Multi-user Virtual Reality for Social Connectedness: Exploring the Design Preferences of People Living with Dementia and Their Support Persons

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Abstract

Virtual reality (VR) is increasingly being adopted in dementia research. However, much of the research to date has focused on single-user VR applications with limited attention paid to how multi-user VR (MUVR) applications may be designed to promote or maintain social connectedness. This paper explores the design preferences of seven people living with dementia and their seven support persons to inform a MUVR application for social connectedness. The qualitative data obtained from four focus groups were analysed thematically and resulted in two main themes. The first theme, promoting social connectedness through familiarity, described people living with dementias' need to experience MUVR with someone familiar, including familiar avatars, activities, and multisensory content. The second theme related to the need for an easy-to-use MUVR application to enrich social experiences and improve the quality of the shared MUVR experience. These findings provided design guidelines which supported the development of a MUVR application to promote or maintain the social connectedness of this population. The paper also provides information to support future MUVR design research in this area.

Keywords

Virtual reality · Dementia · Social connectedness

1 Introduction

As the number of people living with dementia continues to increase globally with no present cure, people living with dementia must be supported to live well with the condition [1, 2]. Digital technologies present one alternative means of supporting the social health and wellbeing of people living with a diagnosis of dementia and their support person [3–5]. This paper charts the design process for a multi-user virtual reality (MUVR) application *with* and *for* people living with dementia and their support persons. The bespoke MUVR application explicitly aims to promote or maintain social connectedness.

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1.1 Social Connectedness and Socially Assistive Technologies

People living with dementia experience changes to their social health and wellbeing as their dementia progresses, this may manifest as withdrawal from or avoidance of social situations and interactions or decreased confidence communicating with others [6]. In particular, people living with dementia often report experiencing social disconnectedness [7]. Social connectedness is described as the momentary feeling of belonging to a social group or network. Dimensions of social connectedness may include relationship saliency, closeness, understanding each other's experiences, shared understanding and contact quality [8]. This conceptualisation of social connectedness has underpinned previous technology design research with older adults [9, 10] and the broader Human–Computer Interaction (HCI) landscape [11, 12]. Dementia-related changes impact the social connectedness of people living with dementia, which is an important contributor to overall quality of life, mental health and wellbeing. Despite the importance of social connectedness to health and wellbeing, there are often limited opportunities for people living with dementia to engage in social activities suited to their needs and abilities [13]. This highlights the need for novel opportunities to enrich social connectedness. Enriching social connectedness closely aligns with previous dementia and design efforts aimed at fulfilling a social or emotional need for people living with dementia, shifting the focus from disability to embracing their unique abilities [14–16]. Socially assistive technology may be one novel means of supporting social connectedness [4].

Within the context of this paper and previous publications [4, p. 596], socially assistive technology refers to: "assistive technology that is specifically designed for and/or used to promote social health among people living with dementia by enhancing their capacities to (1) fulfil their potential and obligations, (2) manage life with some degree of independence, and (3) participate in social activities" [4], HCI research has explored how best to support the social health outcomes of people living with dementia harnessing socially assistive technologies [16, 17]. The application of socially assistive technologies in gerontology and dementia research is vast and ranges from social robotics to virtual experiences [4, 5, 18, 19]. Exacerbated by the COVID-19 pandemic, research exploring the role of digital technology for social connectedness has gained additional traction in recent years [20, 21]. One particular social technology is MUVR [22–25].

1.2 Multi-user Virtual Reality (MUVR)

Fully immersive VR is described as a computer-generated virtual environment that can be interacted with as if it were real, using a head-mounted display (HMD) [26–28]. MUVR enables two or more people to simultaneously be present in the same virtual world, whereby they can engage and socialise with one another [29]. Recognising that people living with dementia may face technology-related unfamiliarity and dementia-specific challenges [30], MUVR design must accommodate their unique experiences. Despite the commercial availability of generic MUVR applications such as 'VR Chat' and 'Rec Room', there is a paucity of research surrounding MUVR design *with* and *for* older adults. This is particularly true for older adults living with dementia [31].

A multi-site observational study by Kalantari et al. [32] used a collaborative MUVR environment with older adults consisting of a 360-degree travel videos, group puzzles and creativity tasks. When trialled with older adults dispersed across two locations, the application was considered usable by and resulted in increased social engagement and enjoyment [32]. Moreover, engaging with the application in pairs provided a sense of social presence (e.g. a feeling of being in the same space as another person) for people living with dementia. In another MUVR study, reminiscence activities were

perceived to address the social needs of older adults [23]. The co-designed MUVR scenarios aimed to facilitate reminiscence, support healthy ageing and address ageist stereotypes. Similarly, Wei et al. [25] highlighted that co-designed MUVR activities such as travel, reminiscence or experiencing familiar family events supported equal relationships between grandparents and their grandchildren. While the aforementioned studies focused on older adults more generally, it is important to acknowledge the scarcity of research explicitly focused on MUVR design for older adults living with dementia. To date, few studies have explored this intersection, with fewer still explicitly designed for social connectedness. Afifi et al. [22, 33] explored the design and implementation of a MUVR application in partnership with people living with mild cognitive impairment (MCI) or dementia. Their application consisted of 360-degree videos and personalised family photographs and videos. Using the application enriched the social relationships between users and demonstrated the need for future MUVR research in this area.

