Chapter 7
The Social Interaction Experiences of Older People in a 3D Virtual Environment

Panote Siriaraya and Chee Siang Ang

7.1 Introduction

Aging successfully does not only mean that one remains in good physical health in their later stages of life, but should also be well integrated in their social community and have adequate social relationships (Bowling and Paul 2005). Good interpersonal relationships contribute to active engagement with life which has a positive impact on health and well-being. However, due to factors such as declines in physical abilities and lifestyle changes (such as social networks becoming increasingly narrower in later life) which occur naturally with aging, it becomes more costly in terms of time and effort for older users to obtain meaningful social experience. As such, social isolation has become a major problem which can significantly influence the well-being of older adults.

In recent years, computer technology, in particular, ICT technology has shown much promise as a platform which could help alleviate loneliness for older adults (Khalaila and Vitman-Schorr 2018). A lot of these online communication tools have been shown to be beneficial to older people (Nimrod 2010), allowing older adults to keep in touch with family and friends and helping decrease feelings of isolation (Dunning 2009). 3D virtual world is one such technology which has great potential in supporting social interaction for older users. Much research has been carried out showing how such a platform could be used to support daily life activities such as shopping or keeping in touch with friends and families etc. However, most of these studies focus on "mainstream" computer users (Jung 2011 etc.) and research looking into the use of 3D virtual worlds for older people has been relatively limited. This

P. Siriaraya (✉)
Kyoto Sangyo University, Kyoto, Japan
e-mail: spanote@gmail.com

C. S. Ang
University of Kent, Canterbury, UK
e-mail: c.s.ang@kent.ac.uk

S. Sayago (ed.), *Perspectives on Human-Computer Interaction Research with Older People*, Human–Computer Interaction Series,
https://doi.org/10.1007/978-3-030-06076-3_7

could lead to an unfortunate missed opportunity as such technology could potentially exclude a group of users who could truly benefit from them.

In this chapter, we discuss our work which has been carried out on the topic of older people and 3D virtual worlds. In particular, we discuss in detail an experiment study carried out to investigate how various aspects of the 3D virtual worlds (such as the avatars) influences the social interaction experience of older users.

7.2 Older People and 3D Virtual Worlds

As the computational and graphical processing abilities of computers continue to increase, the platforms which one could use for social interaction has also evolved substantially. One such platform is 3D virtual worlds. Social interaction in 3D virtual environments has many advantages when compared to other communication technology. Unlike video conferencing and text-based message tools, the embodiment of user interaction through avatars allows users to participate in social activities with other users (such as dancing) rather than just to communicate (Zhou et al. 2011). Thus, the social experience in virtual worlds goes beyond just providing an avenue for communication and can offer the opportunity for users to experience social activities with others in a more immersive manner. As such, 3D virtual worlds could offer much potential in supporting social interaction for older people. Through such platforms users are able to expand and maintain their social networks (i.e. meeting new friends etc.) (Zhou et al. 2011) and form online communities (Fetscherin and Lattemann 2008). Such activities could help enrich the social lives of older users. Despite this, there have been few studies which have explored the characteristics and interactions of older users in virtual worlds.

7.2.1 The Digital Lives of Older People in Virtual Worlds

To understand more about the characteristics of older people in virtual worlds, two exploratory studies (an interview study and user profile analysis study) were initially carried out which examined the activities, interests and experiences of older people in virtual worlds (Siriaraya et al. 2014), (Siriaraya and Ang 2012b). The results from both studies revealed several interesting aspects regarding the virtual interaction and experience of older users in virtual worlds. Overall, both studies indicated that social interaction seems to be main reason in which older people use virtual worlds. The majority of the participants in the interviews cited social purposes (socializing, keeping in touch with friends etc.) as their main motivation for using virtual worlds. What was particularly surprising was that such relationships did not only consist of weak ties (as tended to be the case with social capital obtained from social network services (Ellison et al. 2007)), but most participants reported developing strong interpersonal relationships in virtual worlds. Some of these friendships were reported to lasted for

several years and some even transferred offline as well. Analysis of user behavior from the profiles also supported this notion. Even though other online technologies have been used in a similar role, it seems that the unique characteristics of virtual worlds (for instance, being able to carry out social interactions in an immersive 3D spatial context) helped enhance the process of relationship building. For instance, the diverse ways in which users could interact with each other in an immersive 3D environment (visit each other's virtual homes etc.) allowed online relationships to be developed and maintained more easily (Taylor 2002).

Another surprising finding was how older people use virtual worlds to pursue activities which they perceived to make useful contributions to others. A memorable example from the interviews was how a recent retiree nurse offered to teach classes about childbirth in virtual worlds (Siriaraya et al. 2014). Some even used virtual worlds to acquire skills and knowledge. The user profiles showed that older users even joined more groups related to learning or education (photography, history etc.) than younger users and during the interviews, they often reported participating in classes in the virtual world to learn more about programming. Overall, the results from these studies suggest that older people who use virtual worlds do so because they found this platform to be beneficial in augmenting a part of their physical lives (allowing them to again do activities which they were once able to do when they were younger), compared to the typical young user who participated in virtual worlds as a form of diversion or escapism from their daily lives into a novel fantasy world.

