The Kinect project: group motion-based gaming for people living with dementia

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Abstract

Engaging in enjoyable activities is an essential part of well-being, but people with dementia can find participation increasingly difficult. Motion-based technologies can provide meaningful engagement in a wide range of activities, but for people with dementia to take advantage of these devices requires a good understanding of how best to select and present these activities to this population. The objective of this study was to explore the use of motion-based technology (Xbox Kinect) as a group activity for people with dementia who attend adult day programs. This qualitative study took place in an adult day program for older adults with age-related challenges. Participants (n=23) were observed while playing a digital bowling game presented on Xbox Kinect one hour per week for a period of 20 weeks, to capture naturalistic data. Field notes generated through observations were transcribed and analyzed to identify emerging themes. The findings revealed three predominant themes which illustrate the potential of motion-based technology as a group activity for people with dementia who attend adult day programs: (a) the importance of having a trained trainer, (b) learning vs. mastery, and (c) playing 'independently together'. People with dementia can learn to play games presented on motion-based technology and enjoy doing so. Furthermore, using the technology in a group setting fostered an encouraging and supportive environment which further contributed to the leisure experience. However, to be used most effectively, staff must be trained to set-up and interact with the technology, as well as introduce, teach, and support people with dementia to use it.

Keywords
Dementia, motion-based technology, Xbox Kinect, leisure activities, well-being

Introduction

Dementia is an overarching term used to describe a range of symptoms associated with neurodegenerative conditions, such as Alzheimer's disease. Characteristic signs of dementia include noticeable impairment in areas of cognitive functioning such as memory, thinking, attention, executive function, communication and comprehension (World Health Organization, 2012). Age is the biggest risk factor for dementia, and as the world's population continues to age, it is unsurprising that the number of people living with dementia also continues to rise (Alzheimer's Disease International, 2015). As such, the number of people living with dementia globally is predicted to reach to 131.5 million by 2050 (Alzheimer's Disease International, 2015). While considerable research is directed towards the prevention and treatment of dementia, it is also important to explore interventions that can support people with dementia to live as well as possible (Astell, 2013).

Positive psychology, which is the scientific study of the strengths that enable individuals and communities to thrive, is based on the belief that people want to lead meaningful and fulfilling lives. This does not exclude people with dementia. For example, participating in engaging leisure activities (i.e. enjoyable activities undertaken during one's free time) can promote a good quality of life and support overall well-being for people living with dementia (Alzheimer Society of Canada, 2011). However, participation in enjoyable leisure activities can become increasingly difficult for people with dementia. For example, when asked about their level of participation in engaging leisure activities, participants in Genoe and Dupuis (2012), and Innes, Sage and Cutler (2016) frequently described instances where they forewent previously-enjoyed activities (e.g. travelling, cooking, attending social events) that had become too challenging or inaccessible due to their increasing cognitive difficulties. As technology becomes more widely available, there is

growing interest in the use of digital technologies to provide accessible yet engaging leisure activities to people living with dementia (Astell, 2013). For example, novel technologies such as touchscreen tablets (Cutler, Hicks & Innes, 2015; Joddrell & Astell, 2016) and personal computers (Tak, Beck & Hong, 2013) have been used to provide engaging leisure activities to people living with dementia.

While a considerable amount of research has used technology to provide independent activities to people with dementia, the use of technology to provide group activities to people with dementia has not been as thoroughly explored (Dove & Astell, 2017). This underexplored domain remains important when working with this population, as many people with dementia report a lack of social stimulation, and/or feelings of isolation or loneliness (Alzheimer's Society, 2013). As well, in many common care contexts (e.g. long-term care, adult day programs) activities are offered in group settings rather than individually, as it reduces the workload of formal care staff (i.e. scheduling one group activity rather than scheduling and supervising several individual activities) and creates opportunities for socialization between members (Alzheimer's Society, 2013). As such, there is a clear need for technological interventions for people with dementia that are engaging, accessible and socially inclusive.

