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Nintendo Wii as an Intervention:
Improving the Well-being of Elderly in Long-term Care Facilities

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Staff and residents of SASCO Senior Citizens’ Home

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Abstract

This study examined the impact of playing Nintendo Wii on the psychological, social and physical well-being of elders. Based on the unique features of Wii, we also explored the possible mediation effects that social interaction and physical activity that playing Wii had on psychological well-being. Finally, we studied how the benefits of playing Wii may be magnified under different playing conditions. A six week-long intervention was held in SASCO Senior Citizens’ Home, a long-term care facility in Singapore. 45 residents aged between 56 and 92 years old took part in the study. Participants were split into three experimental groups: (1) Multiplayer Wii group (2) Single-player Wii group and (3) control group, who played traditional group games. Game sessions took place three times a week, lasting one and a half hours each. Questionnaires were administered through face-to-face interviews before and after the intervention. Measures included social interaction, physical activity, senior centre belonging, loneliness, affect and self-esteem. Results showed that playing Wii had a positive impact on the overall well-being of the elderly. Mediation effects were found for psychological well-being variables like loneliness and belonging. The elder in the single-player Wii group exhibited more positive affect compared to those in the multiplayer group. Through this study, Wii was proven to have a positive contribution to the overall well-being of the elderly. Explanations and implications for future applications of Wii in interventions for the elderly are were discussed.
Introduction

“Growing old is mandatory; growing up is optional.” – Unknown

Demographic ageing is a global phenomenon, and Singapore is one such country facing this problem. The number of residents aged 65 years or older will multiply threefold from the current 300,000 to 900,000 in 2030 (Ministry of Community Development, Youth and Sports, 2006). By then, one in five Singaporeans will be over the age of 65 (Heng, 2008). These statistics point to future challenges for Singapore, as the government prepares to cope with what they term the ‘silver tsunami.’

In anticipation of a population that will soon be skewed towards the older demographic, greater attention is increasingly paid to prepare the nation for a larger elderly population (Lee, 2009). Over the past decade, there was marked increase in the number of health care centres and care facilities catering to the elderly (Ministry of Community Development, Youth and Sports, 2006). Yet, providing adequate good quality healthcare for the elderly population remains a challenge due to concerns over the affordability and availability of manpower to provide such care. Also, structural issues continue to plague the long-term care sector in Singapore as the demand for care facilities catering to the elderly far outstrips the current supply (Oon, 2009; Ong, 2009; Suhaimi, 2009). Long-term care facilities for the elderly in Singapore are operated by both private and public providers. Cost issues faced by majority of the elderly in Singapore drive them to seek out places in subsidized care facilities that are limited in number. Compounding this dire situation, the subsidized care facilities are typically full and their waitlists are long. Currently, people have to wait for months to gain entry into these places (Suhaimi, 2009).

Recognizing these issues, the Singapore government has been directing greater efforts and more funding into the burgeoning long-term care sector. To cope with the rising demand, the
number of places available in these care facilities, from community hospitals to charity homes, will be increased substantially. Within the next decade, the numbers of beds are slated to increase by at least 50 per cent (Lee, 2009).

On top of logistical planning, the government has also implemented its long-term vision for Singaporeans to age gracefully. The Committee on Aging Issues (CAI) was set up to discuss proposals regarding aging issues in Singapore. Its vision is to ensure that all levels of society—the individual, the family, the community and the nation—are well-prepared for the challenges and opportunities of an aging Singapore. Part of the CAI’s desired outcome for the Singapore society is to see Singaporean elderly staying healthy, active and secure on the individual level, while fostering an integrated community on the societal level. With these pressing issues on the government’s agenda, it becomes essential to explore new ways of allowing the elderly to maintain an active lifestyle and continue to be socially integrated with the community. This means not only adapting already existing tools to the needs of older users, but also developing tools especially devoted to prevent or treat their precise impairments and diseases (Gamberini, Alcaniz, Fabergat, Seraglia, Gomez & Montesa, 2008).

One of the tools that is of great interest in research on health intervention and usage is the use of video games to address health issues. Ever since the inception of the video game, the benefits of these games have been recognized beyond their function as a source of entertainment. Past research has consistently shown that playing video games have the ability to aid improvements in attention span, hand-eye coordination, motor skills, short-term memory, problem-solving and reaction time (Goldstein, Cajko, Oosterbroek, Michielsen, Houten & Salverda, 1997). As such, video game-playing has been implemented in numerous healthcare interventions.
Some examples of video game-based interventions include the use of video game-playing as a treatment or rehabilitative tool for specific health problems like cerebral palsy and improving motor skills (Jannink, van der Wilden, Navis, Visser, Gussinklo & Ijzerman, 2008; Griffith, Voloschin, Gibb & Bailey, 1983). The benefits of video games have also been explored in interventions that involve improving peoples’ perceptual and cognitive abilities, as well as the training of visual attention for better driving skills (Belchior, 2008; Boot, 2007). With technological advancements, online video games were then explored for their therapeutic uses for mental health (Wilkinson, Ang & Goh, 2008). The incorporation of bodily movements in games like “Dance Dance Revolution” have even led to their use for health-related physical benefits (Olmsted, 2008).

Despite their numerous benefits, cutting edge video game technology has seldom found a receptive audience among the elderly. However, Nintendo Wii, a home video game console, has not only achieved tremendous commercial success, (Nintendo Co. Ltd, 2008; Sony Computer Entertainment Inc., 2009) it has also amassed a huge following among the elderly. Dispelling the stereotype that the elderly cannot keep up with technology, people in the above-65 age group have quickly picked up on Wii. Roughly 25 percent of today’s gamers are above 60 years old, and Wii is their game of choice (Howard, 2008). The immense popularity of Wii among the elderly debunks the notion that video games are only for young children and teenagers and shows the tremendous potential of this market for gaming technology (Petrecca, 2007).

Almost three decades ago, Ramm and Gianturco (1973) indicated that technological innovations could help the elderly in long-term care facilities continue as viable societal participants. As the latest technological innovation in video gaming, Nintendo Wii illustrates this example. A vital aspect of Nintendo Wii’s success is not only its uniqueness as a gaming method;
it also has the potential to be put to use as a serious game (Jung, McLaughlin, Rizzo & Weinstein, forthcoming)(i.e. interactive digital games for therapeutic purposes). Besides being highly entertaining, Wii allows the elderly to socialize and exercise while playing the games. Wii bowling leagues have also been known to be organized around its bowling game (Baig, 2009). Playing Wii also has benefits in improving functional abilities like hand-eye coordination and balance, which in turn reduce the incidence of falls among the elderly (Kiefer, 2008). Hence, some nursing homes and care centres have adopted Wii and incorporated it into their daily activities ("U.S. retirees bowled", 2007).

Although researchers are beginning to recognize the appeal of Wii and have begun to make inroads into understanding its benefits ("A Wii to get the elderly moving", 2009), there are few known empirical studies in this area. Therefore, this study seeks to firstly contribute to the research of this popular new video game technology and find out whether playing Wii will be beneficial to the overall well-being of the elderly. The second purpose of this study is to examine how the characteristics of Wii-playing have the ability to contribute to improvements in their psychological well-being. This is based on the unique features of Wii: the visual representation of the players on the game interface, and the physical activity involved in playing Wii games. The final aspect of this study examines a possible way to magnify the effects that playing Wii has on well-being. This area of inquiry focuses specifically on how the game is played and compares between playing Wii in single and multiplayer gaming conditions.
Elderly healthcare in Singapore

Aging brings with it various issues that the elderly have to grapple with, including aspects of the social, physical and psychological. Growing old is often equated with becoming lonely (Dykstra, Tilburg, & Gierveld, 2005). Retirement, loss of spouse, children leaving home, health problems, decline in energy, and disability are major life stressors that may cause feelings of uselessness and inadequacy in elderly people (Bozo, Toksabay & Kurum, 2009; Dykstra, Tilburg, & Gierveld, 2005). By then, most elderly would have gone through disruptions in their close social networks. As a result, they experience a drop in their social activity level. The impact on their social well-being may also spill-over and affect them psychologically too. It has been proven that loneliness among the elderly often adversely impacts their mental health, resulting in depression (Adams, Sanders & Auth, 2004; Holman, Ericsson & Winblad, 1999). This problem is exacerbated among those who have left their familiar home environments to live in long-term care facilities. Long-term care facilities for the elderly are homes for the aged with services ranging from independent living to skilled nursing (Paw, van Poppel, Twisk & van Mechelen, 2006). These facilities are age-segregated communities that cater specifically to the elderly who need shelter or nursing care. Compared to the social openness of younger people, the elderly living in these facilities find it harder to form new connections with the other residents there (Adams, Sanders & Auth, 2004).

