Computer-Based Training Programs for Older People with Mild Cognitive Impairment and/or Dementia

Blanka Klimova1* and Petra Maresova2

1Department of Applied Linguistics, Faculty of Informatics and Management, University of Hradec Kralove, Hradec Kralove, Czechia, 2Department of Economics, Faculty of Informatics and Management, University of Hradec Kralove, Hradec Kralove, Czechia

INTRODUCTION

Mental health affects the quality of life of a large number of individuals and family members (Klimova et al., 2015; Maresova et al., 2016). Dementia is closely linked to aging. Dementia is a consequence of the brain disease and it results in the deterioration of mental and cognitive activities. Most symptoms refers to cognitive impairment, but dementia also affects behavior (Holmerova et al., 2007). Dementia can be diagnosed if there are cognitive and behavioral symptoms which should include at least two of the following aspects (McKhann et al., 2011):

• worsened ability to gain and recall a new source of information (e.g., disorientation in known places, forgetting appointments or asking the same questions several times);
• worsened reasoning and judgment (e.g., low decision-making processes, tendency to safety risks or inability to conduct complex tasks);
applied. Research studies were selected on the basis of the different research studies exploring the research topic was topic. Furthermore, a method of comparison of findings of review of available literature sources dealing with the research et al. (2009). The methods involved in this study include a methodological review of the literature. The methodology of this mini review article follows Moher et al. (2009).

METHODS

The methodology of this mini review article follows Moher et al. (2009). The methods involved in this study include a review of available literature sources dealing with the research topic. Furthermore, a method of comparison of findings of different research studies exploring the research topic was applied. Research studies were selected on the basis of the following keywords:

- worsened visuospatial skills (e.g., failure to recognize known faces or things, inability to dress appropriately or to find things);
- worsened language (e.g., difficulties finding the right words, name the objects correctly, making hesitations or writing mistakes);
- behavioral changes (e.g., frequent changes in mood, social withdrawal or apathy).

Mild cognitive impairment (MCI) is then one of the pre-phases in the development of Alzheimer's disease (AD) and people usually have moderate difficulties with cognitive functions such as memory, attention, language or vision.

Although there already exist a few effective drugs to delay the cognitive decline and the development of dementia (Lyketsos et al., 2011; Klimova and Kuca, 2016), these drug therapies still have, however, quite modest benefits and they are rather expensive (Maresova et al., 2016). Therefore there is ongoing effort to use non-pharmacological approaches as a good support in the treatment of dementia (Klimova and Kuca, 2015; Klimova et al., 2016). One of such support, with the emergence and abundant use of information and communication technologies, seems to be computer-based intervention programs which may contribute to the maintenance and in some cases, to the reduction of cognitive disorders in dementia, particularly in the early stages of this disease as the research studies confirm (Preece and Maloney-Krichmar, 2003; Savitch et al., 2006). These computer programs can be tailored-made and meet patients’ needs. They are also economical and can be more easily disseminated among a wide range of people (Klimova and Maresova, 2016). Recent research studies (Hernandez-Encuentra et al., 2009; Sayago et al., 2011; Kueider et al., 2012) have indicated that older generation groups are now more technologically savvy than two decades ago. However, most of the computer-based training programs are aimed at healthy older individuals such as three well-known commercial, computer-based training programs CogMed, Jungle Memory and Cognifit (Fernandez, 2011; Melby-Lervåg and Hulme, 2013). Thus, more research has been conducted among healthy older individuals and it has shown some evidence of training with the help of modern technologies on cognitive performance as several reviews (see Kueider et al., 2012; Klimova, 2016) and meta-analytic studies have illustrated (see Powers et al., 2013; Lampit et al., 2014; Toril et al., 2014).

The aim of this mini review article is therefore to explore whether computer-based training programs might be an effective intervention tool for older people with MCI and/or dementia or not.