The use of motion-based technology (e.g. Nintendo Wii, Xbox Kinect) for people living with dementia has recently begun to emerge as a tool in both research and care (Dove & Astell, 2017). Motion-based technology operates through gesture recognition, interpreting physical motions (e.g. swinging an arm forward) as commands, and eliciting responses (e.g. throwing a ball) based on those commands. The physical actions required to interact with motion-based technology are intuitive ones that resemble everyday gestures, thereby creating an engaging and naturalistic user experience. A recent literature review revealed that activities presented on motion-based

technology can provide opportunities for people with dementia or mild cognitive impairment (MCI) to engage in cognitive, physical and leisure activities, in both individual and group settings (Dove & Astell, 2017). This highlights the potential of motion-based technology as a creative and innovative tool for use with these populations.

To date, most of the existing literature relating to the use of motion-based technology for people with dementia or MCI reveals a strong focus on cognitive function with little attention to creating opportunities for engaging leisure activities, despite the fact that many participants described the technology as engaging and enjoyable (Dove & Astell, 2017). Additionally, little attention has been paid to the environment in which the technology was used with people with dementia or MCI (e.g. day programs, long-term care homes, research facilities, personal houses), and how these different contexts might impact the use of the technology.

Lastly, the current literature highlights a large gap in information regarding the appropriate methods to introduce, teach and support people with dementia to use motion-based technology (Dove & Astell, 2017). This gap is quite surprising given the extensive research suggesting that people with dementia are able to learn new skills through implicit learning techniques (de Werd et al. 2013; Van Halteren-van Tilborg et al. 2007). Implicit learning refers to acquisition of skills without consciousness effort, which can be unconsciously retrieved from implicit memory (Van Halteren-van Tilborg et al. 2007). Two types of implicit learning used with people who have dementia are procedural and errorless learning. Procedural learning involves practicing a task until the task can be completed automatically (e.g. learning to ride a bicycle; Van Halteren-van Tilborg et al. 2007). Errorless learning is a teaching procedure which guides a person towards the correct response by minimizing the occurrence of errors (de Werd et al. 2013). This technique aims to reduce the incidence of errors throughout the learning process, thus facilitating the

acquisition of skills. While it is suggested that these learning techniques can be useful in teaching new skills to people with dementia (de Werd et al. 2013; Van Halteren-van Tilborg et al. 2007), they have yet to be applied in interventions involving motion-based technology and people with dementia. The present observational study (entitled, 'The Kinect Project') aims to explore the use of motion-based technology (Xbox Kinect) as a group activity for people with dementia who attend an adult day program. This provides an opportunity to study the way people with dementia are introduced, trained and supported to use motion-based technology in a group setting.

Methods

Design

This qualitative study used an observational approach to examine the use of the Xbox Kinect in a specialized adult day program. Participant observations are a commonly used qualitative data collection method, which require direct engagement and involvement with the world being studied (Reeves et al. 2008). Participant observation enables researchers to immerse themselves in a setting, thereby generating a rich understanding of social actions and their intricacies in different contexts (Reeves et al. 2008). The day program owned the Xbox Kinect and used it once a week as the basis of a group activity offered to the people attending on that day. Our aim was to gain a detailed understanding of (a) the day program clients with dementia; (b) the group facilitators; (c) the activity; (d) the environment and (e) the interaction between them.

Participants

Twenty-three people who attended the specialized adult day program for people with age-related challenges, such as significant mobility impairments or dementia that had progressed beyond the mild stage, were approached for permission to be observed during the Kinect bowling activity (see Table 1 for a descriptive summary of the clients). With consent from the clients and/or their

families, general information, including whether an individual had a dementia diagnosis was obtained from the day program staff. While most of the group members had a diagnosis of dementia (n=16/23), seven lived with challenges unrelated to cognition (e.g. age-related vision loss, mobility impairments). Two staff members also gave consent to be observed while facilitating the group sessions. These two staff members had 4.5 and 7 years of experience in care/dementia care and had worked at the day program for 2.5 and 4 years respectively.

To capture the activity in the natural context of the day program environment, all attendees who participated in the Kinect bowling activity (regardless of presence or absence of cognitive impairment) were asked for consent to be observed as: (a) we did not want to modify the natural environment by excluding regular attendees; (b) if motion-based technologies are to be successfully implemented in real-world settings such as adult day programs, they will likely be used to offer inclusive activities to all clients, rather than only being offered to people with memory loss.