The onset of functional disability as a result of chronic illnesses or the aging process is an inevitable part of growing old. Sometimes, such disabilities may have a more serious impact on the day-to-day activities and overall quality of life of the elderly. Inadequate levels of perceived social support and social engagement are one of the most significant factors for depression
among the elderly. In fact, the most prevalent mental health issue among the elderly today is low-level, sub-clinical depression, which affects up to 60% of the people in this age group (Blazer, 2000; Osgood, 1992).

A special group of the elderly population is those residing in long-term care facilities. On top of facing aging-related sources of psychological stress, this group faces more social isolation than their counterparts who have social support from an accessible network of relatives. In Singapore, most of the elderly admitted into the long-term care facilities either do not have a family to depend on, or come from families whom are unable to care for them daily. Either way, they are displaced from their familiar home environments and have minimal contact with their kin, both of whom are vital sources from which the elderly perceive their social support. (Iliffe, Haines, Gallivan, Booroff, Goldenberg & Morgan, 1991)

Golander (1995) outlined four dilemmas that constitute the lives of elderly residing in long-term care facilities. Firstly, the process of aging brings about new modes of somatic attention that the elderly have to grapple with as they are beset with weakening health. They also have to re-adjust to a more dependent position within the facility. Next, the elderly also have to deal with identity fragmentation and their self-image. Lastly, they have to redefine their sense of self, body and biographic time within the cyclical routine of the facility. In addition to these personal changes that take place within the elderly in these facilities, they also have to deal with the unfamiliar social environment in these places. Most people in these homes, residents, caregivers and visitors alike, are preoccupied with the physical management of their daily lives, especially pain management for the elderly residents. Social relationships, especially between demented and non-demented residents, are described as a ‘zero-sum game’ and are mostly non-beneficial to the persons involved. Hence, in the social environments of long-term care facilities,
it is not uncommon for the elderly residents to experience feelings of loneliness despite having company in that community (Adams, Sanders & Auth, 2004).

*Video games and the elderly*

The therapeutic effects of video games for the elderly have caught the interest of researchers for some time now. The concentration, memory and reflexes required in ‘first generation games’ inspired researchers who started using them as methods to enhance the perceptual abilities of the elderly. Clark, Lanphear and Riddick (1987) explored the effects of the elderly playing with ‘Pac Man’ and ‘Donkey Kong’ twice a week over seven weeks, and observed a reduction of their reaction time. Another study required the elderly to play a video game called ‘Crystal Castle’ once weekly over a period of two months. Results indicated that the games improved the elders’ manual dexterity, hand-eye coordination, verbal and non-verbal intelligence (Drew & Waters, 1986). The cognitive functions of video games have also been put to medical uses such as disease diagnosis. For example, ‘FreeCell’, a solitaire game installed in many home computers, was used to diagnose Alzheimer’s (Jimison, Pavel, McKanna & Pavel, 2004). Research that has been done on the therapeutic effects of video games on the elderly has also been applied in physiotherapy and occupational therapy (Sietsema, Nelson, Mulder, Mervau-Scheidel & White, 1993; Krichevets, Sirotkina, Yevsevicheva & Zeldin, 1994). Video games can also act as educational tools for the elderly, and is advocated by researchers in this area as useful for promoting short- to long-term memory functioning (Farris, Bates, Resnick & Stabler, 1994).

Research of video games on the elderly has also extended its scope to take into account the emotional and psychological aspects of gaming. As a result of physical and emotional involvement in video game play, such games have the ability to improve self-esteem among the
elderly (McGuire, 1984; 1986). Besides enhancing information processing, reading, comprehension and memory abilities of the elderly, Whitcomb (1990) reported that gaming also had an impact on their self-image.

In 1997, Goldstein and his colleagues conducted an experiment that investigated the impact of the elderly playing video games on reaction time, cognitive and perceptual abilities, as well as the subsequent effect on their emotional well-being. Their study was conducted on non-institutionalized elderly, who played video games for a period of five weeks. Data for the three measures were gathered before and after the gaming period. Their results showed that gaming positively affected the elderly in terms of their reaction time and also gave them a more positive sense of emotional well-being. A similar longitudinal study conducted by McGuire (1984) examined the effectiveness of playing video games on self-esteem and affect of the elderly who were residents in a long-term care facility. The elders improved significantly on both affect and self-esteem upon completion of the eight-week long study. This study demonstrated the use of video games as a non-instrumental activity to improve the quality of life for the elderly in long-term care facilities.

Emotional benefits as a result of playing video games, such as improved positive affect, have been found to be related to mental health (Banse, Etter, Reekum & Scherer, 1996; Goldstein, 1996; Dustman, Emmerson, Steinhans, Shearer & Dustman, 1992). Also, important skills such as communication and collaboration may be built or reinforced by video games through their capacity to offer a more social approach to learning and collaboration (Bailey, Pearson, Gkatzidou & Green, 2006). These studies have been significant as they demonstrated how video game technology could benefit one’s psychological well-being.
Wii as an intervention

The characteristics and features of Wii have the potential to address the health and well-being concerns of the elderly. First, its game interface provides a real-time visual representation of the players involved in the game. This interactive aspect fosters social interaction between the players. Second, a substantial amount of physical activity is required to play Wii. These two features of Wii differentiate it from other forms of video gaming and are likely to be significantly beneficial in health interventions.

Social Interaction

Playing video games in groups has the ability to foster social interaction among the individuals involved. Unlike the one-way communication flow of traditional forms of media, the new media can be a space for interaction, when more than a single person is involved in the process. Compared to traditional games, the interactive component of video games holds tremendous potential to change the social isolation effects in the environments of long-term care facilities (Corbin & Nelson, 1980). Nintendo Wii represents a unique stage of evolvement in video gaming technology. More significantly, its game interface allows for greater social interaction between the players involved. Yee and Bailenson's Proteus effect (2007) illustrates how the process of Wii-playing fosters greater social interaction.

The Proteus Effect was coined to explain how the visual representations of avatars influence a person's behavior. This perspective hinges on the fact that the differences between real-life environments and online environments are bridged when people identify with their avatars. How they perceive and identify with their avatars has a significant impact on their behaviors. In this study, the Proteus Effect is applied to explain the influence that the process of playing Wii has in facilitating social interaction among the players. Firstly, there has to be a link
established between a person playing Wii and his or her portrayed avatar (known as a ‘Mii’). The differentiating aspect between Wii and other forms of video games or even traditional games lies in how the game is played. The innovative technology of Wii, incorporating infrared technology, motion sensors and Bluetooth into its wireless controller system, allows players to move about freely with the controllers. On top of that, motion sensors in the controller are able to detect tilts, rotation and acceleration (Brain, 2008). These features are highly innovative and revolutionary in the gaming industry because it changes the way video game controllers are used. Game play is controlled by the instinctive natural body movements of the player instead of tricky combinations of buttons. Hence, the movements of the Mii mimic the actual movements of the person wielding the Wii controller. On top of that, Wii allows users to create their own Miis, by deciding how they look and naming them. These two features of Wii act as identity cues that enhance the sense of identification players feel towards their Miis. This sense of identity exceeds that which is possible in previous forms of video games that lack the naturalistic representations of human movements.

As people play Wii games together, their Miis interact with one another on screen. This creates a visual representation of the players in the virtual environment. In these situations, the Proteus Effect takes place when the individual player observes his or her Mii interacting with other Miis. When playing a game, players are exposed to visual representations of themselves interacting together on screen. Through identification with the Mii, the player conforms to the characteristics and expectations that are observed in the Mii’s interaction in the virtual environment. This creates the perception of increased social interaction in the real-life relationships between the player and others. The increase in the perceived social interaction will also translate to greater openness and willingness to interact between all the players in the Wii-
playing social environment. This demonstrates the hypothetical relationship that playing Wii will have on the level of social interaction that occurs between the people who engage in Wii-play.

