Published in final edited form as:
Int J Geriatr Psychiatry. 2014 September ; 29(9): 890–898. doi:10.1002/gps.4075.

Interactive Video Gaming compared to Health Education in Older Adults with MCI: A Feasibility Study

Tiffany F. Hughes[1], **Jason D. Flatt**[6], **Bo Fu**[4], **Meryl A. Butters**[1], **Chung-Chou H. Chang**[2,4], and **Mary Ganguli**[1,3,5]

[1]Department of Psychiatry, School of Medicine, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, PA, USA

[2]Department of Medicine, School of Medicine, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, PA, USA

[3]Department of Neurology, School of Medicine, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, PA, USA

[4]Department of Biostatistics, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, PA, USA

[5]Department of Epidemiology, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, PA, USA

[6]Department of Behavioral and Community Health Sciences, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, PA, USA

Abstract

Objective—We evaluated the feasibility of a trial of Wii interactive video gaming, and its potential efficacy at improving cognitive functioning compared to health education, in a community sample of older adults with neuropsychologically defined mild cognitive impairment (MCI).

Methods—Twenty older adults were equally randomized to either group-based interactive video gaming or health education for 90 minutes each week for 24 weeks. Although the primary outcomes were related to study feasibility, we also explored the effect of the intervention on neuropsychological performance and other secondary outcomes.

Results—All 20 participants completed the intervention, and 18 attended at least 80% of the sessions. The majority (80%) of participants were "very much" satisfied with the intervention. Bowling was enjoyed by the most participants, and was also the rated highest among the games for mental, social and physical stimulation. We observed medium effect sizes for cognitive and physical functioning in favor of the interactive video gaming condition, but these effects were not statistically significant in this small sample.

Corresponding author: Tiffany F. Hughes, PhD, MPH, Department of Psychiatry, University of Pittsburgh School of Medicine, 3600 Forbes Avenue, Suite 205, Pittsburgh, PA 15213. Telephone: 412-647-6619; Fax: 412-647-6555; hughest2@upmc.edu.

Conflicts of Interest: No Conflicts of Interest to Declare.

Conclusion—Interactive video gaming is feasible for older adults with MCI and medium effects sizes in favor of the Wii group warrant a larger efficacy trial.

Keywords

mild cognitive impairment; cognitive intervention; cognitive performance; randomized controlled trial; pilot study

INTRODUCTION

Mild cognitive impairment (MCI) is defined as an intermediate cognitive state between normal aging and dementia. Those with MCI have an elevated risk of developing dementia due to Alzheimer's disease and other conditions (Petersen *et al*., 2009). They may already be experiencing subtle difficulties in everyday functioning (Hughes *et al*., 2012), have substantial depressive symptoms (Apostolova and Cummings, 2008), and impairments in gait and balance (Montero-Odasso *et al*., 2012). MCI may provide an optimal window for preventive interventions as previous research suggests the presence of cognitive plasticity, and there are preliminary findings of cognitive benefit from cognitive interventions targeting those with MCI (Simon *et al*., 2012).

A large body of evidence suggests that older adults who are more engaged in mentally and socially stimulating leisure activities have better cognitive health compared to less engaged peers (Hertzog *et al*., 2009). According to the engagement hypothesis, the "substantive complexity" of engagement is characterized by a diversity of stimuli, large numbers of decisions, multiple factors to be considered in making decisions, and ill-defined and apparently contradictory contingencies resulting from decisions (Schooler, 1984). The cognitive demand associated with engaging in complex activities may be neuroprotective by decreasing neuronal loss, increasing synaptic connectivity, up-regulating neurotropic factors, or modifying disease pathology (Valenzuela *et al*., 2007). These processes contribute to a higher level of brain or cognitive reserve that may compensate for aging- or pathology-related (e.g., vascular, neurodegeneration) brain changes so that cognitive abilities are preserved (Stern, 2012).

Interactive video games are a novel tool to impart cognitive stimulation because they require players to integrate multiple cognitive processes while navigating complex and variable environments (Green and Bavelier, 2008). For example, attentional resources (visual, switch, and divided), processing speed, visuospatial and visuo-motor abilities (Green and Bavelier, 2004) are required to play video games in general, and additional cognitive processes (e.g., executive functions) can be tapped for specific games. In addition, interactive video games can be a source of social stimulation when played with others and can also increase physical activity (Peng *et al*., 2011). The Nintendo Wii™ has the advantages of being commercially available, older adult friendly, and accommodating to those with mobility impairments. The Wii Sports game package, including bowling, golf, tennis, baseball, and boxing, is particularly popular among older adults. The familiarity of these sports games combined with novelty of the interactive video gaming experience may be an ideal cognitive intervention for those with mild impairments in cognition. While there

are preliminary reports of gains in cognitive functioning among cognitively normal older adults who have engaged in interactive video games (Jovancevic *et al*., 2012; Maillot *et al*., 2012; Rosenberg *et al*., 2010), it is unclear whether those with MCI will be interested in, capable of, or show cognitive benefit from interactive video gaming.

The purpose of this study was to examine the feasibility of a group-based interactive video gaming randomized controlled trial (RCT) in older adults with MCI drawn from the community. We also explored its potential efficacy to improve cognitive performance compared to a health education condition that was matched for social interaction and served as a source of passive cognitive stimulation. We hypothesized that (1) Wii gaming would be feasible, and (2) there would be greater gains in the clinical outcomes in the Wii group, compared to health education group, due to the novelty of the experience and the higher cognitive demands required for playing the games.

