An ICT-mediated social network in support of successful ageing

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S. Ballesteros, P. Toril, J. Mayas, J.M. Reales, J.A. Waterworth. An ICT-mediated social network in support of successful ageing. Gerontechnology 2014;13(1):37-46 doi:10.4017/gt.2014.13.1.007.00 **Background** The idea is that an active lifestyle rich in social interactions and active engagement may mitigate age-related decline and reduce healthcare costs. The main aim of the AGNES project was to investigate the potential of new Information and Communication Technology (ICT) environments to help maintain the independence and wellbeing of elders. The innovative applications developed in this research project could have wide application for a large number of older adults living alone. **Method** We used a web-based social network platform, enhanced with devices to detect users´ states and collect activity data. The effectiveness of the ICT-based solution was assessed throughout the project with user and control groups in Spain, Sweden and Greece. User interviews and psychological testing were conducted at the beginning of the project and after a year of deployment of the equipment. Both groups completed the same assessment protocol. **Results & discussion** We found that only the user group showed an improvement from pretest to posttest in the affective dimension of the wellbeing SPF-IL scale. This dimension relates to the degree of confidence, social acceptance, and level of satisfaction with the people around them. Exploring new ways to maintain the cognitive and functional state of older users is today a critical issue, for individuals, their families, and for whole societies. The study suggests the potential of AGNES to improve older adults' perceived wellbeing. However, more research may be needed to determine if AGNES is a tool to maintain mental health and independent living in older adults, especially those with MCI.

Keywords: ageing, cognitive training, ICT, social networking, wellbeing

Developed nations are experiencing large increases in the number of older adults due to falling birth rates and increased longevity[1]. Social isolation in old age has been associated with higher risk of developing depression, and anxiety disorders such as loneliness and depressive pathology may have an effect of diminishing wellbeing in middle-aged and later in life[2]. Importantly, the risk of Alzheimer´s disease is more than double in socially isolated persons compared with more socially engaged older adults[3,4]. In sum, there is an inverse relationship between the strength of social networks and the incidence of depression, cognitive decline and dementia among older adults[5]. The rapid growth of the number of ageing persons has expanded greatly the public interest in aging research and how technology can help improve the quality of life for older adults, by training them to use existing technology, or by developing new products adapted to their needs[6].

AGNES[7] is a European research project funded jointly by the European Union and national bodies through the Ambient Assisted Living Joint Programme (AAL JP) conducted between September 2009 and December 2012. The main aim of AGNES was to investigate the potential of technologically-mediated social networks for improving the quality of life of older adults living at home. The AGNES social network with its dedicated sensing and interaction methods takes an active role to stimulate social interactions. The idea that guided the project was to develop technology that fitted their needs in order to allow older adults to live in their own homes longer, as well as reducing healthcare costs. This is of vital importance considering that the number of older adults living in our society is increasing substantially[8,9].

In the following sections, we first review the main behavioral and brain changes that occur with

aging and the potential role of new Information and Communication Technologies (ICT) environments to increase cognitive stimulation among older adults. Then, we describe the AGNES ICT environment, and summarize the results of evaluating the effects of the system on the mental status and wellbeing of the users compared with those of a limited-contact control group.

Behavioral and brain changes

Current research in ageing (including cross-sectional as well as longitudinal studies) has found older age to be a time of decline, stability, and even growth[10-15]. More specifically, declines occur with age in speed of processing, executive control functions and episodic memory (related to the conscious retrieval of facts and episodes). In contrast, other cognitive processes including world knowledge and verbal abilities are spared or even show improvement across lifespan[13]. Episodic memory, a function that declines with aging, was spared in professionally active and well-educated older adults[16]. A cognitive function that remains relatively unaffected by age is implicit memory, an involuntary type of memory that is preserved not only in healthy older adults[17-22] but also in Alzheimer´s disease (AD) patients[20,22]. In contrast, episodic memory of AD patients is highly impaired compared to young adults and healthy older adults[20]. These findings suggest that the underlying occipital brain structures that support implicit memory remain relatively intact in old age while episodic memory that relies on the hippocampus and medial temporal lobe structures deteriorates[23-25]. The spared implicit memory for objects presented to touch gave us the idea of developing the tangible interaction objects used in the AGNES project.