While the Proteus Effect illustrates the social interaction that takes place within Wii games, another condition in Wii-gaming that encourages social interaction concerns the social environment that takes place around the game. Besides the entertainment value of Wii-gaming, the elderly also enjoy the social interaction that comes along. In short, even the act of watching others playing Wii is enjoyable for them. Nathanson and Cantor's (2000) concept of co-viewing can be used to understand this. Previously applied to the television, co-viewing is defined as the passive process in which a parent participates in the consumption of media along with the child (Kirsh, 2006). In the same way, the game interface of Wii is similar in entertainment value as television programmes, albeit more interactive. When playing Wii, those who are not actively involved in the game have a passive role in the gaming process as co-viewers. The act of co-viewing is a unifying process by which the elderly who engage in it enjoy the activity of playing Wii together. This fosters a sense of belonging among those in the social environment. At the same time, active television mediation can also occur, where the parties exposed to the media actively engage in discussion about what they see on-screen (Nathanson and Cantor, 2000). With its origins in violent television viewing, this concept can also be applied understand how social interaction can occur even among the elderly who are not engaged in Wii-play. In summary, social interaction that arises from Wii-gaming can take place in two ways: first, through interaction that occurs in the game itself and second, between persons in the environment around the Wii game.
Physical activity

Another aspect of Wii that is unique as a video game is the fact that it incorporates substantial physical activity into the act of playing the Wii games. Due to the nature of the Wii controller, a substantial amount of physical movement and activity are required to play the games. Empirical research has demonstrated the medical benefits of Wii for the therapeutic treatment of cerebral palsy, Parkinson’s disease and osteoporosis (Deutsch, Borbely, Filler, Huhn & Guerrera-Bowlby, 2008; Waldrop, 2003). So far, Wii has already been implemented in physical rehabilitation programmes to help improve mobility (Wadsley, 2009). Using Wii as a therapeutic activity with elders allows the clinician to work towards goals such as increasing standing and activity tolerance, improving dynamic balance and reducing fear and anxiety. Video games, which require physical activity, like the Wii, can fight child obesity with its potential to increase energy expenditure in children to a degree similar to that of traditional playtime (Lanningham-Foster, Jensen, Foster, Redmond, Walker, Heinz et al, 2006).

Wii’s uniqueness as a video game does not just lie in its functional characteristics. The nature of the Wii games, coupled with the human motions required in the games, brings a different dimension to video gaming altogether. In the example of Wii Sports, a basic game that comes with every Wii console package, the controllers are used in the simulation of actual sports such as bowling, tennis and golf. Wii incorporates an element of entertainment into the exercise process, which is important for the enjoyment of the game. Wii Sports require players to simulate the arm motions similar to playing the actual sport. In fact, exercising through video games like Wii are likely to be preferred over actual physical sports or instructional exercise activities (Olmsted, 2008). Through the use of Wii as an ‘exergame’ or ‘exertainment’, Wii is an innovative way of reducing sedentary activity in the elderly and promote a more active and
health lifestyle for them (Young, 2008). It allows them to simulate the experience of playing a
sport that they may not be physically capable of doing in real-life. In view of these beneficial
qualities of the Wii, we postulate the possibility of this interactive technology in positively
affecting the well-being of the elderly population.

Well-being: Definition and its Constituents

According to Crisp (2005), a person's well-being, in general, is what is ‘good for’ them
and it amounts to the notion of how well a person’s life is going for that person. Hence, overall
well-being is an important reflection of how one regards his or her own life. The Social
Production Function (SPF) Theory was applied as a structural framework to describe the
satisfaction of the needs of the elderly, where both health-related and non-health related factors
play a part in determining one's quality of life. In this theory, quality of life is defined as
psychological well-being, which is dependent on the realization of both social and physical needs
(Puts, Shekary, Widdershoven, Heldens, Lips & Deeg, 2007). Having a sense of well-being is
related to basic psychological needs and these also include emotional issues such as pleasure,
mood regulation and relaxation, as well as issues of identity, belonging, and agency (Laukka,
2007). Apart from having a sense of well-being, the other two most desirable conditions in order
for the elderly to enjoy life is good physical health and social contacts (Puts, et al., 2007). Being
in a good state of physical and psychological health is necessary for well-being (Gracia, Herrero
& Musitu, 1995; Gracia, 1997). In this study, overall well-being constitutes the following:
psychological well-being, social well-being and physical well-being.
Studies have found the following factors to be constituents of psychological well-being:

A) Affect

The established concept of subjective well-being is a broad category that comprises peoples' long-term levels of affect, lack of unpleasant affect, and their satisfaction with life (Diener, 1984; Lucas, Diener, & Suh, 1996). As the elderly age, they are increasingly beset with deterioration in their physical health. While this process is inevitable, what varies among the elderly is their ability to cope with these changes emotionally. While some may face emotional difficulties in coming to terms with their declining physical states, the elderly who are best able to handle these emotional struggles usually have better perceived states of well-being (Wiesmann & Hannich, 2008). In other words, an elder’s extent of positive emotive feelings is an indicator of how well they adjust psychologically to the challenges of aging and this has a direct impact on their health and well-being (Kahn, Hessling & Russell, 2003). In line with this, evidence shows that low subjective health — not objective health — is a major predictor of mortality in industrialized countries (Idler & Benyamini, 1997).

B) Self-esteem

Another psychological factor that has an impact on the elders' well-being is their self-esteem. Self-esteem is one of the dimensions of psychological well-being and is a component of an individual's self-evaluation (Lawton, 1982). It is determined by the capacity of a person to adapt to the demands and challenges in life, and is likely to have a positive effect on life satisfaction (Rosenberg, 1965; Blascovich and Tomaka, 1991; Fagerström, Holst & Hallberg, 2007). In the case of the stress-related issues of aging, the level of self-esteem the elderly possess determines how well they are able to cope psychologically with their situations. Their psychological resilience in turn has an impact on their actual health and well-being. Essex and...
Klein (1989) found that self-esteem has an indirect relationship with one's health; people with high self-esteem were more likely to interpret their health problems positively and feel more confident when handling tough situations. This is important in determining how the elderly adjust to the physical and social problems they face as they age.

**C) Loneliness**

Results from a number of studies have demonstrated a relationship between having social ties and a variety of physical health outcomes (Lennartsson, 1999). Conversely, a lack of social ties, which leads to social isolation and loneliness, can result in negative physical health. A study was done to measure the effects of different sources of social ties on self-rated physical health of the elderly. The results indicate that social contacts with friends are related to well-being and that consequently fewer contacts lead to less well-being (Lennartsson, 1999).

Feelings of loneliness have negative associations with physical health outcomes as well as emotional well-being. Lee and Ishii-Kuntz (1987) examined the effects of interaction on the emotional well-being or morale of the elderly, and the extent to which these effects are mediated by feelings of loneliness. The results show that loneliness has a major negative effect on emotional well-being.

**D) Belonging**

Having a strong sense of belonging to one’s community also leads to good physical and mental health. Theories on sense of belonging explain it as being an instinctive part of human beings’ nature. Belongingness theory proposes that humans possess an innate drive for a minimum number of lasting interpersonal relationships (Watt & Badger, 2009). Another theory, Maslow’s Hierarchy of Needs, points out that a sense of belonging to a group of people or a community is one of the five most important human needs. A number of studies conducted under
different contexts have proved that a sense of belonging is essential to well-being in different aspects. A study investigated the sense of belonging to a neighbourhood among Australian elderly women and the consequent effect and relation to their mental and physical health. The result concluded that a better sense of neighbourhood was associated with better physical and mental health, lower stress, better social support and being physically active (Young, Russell & Powers, 2004). In individuals’ emotional well-being, a study tested the relationship between sense of belonging and homesickness, and found a positive significant relationship and causal effect between individuals’ need to belong and homesickness. An additional finding showed that individuals who felt accepted into the community were less homesick (Watt & Badger, 2009).

Looking at the theoretical benefits playing Wii has on the psychological, social, and physical well-being of the elderly, we propose the following hypotheses:

\(H_1: \) The elderly who have experienced Wii games will have (a) more positive affect levels, (b) higher self-esteem levels, (c) less feeling of loneliness, (d) stronger sense of belonging, compared to those who have not been exposed to Wii in a long term care facility.

\(H_2: \) The elderly who have experienced Wii games will have greater levels of perceived social interaction compared to those who have not been exposed to Wii in a long term care facility.

\(H_3: \) The elderly who have experienced Wii games will engage in more physical activity compared to those who have not been exposed to Wii in a long-term care facility.

**Mediators of psychological well-being**

The second purpose of our study is to understand how Wii improves the psychological well-being of the elderly in long-term care facilities. Wii’s unique combination of physical interaction and social engagement thus has potential implications for personal and social well-
being. As such, we want to find out if social interaction and physical activity mediates improvements in psychological well-being among the elderly who play Wii.