1.3 MUVR Design and Dementia

Broader MUVR research has identified design choices which encourage social interaction [34]. Some of these considerations include aesthetics, avatar-mediated communication, social mechanics and activity preferences [34]. As noted by Handley et al. [35], MUVR design taxonomy is organised into three design areas: the self (avatar representation, customisation, manipulation and locomotion), interaction (communication privileges, types, activities to scaffold interaction) and the environment (user manipulation of the environment, spawning area, openness of environment).

As reported by Houben et al. [16], the aesthetics of design is important to facilitate meaningful technological experiences for people living with dementia. Although often overlooked in dementia and technology design, aesthetics plays an integral role in how such technologies are accepted and scaffold multisensory experiences [36, 37]. Research with older adults also suggests that the aesthetic appeal of the virtual space contributes to one's sense of presence in VR [38]. This, in turn, may influence one's social experience. Avatar aesthetics and avatar-mediated communication are other key aspects of MUVR design which strengthen social engagement [23, 25, 35, 39, 40]. Avatar-design plays an important role in facilitating social presence [40, 41]. Despite this, limited MUVR research describes avatar design with older adults or people living with dementia [25, 32, 40, 42].

While the previous studies provide frameworks for MUVR design more generally, there remains a lack of consolidated guidance for dementia design that considers the self, interaction and the environment [22, 33]. Moreover, given the subjectivity of experience, the design of digital technologies such as MUVR and their aesthetic must be elicited through the active involvement of people living with dementia and their support persons. Drawing on previous literature, this paper focused on identifying the overall aesthetics, multisensory design features, content and activity preferences of older people living with dementia to inform the development of the MUVR application. This work therefore aimed to expand the evidence surrounding MUVR design for people living with dementia through the lens of social connectedness.

This paper outlines the design, methodology, methods of data collection and analysis used to address the research aims. The qualitative findings are presented and discussed in relation to wider literature in the dementia and design field. Implications for future research are also noted.

2 Method

People living with dementia must be involved in the design of socially assistive technologies, facilitated through the adoption of participatory methods and approaches [15]. This research formed one phase of a larger participatory action research (PAR) project [7, 43, 44]. This study

adopted an explorative approach, using qualitative online focus groups to elicit the MUVR design preferences of people living with dementia and their support persons. The value placed on online design research with people living with mild dementia has been noted by Dixon et al. [45] and informed the design of this study. Given the COVID-19 pandemic and geographical distance between members, focus groups were completed on Zoom between January and April 2022. This research was approved by the University of Galway Research Ethics Committee (reference number 2021.03.007).

2.1 Recruitment and Sample

People living with dementia were eligible for inclusion if they were over 59 years of age, self-reported a formal diagnosis of dementia, resided at home and had a nominated support person who consented to participate in the research. The nominated support person had to be over 18 years of age. All people living with dementia and their support persons were relatives, had participated in previous project phases, had experienced a single user VR application and understood the interactive capabilities of VR [43]. Additional details of the recruitment procedures are available in previous publications [7, 44].

Each person living with dementia participating in this study was considered to have either mild or moderate dementia, with a range of 1–7 + years since experiencing initial memory difficulties. The stage of dementia was guided by the National Institute of Aging-Alzheimer's Association [46] and the Diagnostics and Statistics Manual of Mental Disorders (5th edition) stages of dementia (i.e. mild, moderate, severe) [47]. Table 1 presents demographic information related to the people living with dementia and support persons participating in this study.

Table 1 Demographic information related to people living with dementia and support persons

Characteristics	Number of people living with dementia	Characteristics	Number of support persons
Gender		*Gender*	
Male	5	Female	7
Female	2	*Age Range (years)*	
Age range (years)		30–39	1
59–69	3	40–49	1
70–79	3	50–59	4
80+	1	60–69	1
Current Support Person		*Person living with dementia relationship*	
Spouse/Partner	4	Spouse/Partner	4
Daughter	3	Father	1
Years living with memory difficulties		Mother	2
1–3	4	*Years supporting the person living with dementia*	
4–6	2		
7+	1	0–4	5
		5–9	2

2.2 Procedure

Seven people living with dementia and their seven nominated support persons participated in one of four online focus groups. Each involved a maximum of four attendees, alongside the first author (AF) and the games developer (GR) who assisted with any technical issues. The focus group distribution is reported in Table 2.

For design research, people living with dementia must be supported and empowered to express their needs and preferences [48, 49]. Aligned with PAR, the group co-produced the

Table 2 Focus group distribution*

Focus group	Number of people living with dementia	Number of support persons
A	2	2
B	2	2
C	2	2
D	1	1

* Each person living with dementia and their nominated support person attended the same group

focus group schedule at the end of the previous study phase. People living with dementia expressed a preference for small group sizes, pre-circulated materials (one week prior), comfort breaks and a 90-minutes duration for each session.

