

# Effects of an Interactive Video Game (Nintendo Wii™) on Older Women with Mild Cognitive Impairment

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## Abstract

Older adults with a cognitive impairment in residential care settings are often found to be inactive throughout the day. Participation in video games holds promise for these individuals; however, effects of video games played by older adults have not been studied consistently and the few studies conducted have yielded mixed results. The purpose of this study was to examine effects of an interactive video game (Nintendo Wii™ bowling) on attention to task and positive affect of older adult women with mild cognitive impairment. A single-subject, multiple baseline design comparing a television viewing phase and an interactive video game phase was conducted using observational measures. Results indicated that both participants attended to task more and demonstrated higher levels of positive affect while engaged in the interactive video game as compared to baseline. The low-impact activity of the Nintendo Wii™ bowling program may provide the appropriate amount of physical and mental challenge and stimulation for older adults with mild cognitive impairments.

**KEYWORDS:** *Interactive video game, mild cognitive impairment, older adult, recreation*

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There are an estimated 40 million adults aged 65 and older within the United States in 2010 and this number is expected to increase by 36% within the next decade. In 2008, 1.6 million older adults resided in residential care settings including nursing homes and assisted living facilities (U.S. Department of Health and Human Services, 2009). Research conducted within residential care facilities suggests that older adults with a cognitive impairment are often found to be inactive throughout the day, frequently observed sitting or lying down, and engaged in minimal activity (Burgio et al., 1994; Ice, 2002; Kolanowski, Buettner, Litaker, & Yu, 2006; McClannahan & Risley 1975). Inactivity has been shown to have detrimental effects in older adults related to a variety of health outcomes including maintenance of cognitive function (Baltes, Wahl, & Schmid-Furstoss, 1990). MacRae, Schnell, Simmons, and Ouslander (1996) posited that this inactivity may "accelerate or exaggerate" the rate of cognitive impairments (p. 265).

### Mild Cognitive Impairment

While cognitive impairment is often referred to by varying levels (e.g., moderate, severe), the term *mild cognitive impairment* (MCI) is used for the purposes of this study. A variety of terms exist that can be used to identify MCI among older adults including: cognitive impairment without dementia, prodromal Alzheimer's disease, and isolated memory impairment (Petersen & Morris, 2003). Petersen et al. (2001) places MCI on a continuum between normal, healthy aging and dementia. Although there are currently no standardized diagnostic criteria for MCI, this identification represents individuals who are self-reported to be cognitively impaired or confirmed by an informant (e.g., a spouse or child) but not so severe as to be diagnosed with dementia (Bennett et al., 2002; Petersen, 2004; Salzman, 2006; Schonknecht, Pantel, Kruse, & Schroder, 2005). These in-

dividuals can complete activities of daily living with little difficulty but will exhibit objective memory deficits for their age including memory loss, language disturbances and attention challenges (Petersen et al.; Salzman; Schaie, 2008). Prevalence rates of MCI range from 3-29% (due to lack of standardized criterion for MCI) in older adults over 65 years (Gauthier et al., 2006) and affects 22% of adults 71 and older residing in the community (Plassman et al., 2008). While prevalence rates for residents of assisted living facilities with MCI are not as widely reported, Magsi and Malloy (2005) found approximately 61% of an assisted living sample achieved scores of 18-23 on the MMSE, demonstrating mild cognitive impairment.

### MCI and Attention

Older adults with cognitive impairments who lack active participation during their free time often have challenges related to attending to task (Bagurdes, Mesulam, Gitelman, Weintraub, & Small; 2008). Attention deficits can be one of the first problems other than memory to affect those with MCI due to the centrality of attention to most cognitive tasks. Such attention deficits can include a reduction in visual attention, attention control, attention shift, reaction time and disengaging attention (Bagurdes et al.; Belleville, Chertkow & Gauthier, 2007; Hoffman, Yang, Bovaird & Embretson, 2006; Madden, 2007; Perry & Hodges, 2003). Levinoff, Saumier, and Chertkow (2005) compared focused attention, using reaction time, in older adults with and without a mild cognitive impairment and individuals with Alzheimer's disease. A significant effect for attention to task was found between those with and without MCI. Individuals with MCI were found to be slower than those without MCI on two of three reaction time tasks and faster than those with Alzheimer's disease on all three tasks.