At the brain level, structural imaging studies have revealed substantial age-related grey and white matter shrinkages especially in anterior brain regions (lateral prefrontal cortex, hippocampus) with minimal reduction in the occipital region[26]. Functional imaging research has shown a posterior-anterior shift and a reduction in brain asymmetry in older adults. These changes suggest a compensatory frontal recruitment for deficits that occur with age[11]. Recent electrophysiological[19] and event-related functional magnetic resonance imaging (fMRI)[27] studies suggest that, despite preserved behavioral implicit memory, the neural signatures of neural priming are altered. The findings suggest that age-invariant behavioral implicit memory resulted from a more sustained neural processing of the stimuli in older adults as a sort of compensatory neural activity, which has been interpreted as a form of adaptation. Older adults display additional compensatory frontal recruitment compared to young adults while performing implicit memory tasks[10,19,27].

Ageing is best considered as a dynamic set of gains and losses rather than as a declining process that will inevitably give rise to systematic cognitive deficits[28,29]. The ageing brain understood as a dynamic system that tries to maintain cognitive function by developing complementary, alternative neural circuits to achieve a particular cognitive goal[11]. Recent electrophysiological studies suggest that despite similar behavioral performance of young and older adults in an 'old-new' recognition memory task[30] and in an implicit speeded detection task[31], older adults recruited additional neural resources compared to young adults, possibly as a way of compensation. Neuroplasticity has been demonstrated in animals[32,33] and more recently in human studies[26,34-36], suggesting that the older brain has the potential to reorganize itself in response to environmental stimulation. Based on the idea of neuroplasticity, different types of interventions have attempted to ameliorate cognitive and functional decline by training cognitive skills[37], promoting physical activity[38-41], training older adults with video games[42-45], or strengthening social networking and developing a new system for multimodal social interaction as in the present study.

Given the demographic change occurring in industrialized societies, public and scientific interest has focused on factors that can help to reduce the negative effects of cognitive decline in older adults. Although recent technological development has mostly ignored older adults, gerontechnology is trying to harmonize the increasing proportion of older adults and the technological development of products and services dedicated to them[46]. As many cognitive processes decline early in the lifetime, an important intervention issue is to find ways of maintaining an intellectually engaged as well as a physically and socially active lifestyle and to investigate its effectiveness in promoting successful aging[47,48]. A critical research subject for cognitive aging and wellbeing studies is investigating ways to improve or maintain cognitive and functional status in old age.

A growing body of evidence suggests the potential role of new interactive technologies to promote and maintain independent living and wellbeing in older adults[7,49-52]. Theoretically, we rely on the Social Production Function (SPF) theory[53] to assess wellbeing. The SPF theory identifies two ultimate goals that humans try to optimize. These two goals are physical wellbeing and social wellbeing. The theory also proposes five instrumental goals by which these could be achieved. The core of SPF theory is that people choose instrumental goals so as to optimize the

production of their wellbeing. The five goals or dimensions of subjective wellbeing according to SPF are: (i) affection, (ii) behavioral confirmation, (iii) status, (iv) comfort and (v) stimulation. 'Affection' relates to the love that one gets for who one is regardless of one´s assets or actions. It relates to the degree of confidence, social acceptance, and level of satisfaction with the people around one. 'Behavioral confirmation' refers to the feeling of having done the right thing in the eyes of others, the self-perception of doing good things, to be a good person, useful to others and contributing to a common goal. 'Status' means social approval. It assesses the feeling of being treated with respect, being independent, self-realization, achievement as compared to others, influence, and reputation. 'Comfort' means the absence of deleterious stimuli (e.g., absence of pain, thirst, hunger, or cold). It is conceptualized as the absence of feelings of discomfort, such as pain or stress. Finally, 'Stimulation' refers to mental and physical activation that produces arousal including sensory and mental stimulation, as well as physical effort.

