They used a head-mounted display to show images from three possible game-scenarios: 'Oceans Below®', 'A World of Art®' and 'Titanic: Adventure Out of Time®'. Before and after the treatment, researchers administered the Symptom Distress Scale, the Revised Piper Fatigue Scale and the State Anxiety Inventory (one pre-test and two post-test measures). The results showed a significant decrease in the values of the State Anxiety Inventory; all old women involved in the research declared that they would use Virtual Reality during chemotherapy treatment again.

Another physical disease, chronic pain, can be dealt with psychologically: pain generates a negative loop in which the decrease of physical activity causes an augmentation in pain level when activity is undertaken. The research conducted by Tse, Pun and Benzie (2005) demonstrated that through a non-pharmacological treatment (i.e. the presentation of affective images) the levels of pain experienced by elderly users diminished, while cooperation and participation during and after treatment sessions increased.
Falls and fractures constitute a typical source of trouble in the everyday life of elderly people. In addition to that, Giotakos, Tsirgogianni & Tarnanas (2007) report that about 20% to 60% of them are afraid of falling (Howland, Lachman, Peterson, Cote, Kasten & Jette, 1998) and about 20% to 55% decrease their activity as a consequence of that fear (Fletcher & Hired, 2004) with negative consequence in terms of independence and quality of life (Cumming, Salked, Thomas, & Szonyi, 2000). Giotakos, Tsirgogianni and Tarnanas (2007) used a virtual reality exposure scenario (VRET) to convey a sense of control over risks and fear of falling. The VR represented Kozani city and its surroundings, through which participants could move by walking on a treadmill and wearing pressure-sensor shoes. Their task was to go shopping in the city; the therapist could add some obstacles on the path, and patients could practice their ability to generate appropriate responses in dangerous situations. The effectiveness of the treatment was evaluated by administering the Falls Efficacy Scale-International (FES-I), the Activities-specific Balance Confidence scale (ABC) and the Physiological Profile Assessment (PPA). Preliminary results showed that fear of falling, related to a traumatic hip fracture experience, was highly reduced by the use of virtual reality exposure scenarios, with 98% success.

With retirement and the ensuing increase of free time, elderly people can engage in several leisure activities. Reid and Hirji (2003) report that leisure improves the quality of life (Suto, 1998) and serves as a coping strategy to face stress (Kleiber, Hutchinson & Williams, 2002). Yet, the engagement of elderly people in leisure activities declines, probably because of age-related physical and social constraints; and this decline is more evident for stroke survivors, due to depression or visual/motor dysfunctions (Drummond & Walker, 1996 in Reid & Hirji, 2003). The Virtual reality system called 'Mandala gesture Xtreme Virtual Reality' was used in a study to affect stroke survivors’ “volition”, namely their motivation, enjoyment and satisfaction (Kielhofner & Forsyth, 1997 in Reid & Hirji, 2003). The system provided users with real life experiences, such as playing sports or games. The Volitional Questionnaire (de la Heras, Geist, & Kielhofner, 1998) was administered to measure spontaneity, involvement, hesitancy or passivity in a series of behavioral indicators, such as “seeking challenges” or “showing curiosity”. A global measure of satisfaction with life (Satisfaction with Life Scale; Diener, Lemmons, Larsens & Griffin, 1985), a test to screen cognitive disturbance (Mini-Mental State Exam; Folstein, Folstein & McHugh, 1985) and a measure of depression (Centre of Epidemiological Studies Depression Scales; Radloff, 1977) were also deployed. Results showed that the system involves people in a ‘volitional’ way; scores in the Volitional Questionnaire were related to those of life satisfaction and depression.

Social isolation

Some technological applications have been developed in recent years in order to face social isolation, providing tools to maintain or reinforce elderly people’s social network. For example, ‘Nostalgia’ is a system to listen music and news through a tangible interface, which proved capable of facilitating social contacts between elderly users and stimulating their affective experience (Nilsson, Johansson, & Hakansson, 2003). Morris (2005) proposed a system to provide elderly users with continuous information on their network of social contacts; the visualization was also accessible to caregivers, who then had the opportunity to observe and monitor their relatives’ social status and intervene in cases of isolation. The results of a study with this system showed that the exposure to the social networks display increased social engagement, and made older people more active in maintaining social ties. Moreover, the visualization enhanced contacts within the family and helped caregivers to cope with their responsibilities.

Dancing is not only an entertainment but also a physical activity useful for maintaining or promoting health; it can increase sociability, provide companionship and emotional support, and act as entertainment for both dancers and people watching them. The Human-Computer Interaction Institute at Carnegie Mellon has developed an augmented dancing environment, ‘DanceAlong’, which enables aged people to dance with the protagonists of well-known movies (Keyani, Hsieh, Mutlu, Easterday & Forlizzi, 2005). Users choose a dance scene from a classic movie; the scene is then projected on a large screen, and users join the dancers alone or in a group with other users.

Social involvement, amusement and physical activity are also promoted by playing together. The Age Invaders game
already mentioned above is worth being considered also from this perspective (Khoo & Cheok, 2006). In addition to the physical and cognitive training already described, it is meant to be an intergenerational game involving young people, elderly people and adults. It reinforces interaction and ties among family, providing social support: children interact with grandparents in the physical media space, while parents participate from a distance via Internet connection.