## **MCI and Positive Affect**

Cohen and Pressman (2006) define positive affect as "feelings that reflect a level of pleasurable engagement with the environment such as happiness, joy, excitement, enthusiasm, and contentment" (p. 122). Individuals with cognitive impairments often have difficulty engaging in pleasurable activities and, consequently, may experience declines in positive affect (Schreiner, Yamamoto, & Shiotani, 2005). Low mood (negative affect) is associated with cognitive decline in older adults; and neuropsychiatric disorders (e.g., depression, agitation) affect almost 50% of individuals with MCI which can result in impairment of daily living activities and more rapid cognitive decline when compared to healthy peers (Hendrie et al., 2006; Lyketsos et al., 2002).

### **Conceptual Framework**

The National Institutes of Health, the National Institute of Mental Health, and the National Institute of Neurological Disorders and Stroke launched a joint initiative to identify the "demographic, social, and biological determinants of cognitive and emotional health" in older adults by conducting a critical analysis of current research related to the maintenance of cognitive and emotional health (Hendrie et al., 2006, p.14). While this meta-analysis focused on adults over the age of 65, results are applicable to all older adults regardless of degree of cognitive impairment. Three independent factors emerged from the meta-analysis and appear to be consistent predictors of maintaining cognitive functioning. These factors are: (a) increased levels of physical activity or exercise, (b) increased levels of cognitive stimulation, and (c) increased social engagement (Albert, 2008; Hendrie et al.). Furthermore, each of these factors that can be promoted through recreational activities (Burgener, Schimer, & Murrell, 1993; Schreiner et al., 2005).

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## **Physical Activity**

Research has demonstrated that physical inactivity can lead to declines in physical functioning and disability (Stessman, Hammerman-Rozenberg, Cohen, Ein-Mor, & Jacobs, 2009). Such inactivity can result in changes in brain structure, functioning, and volume, which have the potential to impact cognitive functioning (McDaniel, Einstein & Jacoby, 2008). Research exploring the relationship between physical activity and the risk of cognitive impairment has found both low and moderate intensity activity to protect against further cognitive impairments (Geda et al, 2010). Laurin, Verrault, Lindsay, MacPherson, and Rockwood (2001) used the Canadian Study of Health and Aging and found those with MCI (or cognitive impairment with no dementia) who engaged in low intensity activities were 44% less likely than those who were physically inactive to develop further cognitive impairments (e.g., dementia, Alzheimer's disease). Given the preponderance of free time (i.e., unstructured time not spent engaged in activities of daily living) in the lives of older adults residing in assisted living facilities, structured physically active programs could lead to maintaining or increasing cognitive functioning (Kuhn, Kasayka, & Lechner, 2002).

### **Cognitive Stimulation**

Cognitive training is designed to promote intellectual stimulation and minimize cognitive impairments. One such cognitive training program, Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE), uses memory, reasoning, and speed of processing training and has been associated with improvements in memory for individuals with MCI (Belleville et al., 2007; Gamberini et al., 2008; Jobe et al., 2001). In addition, engagement in intellectual activities has been correlated with improved memory. For example, Schooler and Mulatu (2001) analyzed intellectual

complexity of recreation activities, as determined by task analysis and time spent completing the task, and cognitive functioning, as measured by a word-list free recall task and a semantic memory task. Results demonstrated a cyclical pattern, indicating that complex recreation activities influenced level of cognitive functioning and that level of cognitive functioning had an even stronger influence on complexity of recreation activity (McDaniel et al., 2008).

### **Social Engagement**

Social engagement refers to the level of involvement in social activities as well as the number and quality of social connections (Bassuk, Glass & Berkman, 1999). According to Fratiglioni, Wang, Ericsson, Maytan, and Winblad (2000), incidence of cognitive impairment increases when an individual's social network is limited, especially when the person is living alone and lacks contact from close friends or relatives. Bassuk et al. provided further support for cognitive decline in community dwelling older adults who were socially disengaged, finding that those who reported no social ties were twice as likely to experience cognitive decline as those with five or more social ties.

### **Video Games**

Video games offer an alternative approach to addressing these three predictors of cognitive maintenance. Interactive video games offer a cost-effective intervention that requires both physical and cognitive skills and can be used in a socially interactive setting. Most video games are portable, require limited resources (e.g., space, equipment, staff), provide the flexibility of being used at any time, and have the potential to be used as an assessment tool. Research is limited in regard to the effects of video games and older adults; however, some studies have shown prom-

ise for improvement of cognitive abilities as a result of video game play (e.g., Drew & Waters, 1986; Dustman, Emmerson, Steinhilber, Shearer & Dustman, 1992; Green & Bavelier, 2003).