AGNES: An ICT home-environment

AGNES is a novel ICT solution aimed at providing older adults with technological support and social connectivity to keep them in touch with family and friends, avoiding isolation by promoting connectivity and social inclusion. Since the beginning of the project, we have been in close contact and have been listening to the older adult participants with the idea of making the technology suitable for them. AGNES comprises a sensor-equipped home system, specific web services and dedicated web interfaces[52]. Several input/output (I/O) devices serve different modalities (*Figure 1*).

The main aim of AGNES was to facilitate social inclusion of the older adult with their families, friends, and other significant people, which requires both sides to become socially active – the older adult as well as the caring persons. AGNES established bidirectional communication that informed the older adult about activities, states and news on the network as well as passing on information to the network on the states, situations and activities of the older adult. To this aim, the system displays information from the network in the user's home as well as collecting information from the older adult to be relayed to the social network. 'Modern families'[54] was the social network used in AGNES (*Figure 2*). As they were partners in the project we had the opportunity to adjust the interface and functionality of the platform to the user's needs and requirements. A salient feature of the AGNES approach was intensive user involvement[50-52]. Users were involved in all development stages from the very beginning of the project.

Three complementary instruments that are briefly described below were used for relaying useful information from the network to the older person:
(i) A conventional PC to give the older user access to the web front-end of the social network. The user can look up information about others, read and write stories, view and create pictures or videos, produce or listen to audio notes, play games, and use further features of the whole web site of modernfamilies.net.
(ii) A mobile frontend provides (reduced) content from the 'Modern families' network. An android-based tablet device shows selected information of the network, such as photos, notes, reminders about birthdays and so on. Through this device the user can easily access information from the network, even when not at home and also contact people via the network. Upon request of the older adult, the mobile device can also estimate the person's geographic location and guide her home, a feature many of our users asked for.
(iii) Ambient displays located in the user's living room. These displays served to inform the older person when information was received from the network. Two types of ambient displays were designed: (a) a curtain that was moved by small fans and illuminated by three coloured lamps (*Figure 3a*); and

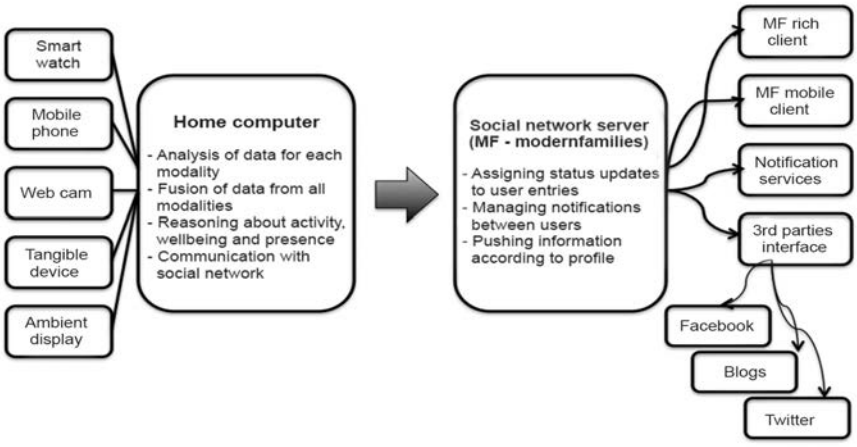

Figure 1. The AGNES system architecture; MF=Modern Families social network[52]

Figure 2. The AGNES interface screen; Photos and names appearing on the screen are fake and come from the public Modern Families website

(b) a bulb-shaped multicolour lamp with added sound installed in a user's home (*Figure 3b*).

The ambient display informs the older person about changes on the network or reminders (even when not actively looking for information). The objective of the ambient display is to present information to the older adult by making use of peripheral perception that may be experienced as less obtrusive.