METHODS

Participants

Participants were recruited from an ongoing population-based cohort study of MCI, entitled the Monongahela-Youghiogheny Healthy Aging Team (MYHAT) study, composed of older adults originally recruited from the voter registration list. MYHAT participants undergo an annual comprehensive in-home assessment that includes a neuropsychological assessment battery sensitive to mild cognitive impairments and change in cognitive functioning over time (Ganguli *et al*., 2009). In addition to the conventional MCI criteria, MYHAT also applies a “Cognitive Classification,” (Ganguli *et al*., 2010a)) based on neuropsychological test performance relative to MYHAT norms (Ganguli *et al*., 2010b)).

Potential participants were initially screened for eligibility using MYHAT study data. The inclusion criterion for the pilot study was classification of MCI based on Cognitive Classification at their most recent MYHAT assessment. Exclusion criteria were severe vision, hearing and motor impairment; history of debilitating neurologic disorders (i.e., Parkinson’s disease, stroke, multiple sclerosis, traumatic brain injury, or seizure disorder); any use of psychotropic medications; consuming 2–3 alcoholic drinks or more per occasion. Additional exclusion criteria assessed for the pilot study were having played the Nintendo Wii ™ on three or more occasions in the past year, or unable to commit to attending 20/24 intervention sessions.

Participants were equally (i.e., 50/50 split) randomly assigned to either interactive video gaming or health education using random numbers generated using Stata Version 11 (StataCorp LP, College Station, Texas, USA). The protocol was approved by the University of Pittsburgh Institutional Review Board. Written informed consent was obtained from all participants.

Intervention

Participants met for 90 minutes once per week for 24 weeks for a total of 36 hours. Since the primary aim was to examine intervention feasibility, this dosage was selected in order to evaluate the acceptability of the intervention. Sessions took place at a centrally located

church within the study area. Transportation was provided as needed. Participants received modest cash incentives for attending the sessions and assessments.

Interactive Video Games (Wii)

The Nintendo Wii™ gaming console was used for interactive video gaming. The Wii™ uses a wireless remote device with motion-sensing capabilities. Players use their arms and/or bodies to simulate actions required for each game (e.g., swinging a golf club, throwing a bowling ball). Participants played the Wii™ in stable groups of 3 or 4 members. The Wii Sports games, including bowling, golf, tennis, and baseball, comprised the “core” games of each of the 24 sessions. Each weekly session followed a regular schedule of first briefly (~10–15 minutes) discussing healthy aging topics, followed by interactive video gaming for the remainder of the session. The first 6 weeks focused on training and developing competence with the Wii system and the Wii Sports games. Beginning in week 7, participants were introduced to new games (e.g., Boom Blox, Wii Play, Sports Resort) for approximately the final 15–30 minutes of the session to provide novel gaming conditions and to maintain motivation and interest. In weeks 10 and 20, the groups competed in a “Wii tournament” to encourage enhanced effort and social interaction.

Healthy Aging Education Program (HAEP)

There is no consensus in the field regarding the appropriate control condition for cognitive intervention trials (Park *et al.*2007). The HAEP was designed to provide a source of passive cognitive stimulation in a socially-matched setting that would allow for the effect of novel and cognitively engaging characteristics of the Wii condition to be isolated.

All ten participants met to learn about and discuss age-specific health-related topics with professionals from the local academic and health care communities. Handouts were distributed each week on the topics for further reading. Topics included the “10 Keys to Healthy Aging” (Newman *et al.*2010), AARP® safe driving, medication management, caregiving, healthy cooking, sleep hygiene, emergency preparedness, urinary incontinence, dementia resources, and others. To promote social interaction similar to the Wii groups, participants were divided into stable groups of 3 or 4 members for small group activities for approximately the last 30 minutes of each session. These same groups also competed in a Jeopardy® style tournament in weeks 10 and 20 to encourage retention of the health information and to match the level of friendly competition in the Wii tournaments.

Outcome Measures

Feasibility—We calculated the proportion of participants completing the intervention. Attendance was examined as the average number of sessions attended and the proportion of those attending 20/24 sessions. At the end of the intervention period, all participants rated, on a 5-point Likert Scale (not at all to very much), their level of satisfaction with the program and how mentally and socially engaging they found it. At the 1- year follow-up assessment, participants indicated their level of interest in future participation and whether or not they would recommend the program to others. Additional measures were examined for the Wii group only, including: satisfaction with the training and use of the gaming

technology, and the level of enjoyment in, and the mental, social, and physical stimulation of, each of the Wii Sports games.

Clinical Outcomes

Assessments were performed in a fixed order within a 2-week window at baseline, post-intervention, and 1 year. Each assessment lasted approximately 90 minutes. The primary outcome was cognitive performance. Secondary outcomes included subjective cognitive ability, mood/social functioning, performance-based instrumental activities of daily living, and gait speed.

The Computerized Assessment of Mild Cognitive Impairment (CAMCI; Saxton *et al*., 2009) was used to assess cognitive performance. CAMCI is a self-administered, computer-based set of cognitive tests tapping the domains of attention, executive function, memory, and processing speed. The total CAMCI score is age and education adjusted based on a normative sample, and ranges between 0–51.4 with a score of 34.3 or higher representing “normal” performance. Two tracking tasks requiring participants to (1) track numbers (from 24-1) in reverse order (Tracking A), and (2) months forward (January – December) and numbers in reverse (Tracking B), were added to the CAMCI battery as measures of psychomotor speed/attention and executive functioning, respectively. We calculated connections per second for each tracking task. The Cognitive Self-Report Questionnaire-25 (CSRQ-25; Spina *et al*., 2006) was used to examine intervention-related improvements in cognition and mood/social functioning. We reverse-coded scores for the cognition and social functioning subscales so that higher scores represented better functioning. The Timed Instrumental Activities of Daily Living (TIADL; Owsley *et al*., 2002) was used to evaluate speed and accuracy of completing everyday tasks with overall time to complete all 5 tasks as the outcome. Finally, we measured time in seconds to complete a 6-meter walk (i.e., gait speed) as a measure of physical functioning.