The selection process of the studies was as follows:

1. The search was conducted according to the keywords in four databases (5888) and in other web sources (32).
2. Furthermore, duplication was removed. Altogether 3718 studies were identified. Afterwards, the titles of only 276 studies/articles were checked in compliance with the research purpose within the Web of Science, Scopus and Medline, which contain the studies on clinical trials. In fact, this type of articles was included in the inclusion criteria. Thus, altogether 276 studies were selected for the further analysis.
3. The authors checked the content of the abstracts in order to discover whether the study examines the research topic. After that, 98 studies/article were selected for the full-text analysis.
4. Altogether 42 studies focused on the research topic, however, only six studies could be eventually used for a detailed specification. These were publications whose findings were new and contained traceable and comparable data such as a number of subjects or results specifications.
FINDINGS

Altogether six studies were identified for this review article. All studies were RCTs. Thus, the subjects were randomly divided into an experimental and control group. In all studies the control groups were active, exposed to traditional cognitive training (TCT) using pen-and-paper exercises designed to improve cognitive functions: attention and concentration, memory, language, calculation, or orientation to reality, or the subjects in the control group were involved in an integrated psychostimulation programs (IPPs) comprising music therapy, art and crafts and physical activity. Only in one trial (Tárraga et al., 2006) there were two control groups; one active and one passive. The mean age of subjects ranged between 74 years and 83 years. The dose of the intervention period was between 4 weeks and 24 weeks. The efficacy of computer-based intervention programs on cognitive impairment among older individuals with MCI and dementia was measured by validated neuropsychological tests such as digit span test, vocabulary recall test, or verbal fluency test. Three studies (Tárraga et al., 2006; Barnes et al., 2009; Herrera et al., 2012) confirmed beneficial effects of computer-based intervention programs on cognitive functions such as episodic memory or abstract reasoning, while the other three (Galante et al., 2007; Gaitan et al., 2012; Yu et al., 2015) revealed no effect of this intervention on cognitive functioning among older people with MCI and/or dementia. The description of the analyzed studies and their findings are summarized in alphabetical order of their first author in Table 1 below.

DISCUSSION OF THE FINDINGS

As Table 1 above demonstrates, the findings of this mini review article are quite modest and neutral on the issue of the efficacy of computer-based training interventions on cognitive decline among older people with MCI and/or dementia because half of the presented studies suggest small benefits for the improvement of cognitive performance among older individuals with MCI and/or dementia and the other half of the studies do not show any effects on cognitive decline.

As the results of the detected trials indicate, the positive effects on the improvement of cognitive performance among older adults with MCI and/or dementia concern especially the following areas: verbal and visuospatial memory, episodic memory, verbal learning, attention and decision-making. For example, Barnes et al. (2009) reported improvements of verbal learning and memory and observed an effect Size (ES) of 0.33 SD as far as the global cognitive function is concerned. Herrera et al. (2012) on the post hoc Newman–Keuls t-test ($p < 0.05$) showed that the trained group had reached the better results in recognition and recall of words than the control group. The same was true for the study by Tárraga et al. (2006). Similar findings were also described by Coyle et al. (2015) who in their review state that especially the cognitive domains of visual and verbal memory and executive functions could be improved. This has been also confirmed by Cipriani et al. (2006).

Although the rest of the studies did not prove any effect on cognitive decline among the target group (Galante et al., 2007; Gaitan et al., 2012; Yu et al., 2015), their results showed that computer-based training may be effective at least in delaying the continuous progression of cognitive impairment in AD (Galante et al., 2007). Furthermore, Gowans et al. (2007) in their study conducted among 40 people with AD and their 30 caregivers indicate that even in later stages of AD people can interact meaningfully when prompted specifically. The computer-based training may help them with reminiscence, communication as well as social contact. In addition, the findings of this mini review article confirm a positive effect of the computer-based intervention on behavioral symptoms such as depression and anxiety on older people with MCI and/or dementia (Yu et al., 2015). A more recent review study by Garcia-Casal et al. (2016) also argue that computer-based cognitive interventions have moderate effects on cognition, depression and anxiety in people with dementia and no significant effects can be found on activities of daily living.