To pass information to the network the older adult uses the PC to create content (news, histories, etc.) on modernfamilies.net. The PC is also equipped with a camera to observe the person's face when she is in the room. From the facial features it may be possible to infer the user´s basic emotional state. Moreover, from the activities in the room covered by the camera, the system is able to infer the activity level of the older person, and his/her (non)presence. The emotion analyzer is an experimental prototype system, still not validated, that used a classifier developed by AGNES partner CanControls[55]. The Emotion Analyzer tries to classify the basic emotions and maps them onto three elementary states: happy, unhappy and neutral.

Various tangible objects were also developed as another form of direct input device. The basic idea behind the devices was to allow the user

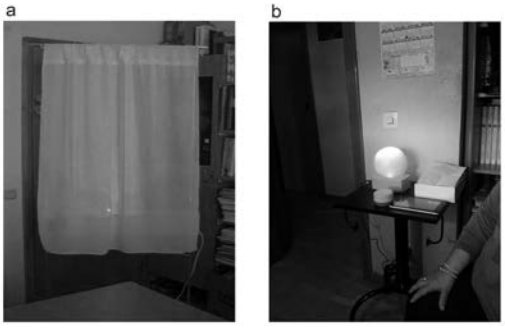

Figure 3. The set-up at home; (a) The illuminated curtain; (b) The multicolour lamp

to communicate with the network directly just by touching or tapping an object. The initial tangible object was a cylindrical box equipped with motion sensors (*Figure 4*). This small device allows the person to interact with the network without having to use the computer itself. For instance, knocking on the device three times is interpreted by the system as a request for contact, with a significant person being informed by email. Heavy knocking the device is interpreted as an urgent contact request.

The system also uses a mobile phone as an information source. Our users agreed to use a mobile phone when leaving the home and this information allows the network to know when the person is at home and when not. Furthermore, the smartphones used in the AGNES project come equipped with acceleration sensors that could be used to infer bodily activities of the person outside the home[52].

In summary, the AGNES home-based system was designed to provide users with different interaction possibilities with their social network. The older adult could share information with chosen family and friends via the online social network. The network could also get basic information on the well-being of the cared-for person even if that person were not actively using the ICT system, and convey that to nominated others such as carers, family members or friends. Also, these others could share information with the older adult, including at times when physical visits were not possible.

The present study sought to investigate the effectiveness of AGNES in improving general cognition and wellbeing of older adults living at home. We hypothesized that the AGNES group would have increases in cognition and wellbeing at post-test. Pre- to post-test changes were not expected on depression or in the performance of daily living activities that were assessed for screening purposes. Nor did we expect changes in daily living activities, as the participants in the present study were all healthy older adults that lived independently at home.

Method

Participants

Fifty-seven older adult volunteers (age range 65 to 85 years-of-age) from Spain, Sweden and Greece participated in the study. After signing their informed consent, they were randomly assigned to either the experimental group (n=28) or the limited-contact control group (n=27) before being evaluated. Forty-one older adults completed the study. All participants lived active independent lives. All reported being right-handed, and were free of neurological or psychiatric disorders. The

Figure 4. A person tapping on the top of the first tangible object prototype

users (experimental) group included 25 participants (9 males, 16 females) from 65 to 80 years of age (mean age=74). The limited-contact control group was composed of 16 older adults (5 males, 11 females) with ages from 68 and 85 years of age (mean age=75 years). Participants in this group did not use the AGNES technology but met with the research team several times during the project to talk and have coffee. All the participants signed an inform consent form. The local institutional Ethical Committees approved the project.

Procedures

Interviews and psychological tests were conducted in the quiet environment of the users' homes. All the participants responded to semi-structured interviews and psychological tests. Interview questions included their habits, contacts with their relatives and friends, the type of technology that they use and what would be the technology of the future. The interviews and testing lasted about an hour and were conducted before the placement of the basic equipment there. The control group did not receive the equipment but the interviews and tests were also carried out in their homes and they met several times with the research team. The second assessment was conducted a year later after the deployment of first AGNES prototype to the experimental group. The control group was also assessed at the same time.