Statistical Analyses

All data were analyzed using SAS software version 9.2 (SAS Institute, Inc., Cary, NC, USA). First, baseline demographic characteristics, MMSE (Folstein *et al*., 1975) score, and the number of prescription medications were compared between the Wii and HAEP groups. Next, descriptive statistics were calculated to examine the feasibility of the study. Comparisons were made using Wilcoxon Rank Sum for continuous variables and Fisher’s Exact test for categorical variables. To describe the magnitude and direction of change in the clinical outcomes between baseline and post-intervention (24 weeks) and baseline and the 1 year follow-up, Cohen’s *d* effect size estimates were calculated as the mean difference between pre- and post-test scores divided by the sample standard deviation (SD) of the change score. Overall effect sizes were calculated by subtracting the HAEP effect size from Wii group effect size, so that positive effect sizes favor the Wii group while negative effect sizes favor the HAEP group. Total IADL time and gait speed were scored such that higher scores represent worse performance, so that positive overall effect sizes favor the HEAP group and negative effect sizes favor the Wii group. Due to the small sample size, the signed rank and Wilcoxon Rank Sum tests were run to explore any significant differences within and between groups, respectively.

RESULTS

Feasibility Assessment

We received funding to enroll 20 participants for this trial. We first screened MYHAT participants based on whether or not they would be interested in participating in a group activity study comparing the potential health benefits of playing the Nintendo Wii™ and discussing healthy aging topics. Among the 445 participants classified as MCI, 128 (28.7%) expressed potential interest in the study and 91 (20.4%) were eligible to be contacted. They were mailed brochures describing the study followed by a phone call by a MYHAT study interviewer. Over a 4 week recruitment window, 37 were not interested, 14 could not be contacted, 3 had played the Nintendo Wii ™ on three or more occasions in the past year,10 were unable to commit to attending 20/24 intervention sessions, 7 were interested but unavailable at the required time, and 20 participants were enrolled (Figure 1). Those enrolled had a mean age of 77.4 [SD 5.8] years, were 70% were female and 80% White; had a mean education of 13.5 [SD 2.14] years and a mean MMSE score of 27.1 [SD 1.8], and were taking an average of 4.2 [SD 3.4] prescription medications. There were no significant differences between the Wii and HAEP intervention groups at baseline (Table 1).

All 20 participants completed the intervention and post-intervention assessments without difficulty. Only one participant was unable to complete the CAMCI at post-intervention due to transportation issues, and therefore did not receive a total score. Nineteen participants completed the one year follow-up assessment, with 1 participant lost due to death. The Wii group attended an average of 23.1 [SD 1.1, range 21–24] sessions compared to 21.8 [SD 3.3, range 14–24] in the HAEP group; 18 participants attended at least 20/24 sessions; 9 attended all sessions.

The majority of participants were "very much" satisfied with the intervention; with all being at least "more or less" satisfied. The program was rated "very" mentally and socially stimulating by more Wii than HAEP group participants. All indicated that they would participate in the intervention again in the future, and nearly all would recommend it to others. (Figure 2). The Wii and HAEP groups were not significantly different in any of the feasibility measures examined (all $p > 0.20$).

Examining participants' level of satisfaction with the training and equipment, we found that the majority of participants were "very much" satisfied with the training provided and the ease of playing the Wii games. Further, more than half were "very much" satisfied with using the controller and the games selected. With regard to the level of enjoyment in and the cognitive, social, and physical stimulation of each of the core Wii Sports games, bowling was enjoyed most by the participants and was most frequently endorsed as providing "very much" mental, social, and physical stimulation. Golf was the second most frequently enjoyed game, and was also second with regard to level of mental, social, and physical stimulation. Baseball and tennis were enjoyed by fewer participants, and were not considered as mentally, socially, and physically stimulating as bowling or golf (Table 2).

Exploratory Assessment of Clinical Outcomes

Overall, neither condition significantly affected cognitive functioning or any secondary outcome. Medium effect size estimates were found for the CAMCI total score, Tracking B task, subjective cognition, and gait speed in favor of the Wii group (Table 3).

DISCUSSION

The primary goal of this pilot study was to determine the feasibility of an interactive video gaming intervention in individuals with MCI. Results suggest that older adults with MCI are capable of engaging in interactive video gaming over a period of 6 months. Although not statistically significant, medium-sized effects were observed in favor of the Wii group, compared to health education, for objective and subjective cognitive functioning as well as physical functioning. These preliminary findings support a more intensive and adequately powered trial to draw more definite conclusions.

By recruiting from an established cohort study of MCI we found that 29% of those with MCI were interested in participating in the study. This is lower than MYHAT participants classified as cognitively normal among whom 36% were potentially interested. These results provide important information to guide recruitment efforts for behavioral intervention studies targeting those with MCI. We were able to enroll 20 participants during a short recruitment period. We may have reached our target of 30 if we had a longer recruitment window and/or offered additional session meeting times. We had high levels of attendance and retention at the sessions, and high interest in participating again if given the opportunity. We speculate cautiously this was related to the following factors. First, we recruited participants from a well-established cohort study using study interviewers with whom they were already familiar. Second, we lessened the burden of study participation by arranging transportation for those in need, and by choosing a familiar and easily accessible location with ample parking and interior space for all study activities. We provided simple, healthy snacks and a small incentive payment tracked using a wallet card; developed strong rapport between the interventionists and participants; encouraged social cohesion among the participants through small group discussions and activities; and held the intervention from June – November to avoid inclement weather and major holidays.