### **Video Games and Attention**

Video games have been associated with improved attention when regular video game players (individuals playing at least 1 hour, 4 days a week for the previous 6 months) were compared to non-players, as well as in children with attention deficit disorders (Green & Bavelier, 2003; Pope & Bogart, 1996). The cognitive effect of video games played by older adults has not been studied thoroughly and the few studies that have been conducted have yielded mixed results. Previous research with video games has demonstrated significant improvements in reaction time of older adults residing in the community (Clark, Lanphear, & Riddick, 1987; Dustman et al., 1992; Goldstein, Cajko, Michielsen, Van-Houten, & Salverda, 1997), improvements in knowledge acquisition and retention (Ricci, Salas, & Cannon-Bowers, 1996), and significant increases in positive affect of older adults in residential care facilities (McGuire, 1984).

### **Video Games and Affect**

From a theoretical standpoint, the relationship between positive affect and video games can be explained through Csikszentmihalyi's flow theory (Johnson & Wiles, 2003). Within the flow theory, optimal enjoyment or a flow experience results when participants' skills and interests are appropriately matched with the challenge level of an activity (Csikszentmihalyi, 1991). When engaged in flow, the individual can experience a sense of control, concentration on the current task, loss of self-consciousness that is associated with increased enjoyment, fulfillment, and cognitive efficiency (Csikszentmihalyi).

Johnson and Wiles described components of flow as they related to video games. For example, video games use skill selection and increasing levels that result in finishing a goal. Video games also provide immediate feedback to players concerning their progress toward achieving their goals. These games also use visual graphics to engage the player and increase attention and concentration. The feeling of achievement or excitement associated within video games is associated with positive affect. These components work together to foster motivation to engage in the activity and provide an enjoyable experience for the participant.

Interactive video games offer a novel and challenging activity for older adults as they allow the participant to directly control the video game by interfacing through physical movements to influence activity within the video game. One increasingly popular video game is the Nintendo Wii™. The purpose of this study was to examine effects of an interactive video game (Wii Sports™ bowling) on attention to task and positive affect of two older adult women (ages 86 and 93) with mild cognitive impairments. More specifically, it was hypothesized that:

1. Participants will increase attention to task during the intervention over baseline.
2. Participants will increase positive affect during the intervention over baseline.

## Method

### Participants

Older adults with MCI from a local community assisted living facility were recruited with help from the facility recreation therapist. Three eligible volunteers

were considered for participation; however, one was unable to participate due to an injury unrelated to this study. The remaining two volunteers (ages 86 and 93 years old) were enrolled as participants in the study. Participation in the research project was voluntary and in addition to signing an informed consent, verbal consent from each woman was obtained prior to each session. Only individuals who (a) expressed an interest in bowling and playing an interactive video game, and (b) had sufficient seated balance, ambulation, and vision were accepted. Specific diagnoses were not obtained due to participant privacy requirements.

Participants were administered the Mini-Mental State Examination (MMSE) to determine admission criteria. This test of cognitive impairment has been determined to be valid and reliable since its introduction in 1975 (e.g., Folstein, Folstein, & McHugh, 1975; Kurlowicz & Wallace, 1999). Only individuals with a score of 21-26 were accepted for participation in the study. A standardized range does not exist for individuals with MCI and within previous research differing ranges have been used. Folstein et al. (1975) concluded that individuals with dementia score 20 or less and Zaudig (1992) identified the upper cut-off point for individuals with MCI using an MMSE of 27.<sup>1</sup>

Martha was a 93-year-old woman who scored 21 on her initial MMSE. She typically napped during the day and required reminders and prompts to attend sessions for this study. She was easily distracted when engaging in passive leisure pursuits such as television watching or listening to the radio, books on tape or live entertainment (e.g., music). Martha was ambulatory within her room, but used a wheelchair for

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<sup>1</sup> Both participants fell within the criteria for MMSE scores but scored on opposite ends of the stipulated range. While the MMSE range for MCI was supported by literature, this range has not been examined relative to reliability.

mobility when outside of her room. She wore glasses due to a visual impairment, but was able to see the television screen. She had difficulty seeing in environments with bright or excessive lighting; therefore, actions taken to accommodate her visual impairment were to draw the shades on the windows and dim overhead lighting.

Judy was an 86-year-old woman who scored 26 on her initial MMSE. She spent her free time doing puzzles (e.g., jigsaw, crossword, Sudoku), reading, and taking walks around the facility grounds. She frequently self-initiated individual activities, but required prompts to join group activities. Judy declined to participate in some sessions for this study, choosing to take a walk instead. She was ambulatory and required reminders to attend sessions for this study and facility provided activities.