7.2.2 Factors Affecting 3D Social Interaction Experience

Despite the potential advantages of virtual worlds for social interaction, few studies have investigated how virtual worlds, as platform, could be designed to effectively enhance social experience for older people. Although we have identified a number of older adults who have benefited from social interaction in virtual worlds in our earlier studies, these users could be considered the minority (Pew Research Center 2010). A previous study of ours had identified various age-related differences between older and younger users in several aspects of their interaction with virtual worlds which could influence their social experience in this platform (Siriaraya and Ang 2012a). However, little is still known about the reasons why such factors effect social interaction experience and more importantly how they could be improved for older users. Therefore, a further experimental study was carried out to provide a more in-depth analysis on how and why factors related to older user's characteristics and the virtual world influence the quality of their social interaction.

Various measures have been proposed to evaluate the quality of the social interaction in a 3D virtual world. One such measure is social presence (or co-presence) which could be thought of roughly as the sense of being together with others (see Biocca et al. 2003). Other factors used to evaluate the quality of social interaction include the perceived quality of the communication process (i.e., how well users can understand each other) and the perceived satisfaction in the outcome of the task (i.e.,

how satisfied users are with their performance in carrying out the social interaction task) (Vilhjálmsson 2003).

For factors which could affect the quality of the social interaction experienced by older people in 3D virtual worlds, these could be divided into factors related to the characteristics of the users themselves (User factors), and factors related to the virtual world design (Platform factors). In regard to user characteristic, past experience with similar technologies is one factor which could play a role in how well older people are able to use 3D virtual worlds (Czaja and Lee 2007). Another often cited factor is computer anxiety (Jung et al. 2010) as studies have also shown how this factor acted as a psychological barrier to the acceptance of and use of technologies (Jung et al. 2010). Factors related to the 3D virtual world platform itself could also have an impact on the experience of older people. The ability to navigate in particular, could affect the social experience of older people in a 3D environment due to declines in their cognitive functions (spatial ability etc.) (Sjolinder et al. 2005). Physical presence or the sense in which a user perceives as being located in a place or environment (see IJsselsteijn et al. 2000) could affect how well users perform or enjoy their virtual world experience (see Lombard and Ditton 1997). Apart from this, the visual representation of the users in the virtual worlds or what is known as the "Avatars" could affect their social interactions in virtual worlds. Some studies have posited for example, that certain characteristics of the avatars (such as avatar realism and anthropomorphism etc.) could influence the quality of communication for users (Nowak and Biocca 2003).

7.3 Method

An experimental study was carried out to examine the various user and platform factors in relation to the social experience of older people in 3D virtual world. Overall, 38 older people were recruited to engage in a collaborative shopping activity in the 3D virtual world. We chose to focus on shopping activity because it was an activity older people are familiar with in their daily life (and as such they could more easily evaluate and reference their virtual world experience in comparison to their physical life experience). A non-3D virtual store (see Fig. 7.1) was also developed to allow participants to more easily compare and relate their 3D experiences (by providing a non-3D experience for reference). Each pair of participants would visit both 3D and non-3D virtual stores in the study. As identifying older people who were willing to use 3D technology was challenging, for practical reasons, participants were recruited by snowball sampling and participants were given a shopping voucher worth £10 for participating. The study was also reviewed and approved by the University's research ethics committee.