Through this work we were also able to demonstrate that community-dwelling older adults with MCI are capable of, enjoy, and are stimulated by interactive video games. We observed that bowling was enjoyed most, followed by golf. These games were also perceived as offering more mental, social, and physical stimulation. Although the self-perceived level of stimulation may provide useful information, future work is needed to objectively measure the level of mental, social, and physical stimulation provided by interactive video games.

Exploratory analyses of our pilot data did not reveal any significant changes on the clinical outcomes. Due to the small sample, interpretation of the effect sizes should be made with caution. We found a medium-sized improvement for global cognition, perceived cognitive ability, and gait speed in favor of the Wii group after 36 hours of active intervention spread over 6 months. This is promising given that other computer-based cognitive interventions, including non-interactive video gaming, have produced effects sizes ranging between 0.09

and 1.70 for cognitive measures in cognitively normal older adults (Kuider *et al*., 2012), and there is growing evidence that older adults with MCI can also benefit from cognitive interventions across a number of cognitive domains as well as non-cognitive outcomes (Belleville, 2008; Jean *et al*., 2010; Li *et al*., 2011). A future, adequately powered, trial should examine whether a more intensive dosage would lead to significant improvement.

To include older adults with mobility impairments, we did not require participants to stand to play any of the games and did not emphasize the physical nature of the gaming. However, 8/10 participants reported that Wii gaming was “very much” and the other 2 reported “quite” physically stimulating, suggesting that even the minimal effort to play the games may have provided more physical activity than participants typically engage in during their daily routines. There is growing literature supporting the benefits of physical activity for cognitive health (Erickson *et al*., 2012; Smith *et al*., 2010) as well as physical functioning. Therefore; the preliminary results here favoring the Wii group may be a due in part to increased physical activity. Future work should examine the unique and combined influence of the cognitive, social, and physical stimulation provided by interactive video games on cognitive health.

Conduct of this pilot study highlighted the importance of social interaction among the group members. There is wide variation across cognitive intervention studies in whether the format is an individual or group setting. Evidence suggests that social relationships influence cognitive functioning (Flatt and Hughes, 2013), possibly through the cognitive demand of interacting with others in social situations. Social relationships are also related to a variety of other health outcomes associated with cognitive functioning, such as cardiovascular disease and depression (Cohen, 2004). In one intervention study, tai chi, walking, and social interaction were evaluated for their effects on cognitive functioning and brain volume, as compared to no intervention. The tai chi and social interaction conditions, but not walking, led to improvement on select cognitive measures and increases in brain volume (Mortimer *et al*., 2012). Social interaction may also be important for adherence to the intervention (Stathi *et al*., 2010). At the exit interview, nearly all participants mentioned that they had decided to join and/or remain in the study because they enjoyed interacting with other participants. Future work should examine the extent that, and mechanism by which, social interaction influences the efficacy of cognitive interventions.

“Brain games” are aggressively being marketed to older adults for their benefits to brain and cognitive health (Fernandez, 2011). There is also a rapid growth in popularity of interactive video games such as the Nintendo Wii among older adults (Moses, 2007). The scientific community has an obligation to assess these games’ effectiveness using the same level of scientific rigor demanded of pharmacological studies. To our knowledge, this is the first study to examine interactive video gaming as a source of cognitive and social stimulation in older adults with MCI. Since the primary aim was to examine the feasibility of the study protocol, the sample was small and limited our ability to conduct reliable inferential statistical analyses to test for significant changes in cognitive and other secondary outcomes. Our neuropsychological definition of MCI may have led to heterogeneity in the sample in terms of underlying etiology, and thus limited our ability to detect intervention effects. The

MYHAT sample of MCI is, however more representative of older adults in the community with mild difficulties in cognitive functioning than clinic-based samples (Farias *et al*., 2009).

Conclusion

Interactive video games are potentially useful tools to increase cognitive, social, as well as physical activity in older adults without requiring specialized settings or trained professionals. They are relatively affordable, can be can be played at home alone or with others, even virtually, and there are a wide array of game choices that give players a "personalized" experience based on their preferences and abilities, which reduce barriers and increase adherence to participation. These considerations, along with demonstration of feasibility and preliminary gains in cognitive and physical functioning, support a larger, adequately powered, trial in older adults with MCI.

Acknowledgements

The authors express their gratitude to Kathryn McMichael for project coordination; Jennifer Jakubcak for database administration; Jack Doman for academic computing support; the MYHAT staff for recruitment, data collection, and data management; Judith Saxton, PhD, Lisa Morrow, PhD, and Psychology Software Tools, Inc. for CAMCI support and for helpful comments on the manuscript; Carol Thomson and Ronnie Cook Zuhlke for program development assistance; the HAEP program presenters; and the 20 senior citizens who participated in the study.

Source of Funding: This work was supported in part by grants P50-AG05133 and R01 AG023651 from the National Institute on Aging.

REFERENCES

Apostolova LG, Cummings JL. Neuropsychiatric manifestations in mild cognitive impairment: a systematic review of the literature. Dement Geriatr Cogn Disord. 2008; 25:115–126. [PubMed: 18087152]

Belleville S. Cognitive training for persons with mild cognitive impairment. Int Psychogeriatr. 2008; 20:57–66. [PubMed: 17958927]

Cohen S. Social relationships and health. Am Psychol. 2004; 59:676–684. [PubMed: 15554821]

Erickson KI, Weinstein AM, Lopez OL. Physical activity, brain plasticity, and Alzheimer's disease. Arch Med Res. 2012; 43:615–621. [PubMed: 23085449]

Fernandez A. The business and ethics of the brain fitness boom. Generations. 2011; 35:63–69.