## Setting

The study occurred in the day room of an assisted living facility where both participants resided. A single participant at a time and the instructor were present during each session. Participants were initially scheduled for three individual sessions per week (Monday, Wednesday, and Friday); however, due to facility scheduling issues, this schedule was altered in the third week of the study to four individual sessions per week (Monday through Thursday) with each session being conducted in the afternoon. The study lasted 16 weeks including follow-up. Participants were seated in an armless chair, directly facing the television, approximately 6 feet from the television (a 42-inch, flat panel, LCD screen).

## Equipment

The Nintendo Wii™ is an interactive video game console that uses a television remote-sized wireless controller to sense movement and orientation in three dimensions through the use of accelerometers and a sensor bar that detects infra-red

movements within the controller. Depending upon the game being played, participants simulate movement similar to real-world activities. With WiiSports™ bowling, participants swing one of their arms back and then forward while releasing a trigger button at the same time that results in the bowling ball rolling down the alley towards the pins, similar to actual bowling (Deutsch, Borbely, Filler, Huhn, & Guarre-Bowlby, 2008).

Within this study, playing the Nintendo WiiSports™ bowling game engages two of the three predictors of cognitive maintenance identified by Hendrie et al. (2006). While the game is not an aerobic activity, it does require the use of upper extremities, lower extremities (if participant is standing), trunk stability, balance, and fine motor control. The game also requires cognitive abilities such as attending to a task, following directions, remembering, and coordinating hand/eye movement. Participants must push an appropriate sequence of buttons on the controller to adjust the bowling ball and throw the ball down the lane.

## Experimental Design and Conditions

A single-subject multiple baseline ABAB design was used in this study. The design included a television watching baseline phase (A) and an interactive video game intervention phase (B) that were both repeated. The design allowed for within subject replication, providing evidence of treatment effect (Dattilo, Gast, Loy, & Malley, 2000). A multiple baseline was used so that participants began intervention and baseline phases at different points in time. Participants engaged in training, baseline, and intervention separately.

**Wii™ training session.** The instructor set up the Nintendo Wii™ game prior to each session. Prior to the initial baseline session, participants were introduced indi-

vidually to the equipment and provided an instructional session on how to use the Wii™ remote, how to navigate through the menus, and how to play the game. Prompts and cues (e.g., verbal instruction and physical demonstration) were provided as needed prior to sessions as well as during sessions.

**Television watching (Baseline).** During baseline, participants were seated and watched a pre-recorded video of a Professional Bowlers Association competition for approximately 15-min, four times a week (15 min is the approximate time it took each participant to bowl a Wii™ game). Three data points have been identified as the default number needed per phase (Kennedy, 2005). While three data points is a minimum, the number of sessions in each phase depended on the stability of each variable. After at least three sessions demonstrating a lack of trending within baseline, participants began the intervention phase. The initial baseline phase for each participant lasted 3 weeks due to the schedule change and the second baseline lasted 2 weeks.

**Nintendo Wii™ (Intervention).** The intervention included participants seated and actively participating in a Wii™ bowling game for approximately 15 minutes, four times a week. The session duration was determined by the approximate amount of time it took a participant to complete one Wii™ bowling game. Previous case studies with the Nintendo Wii™ used session durations of between 30 and 90 minutes (Deutsch et al., 2008; Drexler, 2009). A 15 minute duration was used in this study given the cognitive limitations of participants, facility schedule, and lack of participant interest in playing multiple games alone. Active play within the game included participants visually attending to the television screen and engaging in upper extremity movement that corre-

sponded with the game. Each intervention phase lasted 2 to 3 weeks per participant. Participants returned to baseline after at least three sessions demonstrating a lack of trending within the intervention.

**Follow up.** Three follow up observations were planned to occur once per week for 3 weeks upon conclusion of the intervention to determine maintenance of attention to task and positive affect. Follow up began 3 weeks after the final intervention was completed.

### **Observation and Recording Procedures**

Both attention to task and positive affect were documented via observations of videotapes using two interval recording procedures with an interval length of 6 seconds. One interval was used to code both dependent variables. Attention to task was measured by observing fixed eye gaze toward the television screen and active participation in the game as evidenced by upper body movements that corresponded with activity exhibited in the video game. Fixed eye gaze was evidenced by the participant's head pointed in the direction of the television and her eyes fixed on the television or the remote. A checklist was used to mark separate observations of fixed eye gaze and active participation. Whole interval recording was used to code attention to task. Attention that was held for the entire 6-second interval was recorded as an occurrence.