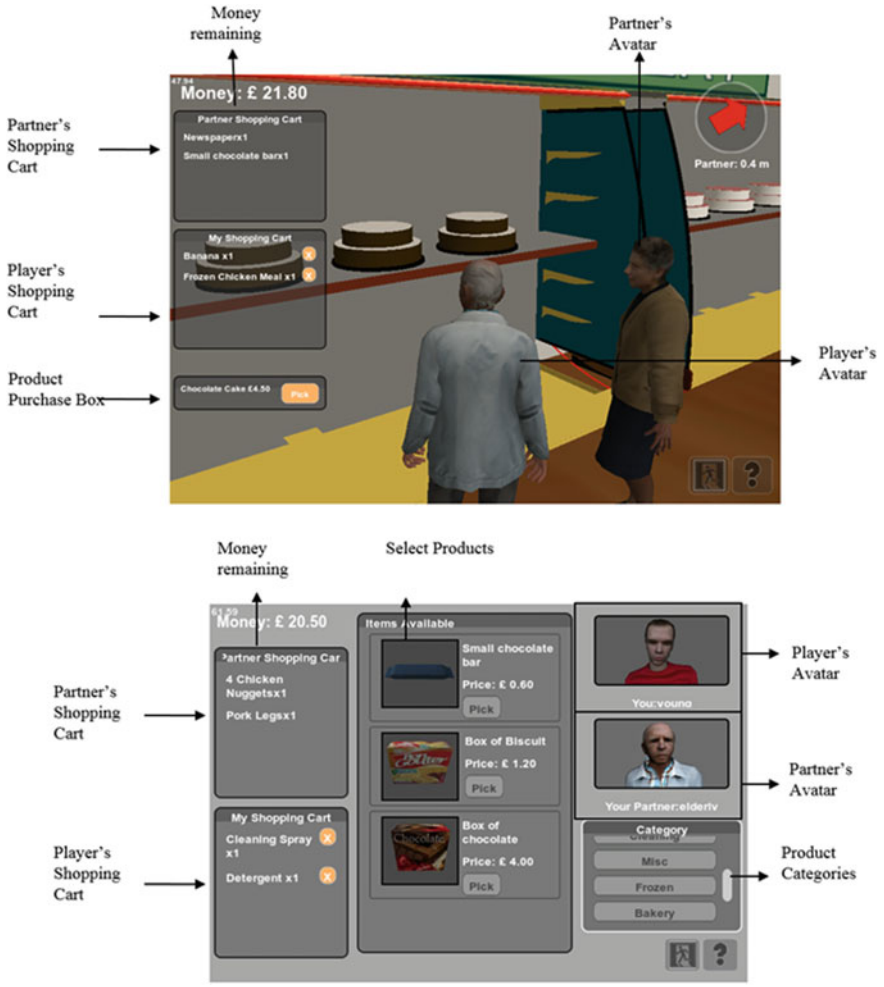

Fig. 7.1 Screenshots of the 3D (top) and non-3D store (bottom)

7.3.1 Virtual World System

The multi-user online virtual world systems (3D and non-3D) were developed using Unity3D. Users are able to choose between a non-human (a robot), older male, older female, younger male and younger female avatar to represent themselves in the study. For the 3D virtual store, users controlled their avatar by using the arrow keys on the keyboard. To make purchases, the user moves their avatar towards a shelf with the product they would like to purchase. When the avatar moved close enough to the shelf, a small "product purchase" window would appear on the user interface with the name of all the products available on that particular shelf (see Fig. 7.1).

In the non-3D store (as shown in Fig. 7.1), users make purchases by first selecting one of the categories from the "products category" menu. All the products in that category would be shown on the "select product" box and users would then click on the "pick" button next to the image of the product they would like to purchase. In both the 3D and non-3D store, participants communicated with each other by voice.

7.3.2 Study Procedure

A pair of older users participated in each experiment session, carrying out a collaborative activity in both the 3D and non-3D store. The session started with a brief explanation about the purpose of the study and the key concepts in the study (avatar, 3D virtual environment etc.) were explained. Then, participants accessed the virtual dressing room and selected an avatar to represent themselves. A brief tutorial session was then given, after which participants were asked to proceed to two separate rooms where they were unable to see or hear each other in the physical world. This was done to ensure that the social presence and interactions of the participants were limited to only inside the virtual environment during the study. In the virtual environments, participants were asked to carry out two tasks (one in 3D and another in non-3D store). Both involved a virtual shopping task which was purposely designed to involve collaboration. To complete these tasks, participants would need to communicate with each other in the virtual environment and reach an agreement on certain decisions. More specifically, in the first task, participants were asked to imagine that they and their partner needed to prepare a birthday and needed to collaborate with each other in the virtual store to choose the goods that they think would be best for their party (both were given a limited sum of money). In the second task, participants were asked to imagine that they and their partner were planning a picnic at the local park and were asked to cooperate with their partner in selecting the goods for the picnic. To compensate for order effect, 20 participants were asked to use the non-3D store for task 1 and the other 18 participants used the 3D store for task 1. After completing both tasks, participants filled in a questionnaire to evaluate their experience. Afterwards, semi-structured interviews were carried out individually with each participant. Overall, each session lasted approximately 2.5 h.

7.3.3 Data Collection and Analysis

A mixed method was used to collect data for this study. First, questionnaires were administered to examine the factors related to social interaction experience of the participants. Semi-structured interviews were later carried out to help provide context and illustration to the questionnaire findings. The questionnaires used were adapted from a previous study which we carried out (Siriaraya and Ang 2012a). A pre-study questionnaire was used to gather data about the demographics and characteristics of

the participants and a post-questionnaire was used to examine their experience with the virtual worlds. Key measures used to evaluate the quality of social interaction experience (in the post-questionnaire) include social presence, perceive quality of communication, perceived efficiency of the medium in task performance and overall satisfaction with social experience. In addition, questions were also used to measure user factors (in the pre-questionnaire) such as skepticism of using technology to communicate, computer anxiety and perceived health as well as platform factors (in the post-questionnaire) such as physical presence, perceived value of the avatar and navigational ability. After data collection, reliability tests were carried out which showed good statistical reliability on all the multi-item measures variables (>0.8) except for the skepticism of using CMC technology which was removed from the statistical analysis.