**Mediating effect of social interaction**

There has been burgeoning interest in recent years of the benefits of social support on the well-being of the elderly (Antonucci & Akiyama, 2009; Fiori, Smith, & Antonucci, 2007; Chou and Chi, 2005; Magai & Consedine, 2004; Cummings, 2003; Siebert, 1999). Compared to those who do not maintain meaningful ties with others, the elderly who enjoy adequate support from their social networks appear to have a higher quality of life on the overall. This in turn, has positive effects on their physical and mental health as well (Schaie & Carstensen, 2006; Hays, Steffens, Flint, Bosworth & George, 2001; Smith, Toseland, Rizzo & Zinoman, 2004). Being actively engaged in social networks also benefits the elders' overall emotional satisfaction and cognitive functions (Bassuk, Glass & Berkman, 1999; Seeman, Lusignolo, Albert & Berkman, 2001). Elderly who have adequate social networks and support have been found to be better off psychologically in terms of feelings of affect, cognition, and their self-esteem (Phillips, Siew, Yeh & Cheng, 2008). While the emphasis on the importance of family is intrinsic to Asian culture, especially among the Chinese, family relations are not the only sources through which social support can be found. In fact, on top of social engagement with spouses or family, friendships and group memberships have also been associated with better cognitive functioning (Bassuk, Glass & Berkman, 1999). Research has shown that apart from social support from their kin, people over 80 years of age may even feel more emotional satisfaction from relationships with people around their age, by producing more feelings of autonomy and independence (Tiikkainen et al., 2008). In the context of the elderly residing in long-term care facilities, there is
potential to foster emotional and social support among the residents, even though they may have limited or no contact from their families and relatives.

The social support that the elderly get has been found to be vital in determining the state of their psychological well-being, and even has links to their actual physical state of health. Evidence in Glass, Mendes de Leon, Bassuk, and Berkman’s studies showed that social engagement significantly predicted mental health in later life and also protects against self-reported disability (2003 & 2006). Central to this intervention is the ability of Wii to facilitate social interaction by creating and strengthening social networks within a community, which in turn, generates more positive feelings of well-being among the elderly. The perceived quality of an individual’s social relationships is an important factor in reducing loneliness and enhancing the sense of well-being in the elderly (Kim, 1999; Mullins & Dugan, 1990). The health benefits stemming from an individual's sense of social support are important too. Studies have found lonely people have a higher risk of developing Alzheimer’s disease (Wilson, Krueger, Arnold, Schneider, Kelly, Barnes, et al., 2007), while positive social environments are able to lessen the incidence of dementia (Fratiglioni, Wand, Ericsson, Maytan & Winblad, 2000; Fabrigoule, Letenneur, Dartigues, Zarrouk, Commenges & Barberger-Gateau, 1995). Social factors have also been found to be related to general cognitive functioning. Social engagement can be beneficial for both short- and long-term mental health, as the need for social cognition in interpersonal interactions can help “exercise” general cognitive processes (Draganski, Gaser, Busch, Schuierer, Bogdahn & May, 2004; Ybarra, Burnstein, Winkielman, Keller, Manis, Chan & Rodriguez, 2008).

Interventions that have been carried out include Semenza and March’s (2009) macrosocial approach to enhancing social capital, health and well-being of individuals in a
community by promoting social interactions. Research on the elderly has recommended intervention methods for strengthening community ties in order to bring about improvements in psychological well-being and overall quality of life (Phillips, Siew, Yeh & Cheng, 2008). In this study, the building of stronger social relationships through playing Wii is predicted to help improve the psychological well-being of the elderly.

*Mediating effect of physical activity*

Another issue related to aging is the weakening ability of the elderly to manage their activities of daily living (ADL) as they age. These are activities an individual needs to perform to live independently, such as bathing, feeding, dressing and taking care of their toilet hygiene (Huber, 2005). Failure in carrying out ADL was found to trigger depression among elderly people (Mancini & Bonanno, 2006). When elderly people cannot take care of their basic needs, it may cause them to feel incapable and dependent, and become distressed and pessimistic (Bozo, Toksabay & Kurum, 2009). Also, a sedentary lifestyle and a fear of falling often go hand in hand, creating a reciprocal nature among fall risk factors in the elderly (Edelberg, 2001). Studies have shown that the increasing functional disability in the elderly is associated with psychological problems such as depression (Gureje, Ogumniyi, Kola, and Afolabi, 2006; Koenig & George, 1998). Furthermore, the brain’s functional abilities deteriorate with age and the inability of the elderly to experience the capabilities that they once had add more stress to their psychological well being (Jaffe-Gill & Kemp, 2009).

Hence, there is a need to incorporate adequate physical activity into the daily lives of the elderly while taking into account their reduced functional abilities. Studies have shown that low-intensity exercises have the same beneficial effects on well-being as moderate-intensity exercises, and hence are more suitable for the elderly (Stevenson & Topp, 1990; Brown, Wang, Ward,
Ebbeling, Fortlage, Puleo, Benson & Rippe, 1995). Even the lowest levels of physical activity, when practiced often enough, have been shown to be able to improve the physical health of elderly persons (Kerse, Peri, Robinson, Wilkinson, von Randow, Kiata et al., 2008; Ho, Wen-Miin, Lien, Ma, Kuo, Chu et al., 2007; Lan, Chang & Tai, 2006). Besides being beneficial for physical health, exercise also has a positive impact on the mental health of elders (Chou, Macfarlene, Chi & Cheng, 2006). The simple motor skills involved in playing Wii can help to improve or maintain hand-eye coordination, thus preventing falls (Kiefer, 2008). The physical benefits of regular exercise include increases in cardiovascular fitness, muscle strength, and functional capacity in the long term. This increases the ability of the elderly to participate in their daily activities, and thus allows them to maintain their sense of independence. Taken in its totality, the benefits of regular exercise can significantly improve the quality of life among the elderly (Tanaka, 2009; Daltroy, Larson, Eaton, Phillips & Liang, 1999).

This study applies the two-step flow model as a theoretical framework to illustrate how these functions of Wii may be beneficial for the well-being of the elderly in the long term. The theory of the two-step flow has been influential for decades in thinking about interactions between the mass media and interpersonal relations (Kayahara & Wellman, 2007). The theory was put forward initially to explain for the minimal influence media messages have on people’s opinions, stating that the effects the media has on people are indirect because they are first filtered through opinion leaders before reaching the public. Thereafter, the two step flow has also been applied in the creation of entertainment-education (E-E) programmes. E-E programs utilize the two-step flow theory to account for interactions between the mass media and interpersonal relations. The mass media, in the form of E-E programs, can be used to promote social development goals (Sabido Methodology, 2008; Singhal & Obregon, 1999). Since then, two-step
flow theory has also been applied to more contemporary contexts like the Internet (Kayahara & Wellman, 2007) and blogs (Meraz, 2008).

The same rationale can also be applied to video games like Nintendo Wii to examine the social functions that the device may have apart from entertainment. The characteristics of Wii may be mediating factors that lead to improvements in well-being. This theoretical framework was applied to derive the hypotheses of how the factors of social interaction and physical activity mediate the improvements in quality of life from playing Wii. In Figure 1, the two-step flow diagram illustrates how playing Wii encourages social interaction and increases the level of physical activity, which has resulting benefits on their psychological well-being. The following hypotheses depict the relationships that social interaction and physical activity play as mediators between playing Wii and psychological well-being:

\[ H_4: \text{Social interaction through Wii-play mediates the improvement in the well-being of elders.} \]

\[ H_5: \text{Physical activity through Wii-play mediates the improvement in the well-being of elders.} \]

**Single vs. Multiplayer gaming conditions**

Focusing on the social interaction that is mediated through Wii play, our last area of inquiry in this study examines the social aspect of Wii-playing and how it may be related to the way the game is played. We want to understand if there are any contextual factors within the game that can help facilitate social interaction within the game-play environment, thus magnifying the utility of playing the games. While the entertainment value and the physical activity involved in each Wii game are constant regardless of the number of players involved, the
act of playing together cooperatively or competitively in a game can help to enhance interaction between the people involved in the game (Cole & Griffiths, 2007).

When a few players play together using multiple controllers simultaneously, Wii turns into a multiplayer game and this requires teamwork and cooperation. This in turn helps to facilitate social interaction. In fact, it is the key factor in determining the enjoyment that gamers derive from engaging in the game (Chen, Duh, Siew & Zi, 2006). Interaction occurs when players form teams and cooperate with one another, or engage in the game competitively.

Regardless of the type of game or the medium, social activity is an inevitable and vital component of most electronic games nowadays. Similarly, playing Wii also involves a certain level of communication among the players. In their study of video games and the elderly, Goldstein and his colleagues (1997) observed that, like young people, elderly players also used the games as a topic of conversation in an effort to make and maintain friendships. This was done through discussing their play with other people in various social settings in the community.

Besides interpersonal interaction, group play may also involve collaborative, communicative and leadership strategies among those playing multiplayer games (Harris, 2008). Relative to single-player games, games which involve multiple players are more enjoyable and the players benefit from the social interaction and additional relationships that form through the games. This is the definitive feature of multiplayer electronic games (Smyth, 2007).