Positive affect was measured by observing facial response in the form of smiles. Smiling is one expression that has demonstrated reliability cross-culturally (Ekman & Friesen, 1975). According to Ekman and Friesen, smiling is demonstrated by the corners of the lips drawing back and slightly up; however, the lips may be parted or remain together. The appearance of naso-labial folds or Crow's feet (wrinkling at the outer corner of the eyes which presents itself more with age) also

increases with higher intensity of smiles. Partial interval recording was used to measure positive affect. Smiling was coded as an occurrence if participants smiled at any point in time during the 6-second interval. Counting of smiles was used based on recommendations by Briton and Hall (1995) that measuring affect by counting smiles has been determined to be effective.

A video camera was focused on the participant's upper body including trunk, upper extremities, head, and face. The instructor set up the camera prior to each session and the entire session was taped. The camera was placed next to the television. Observation and coding was conducted by the instructor prior to the start of the next session.

**Observer training.** The first author served as the primary observer. The secondary observer was trained to 100% criteria with detailed training sessions including target behavior definition, tape viewing, discussion, and further trials. The secondary observer received training on the dependent variables as well as whole interval and partial interval coding. Target behavior training occurred prior to study implementation using a videotaped session of a sample participant. Training also occurred during the study as needed.

**Inter-rater reliability.** Inter-rater reliability serves as a way to "monitor and assess the integrity with which information regarding variables is being recorded" (Kennedy, 2005, p.113). As suggested by Kennedy, inter-rater reliability was calculated for each session using interval agreement (see Table 1). This method scores an agreement if both the primary and secondary observer recorded the response as occurring or not occurring and was determined by dividing the number of agreements between observers by the number of agreements plus the number of disagreements multiplied by 100. A second observer reviewed and coded

22% of the videotaped sessions to provide a measure of inter-rater reliability including at least one session for each condition. This is above the suggested target of 20% of sessions (Kennedy, 2005). Inter-rater agreement ranged from 80-99% with an average agreement of 96%. Only one occurrence of agreement fell below 96%, which was 80%.

### Social Validity

It can be helpful to solicit verbal comments from participants and relevant service providers to assess the social validity of an intervention. Social validity refers to gathering information about the acceptability and practicality of the intervention from participants and others interested in or affected by the intervention (Schwartz & Baer, 1991). As a measure of social validity in this study, staff surveys and participant interviews were conducted at the conclusion of this investigation. Participant interviews targeted the perceived outcomes of participation, overall desirability of study effects, and efficacy of intervention through the following items:

1. Did you enjoy playing the Nintendo Wii™ bowling game?
2. Do you feel that you experienced any benefits as a result of the Nintendo Wii™ bowling game? If yes, what were these benefits?
3. Tell me how you feel when you watch bowling on TV compared to playing the Wii™ game.
4. Tell me about your attention to the bowling on television as compared to playing it on the Wii™. Did you seem to pay attention to one more than another? If so, please explain.
5. What did you like best about the Wii™ bowling game?

The therapeutic recreation staff members were indirect consumers of the intervention since they were responsible for continuing to provide Nintendo Wii™



**TABLE 1:**  
*Inter-Rater Reliability Agreement*

Participant	Session	Agreements	Agreements plus Disagreements	Proportion
Martha	2	80	100	80%
	3	97	100	97%
	6	121	122	99%
	12	110	112	98%
	18	113	118	97%
	24	106	110	96%
Judy	2	99	100	99%
	6	119	122	97%
	13	112	116	97%
	20	121	126	96%
	23	118	121	98%
Total	22% of Sessions	1196	1247	96%

bowling to the residents. Staff surveys targeted perceived efficacy of the intervention as well as observed changes in participants since the start of the study with the following questions:

1. Have you noticed any changes in (name) as a result of participating in the Nintendo Wii™ bowling game?
2. What effects do you feel the Wii™ bowling game would have for participants in the future?
3. How do you feel about residents participating in the Wii™ bowling game in the future?
4. Do you feel the Wii™ bowling program influenced (insert name)'s attention to tasks? If so, how?
5. How do you think (insert name) felt about participating in the Wii™ bowling game?

Given the small numbers of interviews (2) and surveys (3), data were condensed and visually analyzed for patterns among respondents. An additional measure of social validity was observed through the

continued offering of Nintendo Wii™ bowling to residents for more than a year following the conclusion of the study.