**How Videogames Can Help the Elderly Stay Active: The Eldergames Project**

ElderGames (http://www.eldergames.eu/) is an EU funded project in which partners are designing, developing and ergonomically testing an interactive-play board (ElderGames). It represents a great opportunity to scientifically explore how emerging advances in ICT can be adapted, applied and combined with play activities to improve cognitive skills and quality of life (affective, physiological and social) in elderly people. Eldergames prototypes are meant to help counter the natural physical and cognitive decline of elderly people by having them engaged in individual and social game activities, and by using a low-budget mixed reality system that can make ICT usage more natural, in accordance with current trends analyzed above (Gamberini et al, 2006).

The project involves geriatric and gerontologist experts, universities, and specialists in elderly care, as well as companies specialized in the development of commercial systems. Several categories of professionals (across Spain, the United Kingdom and Norway) have been involved to exploit a large and various field of experience: ICT experts, occupational therapists, social educators, medical doctors, psychologists, nurses, social workers, physiotherapists, ergonomists, and sociologists.

Eldergames includes problem-solving exercises, performance measurements, psychomotor activities, and readapted classic games such as quizzes, puzzles and riddles to provide cognitive training and fun simultaneously; they are aimed to enhance selective attention, divided attention, short-term memory, categorization, problem solving, fine psychomotor skills, perceptual functions, language and calculation. A set of tests is also being incorporated or adapted to the platform, such as the Stroop Test and Trail Making Test (Strauss, Sherman & Spreen, 2006).

Eldergames prototypes will also offer a communication environment that enhances involvement; multiple players can participate in the game session, both by sitting around the same table, or by connecting to the game table by way of a normal Internet connection. Remote players can be of a different nationality than those sitting around the table, thanks to a communication system that tries to overcome linguistic differences.

**Eldergames: the games module**

The games module is one of the main components of the Eldergames device, and is divided into two sections: the Eldergames zone, hosting the main game, and the mini-games zone, a collection of different cognitive games and exercises, which also allows psychological experts to personalize the session for specific needs. In the Eldergames zone, up to four players face a classic card pairing memo game. Success or failure in the game involves bonuses and penalties: when they succeed in a round of the Memo game, users gain extra time to play; incorrect responses, instead, activate a mini-game, where cognitive abilities chosen by therapists according to a stimulation program are practiced. If the mini-game is finished unsuccessfully, then a penalty is assigned. The process continues until the Memo game ends. After the Memo session, users resolve, cooperatively or competitively, another quiz game, in which the time necessary for the solution is based on success in the previous Memo game. Players collecting the greatest number of cards at the end of the entire session win the game; a scoreboard with the results is also presented.

**Interfacing elderly: a mixed environment on a comfortable table-top solution**

The physical support of the Eldergames digital environment is an ergonomic table-top incorporating a 3D interactive-play platform working by way of a camera-based visual pattern recognition system. Table-top solutions to structure the interaction between humans and computers are currently growing, given the ease with which they afford the col-
Collaboration of a small group of users on the same mediated activity. TeleTable, for instance, is a similar technological application developed to improve social life in the elderly (Donaldson, Evnin & Saxena, 2005). TeleTable is composed of several parts: a touch-screen digital surface, which enables the user to sort and organize items by means of a stylus or hands; a mobile container for physical-digital information, called Pitara; a Placeholder through which users can associate digital media of the TeleTable with physical objects contained in Pitara; and a specialized operating system and hardware, which permits the table to receive input from other devices. Users can play games, like board or card games, write digital letters with the help of a stylus and of a visual address book, and collect, store and manage photos in a natural way in order to share them with others. Another example of a tabletop application for elderly people was proposed by Apted, Kay and Quigley (2006), and consisted of a multi-user, multi-touch, gestural, photograph sharing application, called ’SharPic’. It allows the user to use both hands to move, rotate and resize images over the table, as well as capturing and deleting them. The validation of SharPic showed that elderly people took twice as long to complete exercises as younger users; however, they succeeded in completion, and understood the interface and manipulation concepts well.

The concept design of the Eldergames interface adds the possibility of mixed reality systems to an ergonomic and comfortable tabletop solution; it deploys a 3D pattern recognition system allowing participants to interact both with virtual and with real objects in a more natural way. Players access the digital content with objects that belong to their everyday experience, such as a pen or a card or simply their hands. Intercultural exchange is supported by using non-verbal communication based on icons, symbols, mathematics, pictures, visual geometry and metaphors.

In the next step of the project, the prototype under development, after an in-depth ergonomic and accessibility evaluation, will be tested in Northern, Central and Southern Europe in places where the elderly habitually spend much of their free time. The goal is to measure the effectiveness of the games and exercises proposed, and the overall satisfaction with the prototype of elderly users in different contexts.

Conclusions

Our aging society is launching a serious challenge that opens new possibilities for research and development in usable, empowering and effective technologies. In several contexts, ICTs allow scientists to reach and take care of elderly people more effectively than by providing personal human assistance. A range of novel solutions for elderly cognitive training is reviewed by Rebok, Carlson and Langbaum (2007), where these technologies emerge as a valuable alternative to classic ways of stimulating the users' cognitive processes.

In addition, communication technologies allow users to overcome physical impairments that limit participation in social life. All of these applications are just starting to be explored, posing scientific questions about the precise cognitive process stimulated by a certain kind of game, on game categorizations, on the advantage of collective training over individual training, on the long-term motivating effects of games, on the changing abilities and needs of new cohorts of aging populations, and on the tradeoff between age-specific tools and intergenerational integration. Finally, a bottleneck is created by the extent to which interfaces go further in the direction of natural interaction; for elderly people, who may not be motivated to learn completely new usage practices, to memorize complex commands and to deal with alien interaction devices, natural interfaces are not just a fancy product, they can make a real difference in defining whether ICTs are persistently adopted or not in their daily life.

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