Additionally, the concept of the aforementioned Proteus Effect makes provisions for how the perception of social interaction between avatars affects the eventual behavior of the players. A logical deduction from this concept is that the number of people involved in playing a game has the ability to affect how one perceives the extent of social interaction. For example, a Wii game that involves multiple players gives the individual player the perception that they are
interacting with the other players as well. In contrast, in a single player game, the player interacts solely with a computer-controlled avatar instead of one that represents the actual people in the social surroundings. Therefore, the perception of social interaction that one has in a multiplayer game setting is markedly different from that which is experienced when playing alone.

Hence, the differences between the multiplayer and single-player gaming conditions lie in the factors concerning the players' enjoyment, communication and social interaction through playing Wii. The consequences of these differences can be seen in the resulting well-being improvements that ensue. In line with this argument, we posit hypotheses that support how multiplayer gaming conditions maximize the utility of playing Wii in comparison to single-player games. This is subsequently associated with more evident improvements in the psychological well-being among the elderly who are in the multiplayer Wii-gaming condition.

\textit{H}_6: \textit{The elderly who play multiplayer Wii games will have (a) more positive affect levels, (b) higher self-esteem levels, (c) less feelings of loneliness, (d) stronger sense of belonging, compared to those who play single-player Wii games.}

\textit{H}_7: \textit{The elderly who play multiplayer Wii games will have greater levels of perceived social interaction compared to those who play single-player Wii games.}
Methodology

Overview

To explore the long-term psychological benefits of video games on the elderly, we collaborated with SASCO (Singapore Amalgamated Services Co-operative Organisation) Senior Citizens' Home, a long-term care facility which has been providing shelter for needy elderly over 60 years of age in Singapore. Guided by our model of the two-step flow, our goal was to implement a programme involving Wii play that investigated whether playing Wii would be beneficial to the elderly, and how it may help to address the common needs faced by the elderly - and in specific, those residing in long-term care facilities like SASCO.

The intervention was a six-week long programme, implemented in SASCO. Residents in SASCO are made up of men and women of various ethnicities and dialects. The participating seniors were mostly semi-ambulant but were able to move around independently. They qualified for the study if they had reasonable motor skills and vision and had functional cognitive abilities to play Wii games. In total, 45 residents took part in the study. The residents in the programme were divided into three groups of 15 people each. In each group, quota sampling was employed to ensure that there was an equal mix of both males and females in the group. The participants were randomly assigned to one of the three conditions with gender balanced across conditions via the quota sampling method.

In the first condition, participants were given a Wii set that had four controllers. This allowed up to four people to play a game together at any one time. Individual game-play was not allowed. In the second condition, participants had a Wii set with only one controller, so only one person could play at any given time. The third condition was a control group where participants...
played traditional games like memory games, UNO and Jenga. To ensure comparability between this group and the Wii-playing groups, the games introduced were new to the participants.

As the content of the games played is not central to the focus of this study, the Wii games that the participants played were not strictly restricted. To maintain interest in Wii and to provide constant challenges to the participants, a decision was made to include as many relevant games as possible instead of just restricting the games menu to a particular type. This is because males and females have different gaming preferences in terms of competitiveness and gaming styles (Hayes, 2007). In total, four games from Wii Sports and Cooking Mama were introduced in the intervention. The Wii sports games were tennis, bowling, baseball and boxing.

The activity sessions, lasting 1.5 hours each, took place three times a week. During these sessions, the participants of each group gathered in separate activity rooms, where the various activities were facilitated by the researchers and volunteers from Fei Yue Community Services. Caregivers from SASCO were also present to assist the games. Taking into account the time taken for new technology to be adopted, three training sessions lasting 1.5 hours each were held one week before the actual intervention started. During the training, the participants were slowly introduced to Wii technology and taught how to use the controllers. Both of the Wii-playing groups were first taught to play Wii Tennis. By the time the programme was implemented, the elders had gained a level of familiarity with Wii. During the programme, facilitators were present to help the participants play the games and to ensure that everyone had a chance to play during that session. A researcher was also present to log in the amount of play time that each participant clocked in for that session. The amount of play time for each participant was tracked so that at the end of the week, every one would have roughly spent equal amounts of time playing the games. On the average each week, participants in the single-player group clocked an average of
about 15 minutes playing Wii. Those in the multiplayer group clocked in about 55 minutes per week, taking into account the Wii-play time that was shared between four players each time. This amounted to almost the same time as the single-player group when averaged out among the four players.

Similarly, the elders in the control group who played traditional games instead of Wii, also clocked the same amount of playing time as the two Wii-playing groups. Three training sessions, each lasting 1.5 hours a week, were also conducted in this group, one week before the actual commencement of the games. Participants in all three groups were also unaware of each other’s activities and the type of games they were playing. This ensured that conditions in all 3 groups were properly controlled for, thus preventing any sensitization effect.

Procedure

Face-to-face interviews were conducted on all 45 participants. Interviews were used instead of self-administered surveys as literacy was an issue with some of the participants. Another reason for conducting the interviews was the unique mix of languages and dialects that characterize first-generation Singaporeans. The participants were of various ethnicities and dialects and spoke a range of languages, such as English, Mandarin, Hokkien, Cantonese and Malay.

The questionnaire, originally in English, was translated into Mandarin by a professional translator. However, written translations for dialects like Hokkien and Cantonese were unavailable, if not unheard of. Interviewers who were proficient in the various languages were recruited to conduct the interviews. The interviewers consist of these researchers and volunteers from Fei Yue, all of whom were highly proficient in at least one of the dialects. In the case of the dialect languages, verbal translations were made based on the Mandarin version of the
questionnaire. To ensure accurate translations, training sessions were held for the interviewers prior to the interviews. Apart from familiarizing them with the questionnaire and interviewing protocol, we also established a standard for translations in Hokkien, Cantonese and Malay to ensure that the translated words accurately reflected the intended meanings of the questions. All the interviewers were instructed to follow closely to the questionnaire to avoid any potential confounds that may arise because of the individual interviewers. For participants who were bilingual, interviews were conducted in the language that they were most comfortable with.

Altogether, two sets of data were collected: the first round of data collection was conducted in the first week of January 2009, before the commencement of the training and the programme. The same participants were interviewed again in mid-February 2009, after the intervention had concluded.

Participants

Fourty-five elders participated in the study. The participants had the following characteristics: 60% were male and 40% were female; with respect to ethnicity, 93.3% were Chinese, 4.4% were Malay, 2.2% were Indian. With respect to marital status, 20% were married or had a domestic partner; 48.9% were single; 22.2% were widowed; 4.4% were separated or divorced. Highest education level was represented in the sample as follows: 4.4% had tertiary education or above; 24.4% had graduated from secondary or pre-university, 64.4% are from primary school and below while 6.7% are unsure of their education levels. With respect to age, the average age was 76.31 with a range from 56 to 92.

Measures

Loneliness was measured with the UCLA Loneliness Scale (Version 3). The scale has been tested in many studies and is regarded to be highly reliable in terms of internal consistency
(coefficient α ranging from .89 to .94) and test-retest reliability over a 1-year period ($r = .73$) (Russell, 1996, p. 20). The twenty items in the scale contain statements about participants’ feelings on loneliness in a particular setting. Participants can choose between “Never”, “Rarely”, “Sometimes” and “Always” in response to the statements, with scores of ‘1’, ‘2’, ‘3’ and ‘4’ attached to them respectively. The scores on this index were averaged, with higher scores indicating a stronger sense of loneliness.

The *Rosenberg Self-Esteem Scale (SES)* (Rosenberg, 1965) was used as a measure of the participants' level of self-esteem. This scale was initially designed by Rosenberg to measure adolescents' feelings of self-worth and acceptance, but has since been applied to many other contexts, including the elderly. This is a 10-item Likert-style questionnaire consisting of five positive and negative statements each. It is one of the well-used measures to assess self-esteem because of its proven validity (Blascovich & Tomaka, 1991). The scores for all ten items were averaged ($\alpha = .89$), with higher scores indicating more positive self-esteem.

The *Bradburn Affect Balance Scale* (Bradburn & Caplovitz, 1965) was used to measure the level of positive or negative affect of the participants. The ten statements in the scale are to be rated either "YES" or "NO", with five statements each reflecting Positive and Negative Affect. Positive responses (reflecting positive affect) to the statements were given a score of “1”, and negative responses (reflecting negative affect) were scored as “0”. The scores for all ten statements were totaled, with higher scores indicating a strong positive affect.

To measure social interaction, measures were adapted from the *Interview Schedule of Social Interaction (ISSI)*, an abbreviated version of Henderson and colleagues’ original 52-item questionnaire (Henderson, Byrne & Duncan-Jones, 1981). The scale is subdivided into four subscales, out of which we chose the two most relevant sections: the availability of social
interaction (AVSI; up to 4 points), and the adequacy of social interaction (ADSI, up to 5 points). This gives a total score of 9 points, with higher scores indicating stronger social network and more satisfaction.