Semi-structured interviews were then carried out to explore further how each of the factors (from questionnaires) affected the participants. First, open-ended questions were asked to encourage participants to discuss their experience of using the virtual stores, such as their overall experience in the virtual, their experience of communicating and collaborating with another user in a virtual environment (and also any factors which they felt facilitated or impeded the efficiency of the communication) and what they enjoyed/disliked about the two virtual stores. Afterwards, probing questions related to the specific factors of the platform and the user characteristics were asked (such the reason for choosing a particular avatar and the implications of it towards their experience). The interview structure and questions were adapted to suit the context of our participants who generally had little prior experience with technology and 3D virtual environments. For example, to help participants more easily frame their discussion, they were asked to discuss their experiences with the various aspects of the 3D virtual environment by comparing them to their experiences with the non-3D environment. Examples of questions include: "How did you feel about communicating and collaborating with the other person in the virtual store? In this aspect, which store do you think was better? How so?" and "Did the ability to see everything in 3D and move around in 3D have any effect on your social experience?"

To analyze the interview data, the audio recordings from all the interviews of the 36 participants were first transcribed (the data from one pair of participants was not available due to technical difficulties in recording). Altogether, there was approximately 19 h worth of data. The data was analyzed using thematic analysis (Braun and Clarke 2006). First the transcripts were re-read to help gain an overview of the key topics and then coding the data. Codes of similar nature were then grouped together into themes which were reviewed against the overall data and refined until saturation had been achieved.

7.4 Results

The key characteristics of the participants are shown in Table 7.1.

Table 7.1 Participant characteristics

Gender	Male	16
	Female	22
Age		Mean = 66.84 (SD = 6.55) (Min = 55, Max = 82)
Prior experience (out of 10)	Computer	Mean = 8.57 (SD = 2.4)
	Internet	Mean = 8.08 (SD = 2.27)
	E-mail	Mean = 8.24 (SD = 2.20)
	Skype	Mean = 3.43 (SD = 1.59)
	3D games	Mean = 2.54 (SD = 1.37)
Computer anxiety (out of 5)		Mean = 1.96 (SD = 1.00)
Perceived health (out of 5)		Mean = 2.00 (SD = 0.96)
Level of acquaintance with partner (out of 5)		Mean = 3.79 (SD = 1.6)

7.4.1 Avatars

As shown in Table 7.2, the most popular avatar selected by male participants was the older male avatar. However, for female participants the younger female character was the most popular.

When asked to describe the reason they chose their avatar in the interview, most male participants wanted to select avatars which best resembled their physical world appearances (n = 9). Female participants (n = 5) who selected the old female avatar also reported a similar reason. These participants did not want the avatars to misrepresent their real-world characteristics. There were also a number of older people selecting avatars which appeared younger than their actual age or were of opposite gender. What was particularly interesting was that the majority of the female participants selected the young female avatar. The reasons given for selecting these avatars were that they wanted the avatars to reflect their personality or outlook of still being young and perhaps female users tended to prefer avatars which had a similar appearance to their idealized selves (Ducheneaut et al. 2009).

Table 7.2 The types of avatars selected in the study

Avatar	Gender	
	Male	Female
Older male	12 (70.58%)	1 (4.76%)
Older female	0 (0%)	5 (23.8%)
Younger male	2 (11.76%)	2 (9.52%)
Younger female	1 (5.88%)	9 (42.85%)
Non-human	2 (11.76%)	4 (19.05%)

"*[I chose this avatar] because I feel I think of myself as young. I've got a young outlook to life*" (Participant 4, Female, 61, selected the young female avatar).

Other reasons given were that participants (n = 2) felt that these young avatars were the most realistic or best suited the context of the task (shopping) or to represent a family member or a shopping companion (n = 3). As for the non-human avatars, participants reported selecting them for their entertainment value. Three participants reported selecting the non-Human avatar either "for fun" or due to the perception of their experience in the virtual world as being unreal or similar to a video game.

"*I don't know, to me an avatar is an alien. I mean I don't think I've seen avatars…. I think it was the fact that I felt I was playing a game more than it was real life. So that's why it seemed right to chose something that looked like an alien or avatar in this context*" (Participant 34, 67, Female selected the non-human avatar).

7.4.2 Differences Between the 3D and Non-3D Store

T-tests were carried out to analyze the differences in the quality of social interaction and the various aspects of interaction within virtual worlds (e.g. physical presence, quality of communication etc.) between the 3D and non-3D platforms. Overall, we found no significant difference in all measures for the quality of social interaction between the 3D and non-3D store. The 3D virtual store did not provide a better quality of social interaction for older people. Not surprisingly, participants found it significantly easier to navigate in the non-3D store (mean = 4.09) than the 3D store (mean = 3.04), $t(74) = 4.54$, $p < 0.001$ and also felt that avatars played a more prominent role in the 3D store (mean = 3.07) than in the non-3D store (mean = 2.00), $t(74) = -4.10$, $p < 0.001$. There was a borderline significance in physical presence where older people in the 3D store (mean = 3.08) reported higher levels of physical presence than the non-3D store (mean = 2.51) ($t(74) = -1.98$, $p = 0.052$).