Flatt JD, Hughes TF. Participation in social activities in later life: Does enjoyment have important implications for cognitive health? Aging Health. 2013; 9:149–158.

Folstein MF, Folstein SE, McHugh PR. "Mini-mental state" A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res. 1975; 12:189–198. [PubMed: 1202204]

Ganguli M, Chang C-CH, Snitz BE, Saxton JA, Vander Bilt J, Lee C-W. Prevalence of mild cognitive impairment by multiple classifications: The Monongahela-Youghiogheny Healthy Aging Team (MYHAT) Project. Am J Geriatr Psychiatry. 2010a; 18:674–683. [PubMed: 20220597]

Ganguli M, Snitz BE, Lee C-W, Vander Bilt J, Saxton JA, Chang C-CH. Age and education effects and norms on a cognitive test battery from a population-based cohort: The Monongahela-Youghiogheny Healthy Aging Team (MYHAT). Aging Ment Health. 2010b; 14:100–107. [PubMed: 20155526]

Ganguli M, Snitz B, Vander Bilt J, Chang C-CH. How much do depressive symptoms affect cognition at the population level? The Monongahela-Youghiogheny Healthy Aging Team (MYHAT) study. Int J Geriatr Psychiatry. 2009; 24:1277–1284. [PubMed: 19340894]

Green, CS.; Bavelier, D. The cognitive neuroscience of video games. In: Humphreys, L.; Messaris, P., editors. Digital media: Transformations in human communication. New York: Peter Lang; 2006. p. 211-223.

Green CS, Bavelier D. Exercising your brain: a review of human brain plasticity and training-induced learning. Psychol Aging. 2008; 23:692–701. [PubMed: 19140641]

Hertzog C, Kramer AF, Wilson RS, Lindenberger U. Enrichment effects on adult cognitive development: Can the functional capacity of older adults be preserved and enhanced? Psychol Sci. 2009; 9:1–65.

Hughes TF, Chang C-CH, Vander Bilt J, Snitz BE, Ganguli M. Mild cognitive deficits and everyday functioning among older adults in the community: The Monongahela-Youghiogheny Healthy Aging Team (MYHAT) Study. Am J Geriatr Psychiatry. 2012; 20:836–844. [PubMed: 22337146]

Jean L, Bergeron ME, Thivierge S, Simard M. Cognitive intervention programs for individuals with mild cognitive impairment: Systematic review of the literature. Am J Geriatr Psychiatry. 2010; 18:281–296. [PubMed: 20220584]

Jovancevic J, Rosano C, Perera S, Erickson KI, Studenski S. A protocol for a randomized clinical trial of interactive video dance: Potential effects on cognitive function. BMC Geriatr. 2012; 12:23–31. [PubMed: 22672287]

Kuider AM, Parasi JM, Gross AL, Rebok GW. Computerized cognitive training with older adults: A systematic review. PLoS One. 2012; 7 Epub.

Li H, Li J, Li N, Li B, Wang P, Zhou T. Cognitive intervention for persons with mild cognitive impairment: A meta-analysis. Ageing Res Rev. 2011; 10:285–296. [PubMed: 21130185]

Maillot P, Perrot A, Hartley A. Effects of interactive physical-activity video-game training on physical and cognitive function in older adults. Psychol Aging. 2012; 27:589–600. [PubMed: 22122605]

Montero-Odasso M, Verghese J, Beauchet O, Hausdorff JM. Gait and cognition: A complementary approach to understanding brain function and the risk of falling. J Am Geriatr Soc. 2012; 60:2127–2136. [PubMed: 23110433]

Mortimer JA, Ding D, Borenstein AR, DeCarli C, Guo Q, Wu Y, Zhao Q, Chu S. Changes in brain volume and cognition in a randomized trial of exercise and social interaction in a community-based sample of non-demented Chinese elders. J Alzheimers Dis. 2012; 30:757–766. [PubMed: 22451320]

Moses, A. Sydney Morning Herald. Sydney: Fairfax Media; 2007. Now it's nantendo: elderly game for new technology.

Newman AB, Bayles CM, Milas CN, et al. The 10 keys to healthy aging: Findings from an innovative prevention program in the community. J Aging Health. 2010; 22:547–566. [PubMed: 20495156]

Owsley C, Sloane M, McGwin G, Ball K. Timed instrumental activities of daily living tasks: Relationship to cognitive function and everyday performance assessments in older adults. Gerontology. 2002; 48:254–265. [PubMed: 12053117]

Park DC, Gutchess AH, Meade ML, Stine-Morrow EAL. Improving cognitive function in older adults: Nontraditional approaches. J Gerontol B Psychol Sci Soc Sci. 2007; 62B:45–52. [PubMed: 17565164]

Peng W, Lin J-H, Crouse J. Is playing exergames really exercising? A meta-analysis of energy expenditure in active video games. Cyberpsychol Behav Soc Netw. 2011; 14:681–688. [PubMed: 21668370]

Petersen RC, Roberts RO, Knopman DS, Boeve BF, Geda YE, Ivnik RJ, Smith GE, Jack CR. Mild cognitive impairment. Ten years later. Arch Neurol. 2009; 66:1–9.

Rosenberg D, Depp CA, Vahia IV, Reichstadt J, Palmer BW, Kerr J, Norman G, Jeste DV. Exergames for subsyndromal depression in older adults: A pilot study of a novel intervention. Am J Geriatr Psychiatry. 2010; 18:221–226. [PubMed: 20173423]

SAS System for Microsoft Windows: Version 9.2. Cary, NC: SAS Institute Inc.; 2002-2008.