On top of measuring social interaction, the *senior centre belonging index* was used to measure the participants' feelings of belonging to the community at SASCO (Cody, Dunn, & Witmer, 1999). The 20 items in this index contain statements about relationships with other seniors in the home and the depth of these relationships, if they helped each other and whether they enjoyed the company there. The scores on this index ($\alpha = .89$) were averaged, with higher scores indicating a stronger sense of belonging.

The *Physical Activity Questionnaire for Elderly Japanese* was adapted as a measure of physical activity (Yasunaga, Park, Watanabe, Togo, Park, Shephard et al., 2007). It was developed as a recall questionnaire that explores the frequency and duration of involvement in each of seven categories of physical activity during a typical week in the preceding month. Hence, it acted as a valid reflection of any physical changes that would have taken place during the duration of the intervention. Four types of physical activity that were relevant to the lifestyles of the elderly at SASCO were chosen: these include Light Exercise, Moderate Exercise, Light Housework and Labor. For each category of physical activity, respondents were asked often they performed this activity in a given week: never, seldom (1 or 2 days), sometimes (3 or 4 days), or often (5–7 days). Based on their answer, there were then asked about time taken to perform that activity, with options ranging from <1 hour, 1 to <2 hour, 2 to <4 hours, or $\geq$4 hours. The categorical data was subsequently converted to arbitrary scores, using midpoints for the stated frequency and duration of potential responses. The midpoints for frequency are never = 0, seldom = 1.5 days, sometimes = 3.5 days, and often = 6 days, and for the duration of effort, the
corresponding midpoints are <1 hr = 0.5 hours, 1 to <2 hours = 1.5 hours, 2 to <4 hours = 3 hours, and ≥4 hours = 5 hours. To convert these arbitrary PAQ-EJ scores to MET hours per week, an intensity weight was assigned to each physical activity. The weightings used for this purpose were light exercise = 3.0 METs, moderate exercise = 4.3 METs, light housework = 2.0 METs, and labor = 2.8 METs. The final PAQ-EJ score was computed as the product of: the number of days, time taken, and the intensity weight of that activity.
Results

An independent-samples $t$ test was conducted to evaluate the first hypothesis that elders who play Wii are better off in their psychological well-being than elders who engage in traditional activities. The various aspects of well-being measured were senior centre belonging, loneliness, affect and self-esteem. Compared to those in the control group, the elderly in the Wii condition scored significantly higher on belonging, self-esteem affect, and significantly lower on loneliness. To investigate H2 and H3, the same test was conducted on the variables of social interaction and physical activity respectively. Elders in the Wii condition reported higher levels of social interaction than the control group. Similarly, those in the Wii group reported higher levels of physical activity compared to the control group. The means, standard deviations and $t$ values of all the variables tested on these two groups are shown in Table 1.

The same tests were conducted on the pre-test data, comparing how the Wii group and the control differed on psychological well-being, social interaction and physical activity. No significant differences were found for any of the pre-test variables. The full set of results is available in Table 2.

A series of paired-samples $t$ tests using pre- and post-test data were conducted on the same set of variables. These acted as explanatory analyses to investigate whether there was a change in the Wii-playing group from the intervention. Results indicated that social interaction, physical activity, senior centre belonging were significantly higher and the level of loneliness was significantly lower among the participants. Table 3 shows how the Wii group differed in their means, standard deviations and $t$ values between the pre- and post-tests.

To eliminate other alternative explanations such as the Hawthorne effect, which may account for the changes in the participants, paired-samples $t$ test were conducted on the pre- and
post-test data of the control group. Results indicated that the participants in the control condition showed higher levels of post-test social interaction ($M=5.71, SD=1.73$), compared to the pre-test ($M=3.21, SD=3.04$), $t(13)=6.68, p<.01$. There were significant differences in physical activity and affect between pre- and post-test, but in the negative direction. Physical activity was significantly lower ($M=9.91, SD=6.23$) compared to the pre-test ($M=18.76, SD=13.62$). Similarly, affect was also significantly lower ($M=2.93, SD=1.64$) than before it was introduced ($M=4.79, SD=1.58$).

**Mediation analysis**

The Baron and Kenny (1986) mediation analysis, Sobel test and bootstrapping test were used to find out whether social interaction and physical activity are mediating factors of Wii-play.

For the Baron and Kenny mediation analysis, five things need to be confirmed in order to demonstrate mediation. First, the independent variable has a significant effect on the mediating variable. In this study, Wii-play (independent variable) was a significant predictor of social interaction (mediating variable), the standardized regression coefficient ($\beta=.48, p<.01$), as well as for physical activity ($\beta=.55, p<.00$).

Second, the mediating variable has a significant effect on the dependent variables. Social interaction significantly predicted all the dependent variables when it was the only predictor in the regression equations: loneliness ($\beta=-.54, p<.00$); self-esteem ($\beta=.42, p<.01$); affect ($\beta=.41, p<.01$) and senior centre belonging ($\beta=.66, p<.00$). For physical activity as a mediating factor, it was also a significant predictor for all the dependent variables as the only predictor in the regression equations: loneliness ($\beta=-.38, p<.05$); self-esteem ($\beta=.43, p<.01$) and senior centre belonging ($\beta=.54, p<.01$).
Third, when the dependent variables are regressed on the independent variable alone, the independent variable has a significant effect. Wii-play was a significant predictor for all dependent variables when it was the only predictor in the regression equations: loneliness ($\beta = -0.63, p < .00$); self-esteem ($\beta = 0.52, p < .00$); affect ($\beta = 0.40, p < .01$) and senior centre belonging ($\beta = 0.52, p < .00$).

Fourth, when the dependent variables are regressed on both the mediating variable and the independent variable, the effect of the mediating variable on the dependent variables should keep significant. The effect of social interaction remained significant for loneliness ($\beta = -0.31, p < .05$) and belonging ($\beta = 0.54, p < .01$) when both the independent variable (Wii-play) and the mediating variable (social interaction) were entered into the regression equations. On the other hand, the effect of physical activity only remained significant for belonging ($\beta = 0.36, p < .05$) when both the independent variable (Wii-play) and the mediating variable (physical activity) were entered into the regression equations.

Finally, the effect of the independent variable on the dependent variables should decline, when the dependent variables are regressed on both the mediating variable and the independent variable. A regression analysis confirmed this final requirement for mediation. The effects of playing Wii on loneliness ($\beta = -0.48, p < .01$) and senior centre belonging ($\beta = 0.26, p < .05$) declined as to lose their previous statistical significances. For physical activity as a mediating factor, the effects of playing Wii on senior centre belonging ($\beta = 0.33, p < .05$) declined to lose its previous statistical significance.

Put together, the series of the regression analyses provide strong evidence for the mediating effect of social interaction on elders’ loneliness and senior centre belonging as well as mediating effect of physical activity on elders’ loneliness when playing Wii. Figures 2 and 3
depict a pictorial view of this entire analysis using social interaction and physical activity as mediating factors.

For a more rigorous analysis, additional mediation analyses with the Sobel and bootstrapping tests were conducted to investigate the mediating effects of social interaction on our psychological dependent variables (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002; Preacher & Haye, 2004). Consistent with Baron and Kenny’s criteria for mediation, social interaction has mediating effects on the feelings of loneliness and senior centre belonging. For the feeling of loneliness, the bootstrapped estimate of the indirect effect is similar to the point estimate computed from the conventional regression analysis of the raw data, and the indirect effect is estimated to lie between -0.5562 and -0.328 with 95% confidence interval. Thus we can conclude that the indirect effect is indeed significantly different from zero at $p < 0.05$ (two-tailed). The Sobel test (Preacher & Leonardelli, 2001) also revealed that the mediated path was significant ($z = -1.96, p = .05$), indicating that social interaction mediated the effects of Wii-play on loneliness.

In a similar vein, both the Sobel test and bootstrapping test showed significant mediation effects of social interaction on senior centre belonging. The Sobel test suggests there is mediation ($z = 2.71, p < .05$) on senior centre belonging. The bootstrapped estimate was significantly different from zero (between 0.1060 and 0.7494) at 95% confidence.