Table 1. Player Characteristics

Total Group Members (n=23)		
Age (years)	Mean=77.7	Range=63-92
Sex	Male=10	Female=13
Diagnosis of Dementia	Yes=16	No=7
Presence of Physical Impairment (i.e. use of a mobility device)	Yes=14	No=9
Type of Difficulty	Cognitive=9 Physical=7	Cognitive and Physical=7

Prior to conducting the study, a favourable approval opinion was obtained from Ontario Shores Centre for Mental Health Sciences (Research Ethics Board #16-012-B). To be considered eligible to take part in the study, participants were required to be an attendee of the adult day

program, and to agree to all terms outlined in the consent form. Day program attendees were not required to have dementia as we did not want to exclude people who were already a regular part of the activity, and we realize that it is unfeasible to assume that only people with dementia would be invited to participate in these types of activities if they were to be implemented in real-world settings such as adult day programs. Informed consent was obtained from each person either independently or through a substitute decision-maker (e.g. family member), if the client lacked the capacity to consent.

Materials

The Xbox 360 Kinect (Microsoft) and the bowling game from the Kinect Sports package (Microsoft) were used in this study. This motion-based technology was chosen due to the fact that it was readily available at the recruitment site, and has been described as user-friendly by other rehabilitative populations, including people with Parkinson's disease (Galna et al. 2014), stroke (Sin & Lee, 2013), and traumatic brain injury (Venugopalan et al. 2013). Our decision to use the Xbox Kinect was also influenced by a recent literature review exploring the use of motion-based technology for people living with dementia or MCI (Dove & Astell, 2017), which noted that the commercially-available Nintendo Wii console had received far more focus in the literature than the newer and more advanced Xbox Kinect console. Interaction with the Nintendo Wii requires players to hold and operate a motion-based, hand-held controller called the Wii-mote. To successfully use the Wii-mote, people are required to learn and remember which buttons are associated with which specific actions on the screen (e.g. pressing 'B' throws the ball) while simultaneously performing physical actions (e.g. swinging an arm forward). This associative learning places a high demand on both cognitive and motor systems, which can be challenging for people with dementia (Benveniste et al. 2010; Boulay et al. 2011; Higgins et al.

2010; Tobiasson et al. 2015). Additionally, holding and operating the Wii-mote requires manual dexterity, grip strength and fine motor control, which may be difficult for people with age-related physical impairments, such as arthritis (Higgins et al. 2010; Tobiasson et al. 2015). The usability issues related to the Nintendo Wii controller further influenced our decision to choose instead the Xbox Kinect for people with dementia, as it avoids any controller-related usability issues.

The Kinect sensor (Figure 1), used in combination with the Xbox 360 console, is embedded with gesture-recognition equipment that tracks motion in three different dimensions. Physical gestures made by the player are replicated by a virtual avatar (i.e. an icon or figure representing an individual in video games) on the screen. Users control the gaming interaction through physical motions rather than a hand-held controller, allowing for an interaction that is user-friendly and accessible for people with a wide range of abilities. The bowling game from the Kinect Sports software package (Figure 2) was chosen for this study due to the simplicity of the game and the movements required to play (e.g. single limb involvement).

Figure 1. The Xbox Kinect sensor (front) and the Xbox 360 console (rear)

Figure 2. The Kinect Sports bowling game, featuring the lane and the avatar

Environment

The observation was conducted at a specialized adult day program for people living with age-related challenges, such as significant mobility impairments or dementia that had progressed beyond the mild stage. This site was chosen through interest expressed by the day program staff, who already owned an Xbox 360 Kinect console donated by a community member. The sessions were held in the activity room of the day program, as it was large enough to comfortably accommodate both the group members and the technology. Players were seated in view of the television screen in two parallel lines, with the middle of the floor open for play. This allowed group members plenty of space to sit or interact with the technology, while also providing the Kinect sensor with enough space to function properly (i.e. not having too many people in its view at once). During the sessions, the researcher was situated at a small table at the back of the room as to observe all aspects of the activity without interfering with the natural environment.

Procedure

The gameplay sessions took place once per week for twenty weeks (20 sessions), and were facilitated by two members of staff at the day program (i.e. the 'trainers'). Each trainer took turns leading the sessions, with the non-leading trainer remaining present for physical assistance (e.g. helping to lift someone from a wheelchair). Each session lasted approximately one hour and was

held in the activity room of the day program as a regularly-scheduled group activity. Observations (n=20; 1 per session) were documented in the form of descriptive field notes, which included general comments, questions, environmental sketches, movement sketches and direct quotes from players and trainers. This was undertaken by focusing on each aspect separately (e.g. what role does the trainer play?), and as a whole (e.g. how do the trainer, players and environment interact during the activity?).