The findings of the detected randomized control trials generated several important issues since they differed on numerous dimensions that might have affected the results of the training. First, the age range of the subjects was quite wide, for instance 54–91 years (Barnes et al., 2009) or 57–85 years (Gaitan et al., 2012) and the researchers did not study the effects of younger-older adults or older-older adults as, for instance, was done in the meta-analytic studies by Powers et al. (2013), Lampit et al. (2014) and Toril et al. (2014) who performed research on this issue among healthy older individuals. They revealed that there had been small benefits after training with larger effects in old-older adults than in young-older adults. However, in a recent meta-analysis by Wang et al. (2016), young adults have benefited more from the cognitive training than the older adults. Second, there was a question of the duration of these trainings. Some research studies suggest that longer and more intense interventions might contribute to the improvement of cognitive functions among people with MCI and/or dementia (Bozoki et al., 2013). On the contrary, Ballesteros et al. (2014) or Toril et al. (2014) claim that the effects of cognitive training in healthy old individuals are greater when training is of short duration (1–6 weeks) than when it is long (7–12 weeks). Third, the study designs of the selected studies also differed in the type of intervention programs. Only two studies, for example, had the same type of training for their control groups.

Thus, the limitations of this review article were quite significant since the identified studies consisted of the small sample sizes, large variability of study designs and outcome measures used in the analyzed RCTs, which may have had ambiguous results due to the underestimated effects of training interventions. Moreover, apart from the study by Garcia-Casal et al. (2016), the authors did not manage to detect any negative studies on this issue, which contributes to publication bias since studies with negative results tend to be less likely published. For
### TABLE 1 | An overview of the selected studies on computer-based intervention programs for cognitively impaired people with mild cognitive impairment (MCI) and/or dementia and their efficacy.

| Study | Objective | No. of subjects, age range | Dose of interventions, follow-up period, active vs. passive control group | Main outcome measures | Experimental group intervention | Control group intervention | Findings, statistically significant differences |
|-------|-----------|-----------------------------|------------------------------------------------------------------------|-----------------------|-------------------------------|-------------------------------|------------------------------------------------|
| Barnes et al. (2009) | To determine whether intensive computer-based cognitive training is feasible in subjects with MCI and to estimate the size of its effect on cognition. | 47 subjects with MCI, mean age: 74 years; age range: 54–91 years. | 100 min/day, 5 days/week for 6 weeks; no follow-up period; active control group. | Repeatable battery for assessment of neuropsychological status. | 22 subjects did exercises specifically designed to improve auditory processing speed and accuracy. | The control group subjects (N = 25) performed more passive computer activities (reading, listening, visuospatial game). | The findings indicate that intensive, computer-based mental activity is feasible in subjects with MCI and that these training programs may have domain specific effects because the intervention group improved in verbal learning and memory measures (range, 0.16–0.53), while the control group in language and visuospatial function measures (range, −0.51 to 0.01). |
| Gaitan et al. (2012) | To evaluate the efficacy at 12 months of a computer-based cognitive training (CBCT) program, adjunctive to traditional cognitive training (TCT). | 60 patients with multi-domain mild cognitive impairment and mild Alzheimer’s disease; mean age: 75.82 years; age range: 57–85 years. | 30 sessions of 1 h, two or three times a week for 12 weeks; 12-month follow-up; active control group. | Battery of neuropsychological tests. | 37 subjects participated in CBCT and TCT. | The control group subjects (N = 23) only performed TCT. | The results reveal that The addition of a CBCT program was effective in anxiety (p = 0.03) and decision making (p = 0.04) but had no significant effects on outcomes in basic cognitive functions. |
| Galante et al. (2007) | To explore the efficacy of computer cognitive rehabilitation in patients with mild cognitive decline. | 11 subjects with AD and MCI; mean age: 76 (± 6.0), years; age range: not stated. | 12 individual 60 min sessions of training, three times per week for 4 weeks; in addition, there was a 3-month and a 9-month follow-up period; active control group. | Neuropsychological tests. | Seven subjects were doing specific treatment—computer exercises focused on cognitive functions. | The control group subjects (N = 4) attended the aspecific treatment—a semi-structured interview on current affairs and relevant events of their own life history. | The Mini Mental State Examination (MMSE) score of the control group decreased significantly at the 9-month follow-up with respect to baseline (p = 0.04) and to the 6-month follow-up (p = 0.008), while the mean MMSE score of the experimental remained stable over time. Generally, the findings show that computer training technique is effective, at least in delaying the continuous progression of cognitive impairment in AD. |