7.4.3 Factors Linked to the Quality of Social Interaction

Regression analysis was then carried out to investigate the degree to which certain factors influenced the quality of social interaction. Person's correlation tests showed that the variables Experience with computers and E-mail had an almost perfect correlation (all higher than 0.95) and were removed to prevent multi-collinearity. As the model building was exploratory, independent variables were entered using the stepwise method. The user factors entered into the model were experience with E-mail, Skype, 3D games, computer anxiety, level of acquaintance and health and were further divided into two groups when constructing the model. This was done to examine the effect of computer experience (E-mail, Skype, 3D games) and general characteristics (computer anxiety, level of acquaintance and health) on social interaction experience separately. The platform factors entered were perceived physical

presence, navigation and avatar. Each of these three groups of independent variables was tested for regression for each dependent variable (i.e. social presence, quality of communication, performance, overall satisfaction in social experience and enjoyment). As such, a total of 12 regression models were calculated (6 for the 3D and 6 for the none 3D virtual store). Multi-collinearity within the variables was minimal (VIF < 10). A summary of the results of the regression analysis is shown in Table 7.3.

For social presence in the 3D store, multiple-regression showed only physical presence and experience with 3D games to be a significant predictor of social presence. For the quality of communication, physical presence is the only significant predictor for both 3D and non-3D store, and Navigation is the only significant predictor for the non-3D store. However, both models explained only a small portion of the overall variance (13% for the 3D store and 17% for the non-3D store). This could be expected as a majority of the communication between the participants in the non-3D store consists of searching for the products by navigating through a list of items. For performance, only navigation was a significant predictor for both stores. However, navigation was able to explain more of the overall variance of performance the 3D store than in the non-3D store (22% compared to 12%). Part of this could be expected as a major component of the task that was given required participants to move around in the 3D store (or navigate through the 2D store) to find the appropriate products. For the user factors, only experience with computer games was found to be a significant predictor of social presence in the 3D store.

Overall, the results show that physical presence was a key factor to many of the measures for the quality of social interaction in the 3D store, including social

Table 7.3 Summary of the regression analysis

		Adj R^2	Physical presence	Avatar	Ease of navigation	3D games experience
Social presence	Non-3D	0.24**	0.52**	–	–	–
	3D	0.45**	0.68**	–	–	–
		0.09*	–	–	–	0.34*
Quality of communication	Non-3D	0.17**	–	–	0.43*	–
	3D	0.13*	0.39*	–	–	–
Performance	Non-3D	0.12*	–	–	0.38*	–
	3D	0.22*	–	–	0.41*	–
Overall satisfaction with social experience	Non-3D	0.44**	0.50**	–	0.41*	–
	3D	0.63**	0.59**	–	0.28*	–
Enjoyment	Non-3D	0.19**	0.47*	–	–	–
	3D	0.42**	0.39*	–	0.34*	–

*Significance at 0.05 (2-tail)
**Significance at 0.01 (2-tail)

presence, quality of communication, overall satisfaction in social experience and enjoyment. For the 3D store, navigation was found to be a significant predictor of performance, overall satisfaction in social experience and enjoyment when other platform factors were controlled. The avatar however was not found to be a direct significant predictor of any of the measures. Part of this could be because both navigation and avatar indirectly influence the dependent variables through physical presence and the remaining variance not explained by physical presence was not a significant predictor of these measures. Indeed, for social presence, when not controlling for physical presence, single variable regression analysis also showed that Navigation (standardized beta = 0.535, $p < 0.01$), (Adjusted $R2 = 0.27$, $F(1,36) = 14.45$, $p < 0.001$) and Avatar (standardized beta = 0.47, $p < 0.01$), (Adjusted $R2 = 0.20$, $F(1,36) = 10.02$, $p < 0.01$) each significantly predicted social presence. In the non-3D store, both were not significant predictors of social presence.

7.4.4 Analysis of the Interview Data

The interview data was analyzed and the themes were categorized into three groups: (i) factors related to social interaction experience in the 3D virtual world; (ii) difficulties of older users in suspending disbelief and immersing themselves in the virtual environment; (iii) user barriers which effect interaction in 3D virtual worlds.

7.4.4.1 Social Interaction Experience

A large number of participants reported no difference in the quality of communication and collaboration between the non-3D and the 3D store (n = 14). For them, the 3D spatial environment did not influence their social experience. The main reason seems to be that participants (n = 15) felt that the audio and not the visual avatars were of more importance to their communication. The 3D spatial presentation of the store was helpful in other aspects however, such as helping provide a sense of realism in regards to the shopping experience and helping provide physical presence (n = 13). In particular, participants (n = 11) reported enjoying the experience of being able to move around in a 3D store.

"*The 3D store was much more fun (…) being able to walk around, navigating, going up to the counter and having the food identified by a little logo, very interesting, very useful…. and the fact that I could tell where my partner was and I could go and see her*" (Participant 22, Male, 65).

Two major factors were identified on why participants felt that the visualization of the avatar in a 3D spatial environment did not help improve their social interaction experience. First, participants reported a difficulty in associating the avatar with physical people. Second, participants cited a lack of non-verbal cue in communication as a reason which limited the perceived usefulness of a 3D avatar.

7.4.4.2 Difficulty in Associating a Virtual Avatar with Physical People

A commonly theme which was reported by older users was the difficulty in associating virtual avatars with real people. 16 participants reported some kind of difficulty in associating themselves or their partners with the avatars when communicating in the 3D virtual world. Part of this was due a perceived discrepancy between the visual avatars and the audio communication in virtual world. For these participants (n = 9), the social presences of their partners mainly came from their partner's voice which they felt was separate from the visual representation of the avatar. Therefore, this made it harder from them to associate the avatars with the partner they were communicating with.