### **Data Analysis**

Data analysis occurred through visual inspection using graphical measures to identify changes in trends, stability of dependent variables, changes in levels, and percentage of non-overlapping data (Dattilo et al., 2000). Trend was identified through changes in both slope and magnitude of the dependent variables within each treatment (Kennedy, 2005). Stability was the difference or variation in behaviors among a single treatment and was calculated using the percentage of data points falling within 15% of the phase mean. Level changes were identified as changes in behavior from baseline to intervention (Morgan & Morgan, 2009). Percentage of non-overlapping data was calculated by identifying the most extreme or highest data point within each baseline and calculating the percentage of treatment data points that overlap this extreme. Calculations of non-overlapping data provide a

measure of stability and add confidence to the power of the intervention when the percentage of non-overlapping data is high. In addition, mean scores of attention to task and positive affect were compared within and across conditions.

## Results

Figure 1, graphically displays the result of the interactive video game to baseline conditions for Martha and Judy, whereas Table 2, provides the means for each dependent variable in each phase.

### Martha

Upon visual inspection, Martha had large and abrupt level changes from each baseline and intervention conditions for both attention to task and positive affect. For the first baseline phase, Martha's mean attention to task was 25% and her mean positive affect was 1%. During the first intervention phase, her mean attention to task increased to 95% and her mean positive affect increased to 19% (see Table 2). For the second baseline (reversal) her mean attention to task decreased to 25% and her positive affect decreased to 6%. During the second intervention phase, her mean attention to task increased to 98% and positive affect to 22%. She maintained similar averages at follow-up with means of 95% for attention to task and 16% for positive affect. Visual inspection demonstrated a dramatic difference between the average for each of Martha's baseline and intervention phases. No high-magnitude slopes were observed for any of the four phases. Within both baseline phases, the dependent variable of attention demonstrated a low-magnitude slope (downward in the first baseline and upward in the second baseline). Follow-up data for Martha also demonstrated an overall low-magnitude, downward slope. To address this issue, follow-up was extended from three to four data points and the fourth data point in-

creased for both dependent measures. Percentage of non-overlapping data was 100% for both positive affect and attention and each baseline-intervention phase as Martha's baseline data were lower than her intervention and follow-up data for each dependent variable.

Both participants reported that they found the intervention to be enjoyable. Martha stated, "I would bowl every day. I love to bowl. It makes me happy." Staff members noted that Martha looked forward to each session and stated she "... is proud of her performance and has shared her new talent with her family members." Staff also reported an increase in Martha's ability to recall routine events and schedules stating she is able to "... remember when it is time for bowling. She has short term memory loss and is able to remember bowling."

### Judy

Judy demonstrated greater attention to task during the passive television watching (i.e., baseline conditions) than Martha as demonstrated by the high baseline. As seen in Figure 1, Judy also had level changes between each baseline and each intervention phase; however, these changes were small. For the first baseline phase, Judy's mean attention to task was 94% and her mean positive affect was 3%. During the first intervention phase, her mean attention to task increased slightly to 99% and her mean positive affect increased to 11%. For the second baseline (reversal) her mean attention to task decreased slightly to 95% and her positive affect decreased to 4%. During the second intervention phase, her mean attention to task increased to 97% and positive affect to 16%. She maintained similar averages at follow-up with means of 99% for attention to task and 12% for positive affect. Through visual inspection, mean changes in affect were identified as being greater than changes in attention and there were