(Continued)
| Study            | Objective                                                                 | No. of subjects, age range                                      | Dose of interventions, follow-up period, active vs. passive control group | Main outcome measures                                                                 | Experimental group intervention                                                                 | Control group intervention                                                                 | Findings, statistically significant differences                                                                 |
|------------------|---------------------------------------------------------------------------|-----------------------------------------------------------------|--------------------------------------------------------------------------|----------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| Herrera et al. (2012) | To evaluate the efficacy of a 12-week computer-based memory-attention training program based on recognition in subjects with MCI. | 22 subjects with amnestic MCI multiple domains subtype; mean age: 75 years; age range: 65–90 years | 24 sessions of 1 h for 12 weeks; 6 month follow-up; active control group | Neuropsychological tests, i.e., digit-span test, the 12-word-list recall test from the BEM-144 memory battery and cued reminding test. | The experimental group (N = 11) was doing a computer-based memory-attention training program. | 11 subjects of the control group were trained in cognitively stimulating activities. | The findings show that the intervention group improved episodic recall and recognition in comparison with the control group although only recognition was trained. |
| Tárraga et al. (2006) | To determine the usefulness of an interactive multimedia internet-based system (IMIS) for the cognitive stimulation of Alzheimer’s disease. | 43 mildly impaired patients, suspected of having Alzheimer’s disease; mean age: 77 years; age range: not stated | 12 weeks of treatment; a 24-week follow-up period; one active and one passive control group | Alzheimer’s Disease Assessment Scale-Cognitive, Mini-Mental State Examination, Syndrom Kurztest, Boston Naming Test, Verbal Fluency, and the Rivermead Behavioral Memory Test story recall subtest. | 15 subjects of the experimental group had 3 weekly, 20-min sessions of IMIS in addition to 8 h/day of an integrated psychostimulation program (IPP) and cholinesterase inhibitors (ChEIs) treatment. | One IPP and ChEIs treatment control group (N = 16); and one control group (N = 12) with only ChEIs treatment. | After 12 weeks, the patients treated with both IMIS and IPP had improved outcome scores on the Alzheimer’s Disease Assessment Scale-Cognitive (ADAS-Cog) and MMSE, which was maintained through 24 weeks of follow-up. Both the IPP and IMIS improved cognition in patients with Alzheimer’s disease, the IMIS program provided an improvement above and beyond that seen with IPP alone, which lasted for 24 weeks. |
| Yu et al. (2015)  | To explore the potential benefits of a computer-assisted intervention using touch-screen videogame technology on cognitive function and behavioral symptoms in older adults with mild-to-moderate dementia. | 32 subjects with mild-to-moderate dementia; mean age: 83 years; age range: 70–99 years | 30 min per session, 1–2 sessions per week for a total of eight sessions; 4 weeks of follow-up; active control group | Montreal Cognitive Assessment, digit span, the category verbal fluency tests, Neuropsychiatric Inventory test. | The intervention group subjects (N = 16) had a videogame training. | The control group (N = 16) performed a traditional cognitive training. | The experimental group showed significant improvements in MoCA language sub-scores (pre 1.5, post 2.0, P < 0.05, Effect Size (ES) 0.82). In addition, the findings indicate that the touch-screen videogame training can alleviate behavioral symptoms in older adults with mild-to-moderate dementia. Its efficacy to improve cognitive and other related functions warrants further investigation. |

Explanation: AD, Alzheimer’s disease; aMCI, Amnestic Mild Cognitive Impairment; IMIS, interactive multimedia internet-based system; IPP, integrated psychostimulation program; MCI, Mild Cognitive Impairment; MSA, multiple system atrophy; RCT, randomized controlled trial.
these reasons and the reasons described above, the authors of this study could not conduct the meta-analysis.