"*She was hiding behind her avatar, I was hiding behind my avatar (…) those two avatars does not represent us as we are now… so it was a dual function if you like… we were communicating by phone[audio], our avatars were running around the store buying [products]*" (Participant 25, Female, 67).

In addition, seven of the participants felt that it was difficult to associate the avatars with their partners as the avatar's visual appearance did not match with the real appearance of their partner. A considerable number of older users also reported preferring avatars with appearances that match the actual characteristics of the people they represent.

7.4.4.3 Lack of Non-verbal Communication

Another limitation commonly mentioned in regard to avatar-mediated communication was the lack of non-verbal communication. 17 participants mentioned wanting to be able to display non-verbal communication cues while communicating with their partners in the virtual store. Overall, the inability of avatars to display facial expressions and other forms of body language had a significant impact to their social experience in this platform. In particular, one participant reported that the inability of avatars to display facial gestures made her feel they were emotionless and made her perceive the avatars as less human. Two participants even reported that their inability to display emotions and their awkward movements made them feel more like robots. Other participants felt that the lack of such cues limited the efficiency of their communication and made it more difficult to trust their partners as they felt that users could hide their emotions and body language during communication.

7.4.4.4 Difficulty in Suspending Disbelief

Participants also tended to report a sense of artificiality when engaging with the 3D store feeling that their experience was not real enough. Some participants felt that the inability of computers to transmit other senses such as touch and smell was one of the key factor which reduced their perceived sense of realism (n = 7). For example, one participant cited the inability to feel the paper cups in the stores, to see if they could bend it or if it was strong enough.

Part of this difficulty in suspending disbelief could also be due to their inherent perception of 3D virtual environments as being a "playful" or an "imaginary" game based on their past experience and perceptions with similar technology. Often, participants reported that their experience was more akin to that of a video game than a serious shopping experience (n = 14). For them, the perception of "moving around a character in a 3D virtual environment" reminded them of the games they had played when they were younger or the games they had seen their younger family members play. Participants tended to use words such as "play" and "having fun" to describe their virtual world experience (17 participants). Compared to the non-3D store which was more practical and task based, participants felt the 3D store was more play oriented. For instance, one participant described how her experience in the 3D virtual world was similar to playing in a dolls house. This perception of virtual worlds as being a "playful" and a "game" could be one reason which made them perceive their experience as less real and this perception of games being a fabricated construct could make participants less willing to immerse themselves inside the virtual world.

7.4.4.5 User Barriers

A number of barriers to the use of technology by older users were identified during the interviews. One key theme was in relation to the negative perception towards online technologies, in particularly CMC. Participants (n = 8) expressed concerns about the safety of such technologies, especially related to the use of false identity, privacy and the dangers of being deceived.

In addition, participants (n = 6) expressed doubt towards developing relationships online through a computer, as opposed to meeting face-to-face. The notion of communicating virtually made them feel uncomfortable and participants preferred to socialize in the physical world. One major concern with socializing in the virtual world was the possibility of avatars being used to give false representations or being used to deceive other users (n = 13).

"*Well there are some difficulties, because you don't quite know if the avatars that you're meeting is anything like the person they are representing, so you have got snakes there…. they might be trying to give me the impression of such and such. If they could… they could give a false image of themselves, they could use their avatar in that way and you would have to be careful*" (Participant 11, Male, 70).

In addition, the lack of transparency in avatar mediated communication (such as how the avatars can be used to give false impressions) made some participants (n = 7) reluctant to use virtual worlds to communicate with other users in a public social space. However, participants expressed more willingness to use virtual worlds to communicate with those who they already knew (such as family members or friends) and could confirm their identities. The other barriers reported were related to the cognitive ability. Cognitive load problems (Ang et al. 2007), i.e., difficulty in multi-tasking or the inability to give adequate concentration on a particular aspect of user interaction, were reported by the participants (n = 6).

7.5 Discussion and Conclusion

The results from this study showed that there was not a significant difference in the measures for the quality of social interaction experience between the non-3D and the 3D virtual stores. Of particular interest was how the results showed that older people found 3D avatars to be of limited use to their social interaction. Regression analysis shows how this factor was not a direct predictor of the measures for social interaction when the other factors (namely physical presence) were controlled. Overall, it appears that rather than perceiving the avatars as an extension of themselves in the virtual world (a "representation") (Bartle 2004), older users perceived the avatars as just being a representative, or a puppet which they only control but do not truly embody. While further controlled studies would need to be carried out to confirm why this is the case, the results from the interviews in this study led us to believe that this could be due to the inability of avatars to display non-verbal behavior and reflect facial expression through avatar-mediated-communication. This lack of such none verbal cues which could serve as indicators for deception not only made it difficult for users to trust their partners (Zuckerman et al. 1981), but also reduced their perceived level of realism. Such concerns about issues of deception and false identity are commonplace with older people in other CMC technologies (such as in social networking services (Lehtinen et al. 2009)). For virtual worlds however, the use of a 3D avatar seems to further compound this problem, as there was "an avatar representation" but not one which is realistic enough to display emotions or has a facial appearance which matches their partner. Part of this sense of uneasiness could also be due to the perceptual mismatch between the artificial features of the 3D avatars and the actual human feature perceived by users which could invoke a negative affinity towards the avatars (see Kätsyri et al. 2015).