The same tests also showed significant mediating effects of physical activity on senior centre belonging. The Sobel test revealed that the mediated path was significant ($z = 2.06, p < .05$). The bootstrapped estimate was significantly different from zero (between .096 and 0.5413) at 95% confidence.
Baron and Kenny’s mediation analysis was also conducted to test for possible mediation effects of social interaction on the style of play. However, the results showed that the style of play (single player or multiplayer) as an independent variable was not a significant predictor of social interaction in the regression equation and thus dismisses any possible mediation effects of the latter. For a more comprehensive analysis of different styles of Wii-playing, a series of independent sample \( t \) tests was conducted to investigate whether the participants’ well-being improved after being exposed to single-play and multi-play respectively, using the same variables of psychological well-being: loneliness, self-esteem, affect, and belonging. All the tests were insignificant except for affect. The elderly in the single-player condition scored more positively on affect \((M = 5.13, SD = 1.55)\) than those in the multiplayer group. \((M = 3.63, SD = 1.09)\), \( t(30) = -3.15, p < .01 \).
Qualitative findings

In-depth interviews were conducted upon the conclusion of the intervention with the caregivers, supervisors, and the residents at SASCO. This was to gain an in-depth understanding of the possible reasons and explanations on the changes of the elderly being exposed to the Wii games. The opinions and expressed observations of the people involved in the intervention allowed us to piece together a clearer picture of the possible explanations that support our findings.

Social Interaction & Affect

Learning how to operate and play Wii was a challenge for many of the elderly, as observed by the caretakers and the supervisors. Their apprehension and uncertainty towards being able to cope with a new technology made many of the elderly people hesitant and even negative attitudes towards picking up Wii gaming. However, when placed under the programme which made it compulsory for them to be in contact with the device regularly over each week, it created an agenda for the elderly to talk among themselves. A common topic of discussion was developed. This was reflected by an observation by one of the caretakers:

“I observe that they talk among themselves and mix around more than usual. They talk about the game, the tactics and comment on each other’s game, sometimes laughing off each other’s silly mistakes.” – Aprine, caregiver in single-player group

Among the elderly in the single-player Wii group, discussion was also evident when they played:

“Tan Yian Swee and I talk and discuss when someone plays so that we will know what to do right when we play.” – Ong Chwee Tow, participant in single-player group

Besides interaction, the process of playing Wii games also generated a positive atmosphere among the elderly as the excitement of the games initiated encouragement and support for the players:
“When somebody bowls the ball, while the ball is rolling, they all like to shout ‘drop’ or ‘strike’, which motivates the person playing.” – Maniseh, caregiver in multiplayer group

“When Ong Lian Khim hits the ball, his ‘Pah’ sound always makes them laugh” – Aprine, caregiver in single-player group

The caretakers also observed that the excitement and energy level of the elderly increased as they grew more familiar and comfortable with the games. There was a vast difference in the atmosphere within the Wii-playing groups and the group that was engaged in traditional board games.

“When I take care of those who play the board games on the second level, we will be shocked to hear loud shouts and laughter coming from the rooms above us playing the Wii.”
– Roma, caregiver in control group

“[The noise upstairs is] always very loud. We don’t know why but they sound like they are always having a lot of fun.” – Rosalind Goh, participant in control group (referring to the Wii groups)

The process of learning a new technology put the elderly residents on similar learning curves. Over time, some individuals who picked up the skills faster started to stand out. This variation in skills levels among the residents allowed those who were better at the games to help or instruct the others. It was noted that the more skillful players took the initiative to help and teach the other players:

“I notice that the other activities we do here is always they ask me to help them, but when it comes to the Wii games, they tell one another what buttons to press because they are all learning together.” – Maniseh, caretaker in Multiplayer group

“Lee Kwee Hock, Ong Hong Chai and some others tell me how to ‘hit’ or swing the ball lor, so now I know. If not, very hard…” – Tan Lick Sean, participant in Single-player group

Ultimately, playing Wii brought about a positive change to the residents at SASCO. The caretakers and supervisors agreed that the elderly enjoyed playing Wii and that they felt happier during each session:
“We can see a cognitive improvement in them even in a short period of time. They (the elderly) are most importantly happier.” – Paran, supervisor at SASCO

“They enjoy themselves when they play the games… I think they will miss all of this when this game is taken away.” – Karen, caregiver in single-player group

Loneliness and belonging

The increased social interaction level between the elderly through the Wii gaming sessions helped to bridge the hostility and differences between the individuals. From the perspective of the caretakers, the elderly felt more included as a result of the greater amount of interaction through the gaming sessions. Some of the elderly felt that through the Wii gaming sessions, more people talked to them, and this made them feel less isolated and more at ease:

“Of course, I really enjoy myself. When I play with Valentine, Tang Mary and the others, we enjoy ourselves…because we play together.” – Marie Teresa Seet, participant in multiplayer group

“There is actually no need to talk, very little to talk…But when we play (the Wii), I can discuss and talk more.” – Ong Hong Chai, participant in multiplayer group

At the same time, through the Wii gaming sessions, friendships between individual elderly persons were deepened from all the help and advice offered to each other when they played. Such is the case for two friends in the home, Peter Lim and Wee Ah Bee, who felt that they enjoyed each other’s company and got to know each other even more through the sessions.

Physical Activity

Some of the elderly commented on how the frequent arm movements involved in playing Wii created a form of exercise for their arms, and that the sessions made their arms ache:

“We got exercise la, when I move my arms. It is very fun to play the game.”- Valentine Wong, participant in multiplayer group

“Sometimes it’s very tiring, I play five minutes only and it (her arms) is so painful!” –Ee Kuey Teng, participant in single-player group
Some of the elders in the control group lamented about the lack of variety in the traditional games that they played:

"The Uno and Jenga games are fine but they get less interesting over time." – Koh Kim Jee, participant in control group

An interesting comment made by some of the elderly who were initially reluctant to play the Wii games was that physical activities were already scheduled into in their daily programme. This reflected their perception that playing the Wii was equivalent to the daily exercises they had been doing:

"Before we play the Wii, sometimes we already do a lot of exercise in the morning. If we are going to play Wii in the afternoon, here (the arms) will be painful." – Tan Ah Pee, participant in multiplayer group.

**Self-esteem**

When it was first introduced, Wii generated some apprehension and negativity in the elderly residents. However, as time and training was provided to them to learn the skills of playing the games, the elderly slowly began to grasp hold of the tactics and started winning games. This helped to boost their self-esteem, as noted by the caretakers, who felt that the elderly believed in their capabilities and abilities more.

“I like the bowling game because every time I always get strikes and everybody always cheer... Even those that I seldom talk to cheer for me.” – Ho Lai Hoe, participant in multiplayer group

By learning how to play the Wii, the elderly saw themselves as individuals who were able to use technology, after their initial skepticism. This made them feel good about themselves and their abilities:

“I feel good about this game because I learn something new and I can help others who don’t know how to use, Tan Yian Swee, or the rest…” – Ong Hong Chai, participant in single-player group
As most of the elderly being exposed to the Wii condition have slight physical disabilities, it is almost impossible for them to be able to play any physical sport. However, the Wii game has allowed them to experience what they would otherwise not be able to do out in the actual sports fields and courts.

“When I was young, I used to play baseball, but after losing my leg, I couldn’t play many sports. It’s good to be able to play something similar now.” – Peter Lim, participant in single-player group

The ease of use when playing the Wii has also led to higher confidence among the elderly.

"I have never played video games in my life but this Wii is very easy to learn. Now I know at least how to use some form of computer." - Ong Lee Kuan, participant in multiplayer group

The increase in self-esteem is especially evident among those who felt confident or an expert on the game and took the lead to guide and teach the other elderly people. It gives them an area where they can feel a sense of ownership and control over, which is vital for the elderly, in an age where most people would feel a declining sense of control over their lives.
Discussion

Our main goal in this study was to assess the potential of Nintendo Wii in improving the quality of life of the elderly. The facets of well-being that formed the focus of this study centred on the social, physical, and psychological – how playing Wii may impact these various aspects. The results and findings from this research can serve as a guide and understanding for future possible implementations of Nintendo Wii in similar long-term care facilities.

Impact of playing Wii on well-being

The results of our study showed that the elderly participants in SASCO who played Wii responded very well to the intervention. Compared to the control group exposed only to traditional games, the Wii group scored significantly higher on all the measures at the end of the intervention. This finding implies the positive effects that playing Wii has on the overall well-being of the elderly. This was measured by their social well-being (social interaction), psychological well-being (self esteem, affect, loneliness, belonging), and physical activities. In the pre-test measure, there were no differences between the Wii group and the control group on these variables. Hence, the post-test results indicated that the overall well-being of the Wii-playing group improved more significantly after the intervention.