**CONCLUSION**

The findings from the selected studies seem to be quite neutral with respect to the efficacy of the computer-assisted intervention programs on the improvement of basic cognitive functions. On the one hand, they suggest that the computer-based training interventions might generate some positive effects on patients with MCI and/or dementia, such as the improvement of learning and short-term memory, as well as behavioral symptoms. On the other hand, these training interventions seem to be short-term, with small sample sizes, and their efficacy, as far as the statistically significant differences are concerned, was proved only in the half of the detected studies. Therefore there is a need for more longitudinal RCTs which would prove the efficacy of these computer-based training programs as a suitable intervention tool for cognitively impaired older people since the pharmacological treatment generates quite modest benefits, it is invasive, and rather expensive. Furthermore, earlier diagnosis of cognitive degeneration, with the accurate assessment tools (see Vestal et al., 2006) may help not only to assign the right medication treatment but also the management of cognitive disorders.

**AUTHOR CONTRIBUTIONS**

BK and PM equally contributed to the drafting, analyses and final version of the whole manuscript. Both authors read and approved the final manuscript.

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**REFERENCES**

Ballestero, S., Prieto, A., Mayas, J., Toril, P., Pita, C., de Leon, L. P., et al. (2014). Brain training with non-action video games enhances aspects of cognition in older adults: a randomized controlled trial. *Front. Aging Neurosci.* 6:277. doi: 10.3389/fnagi.2014.00277

Barnes, D. E., Yaffe, K., Belfor, N., Jagust, W. J., DeCarli, C., Reed, B. R., et al. (2009). Computer-based cognitive training for mild cognitive impairment: results from a pilot randomized, controlled trial. *Alzheimer Dis. Assoc. Disord.* 23, 205–210. doi: 10.1097/WAD.0b013e31819c6137

Bozoki, A., Radovanovic, M., Winn, B., Heeter, C., and Anthony, J. C. (2013). Effects of a computer-based cognitive exercise program on age-related cognitive decline. *Arch. Gerontol. Geriatr.* 57, 1–7. doi: 10.1016/j.archger.2013.02.009

Cipriani, G., Bianchetti, A., and Trabucchi, M. (2006). Outcomes of a computer-based cognitive rehabilitation program on Alzheimers disease patients compared with those on patients affected by mild cognitive impairment. *Arch. Gerontol. Geriatr.* 43, 327–335. doi: 10.1016/j.archger.2005.12.003

Coyle, H., Traynor, V., and Solowij, N. (2015). Computerized and virtual reality cognitive training for individuals at high risk of cognitive decline: systematic review of the literature. *Am. J. Geriatr. Psychiatry* 23, 335–359. doi: 10.1016/j.jagp.2014.04.009

Fernandez, A. (2011). Transforming brain health with digital tools to access, enhance and treat cognition across the lifespan: the state of the brain fitness market. Available online at: http://www.sharpbrains.com/executive-summary/printpage/. [Accessed March 30, 2016]

Flak, M. M., Hernes, S., Skranes, J., and Lohaugen, G. C. C. (2014). The memory aid study: protocol for a randomized controlled clinical trial evaluating the effect of computer-based working memory training in elderly patients with mild cognitive impairment (MCI). *Trials* 15:156. doi: 10.1186/1745-6215-15-156

Gaitan, A., Carolera, M., Cerulla, N., Chico, G., Rodriguez-Querol, M., and Canela-Soler, J. (2012). Efficacy of an adjunctive computer-based cognitive training program in amnestic mild cognitive impairment and Alzheimers disease: a single-blind, randomized clinical trial. *Int. J. Geriatr. Psychiatry* 28, 91–99. doi: 10.1002/gps.3794

Galante, E., Venturini, G., and Fiaccadori, C. (2007). Computer-based cognitive intervention for dementia: preliminary results of a randomized clinical trial. *G Ital. Med. Lav. Ergon.* 29, B26–B32.