A number of steps could be taken to improve avatar-mediated communication for older users. To address the issue of the lack of transparency, instead of relying on the 3D avatar to embody and convey the identity of the users, a separate 2D photographed avatar could be used to instead convey the identity of the user (with the 3D avatar being used mainly to convey a physical presence in the spatial realm). In addition, gesture-based sensors (such as the Microsoft Kinect) have the ability to directly map user motions and facial expressions towards their avatars which could provide a more accurate representation of body language (particularly those which are displayed unconsciously). While physical presence was found to be a significant predictor in most of the measures for the quality of social interaction which is in line with previous studies carried out with general users (Jung 2011) (Stanney et al. 1998), what was particularly interesting was how older people seem to hold a stereotype of virtual worlds as being a "game" (based on their past experience with similar looking technology) and associating it with mainly with "playfulness. Due to the sense of artificially associated with "games" and "play" as being an artifact outside real life, some users found it was difficult for them to suspend their disbelief and immerse themselves in the store. This perception could have negative implications for example if virtual worlds were to be used in more serious contexts. While it could

be impossible to convey senses and project a high sense of realism through only a static computer screen, emerging technology such as Augmented reality or by simply using digital projectors, we would be able to project a virtual world dimension onto an existing plane of reality, therefore not necessitating us to recreate all aspects of the environment in a highly realistic manner.

Although some of these findings have been previously reported in past studies on 3D virtual world, very few of these past studies focused on older people. When older people were involved, most studies focused on only a specific aspect of the virtual world, for instance on the use of avatars as computer controlled interfaces to interact with older people (such as embodied virtual agents (Straßmann and Krämer 2017)) or the ability to navigate in a 3D space (Sjolinder et al. 2005). In this study, the avatars are evaluated as entities controlled by actual users and used in social interaction in a 3D spatial environment. The findings from this chapter generally supported the results from previous studies, for example, showing how some older adults selected avatars to represent their actual or idealized selves (Carrasco et al. 2017) or how older users were unable to relate and identified themselves with computer generated avatars (Cheong and Theng 2011).

There are several limitations in this study, the foremost being the relatively limited sample size. Although 38 samples are sufficient to detect a large effect size, our regression models might fail to detect results of low and medium effect sizes. In addition, as participants were recruited through convenient sampling (namely snowball sampling), most were quite acquainted with each other prior to the study. Whether the social experience of participants would be different had they never met face-to-face before would need to be further investigated. The interviews hinted that this might be the case as participants reported factors such as false identity and deception as being key points of concerns when using such technology.

Overall, the results from this chapter and from previously related studies which were carried out offers several interesting perspectives on how older people engage with 3D virtual world environments. When examining older people who engaged with virtual worlds, we found that despite the considerable difficulty in learning how to interact with virtual world, several were able to overcome these initial usability barriers and use virtual worlds to productively expand and maintain their social networks, learn new skills and knowledge and contribute back meaningfully to society (Siriaraya et al. 2014), (Siriaraya and Ang 2012a, b). A more in-depth study carried out in this chapter showed that it was not only the commonly assumed cognitive ability barriers such as difficulties of navigating in a 3D environment which impacted their social experience, but psychological barriers such as concerns about deception and false identity and prior expectations of 3D computer generated environments as being non-serious fictional spaces also contributed to their negative social experience as well. In particular, while the 3D environment seems to contribute to a borderline increase in physical presence, the environment did not contribute to an increase in social presence, with older people not perceiving avatars as being representations of actual human users and only as placeholders in the 3D environment. This shows to an interesting future research direction on how a more satisfactory embodiment in social interaction could be achieve for older users in a 3D environment.

References

Ang CS, Zaphiris P, Mahmood S (2007) A model of cognitive loads in massively multiplayer online role playing games. Interact Comput 19(2):167–179

Bartle RA (2004) Designing virtual worlds. New Riders, Indianapolis, IN

Biocca F, Harms C, Burgoon JK (2003) Towards a more robust theory and measure of social presence: review and suggested criteria. Presence 12(5):456–480

Bowling A, Paul D (2005) What is successful ageing and who should define it? BMJ V331:1548–1551

Braun V, Clarke V (2006) Using thematic analysis in psychology. Qual Res Psychol 3(2):77–101

Carrasco R, Baker S, Waycott J et al (2017) Negotiating stereotypes of older adults through avatars. In: Proceedings of the 29th Australian conference on computer–human interaction, Brisbane, Australia, pp 218–227

Cheong WL, Theng YL (2011) Avatar: a virtual face for the elderly. In: Proceedings of the 10th international conference on virtual reality continuum and its applications in industry, Hong Kong, China, pp 491–498