To gain a deeper understanding into these differences, longitudinal comparisons were conducted for the Wii-playing group and the control group. However, there was a significant increase in social interaction among those in the control group. These findings were not unexpected as the traditional games played by those in the control group were multiplayer games like UNO and Jenga, which facilitated social interaction within the group. Research on group activities involving games generally found support that engaging the elderly in group games encouraged interaction (Mangrum & Mangrum, 1995; LeCroy, 1987; Menks, 1983). Similarly, the
level of social interaction in the Wii group also increased over time but the magnitude of increase was greater than the increased level of social interaction in the control group. Results from the longitudinal analysis on the rest of the well-being measures for the control group indicated that there was no change between the pre- and post-tests. Some variables even declined over time. In contrast, the overall well-being of the Wii-playing elderly improved from before the intervention, and was also more positive when compared to those in the control group. The second function of the longitudinal comparisons was to eliminate an alternative explanation, the Hawthorne effect, for the improvement of well-being among the elderly. It is possible that the elderly may appreciate the increased amount of attention paid to them during the intervention, which could have resulted in their improved well-being. However, the lack of significant positive changes in the control group negates the Hawthorne effect as both groups received the same amount of attention during the intervention. Taken together, the result provides further support for the first hypothesis, which states that playing Wii will improve the overall well-being of the elderly.

The qualitative and quantitative results support the popularity of Wii among the elderly and its effectiveness on well-being. In comparison, traditional games used in the control group were considered more mundane and did not provide much stimulation for the elderly in that group. On the other hand, some of the elderly in the Wii-playing groups felt that there was too much physical activity in their daily programme due to the physical exercises already in place. This shows that Wii is a versatile tool that can be used in long-term care facilities as it combines both physical exercise and group games in a much more fun and interactive way.

Importance of Social Interaction and Physical Activity

Additionally, this study identified the physical activity and social interaction function of Wii as important mediators of Wii-play. The mediation analysis found that social interaction was
a mediating factor for senior centre belonging and loneliness. Physical activity was also found to be a mediating factor for belonging. These results prove that the social interaction and physical activity that occur through Wii-play mediate the subsequent improvements in well-being. This lends support for the hypotheses concerning the mediating factors of playing Wii and their importance in contributing to psychological well-being in the elderly. A condition of these findings is the specificity of the effect that social interaction and physical activity have on well-being. These two mediators impacted the socially-related variables of well-being like loneliness and belonging. This allows us to conclusively illustrate the relationship between social interaction and physical activity in reducing loneliness and increasing the sense of belonging that the elderly in care facilities have.

The mediating effect of social interaction on ameliorating loneliness and instilling a sense of belonging shows that it is vital component in the playing of Wii. It highlights the role of the community in the process of playing Wii. In this study, Wii-playing sessions were conducted with the residents in enclosed environments. Such conditions were favorable for them to participate fully in the Wii-games and created opportunities for them to interact. This shows the importance of creating conditions that are suitable for social interaction, and is an important point of consideration for future applications of Wii.

The relationships between playing Wii and the other facets of well-being such as self-esteem and affect were significant but not mediated through social interaction and physical activity. This implies that these two mediating factors were able to account for a part of the psychological well-being among the elderly, but not all. There might be other undiscovered features of Wii that may explain the improvement of the elderly on the other areas of their psychological well-being. Qualitative findings suggested that the relative ease of use in learning
the new technology may be a plausible explanation for improving self-esteem levels among elderly. Future studies could explore these additional mediating effects of Wii and investigate their impact on well-being.

*Differences in Single-player and Multiplayer games*

The final research question in the current study was to investigate various conditions under which Wii is played that may maximize the benefits of playing Wii. Contrary to our expectations, the results revealed no differences in the intensity of social interaction between the single-player and multiplayer game styles. This lack of difference between both Wii conditions can be explained by the fact that social interaction took place for both groups, but in different ways. In the single-player condition, much of the social interaction that took place can be attributed to co-viewing or active viewing by the elderly. Between the single-player and multiplayer groups, the elderly who were placed in the latter had more playing time with one another than those in the former group. Qualitative evidence showed that even when the elderly in the single-player group were watching others play, social interaction took effect when they engaged actively by voicing their comments or suggesting how the player should play the game. They interacted more through discussions with one another. In comparison, the elderly in the multiplayer condition engaged more in social interaction that occurred through playing the games together. Both ways, playing Wii enabled chances for different forms of interaction to take place between the elders across conditions of different play styles. This shows that playing Wii in general, regardless of the number of players involved in the games, is effective in facilitating social interaction. Results from the first part of this study lend further support to this conclusion.

The different Wii-gaming conditions were found to have a significant impact on the
elders' affective well-being. However, the results obtained were contrary to what was hypothesized. The single-player Wii group exhibited more positive affect compared to the multiplayer group. One plausible reason could be the characteristic of the games played by the Wii groups. The Wii groups were exposed to Wii Sports in most of their playing sessions, which was more competitive rather than cooperative in nature. This competitiveness was intensified and strengthened in the multiplayer group because of the need for individuals to play and compete against one another. This is in contrast to the single-player group, where the individual competes against the computer instead of another individual. As a result, greater competitiveness in the multiplayer group could lead to lower positive emotional feelings towards one another. This explanation is supported by research in competition and cooperation. Competitive circumstances have been shown to be precursors to the destructive pattern of argument, anger and aggression, while cooperative circumstances are precursors to the constructive pattern of agreement, affection and affiliation (Anderson & Morrow, 1995).

This may be changed if more cooperative Wii games are introduced to the multiplayer group instead, which will incorporate more chances of working and cooperating together. According to Deutsh (1993), one way of creating a more peaceful society is to build more cooperation and less competition into many of our societal structures. Game creators are already recognizing the fact that too much competition dampens the enjoyment of games and have done away with the “You Lose” screen (Howard, 2008). An additional factor to consider is the demographic which plays the video game. The elderly may be more sensitive to competition and cooperation than younger players, and thus are more affected by competition. Hence, more research in the area of competitive versus cooperative gaming on individuals’ affect and emotional well-being need to be conducted to give more support to these explanations.
Nintendo Wii as an Intervention

So far, this study has mainly focused on the importance of the Wii gaming technology and its characteristics in bringing positive changes to the well-being of the elderly. However, it is important to note that there are human factors which are equally significant and essential in order for technology to have a positive impact on the elderly. In this aspect, the role of the caregivers and supervisors in long-term care facilities cannot be underestimated. Their support and enthusiasm towards the technology provides positive feedback and encouragement for the elderly as they pick up on the new skills. This is especially vital as the elderly tend to be more resistant towards technology (Smither & Braun, 1994). Their openness and willingness to accept this new technology is crucial, before any form of significant results or positive change can take place. This can be done through continuous encouragement from the caretakers as well as introducing a rewards system to motivate the elderly in learning how to play Wii.

Effectiveness of Nintendo Wii as an Intervention

These results show the potential of Wii to impact diverse aspects of the elders’ lives, from social, to physical and psychological well-being. Not only do the significant improvements in the Wii-playing groups demonstrate how Wii is effective in improving the overall well-being of the elderly, they also reflect the multi-functional nature of the Wii and its unique ability to combine physical activity and generate social interaction among those who play Wii. In turn, the use of this device has shown that this combination of functions has a broad impact on the lifestyle on the elderly, as well as far-ranging benefits on psychological well-being. While past research has generally proven the usefulness of technology and all its features on psychological well-being and interaction (Danowski & Sacks, 1980), there have been relatively a fewer studies that examined the multiple roles that a video game can have in the context of the elderly and healthcare. The confluence of physical, social and psychological aspects of playing Wii makes it
a unique device that has the potential to be a source of entertainment, exercise, and interpersonal bonding.

With regards to the long-term viability of implementing Nintendo Wii in care facilities for the elderly, these findings are highly persuasive as such changes were evident after a six-week period, with the elders clocking in an average of 45 minutes of Wii-play per person weekly. The improvements indicate that, when Wii is incorporated into the daily lives of the elderly in these facilities, with time the psychological changes are likely to translate to an actual improvement in the elders’ quality of life, and even evident physical and health improvements. Instead of being a short-term medical-treatment that focuses on the medicine behind a certain ailment in the elderly, Wii has the potential to function as more of a preventive measure that helps maintain or improve the elders’ perception of their quality of life, and outlook towards their life in general.
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Table 1

Results of Independent-samples t test on Wii vs. Control Group

<table>
<thead>
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<th>Wii</th>
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<td>M</td>
<td>SD</td>
<td>M</td>
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<td>Affect</td>
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<td>Self - Esteem</td>
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Note: * p < .05, ** p < .01 (2-tailed).
Table 2

Results of Independent-samples t test of Wii vs. Control Group on Pre-test Variables

<table>
<thead>
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<th></th>
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Note: * p < .05, ** p < .01 (2-tailed).
Table 3

Results of Paired-samples t test on Wii-playing Group Before and After Being Exposed to Wii.

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Note: * p < .05, ** p < .01 (2-tailed).
Figure 1. Two-step Flow Diagram for Wii-play.