Garcia-Casal, J. A., Loizeau, A., Csipke, E., Franco-Martin, M., Pereia-Bartolome, M. V., and Orrell, M. (2016). Computer-based cognitive interventions for people living with dementia: a systematic literature review and meta-analysis. *Aging Ment. Health* 21, 454–467. doi: 10.1080/13607863.2015.1132677

Gowans, G., Dye, R., Alm, N., and Vaughan, P. (2007). Designing the interface between dementia patients, caregivers and computer-based intervention. *Des. J.* 10, 12–23. doi: 10.2752/146069207789318018

Hernandez-Encuentra, E., Pousada, M., and Gomez-Zuniga, B. (2009). ICT and older people: beyond usability. *Educ. Gerontol.* 35, 226–245. doi: 10.1080/03601270802466934

Herrera, C., Chambron, C., Michel, B. F., Paban, V., and Alescio-Lautier, B. (2012). Positive effects of computer-based cognitive training in adults with mild cognitive impairment. *Neuropsychologia* 50, 1871–1881. doi: 10.1016/j.neuropsychologia.2012.04.012

Holmnerova, I., Jarolimova, E., and Sucha, J. (2007). Pce o Pacienty s Kognitivni Poruchou. [Care about Patients with Cognitive Disorders.] Praha: EV public relations.

Klimova, B. (2016). Computer-based cognitive training in aging. *Front. Aging Neurosci.* 8:313. doi: 10.3389/fnagi.2016.00313

Klimova, B., and Kuca, K. (2015). Alzheimer’s disease: potential preventive, non-invasive, intervention strategies in lowering the risk of cognitive decline—a review study. *J. Appl. Biomed.* 13, 257–261. doi: 10.1016/j.jab.2015.07.004

Klimova, B., and Kuca, K. (2016). Speech and language impairments in dementia—a mini review. *J. Appl. Biomed.* 14, 97–103. doi: 10.1016/j.jab.2016.02.002

Klimova, B., and Maresova, P. (2016). "Eldeley people and their attitude towards mobile phones and their applications—a review study," in *Advanced Multimedia and Ubiquitous Engineering.* Lecture Notes in Electrical Engineering, eds J. Park, H. Jin, Y. S. Jeong and M. Khan (Singapore: Springer), 31–36.

Klimova, B., Maresova, P., and Kuca, K. (2016). Non-pharmacological approaches to the prevention and treatment of Alzheimer’s disease with respect to the rising treatment costs. *Curr. Alzheimer Res.* 13, 1249–1258. doi: 10.2174/156720501366151116142302

Klimova, B., Maresova, P., Valis, M., Hopt, J., and Kuca, K. (2015). Alzheimer’s disease and language impairments: social intervention and medical treatment. *Clin. Interv. Aging* 10, 1401–1408. doi: 10.2147/CIA.S89714

Kueider, A. M., Parisi, J. M., Gross, A. L., and Rebok, G. W. (2012). Computerized cognitive training in older adults: a systematic review. *PLoS One* 7:e40588. doi: 10.1371/journal.pone.0040588

Lampit, A., Hallock, H., and Valenzuela, M. (2014). Computerized cognitive training in cognitively healthy older adults: a systematic review and meta-analysis of effect modifiers. *PLoS Med.* 11:e1001756. doi: 10.1371/journal.pmed.1001756.
Lu, S., Hongcai, S., Jing, W., Jing, H., and Jun, X. (2011). Assessing the quality of reports about randomized controlled trials of acupuncture treatment on mild cognitive impairment. *PLoS One* 6:e16922. doi: 10.1371/journal.pone.0016922