Data Analysis

The first author acted as the observer and note taker and also undertook the bulk of the analysis in collaboration with the second author. Analysis of qualitative data is often undertaken in an inductive thematic manner (i.e. moving from specific observations to broader generalizations and theories). That is, data are examined to identify and categorize themes that 'emerge' from the data (Reeves et al. 2008). First, field notes generated through observations were transcribed by the researcher. Thematic analysis was then completed by coding every line of text (by hand) with handles that identify key words, concepts, images and reflections. This was an explicit and iterative process in which the researcher adapted and modified the analysis as reflected by the data and as themes emerged. Analysis of qualitative data involves explicit interpretation of the meanings and functions of human actions (Reeves et al. 2008); thus, the product of this analysis primarily takes the form of verbal descriptions and explanations.

Results

Thematic analysis revealed three predominant themes relating to the use of motion-based technology as a group activity for people with dementia who attend adult day programs. The themes are: (a) the importance of having a trained trainer, (b) learning vs. mastery, and (b) playing 'independently together'. Findings pertaining to these themes are summarized below,

with quotes from trainers and players with dementia used for illustrative purposes when relevant and available.

(a) The importance of having a trained trainer

During each of the twenty gameplay sessions, the importance of having a 'trained trainer' was clearly apparent, as the day program staff had a strong influence on all other aspects of the phenomenon under study (i.e. the group members, the activity, and the environment). As such, it is crucially important to ensure that these types of activities are presented by individuals who are trained to use the technology, work with the day program clients, facilitate the activity and navigate the environment.

To initiate each gameplay session, staff/trainers presented Xbox Kinect bowling as a fun and inclusive activity with minimal emphasis on winning or losing, to create an engaging and supportive environment. The trainers offered the Xbox Kinect bowling activity to clients with suggestive prompts that still allowed each group member to exercise personal choice. For example:

"Did you want to give it a try?" (Trainer 01)

"Would you like to try bowling today?" (Trainer 01)

To introduce the players to the technology and the game at each Xbox Kinect bowling session, trainers provided group members with an initial demonstration illustrating how to interact with the technology and play the game (i.e. how to activate the sensor, grab a ball and throw it down the lane). Once the activity was introduced, the trainer would cue each player to approach the 'line' (i.e. a piece of green tape placed on the floor as a marker for where to stand) one at a time with encouraging prompts. For example:

"Okay [participant name], come on down!" (Trainer 02)

"Come on [participant name], do your magic!" (Trainer 01)

To teach the group members to use the technology and play the game, trainers used a range of techniques such as verbal prompts, gesture demonstrations, task breakdown and light physical guidance (e.g. placing a hand over theirs) if required. For example, the trainers frequently coached day program clients to play by dividing the movement sequence into procedural steps:

"Raise your hand above your head. Good, now bring your arm out to the side to grab the ball. Okay, you've got the ball, now bring your arm back behind you, and swing!" (Trainer 01)

"Okay [player name], put your hand in the air. Okay now, arm to the side. Alright, swing behind you, and to then to the front." (Trainer 02)

While independent play was always encouraged (i.e. not 'over-helping'), the trainers provided players with as little or as many prompts as necessary to support the diverse abilities of the day program clientele. If a group member required assistance, verbal prompts were first provided, as they were the least intrusive type of prompt. For example:

"Make sure your hand goes back, and then front." (Trainer 01)

"Put your hand over towards me." (Trainer 02)

"Move your arm a little higher." (Trainer 01)

Gesture demonstrations were frequently used to coach players who experienced difficulties following verbal instructions. For example, trainers leading the sessions would often stand beside or in front of the group member and slowly execute the motions required to play the game, while encouraging them to follow along (Figure 3):

"Copy what I'm doing." (Trainer 01)

"Move your arm like this." (Trainer 01)

Figure 3. Training a participant to play Xbox Kinect using gesture demonstrations