After conducting the initial assessment (pre-test) of all the participants in both groups, participants in the user (experimental) group were provided with a basic ICT platform consisting of a PC computer and the web-based social network, Modern Families[54]. The users were individually trained at home on how to use the equipment and the social network. Some of the participants had never used a computer before and required a long training period (approximately 4-5 hours). Users were continuously involved in AGNES from the beginning of the project and participated actively in all its phases. Users and close family members were interviewed at different times. They provided qualitative data, impressions and opinions that were taken into account by the technical partners involved in AGNES. Their involvement included evaluating implemented components and the developed prototype system, supporting the validity of our approach to find a good fit with the actual needs of our user group. At an early stage of the development, our partners from Spain, Greece and Sweden evaluated the first prototypes by qualitative interviews and in focus groups[51].

To evaluate the effect of using AGNES, we assessed the psychological and social functioning of users and control participants. The basic battery included the Mini Mental State Examination test (MMSE)[56], a widely used screening test for the detection of cognitive impairment. The MMSE contains memory, orientation and arithmetic items. A score equal or smaller than 25 suggests cognitive impairment. Separate 2 (group: experimental, control) x 2 (session: pre-test, post-test) mixed analysis of variance (ANOVA) were performed with scores from the different tests with group as the between-subjects factor and session as the within-subjects factor.

For the detection of depression, both groups were assessed with the short version (15 items) of the Geriatric Depression Scale (GDS)[57]. A score greater than 5 suggests depression. The Barthel Activities of Daily Living (ADL) Index[58] was used to assess their ability to perform daily living activities. A higher score suggests a greater degree of independence in the older adult. The maximum possible score was 100 points. We did not expect differences between participants in this measure because both groups lived independently.

Finally, we used the SPF-IL scale based on the Social Production Function (SPF) theory[53] to assess subjective wellbeing. As mentioned above, the SPF theory proposes that the dimensions of subjective wellbeing are affection, behavioral confirmation, status, comfort and stimulation. We assessed the dimensions of subjective wellbeing with the 15-item short version of the SPF-IL Scale. The maximum possible score in each dimension was 12. A 2x2 mixed repeated measures ANOVA was conducted for the results of each of the 5 subscales of the SPF-IL with group as the between-subjects factor and session as the within-subjects factor. For the 'Assertivity' and 'Comfort' subscales we explored the performance of each

group separately in an independent analyses for each group using Bonferroni correction.

In all tests the confidence limit was set at 0.05.

Results

Table 1 summarizes the results of the first assessment session (pre-test) conducted at the beginning of AGNES, and the second assessment session (post-test) conducted approximately a year later. The results obtained suggest that the deployment of the AGNES ICT-based solution had positive effects on wellbeing.

Mini-Mental State Examination (MMSE)

The ANOVA conducted with group and session showed that neither the main effect of group ($F(1,39)=2.94$, $MSE=1.67$, $p>0.05$, $\eta_p^2=0.07$) nor the main effect of session ($F(1,39)=2.06$, $MSE=1.55$, $p>0.05$, $\eta_p^2=0.05$) nor the two-way interaction group x session ($F(1,39)=0.03$, $MSE=1.55$, $p>0.05$, $\eta_p^2=0.09$) were statistically significant. Both groups of participants performed similarly at pre- and post-test (*Table 1*).

Wellbeing (SPF-IL Scale)

Only one subscale of the SPF-IL showed the expected interaction of group and session, with 'Affection' showing differential positive gains for the AGNES group compared to the control group. In 'Affection', results were non-significant for group ($F(1,37)=0.07$, $MSE=4.35$, $p>0.05$, $\eta2=0.02$), but showed a significant main effect of session ($F(1,37)=4.84$, $MSE=1.87$, $p<0.05$, $\eta2=0.34$) as well as a significant two-way interaction group x session ($F(1,37)=4.84$, $MSE=1.87$, $p<0.05$, $\eta^2=0.34$). Planned comparisons showed that the experimental group improved at post-test (8.9 and 10.2 at pre- and post-test, respectively) while the control group did not (9.35 and 9.50, respectively).