Lyketsos, C. G., Carrillo, M. C., Ryan, J. M., Khachaturian, A. S., Trzepacz, P., Amatniek, J., et al. (2011). Neuropsychiatric symptoms in Alzheimer’s disease. *Alzheimers Dement.* 7, 532–539. doi: 10.1016/j.jalz.2011.05.2410

Maresova, P., Mohelska, H., and Kuca, K. (2016). Social and family load of Alzheimer’s disease. *Appl. Econ.* 48, 1936–1948. doi: 10.1080/00036846.2015.1111986

McKhann, G. M., Knopman, D. S., Chertkow, H., Hyman, B., Jac, C. R., Kawash, C. H., et al. (2011). The diagnosis of dementia due to Alzheimer’s disease: recommendations from the National Institute on aging-Alzheimer’s Association workgroups on diagnostic guidelines for Alzheimer’s disease. *Alzheimers Dement.* 7, 263–269. doi: 10.1016/j.jalz.2011.03.005

Melby-Lervåg, M., and Hulme, C. (2013). Is working memory training effective? A meta-analytic review. *Dev. Psychol.* 49, 270–291. doi: 10.1037/a0028228

Moher, D., Liberati, A., Tetzlaff, J., and Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med.* 6:e1000097. doi: 10.1371/journal.pmed.1000097

Powers, K. L., Brooks, P. J., Aldrich, N. J., Palladino, M., and Alfieri, L. (2013). Effects of video-game play on information processing: a meta-analytic investigation. *Psychol. Bull. Rev.* 20, 1055–1079. doi: 10.3758/s13423-013-0418-z

Preece, J., and Maloney-Krichmar, D. (2003). “Online communities: focusing on sociability and usability,” in *The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications*, eds J. A. Jacko and A. Sears (Mahwah, NJ: Lawrence Erlbaum Associates), 596–620.

Rozzini, L., Costardi, D., Chilovi, B. V., Franzoni, S., Trabucchi, M., and Padovani, A. (2007). Efficacy of cognitive rehabilitation in patients with mild cognitive impairment treated with cholinesterase inhibitors. *Int. J. Geriatr. Psychiatry* 22, 356–360. doi: 10.1002/gps.1681

Sayago, S., Sloan, D., and Blat, J. (2011). Everyday use of computer-mediated communication tools and its evolution over time: an ethnographical study with older people. *Interact. Comput.* 23, 543–554. doi: 10.1016/j.intcom.2011.06.001

Tarraga, L., Becker, J. T., Osada, M., Espinosa, A., Diego, S., Morera, A., et al. (2006). A randomised pilot study to assess the efficacy of an interactive, multimedia tool of cognitive stimulation in Alzheimer’s disease. *J. Neurol. Neurosurg. Psychiatry* 77, 1116–1121. doi: 10.1136/jnnp.2005.086074

Toril, P., Reales, J. M., and Ballesteros, S. (2014). Video game training enhances cognition of older adults? A meta-analytic study. *Psychol. Aging* 29, 706–716. doi: 10.1037/a0037507

Vestal, L., Smith-Olinde, L., Hicks, G., Hutton, T., and Hart, J. (2006). Efficacy of language assessment in Alzheimer’s disease: comparing in-person examination and telemedicine. *Clin. Interv. Aging* 1, 467–471. doi: 10.2147/cia.s.2006.1.4.467

Wang, P., Liu, H. H., Zhu, X. T., Meng, T., Li, H. J., and Zuo, X. N. (2016). Action video game training for healthy adults: a meta-analytic study. *Front. Psychol.* 7:907. doi: 10.3389/fpsyg.2016.00907

Yu, R., Poon, D., Ng, A., Sit, K., Lee, J., Ma, B., et al. (2015). “Computer-assisted intervention using touch-screen video game technology on cognitive function and behavioural symptoms for community-dwelling older Chinese adults with mild-to-moderate dementia: preliminary results of a randomized controlled trial,” in *Proceedings of the 1st International Conference on Information and Communication Technologies for Ageing Well and e-Health* (Lisbon: SCITEPRESS), 297–302.

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