Similar to the teaching techniques, support approaches were tailored to the needs of each player. This required the trainer to possess both a general understanding of dementia and a specific understanding of the needs of each individual client. For instance, people with physical impairments (e.g. wheelchair users) were supported from behind by day program staff, allowing them to stand and play independently (Figure 4). This physical support provided each group member with an opportunity to take part in the activity, irrespective of cognitive or other (e.g. mobility) challenges. Furthermore, this type of support appeared to establish a level of trust between the trainer and the client, as trainers would often provide reassuring comments to the person receiving physical assistance. For example:

"Don't worry, I've got you." (Trainer 02)

"I'm right behind you, okay?" (Trainer 01)

Figure 4. A participant playing Xbox Kinect while being physically supported by a trainer

Lastly, the trainer played a vital role in supporting players throughout the Xbox Kinect sessions by offering positive encouragement and support. This was observed during each of the twenty gameplay sessions, where trainers would cheer on group members and support them with uplifting comments, regardless of the gameplay outcome (e.g. strike vs. gutter ball). For example:

"Way to go, [participant name]!" (Trainer 01)

"That's it!" (Trainer 02)

"Good try!" (Trainer 01)

In summary, observations revealed that the success of the activity was highly dependent on having a 'trained trainer' who possessed both a general understanding of dementia and a specific understanding of each player's needs (e.g. cognitive, physical, etc.). The day program staff played an essential role in setting up and interacting with the Xbox Kinect, as well as introducing, teaching and supporting day program members to use it. This included personalizing both teaching and support approaches to accommodate each person's needs.

(b) Learning vs. mastery

Throughout the 20-session duration of the study, it was observed that several members of the group were able to learn to interact with the technology and play the game. For example, with

recurrent practice, players were able to complete more turns independently (i.e. without any assistance from the trainer) or with little prompting. This was true even for people who were not always able to recollect previous bowling sessions, although it was clear by their performance that they had indeed played before. For example:

"I've done this before? But I don't even remember it." (Player 13)

In the present study, players with dementia were able to learn to play games presented on motion-based technology using task breakdown, verbal prompts, and gesture demonstrations. For example, dividing the entire movement sequence into procedural steps, including (a) raising an arm above the head to activate the sensor, (b) putting the arm out to the side to grab a bowling ball, (c) extending that arm to the rear, and (d) swinging the arm forward proved to be extremely useful for players with dementia. This is unsurprising given that people with dementia can learn new skills through procedural learning techniques (de Werd et al., 2013). Throughout the study, there were numerous examples of people learning to play Xbox Kinect using a step-wise approach. For example:

"Raise it up this high? And then to the side?" (Player 07)

"I gotta go that way… [raises hand above head], and that way… [moves arm out to the side]…" (Player 12)

"Raise my hand, like that? And then swing?" (Player 05)

With repeated exposure to the technology and the game, observations revealed that players with dementia were able to build upon learned skills to reach a level of mastery (i.e. comprehensive knowledge or skill in a subject). For example, many group members required fewer (if any) verbal prompts and gesture demonstrations as they became more competent with the Xbox

Kinect. As well, mastery became evident as players improved their game performance and bowling scores. For example:

"Last time all I got were gutter-balls, this time I got a strike!" (Player 15)

"Wow, 6 pins!" (Player 11)

"Look at me go! Did you see?!" (Player 15)

Furthermore, players displayed mastery of learned skills through improved movement competency, or 'flow of play'. For instance, at the beginning of the study, many players initially started off with a rigid stance and posture, which later progressed to a relaxed 'bowling stance'. As well, with repeated exposure, players began to self-correct movement errors, adjust the aim of the ball to hit more pins, and ask more questions about the game objective and the technology itself. For example:

"Do I throw it straight?" (Player 07)

"Uh-oh, I better try another one… [after realizing she forgot to grab the ball]" (Player 11)

"How do I aim it more that way?" (Player 12)

Furthermore, observations revealed that not only are people with dementia able to learn and master skills related to motion-based technology use, but they are also able to teach these skills to others. This became evident as more experienced players began to coach newer members to play Xbox Kinect bowling by providing cues and sharing advice. For example:

"Look at the little people on the screen, they show you what to do!" (Player 07)

"You don't have the ball yet, [participant name]!" (Player 14)

"Put your hand over that way to get the ball. There, now you can throw it." (Player 03)

Lastly, mastery became evident as group members with dementia promptly took notice when the technology did not operate as it was supposed to (e.g. the ball would not leave the virtual bowler's hand). For example:

"That wasn't supposed to happen." (Player 12)

"How come it's just bouncing? [when the ball was hovering on the screen instead of leaving the avatar's hand] It just bounces…" (Player 07)

"Why did it do that?" (Player 14)

For many members, playing bowling on Xbox Kinect for an extended period of time (20 sessions over 20 weeks; 1 session per week) resulted in learning and subsequent mastery of learned skills. These findings highlight the desire to learn and the positive impact of learning in people with dementia, while challenging negative stereotypes about their learning capabilities.