Saxton J, Morrow L, Eschman A, Archer G, Luther J, Zuccolotto A. Computer assessment of mild cognitive impairment. Postgrad Med. 2009; 121:177–185. [PubMed: 19332976]

Schooler C. Psychological effects of complex environments during the life span: A review and theory. Intelligence. 1984; 8:259–281.

Simon SS, Yokomizo JE, Bottino CMC. Cognitive intervention in amnestic Mild Cognitive Impairment: A systematic review. Neurosci Biobehav Rev. 2012; 36:1163–1178. [PubMed: 22322184]

Smith PJ, Blumenthal JA, Hoffman BM, Cooper H, Strauman TA, Welsh-Bohmer K, Browndyke JN, Sherwood A. Aerobic fitness and neurocognitive performance: A meta-analytic review of randomized controlled trials. Psychosom Med. 2010; 72:239–252. [PubMed: 20223924]

Spina, LMR.; Ruff, RM.; Mahncke, HW. Cognitive Self-Report Questionnaire (CSRQ) Manual. San Francisco, CA: Posit Science Corporation; 2006.

StataCorp. Stata Statistical Software: Release 11. College Station, TX: StataCorp LP; 2009.

Stathi A, McKenna J, Fox KR. Processes associated with adherence to a 12-month exercise programme for adults aged 70 and older. J Health Psychol. 2010; 15:838–847. [PubMed: 20453043]

Stern Y. Cognitive reserve in ageing and Alzheimer's disease. Lancet Neurol. 2012; 11:1006–1012. [PubMed: 23079557]

Valenzeula MJ, Breakspear M, Sachdev P. Complex mental activity and the aging brain: Molecular, cellular and cortical network mechanisms. Brain Res Rev. 2007; 56:198–213. [PubMed: 17870176]

Key Points

1. "Brain games" are aggressively being marketed to older adults for their benefits to brain and cognitive health, and interactive video games such as the Nintendo Wii are increasingly popular among older adults.
2. This pilot study demonstrated that interactive video gaming is feasible in community-dwelling older adults with mild cognitive impairment.
3. Exploratory analyses did not reveal any statistically significant improvements, although, medium effect sizes were found for objective and subjective cognitive functioning and physical functioning in favor of interactive video gaming compared to health education.