FIGURE 1. Participants' Baseline, Intervention and Follow-Up Data

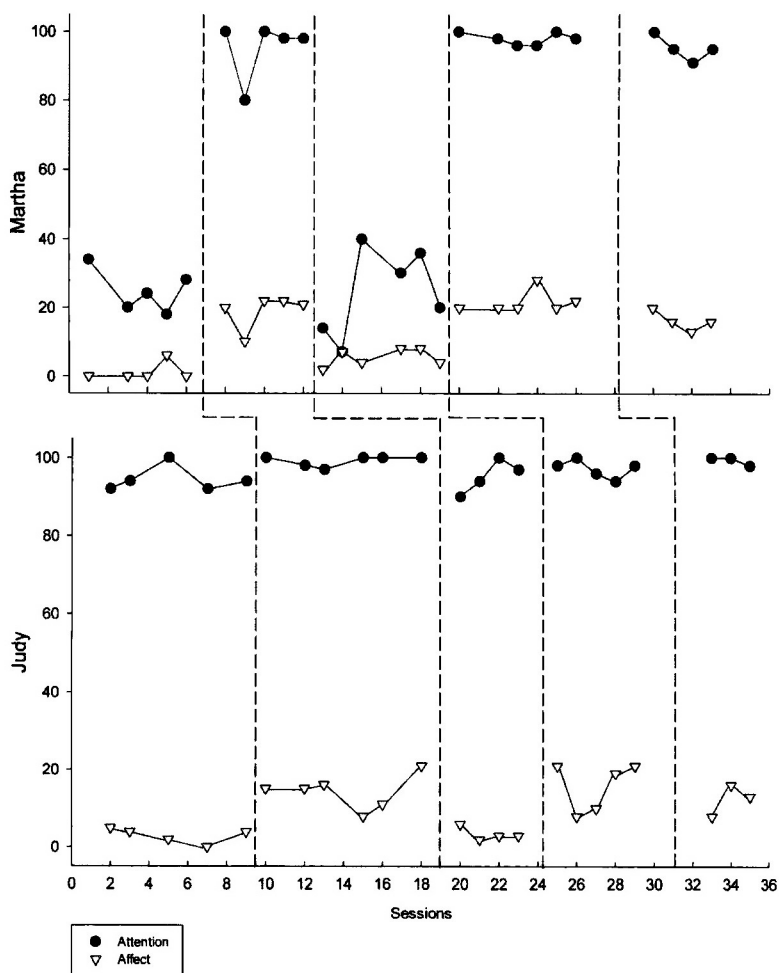


TABLE 2:  
Mean Ratings of Observation Percentages in Both Phases

Phase	Martha		Judy	
	Attention	Affect	Attention	Affect
Baseline	25%	1%	94%	3%
Intervention	95%	19%	99%	11%
Baseline	25%	6%	95%	4%
Intervention	98%	22%	97%	16%

no high-magnitude slopes (indicative of trend) observed for any of the four phases. Judy's second baseline for attention as well as her second intervention phase for affect demonstrated a low-magnitude upward slope. Percentage of non-overlapping data was 100% for each baseline-intervention phase for positive affect but 0% for attention. The low percentage of non-overlapping data was due to Judy's high level of attention during baseline.

When asked what she liked best about the Nintendo Wii™ bowling game, Judy stated, "It gives me something to focus on. It gives me a reason to move." She reported that she preferred playing the game rather than watching it being played on television, stating "I look forward to playing." When asked about benefits of playing the interactive video game, Judy stated it provided her exercise and something to keep her occupied. Staff members reported that they noticed an improvement in Judy's attention with one staff member stating that she "... has responded to participating in programs more frequently and does have a longer attention span."

### Discussion

This study is one of a few to use the Nintendo Wii™ to address cognitive deficits with older adults. Recent case studies have demonstrated benefits of the Nintendo Wii™ in rehabilitation settings when addressing issues such as balance, gait, range of motion, visual-perceptual processing, postural control, and fine motor control (Coyne, 2008; Deutsch et al., 2008; Drexler, 2009). Findings of this study are consistent with previous research (e.g., Dustman et al., 1992; Goldstein et al., 1997; McGuire, 1984) demonstrating cognitive benefits of participating in video games. McGuire identified a significant increase in positive affect for a group of older adults who played video games and resided in a nursing home when compared to a control

group. The current study extends this previous experimental research by using older adults in an assisted living facility and incorporating current interactive technology.

In addition to the two women demonstrating an increase in attention as a reflection of positive cognitive stimulation, data also indicated that they smiled more while engaged in the activity. These smiles are typically indicative of participation in an enjoyable activity. The observed positive affect was supported by participants' verbal comments regarding their experiences during the interactive video game. Further research using direct observation of individuals with more severe cognitive impairments resulting from such conditions as dementia, may extend this research on cognitive impairments.

This study extends previous research on interactive video games due to the physically active nature of the Nintendo Wii™ Bowling. In previous research with older adults (e.g., Goldstein et al., 1997; Schueren, 1986) video games have used joysticks, controller buttons, or keyboards to move through the game. The Nintendo Wii™ is a more interactive and physically demanding game as compared to traditional computer or video games. Although some researchers have examined effects of more physically active video games (e.g., Coyne, 2008), these studies have traditionally been conducted with children or young adults. Further research is needed that examines more thoroughly effects of physically active video games on people with disabilities of all ages.