For all other scales the interaction was not significant suggesting that the AGNES intervention did not differentially benefit the experimental group. The trends were in the expected direction for the other SPF scales. Because the study is underpowered, we chose to analyze trends where interactions were not significant. Replication will be necessary to assess whether the trends are meaningful.

In the 'Assertivity' subscale of SPF-IL, the main effect of group was not significant ($F(1,37)=0.84$, $MSE=3.1$, $p>0.05$, $\eta^2=0.02$) but the main effect of session was statistically significant ($F(1,37)=4.2$, $MSE=1.5$, $p<0.05$, $\eta^2=0.1$). The interaction group x session was not significant ($F(1,37)=0.39$, $MSE=1.5$, $p>0.05$, $\eta^2=0.01$). After Bonferroni correction independent analyses for each group showed that the experimental group improved significantly at post-test (9.2 and 10 for pre -and post-test, respectively) but not the control group (9 and 9.4 for pre- post-test, respectively).

In the 'Status' subscale of SPF-IL, neither the main effect of group ($F(1,37)=0.08$, $MSE=2.84$, $p>0.05$, $\eta^2=0.02$) nor session ($F(1,37)=1.3$, $MSE=1.58$, $p>0.05$, $\eta^2=0.03$), nor the interaction group x session were statistically significant ($F(1,37)=1.3$, $MSE=1.58$, $p>0.05$, $\eta^2=0.03$).

In the 'Comfort' subscale of SPF-IL, the main effect of group was not significant ($F(1,37)=0.22$, $MSE=5.2$, $p>0.05$, $\eta^2=0.64$) but session was almost significant ($F(1,37)=3.38$, $MSE=1.8$, $p=0.07$, $\eta^2=0.08$). Separated analysis of both groups (using Bonferroni correction) showed that only the experimental group improved at post-test (8.1 and 9.1 for pre- and post-test, respectively) while control group did not (8.7 and 9, respectively). The two-way interaction ($F(1,37)=1.36$, $MSE=1.8$, $p>0.05$, $\eta^2=0.05$] was not statistically significant.

Finally, in the 'Stimulation' subscale we found a main effect of group ($F(1,37)=14.85$, $MSE=2.1$, $p<0.05$, $\eta^2=0.28$), suggesting that the experimental group scored higher than the control group in this subscale at pre- and post-test. No other main effect or interaction was significant.

As expected, in the GDS and the Barthel index both groups obtained normal scores and there were no differences between groups at pre-test and post-test.

Table 1. Pre- and post-training performance on psychological measures and wellbeing dimensions for the experimental and control groups; MMSE=Mini-Mental State Examination test; GDS=Geriatric Depression Scale; SPF-IL=Wellbeing

Scales		Mean (SD)			
		Experimental		Control	
		Pre-test	Post-test	Pre-test	Post-test
MMSE		28.28 (1.57)	28.84 (1.31)	28.93 (0.93)	29.19 (0.91)
GDS		2.04 (1.97)	1.36 (1.60)	2.64 (2.65)	3.00 (2.77)
SPF-IL	Affection	8.92 (1.93)	10.20 (1.44)	9.35 (2.02)	9.50 (1.70)
	Behavioral confirmation	9.20 (1.73)	10.00 (1.38)	9.00 (1.75)	9.43 (1.16)
	Status	7.16 (1.67)	7.84 (1.46)	7.86 (1.29)	7.86 (1.35)
	Comfort	8.16 (1.75)	9.12 (2.09)	8.78 (1.48)	9.00 (2.04)
	Stimulation	9.00 (1.41)	8.96 (1.46)	7.57 (1.16)	7.71 (1.27)