(c) Playing 'independently together'

As the Kinect sensor cannot accommodate multiple people in its view at once, bowling on Xbox Kinect initially appeared to be more practical for individual use than for group use. However, observations quickly revealed that bowling on Xbox Kinect served as an engaging group activity where day program clients played 'independently together'. In other words, the group dynamic created a positive social environment where people with dementia were able to connect through encouragement, group cohesion and friendly competition. For example, each person took turns bowling their ball down the aisle while the rest of the group supported them through clapping, cheering, laughing and positive encouragement:

"Show us how it's done, [participant name]!" (Player 20)

"Oh, good throw!" (Player 03)

"You got it, you got it, you got it!" (Player 14)

In addition to providing a social activity for the group members, the Xbox Kinect bowling sessions also provided opportunities for socialization between the players and the day program staff through laughter, playful comments and shared experiences (e.g. watching others play). For example, trainers would often engage in friendly teasing with familiar players:

"Nine more balls and you would have had them all!" (Trainer 02)

"That's your favorite spot! [after player scored a gutter ball]" (Trainer 01)

"Don't leave me hanging! [when reaching for a high-five]" (Trainer 02)

Lastly, player perceptions of the Kinect Sports bowling game and the technology itself were positive, highlighting its potential as an engaging group activity for people with dementia who attend adult day programs. Despite other activities being offered at the day program while the Xbox Kinect sessions were taking place (e.g. table top card games), few day program members chose not to participate in the bowling activity. Additionally, throughout the study, players often shared positive opinions pertaining to the technology and the game, highlighting their engagement and willingness to participate in the activity. For example:

"Can I play one more round?" (Player 14)

"This is cute, I've never bowled on a computer before." (Player 05)

"Oh, look at that! Just wonderful." (Player 15)

Discussion

Principal findings

The present study explored the use of motion-based technology as a group activity for people with dementia who attend an adult day program. The findings highlight three predominant themes: (a) the importance of having a trained trainer, (b) learning vs. mastery, and (c) playing 'independently together'. These themes collectively illustrate the ways in which motion-based

technology (Xbox Kinect) can be used in adult day programs as an engaging group activity for people with dementia. These findings are consistent with the current literature regarding the use of motion-based technology for people with dementia or MCI, where participants commonly described motion-based technology as a stimulating, engaging and enjoyable activity, despite the context in which the technology was used (i.e. cognitive, physical, leisure; Dove & Astell, 2017). In this study, a significant role was played by day program staff, who contributed to both player success and an encouraging and supportive learning environment. Using techniques such as task breakdown, verbal prompts, gesture prompts and light physical guidance, trainers introduced, taught and supported people with dementia to play games on the Xbox Kinect. Interestingly, these same techniques have been employed in much of the current literature relating to the use of motion-based technology for people living with dementia or MCI (Dove & Astell, 2017). The cognitive difficulties faced by people with dementia (e.g. impairments in working memory) make it challenging for them to learn and retain new information. As such, it is critical that trainers possess both a general understanding of dementia, as well as a specific understanding of the abilities of each person in the group. For example, certain types of prompts (e.g. verbal) may work well with some group members, but not with others. If trainers do not understand how to teach new skills to people with dementia, this will affect people with dementia's ability to learn these new skills.