This study examined effects of an interactive video game on attention to task and positive affect of two older adult women with a mild cognitive impairment. Both participants in this investigation attended to task more and demonstrated higher levels of positive affect while they were engaged in the interactive video game

as compared to baseline. Prior research has demonstrated that inactivity can lead to a decrease in cognitive functioning (MacRae et al., 1996) and that many older adults' lives, especially within residential care facilities, are characterized by this lack of cognitively and intellectually engaging activity (Kolanowski et al., 2006). The Nintendo Wii™ provides an opportunity to participate in an engaging, stimulating, and potentially self-directed activity at a low-cost for older adults residing in a residential care facility. This video game console may also provide other benefits when treating older adults with a higher need for daily care (e.g., additional assessment of cognitive abilities). While it is unknown what benefits the interactive video game used in this study may hold long term, the data for these two older women demonstrated that they increased their attention while participating in the Nintendo Wii™ interactive video game when compared to a baseline condition when they were engaged in the passive activity of watching television.

Not only was the interactive video game a way to keep the two older adult women cognitively stimulated, but it also appeared to be an enjoyable experience as indicated by their increase in positive affect and comments regarding the social validity of the intervention. As mentioned by Fredman, Hawkes, Black, Bertrand and Magaziner (2006), positive affect has been associated with a variety of beneficial health outcomes. This study provides empirical support for use of this interactive video game with older adults with cognitive impairments and results in participants demonstrating more positive affect than when they are engaged in a passive activity.

### **Limitations and Future Areas of Research**

Data collected for this study were limited to behaviors associated with attention

to task and positive affect. Our conceptual framework identified three predictors of cognitive maintenance and only two were addressed within this study. Due to this, further research examining effects of video game participation on physical activity and social engagement would be helpful. Given the positive association between declines in physical and cognitive functioning (Yaffe, Barnes, Nevitt, Lui, & Covinsky, 2001), participation in this interactive video game may have positive health outcomes related to physical functioning. Additional research examining effects of physically active video games on participants' motor performance and fitness are warranted.

The theory of flow was used to conceptually support the relationship between video games and cognitive stimulation including positive affect and attention. While the Nintendo Wii™ provided an opportunity for participants to experience flow, this connection was not directly tested within this study. Future research related to the Nintendo Wii™ and Csikszentmihalyi's flow theory would benefit from identifying the level of optimal enjoyment each participant experiences while participating in such interactive video games.

To avoid effects of confounding variables, participants were videotaped during baseline and intervention individually; however, sessions were conducted in a common area where participants may have been distracted by comments from people passing by or verbal interactions and noises associated with ongoing activities. Providing an environment that was less distracting may increase the effects of the intervention. In addition, future studies should examine the application of video games, such as Nintendo Wii™ bowling, as a means of improving social interaction skills and behaviors.

Another limitation to this study is that data for the dependent variables of atten-

tion to task and positive affect were only collected while participants were using the Nintendo Wii™ game and only for 15 minutes. While this study provided support for improved attention to task and positive affect during game play, the impact of game play on overall cognitive abilities is unknown. Sampling of both dependent variables throughout the day, for varying durations, and during non game playing times would provide for a comparison and identification of overall changes.

At least two additional methodological aspects of this study deserve additional attention. First, this study was initially designed to allow participants the opportunity to view a videotape of Nintendo Wii™ bowling during baseline. Both participants objected to viewing the videotape, but agreed to watch a videotape of a Professional Bowling Association competition. As a result, use of Nintendo Wii™ bowling during both baseline and intervention was not possible (i.e., live bowling observation was used during baseline instead of Nintendo Wii™ bowling observation).

Finally, only two participants were involved in this study. Future research is needed whereby the results of this study are replicated with additional participants to increase external validity. Although findings of this study were systematically replicated across two participants and several phases, research with additional individuals would increase the ability to

generalize the reported results to other individuals. When conducting replications of the study, it may be helpful to include variations within the sample relative to gender, age, cognitive ability, level of disability, and residence (i.e., long term care facility versus community).

## Conclusion

In summary, this investigation demonstrated positive effects of participating in an interactive video game on both attention to task and positive affect of two older adult women with mild cognitive impairments. This study provided an intervention that required both (a) physical activity and (b) cognitive stimulation, two predictors of cognitive functioning maintenance identified by Hendrie et al. (2006). Since inactive older adults typically have physical disabilities that limit the types of activities in which they can participate, this low-impact activity may provide the appropriate amount of physical and mental challenge and stimulation for older adults (Yaffe et al., 2001). The finding that an interactive video game played by two older adult women with MCI increased both attention to task and positive affect is important since older adults with cognitive impairments who lack active participation often have difficulties with attention to task and have low positive affect (Bagurdes et al., 2008).

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