Czaja S, Lee CC (2007) Information technology and older adults. In: The human-computer interaction handbook: fundamentals, evolving technologies and emerging applications. Erlbaum, New York, pp 778–792

Ducheneaut N, Wen M-HD, Yee N et al (2009) Body and mind: a study of avatar personalization in three virtual worlds. ACM, NY, pp 1151–1160

Dunning T (2009) Online communities and aging. Adapt Aging 33(4):263–264

Ellison NB, Steinfield C, Lampe C (2007) The benefits of Facebook "friends:" social capital and college students' use of online social network sites. J Comput Mediat Commun 12(4):1143–1168

Fetscherin M, Lattemann C (2008) User acceptance of virtual worlds. J Electron Commer Res 9(3):231–242

IJsselsteijn WA, Ridder Hd, Freeman J et al (2000) Presence: concept, determinants and measurement. In: Proceedings of the SPIE, human vision and electronic imaging V, San Jose, California, January 24–27, pp 520–529

Jung Y, Peng W, Moran M et al (2010) Low-income minority seniors' enrollment in a cybercafé: psychological barriers to crossing the digital divide. Educ Gerontol 36:193–212

Jung Y (2011) Understanding the role of the sense of presence and perceived autonomy in user's continued use of social virtual worlds. J Comput Mediat Commun 16(4):492–510

Kätsyri J, Förger K, Mäkäräinen M et al (2015) A review of empirical evidence on different uncanny valley hypotheses: support for perceptual mismatch as one road to the valley of eeriness. Front Psychol 6:390

Khalaila R, Vitman-Schorr A (2018) Internet use, social networks, loneliness, and quality of life among adults aged 50 and older: mediating and moderating effects. Qual Life Res 27(2):1–11

Lehtinen V, Nasanen J, Sarvas R (2009) A little silly and empty-headed—older adults understanding of social networking sites. The British Computer Society, Cambridge, pp 45–54

Lombard M, Ditton T (1997) At the heart of it all: the concept of presence. J Comput Mediat Commun 3(2). http://jcmc.indiana.edu/vol3/issue2/lombard.html

Nimrod G (2010) The fun culture in seniors' online communities. The Gerontologist 51(2):226–237

Nowak KL, Biocca F (2003) The effect of the agency and anthropomorphism on users' sense of telepresence, copresence, and social presence in virtual environments. Presence Teleoperators Virtual Environ 12(5):481–494

Pew Research Center (2010) Generations 2010. http://pewinternet.org/Reports/2010/Generations-2010.aspx. Accessed 26 Aug 2011

Siriaraya P, Ang CS (2012a) Age differences in the perception of social presence in the use of 3D virtual world for social interaction. Special Issue on presence and interaction. Interact Comput 24:280–291

Siriaraya P, Ang CS (2012b) Characteristics and usage patterns of older people in a 3D online multi-user virtual environment. Comput Hum Behav 28(5):1873–1882

Siriaraya P, Ang CS, Bobrowicz A (2014) Exploring the potential of virtual worlds in engaging older people and supporting healthy aging. Behav Inf Technol 33(3):283–294
Sjolinder M, Hook K, Nilsson LG et al (2005) Age differences and the acquisition of spatial knowledge in a three-dimensional environment: evaluating the use of an overview map as a navigation aid. Int J Hum Comput Stud 63(6):537–564
Stanney KM, Mourant RR, Kennedy RS (1998) Human factors issues in virtual environments: a review of literature. Presence 7(4):327–350
Straßmann C, Krämer NC (2017) A categorization of virtual agent appearances and a qualitative study on age-related user preferences. In: International conference on intelligent virtual agents, Stockholm, Sweden, pp 413–422
Taylor TL (2002) The social life of avatars: presence and interaction in shared virtual environments. In: Living digitally: embodiment in virtual worlds. Springer-Verlag, London, pp 40–62
Vilhjálmsson H (2003) Avatar augmented online conversation. Ph.D. thesis, MIT Media Lab
Zhou Z, Jin XL, Vogel DR et al (2011) Individual motivations and demographic differences in social virtual world uses: an exploratory investigation in second life. Int J Inf Manage 31(3):261–271
Zuckerman M, DePaulo BM, Rosenthal R (1981) Verbal and nonverbal communication of deception. ADV experimental social psychology 14. Academic Press, New York, pp 2–60

Panote Siriaraya (Ph.D., Electronics, University of Kent) is currently working as a Post-Doctoral Researcher at Kyoto Sangyo University. Previously he worked as a Researcher at the Delft University of Technology from 2014 to 2017. His main research interest falls broadly in the field of Human-Computer Interaction and includes topics such as Virtual Environments, Gamification and Designing Technologies for the Aging population.

Chee Siang Ang (Ph.D., City University London) is a Senior Lecturer in Multimedia and Digital Systems in the School of Engineering and Digital Arts, University of Kent. Before joining Kent, he was a research fellow at the City University London. His main research interest lies in the general area of HCI (Human Computer Interaction) with an emphasis on digital health. Specific areas include (i) Games and virtual worlds and (ii) Sensing technologies.