Over the 20-session study period, group members with dementia learned how to use motion-based technology. This finding contributes to the body of literature confirming that people with dementia can learn to use technologies with repeated practice and appropriate training (Astell et al. 2014; Astell et al. 2016; Joddrell & Astell, 2016). Players with dementia learned to play Xbox Kinect through implicit means such as errorless and procedural learning. This is unsurprising

given that errorless and procedural learning techniques have been successfully used with people with dementia in previous interventions (e.g. de Werd et al. 2013, van Halteren-van Tilborg et al. 2007). Evidence of spared implicit memory in people with dementia (Fenney & Lee, 2010; Leahey & Singleton, 2011; Legouverneur et al. 2011) is further validated by the results of the present study, where group members with dementia learned to play Xbox Kinect through implicit means. With repeated exposure to the technology and the game, players with dementia were able to learn and subsequently master the skills required to play games presented on Xbox Kinect. This is highly relevant, as it clearly demonstrates that people living with dementia can still learn meaningful skills and participate in engaging activities (de Werd et al. 2013; Van Halteren-van Tilborg et al. 2007). However, to maximize this effect, this study suggests that staff/trainers must be competent in operating and interacting with the technology to successfully teach others to use it.

While the Xbox 360 Kinect first appeared to be more conducive for single-player activities, this study quickly revealed that using motion-based technology in a group setting created a positive environment that provided opportunities for social interaction amongst group members, and between the players and the trainers. These findings echo previous studies exploring the use of motion-based technology for people with dementia or MCI, suggesting that using motion-based technology in a group setting provides social activity for people with dementia or MCI, further contributing to the leisure experience (Dove & Astell, 2017).

This study adds to the literature regarding the use of Xbox Kinect as an innovative tool to provide cognitive, physical and social activities for people with dementia (Dove & Astell, 2017). For example, in this study, the Xbox Kinect bowling game provided an engaging activity where players regularly performed light physical activity. Similarly, Schikhof & Wauben (2016)

revealed that a virtual cycling interface featuring cycling route videos and images stimulated participants to persevere in cycling through increased engagement. This suggests that motion-based technologies such as the Xbox Kinect can offer engaging physical activities to people with dementia.

To further harness the potential of this type of technology, it is recommended that designers work directly with people with dementia to ensure that motion-based technology software is designed to meet the diverse needs of this population (e.g. designing the game to give prompts directly, rather than constantly relying on caregivers to provide prompts). Additionally, the potential applications of this technology for people with dementia are quite broad. For example, while this study explored its use in an adult day program, there is significant potential for motion-based technology to be used with people with dementia in other environments such as personal homes, assisted living facilities and long-term care homes.

Limitations

This study is not without limitations. Firstly, despite the fact that our analysis solely focused on players with dementia, there were people without dementia (n=7/23) included in the Kinect bowling group. However, these players were included to be representative of the day program context, and to avoid modifying the natural environment which we were observing. Secondly, as the recruitment site already owned the Xbox 360 Kinect prior to the study taking place, all group members had prior experience with motion-based technology, which may have influenced their ability to play games presented on this type of technology. This also means that trainers were familiar with the technology and had previous experience in teaching day program clients to use it. As a result, the pre-study experience held by the trainers may have positively impacted their ability to teach people with dementia to use the technology.

Lastly, given that this study opted to use motion-based technology that was readily available at the recruitment site (i.e. Xbox 360 Kinect), the newer and more evolved Xbox One Kinect was not explored in this study. This could be interpreted as a limitation as the Xbox One Kinect is more accessible for people with mobility challenges than the Xbox 360 Kinect. For example, the Xbox 360 Kinect does not support seated play or accommodate assistive technologies (e.g. wheelchairs), which unfortunately hinders players from using a mobility device while interacting with the technology. This usability issue resulted in the need for physical support from trainers to enable people with mobility challenges to stand so they could participate. With the newer Xbox One Kinect, players can sit or stand while playing and the sensor is more accommodating of mobility devices. Consequently, it can be anticipated that the use of physical support from trainers will not be as necessary when using the Xbox One Kinect due to the device's advanced accessibility features.

Conclusions

The present study revealed that motion-based technology can be used to provide engaging group activities to people with dementia who attend adult day programs. Playing games on Xbox Kinect provided opportunities for learning, socialization, and engagement in meaningful leisure activities; all of which support a good life for people with dementia. This work adds to the body of evidence promoting the use of novel technologies to provide accessible yet engaging activities to people with dementia. However, further research is required to fully harness the potential of motion-based technologies for people with dementia. To maximize the usability and accessibility of this type of technology for people with dementia, it is also recommended that future work actively involves people with dementia in the design and development process (i.e. hardware and software creation).

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Conflict of Interest

The authors declare no conflict of interest.

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