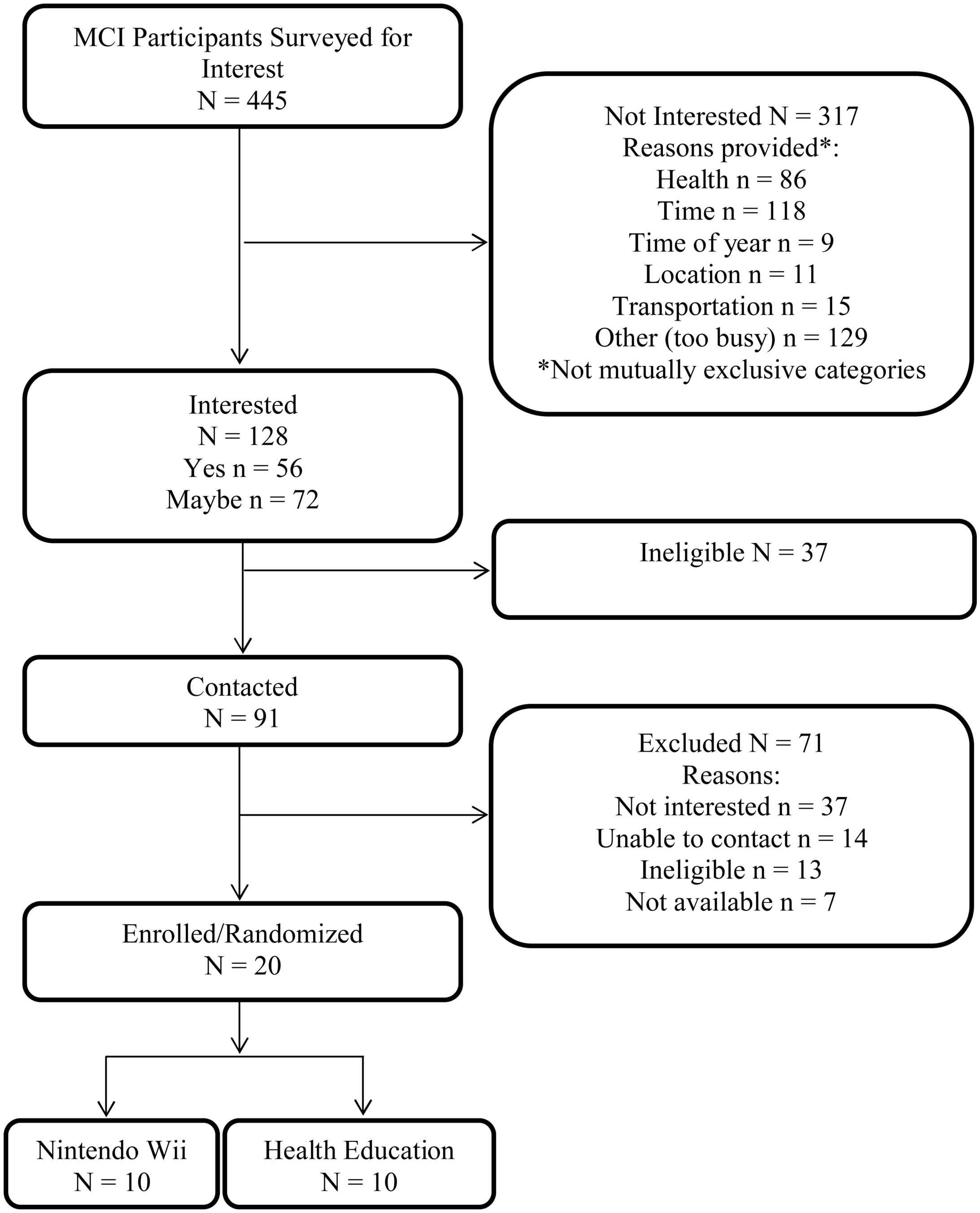

Figure 1.
Flow of Participants in the Study

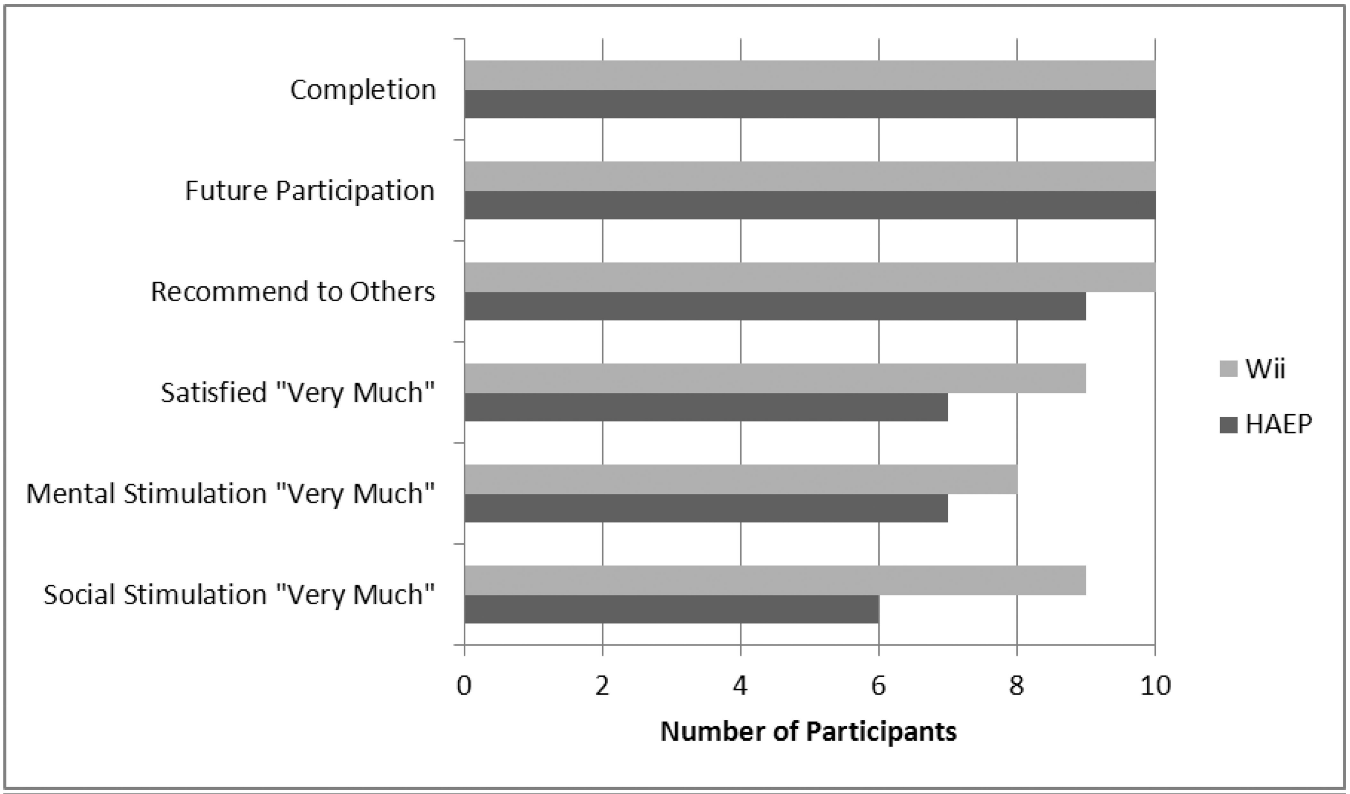

Figure 2.
Overall Feasibility of the Wii and Heath Education Intervention Conditions
Note. HAEP: Healthy Aging Education Program.

Table 1

Baseline Characteristics of the Study Participants by Intervention Assignment

	Nintendo Wii Intervention Group (n = 10)	HAEP Control Group (n = 10)	P-value
Age (years), mean (SD)	78.5 (7.1)	76.2 (4.3)	0.57
Gender, % Female	80	60	0.63
Education (years), mean (SD)	13.8 (2.4)	13.1 (1.9)	0.46
Race, % White	70	90	0.58
MMSE, mean (SD)	27.2 (1.9)	27.1 (1.8)	0.85
Number of Prescription Medications, mean (SD)	3.5 (3.0)	4.9 (3.9)	0.40

Note. HAEP: Healthy Aging Education Program. MMSE: Mini-Mental State Examination (Folstein *et al*., 1975).

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Table 2

Feasibility of the Interactive Video Gaming (Wii) Condition (n = 10)

	Not at all	Not much	More or less	Quite	Very Much
Satisfied with…					
Training	0	0	1	1	8
Ease of playing	0	0	0	1	9
Using controller	0	0	0	4	6
Games	0	0	1	3	6
Enjoy…					
Bowling	0	0	0	1	9
Baseball	1	1	2	4	2
Golf	1	0	1	5	3
Tennis	0	0	3	5	2
Mental Stimulation…					
Bowling	0	0	1	1	8
Baseball	0	2	1	2	5
Golf	0	1	2	1	6
Tennis	0	1	3	1	5
Social Stimulation…					
Bowling	0	0	0	2	8
Baseball	0	1	1	1	7
Golf	0	1	0	2	7
Tennis	0	1	2	1	6
Physical Stimulation…					
Bowling	0	0	1	3	6
Baseball	1	1	3	2	3
Golf	0	1	2	3	4
Tennis	0	0	3	3	3

Note: Number in each cell represents the total number of participants from the Wii group. One participant did not provide a response for the level of physical stimulation provided by Tennis.