Discussion

Physical and cognitive declines occurring with age compromise the older person´s capacity to live independently[2-5]. Behavioral studies have shown that ageing negatively affects many cognitive functions[13] while other functions are spared[13,17,18,]. Some theories identify wellbeing with social interaction, purpose of life, self-acceptance, and autonomy[59-62]. Overall, wellbeing suggests a positive attitude towards life. A major objective of AGNES was to improve the perceived wellbeing of older adults. In the development of the AGNES technology for older adults, we followed a user-centered innovation approach[61]. The technology implemented in AGNES had the needs, opinions, and requirements of the elders as the focal point from the beginning of the study[63]. The project was conducted to respond to the needs of stimulation and social contact of older adults by providing a technological means for keeping them connected to significant others. The system used ambient displays, tangible interfaces, as well as wearable devices for interaction with the network. Other sensors were developed for generating information on the person to be sent to their close relatives or nominated other people[49-52].

To evaluate the effects of using the AGNES system and devices on our aging users, we assessed the psychological and social functioning of a group of users and compared their results with those of a limited-contact control group at the start of the project and after a year of the deployment of AGNES technology at the user´s home. Users and controls were normal older adults living independently at home. They both showed adequate and similar performance at pre-test. Their cognitive performance assessed with the MMSE was almost at ceiling at pre-test and perhaps this was why the user group did not show a significant improvement at post-test. It is important to highlight that in the current study cognition was only assessed rather crudely and generally with the MMSE.

Interestingly, we found that only the user group showed an improvement from pre-test to post-test on the 'Affection' dimension of the Wellbeing SPF-IL scale. No other subscales appeared to be affected by AGNES. The use of the whole version of the scale would provide sharper results in future studies. This dimension relates to the degree of confidence, social acceptance and their level of satisfaction with the people around them. It is worth noting that our wellbeing findings are similar to the affect-centred results of a recent cross-sectional study conducted by Allaire et al.[64] to investigate whether older adults who play digital games perform better than those who did not play games on certain variables of successful ageing. The authors concluded that their results suggest that the positive therapeutic effects of playing games may go beyond improving cognition and improve socio-emotional outcomes as well.

As expected, the results also showed that neither the depression state of our participants nor their capacity to perform daily living activities changed after the intervention. It is important to note that neither the user nor the control group suffered from depression at pre-test. The GDS was used as a screening test. All the participants were living independently in their own homes and were able to perform their daily living activities.

Limitations of the current study

One limitation was the nature of the limited-contact control group. This type of control group accounts for retest effects, but does not control for expectation/placebo effects, the effect of social contact, or the effect of demand characteristics[65].

Our participants were healthy older adults. It would be interesting in future studies to investigate the effects of our ICT system on older adults with mild cognitive impaired (MCI) and in older adults in the first stage of dementia. These new studies would show whether AGNES produces positive effects in general cognition, wellbeing and daily living activities of those older adults. Furthermore, it would be important to investigate the effectiveness of the AGNES technology by including a greater variety of more sensitive psychological tests to explore more deeply possible cognitive impacts of the AGNES system on the older participants. Moreover, a large-scale replication would be needed to confirm the beneficial effects of AGNES on wellbeing and successful ageing. This would allow the gathering of more detailed knowledge on the cognitive and wellbeing benefits of using AGNES.

Conclusion

To conclude, the AGNES system was an attempt to develop new technology that fits the needs of older persons living at home. We found that the system produced positive effects on the users' wellbeing (however, only on the 'Affection' subscale) as compared to a limited-contact control group that did not use the system. Future studies will allow us to investigate further the effectiveness of the developed technology by including a greater variety of psychological tests to explore more deeply possible cognitive impacts on the participants. This will allow us to gather more detailed knowledge on the possible cognitive and wellbeing benefits of AGNES. Further, it is important to validate the present results with larger samples of healthy older adults as well as with older adults with cognitive impairments.

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