Table 3

Scores and Effect Size Estimates for the Clinical Outcomes

	Baseline		24 Week Post-Intervention		1 year Follow-Up	
	Wii (n = 10) Mean (SD)	**HAEP (n = 10) Mean (SD)**	**Wii (n = 10) Mean (SD)**	**HAEP (n = 10) Mean (SD)**	**Wii (n = 10) Mean (SD)**	**HAEP (n = 9) Mean (SD)**
Cognitive Functioning						
CAMCI Total	25.55 (6.24)	25.49 (6.34)	29.41 (5.48)[†]	25.59 (6.86)	28.41 (4.12)	28.88 (6.83)
Cohen's d^* 95% CI			0.60 (−0.06,1.25)	0.02 (−0.45, 0.48)	0.59 (−0.01, 1.19)	0.47 (−0.13, 1.08)
Overall effect size** 95% CI				0.58 (0.23, 1.38)		0.11 (−0.74, 0.97)
Tracking A	0.04 (0.02)	0.04 (0.01)	0.04 (0.02)	0.04 (0.02)	0.04 (0.02)	0.05 (0.02)
Cohen's d^* 95% CI			0.14 (−0.35, 0.63)	−0.25 (−1.09, 0.58)	0.09 (−0.26, 0.43)	0.22 (−0.39, 0.82)
Overall effect size** 95% CI				0.39 (−0.58, 1.36)		−0.13 (−0.83, 0.57)
Tracking B	0.02 (0.01)	0.01 (0.01)	0.02 (0.01)	0.01 (0.01)	0.03 (0.02)	0.01 (0.01)
Cohen's d^* 95% CI			0.44 (−0.06,0.93)	0.29 (−0.12, 0.69)	0.77 (0.13, 1.41)	0.12 (−0.46, 0.69)
Overall effect size** 95% CI				0.15 (−0.49, 0.79)		0.65 (−0.21, 1.51)
Self-Perceived Cognitive Ability and Social Functioning						
CSRQ Total	71.70 (11.75)	76.50 (14.83)	69.20 (8.89)	68.20 (9.25)	71.00 (11.57)	64.00 (17.02)
Cohen's d^* 95% CI			−0.51 (−0.85, −0.17)	−0.48 (−1.38, 0.42)	−0.12 (−0.44, 0.20)	−0.39 (−1.57, 0.78)
Overall effect size** 95% CI				−0.03 (−0.99, 0.93)		0.27 (−0.95, 1.49)
CSRQ Cognitive	27.30 (5.58)	29.90 (7.37)	27.40 (5.10)	25.40 (7.60)	28.40 (5.42)	24.89 (7.88)
Cohen's d^* 95% CI			0.03 (−0.31,0.38)	−0.52 (−1.28, 0.24)	0.27 (−0.20, 0.74)	−0.35 (−1.42, 0.73)
Overall effect size** 95% CI				0.55 (−0.28, 1.38)		0.62 (−0.55, 1.79)
CSRQ Social	33.60 (5.78)	35.20 (4.05)	32.40 (4.48)	32.20 (3.12)	32.20 (5.51)	29.44 (7.60)
Cohen's d^* 95% CI			−0.46 (−0.81, −0.11)	−0.46 (−1.61, 0.69)	−0.68 (−1.06, −0.29)	−0.50 (−1.74, 0.73)
Overall effect size** 95% CI				−0.001 (−1.202, 1.201)		−0.17 (−1.47, 0.96)
Everyday Functioning						
IADL Total[¶]	158.00 (94.74)	171.39 (96.43)	165.08 (97.26)	193.73 (83.22)	180.60 (99.21)	182.46 (86.63)
Cohen's d^* 95% CI			0.13 (−0.22,0.48)	0.28 (−0.27, 0.84)	0.30 (−0.20, 0.80)	0.16 (−0.49, 0.81)

NIH-PA Author Manuscript
NIH-PA Author Manuscript

	Baseline		24 Week Post-Intervention		1 year Follow-Up	
	Wii (n = 10) Mean (SD)	HAEP (n = 10) Mean (SD)	Wii (n = 10) Mean (SD)	HAEP (n = 10) Mean (SD)	Wii (n = 10) Mean (SD)	HAEP (n = 9) Mean (SD)
Overall effect size** 95% CI				−0.15 (−0.81, 0.51)		0.13 (−0.69, 0.96)
Physical Functioning						
Gait Speed¶	7.48 (3.27)	6.58 (1.48)	7.14 (2.16)	7.46 (1.69)	7.00 (2.41)	7.18 (2.29)
Cohen's *d** 95% CI			−0.12 (−0.73,0.48)	0.61 (−0.01,1.24)	−0.14 (−0.87, 0.58)	0.39 (−0.19, 0.96)
Overall effect size** 95% CI				−0.73 (−1.60, 0.14)		−0.53 (−1.45, 0.40)

Note. HAEP: Healthy Aging Education Program.

[*] Within group standardized mean difference between follow-up and baseline, values in SD units.

[**] Wii-HAEP; positive values favor the Wii group, negative values favor the HAEP group.

[†] n = 9

[¶] Higher scores for IADL total and Gait speed represent slower performance; negative Cohen's d value represent improvement over time, negative overall effect size values favor the Wii group.