Images and worksheets were circulated in advance of the focus groups to aid preparation, reduce some anxieties associated with answering questions and facilitate meaningful discussion. Images included a basic multi-user virtual environment (MUVE) (Figs. 1 and 2), sample avatar designs (Fig. 3) (using MakeHuman and Ready Player Me applications), alongside two worksheets to record shared music and activity preferences.

The choice of such strategies to increase engagement were closely aligned with Shastri et al. [50] and provided implicit cues for people living with dementia and their support persons to spark discussion related to abstract topics, such as avatar design, MUVR aesthetics or the scale of the MUVE.

Verbal informed consent was obtained from each person living with dementia and their support person prior to each focus group. These followed a semi-structured format to support flexibility, an important consideration for people living with dementia. These discussions focused around the previously circulated images and worksheets and a video of a basic MUVR prototype. The structure consisted of (a) introductions, (b) an update on the current work to date and outcomes from previous study phases (reviewing the images provided), (c) a discussion of shared activities and music preferences (using the worksheets to prompt discussion), (d) a discussion on the social aspects of avatar representation and communication methods (verbal, non-verbal communication and avatar design preferences, guided by the avatar images), (e) a discussion of controller interaction and the methods of navigation in MUVR.

2.3 Data Analysis

The qualitative data gathered from each focus group were audio-recorded and transcribed verbatim. NVivo 20 software was used to store and

Fig. 1 Images presented to spark discussion

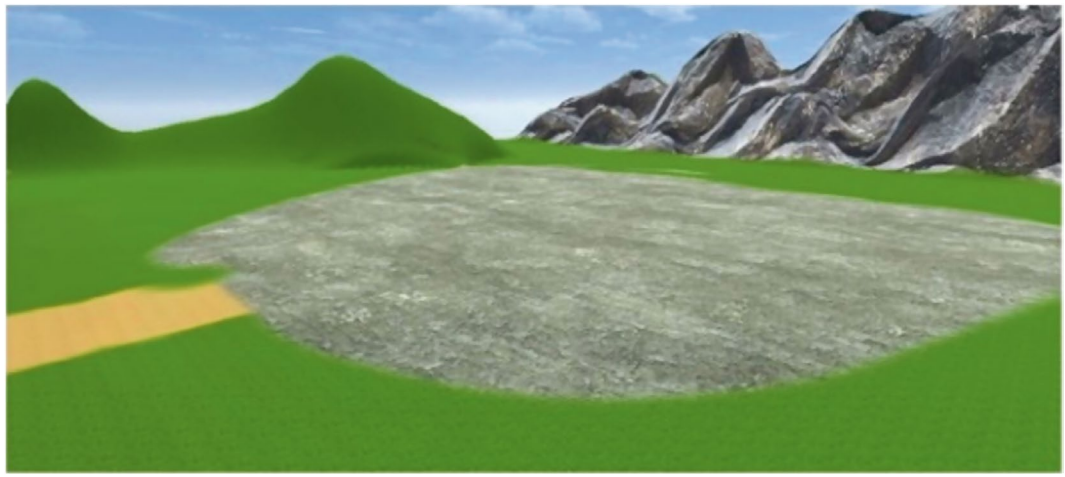

Fig. 2 Image of an open space within MUVR to spark dicussion regarding the content, shared activities and aesthetics

Fig. 3 Avatar design examples (full and partial-bodied)

manage the analysis process, ensuring an audit trail. Braun and Clarke's [51] reflexive thematic analysis approach guided data analysis of each transcript. This approach enabled the construction of themes drawing on the lived experiences of people living with dementia and their support persons to address the research aim and identify their MUVR design preferences. This involved an iterative process of (a) familiarisation, (b) coding, (c) initial theme generation, (d) developing and reviewing themes, (e) refining, defining, renaming themes and (f) report writing [51].

Transcripts were read and re-read to become familiar with their content and AF made some initial notes and observations. Relevant passages from all four focus groups were coded by AF,

capturing the views of both people living with dementia and their support persons. Codes were then grouped into initial candidate themes which reflected the patterns in the focus group data. These themes were then further developed and reviewed by the wider research team (AF, GR, AB, SR, MB, DC) to ensure coherence within each theme and the entire data set and alignment with the overall aim of the study. Moreover, a video presentation of the preliminary themes was circulated to people living with dementia and their support persons to reflect on and confirm whether they felt they accurately reflected their discussions. The feedback received was inputted into NVivo and themes were then further refined and defined. The findings were then drafted, critically reviewed and agreed by the research team (AF, GR, DH, AB, SR, MB, DC).

Several strategies were adopted to enhance trustworthiness including, member reflections, peer debriefing and reflexive journalling. Focus group discussions promoted the triangulation of perspectives between people living with dementia and their support persons. Regular meetings also supported reflectivity, whereby the research team, people living with dementia and their support persons reflected on their experiences and how their worldview influenced the research. The findings are supported by illustrative quotations to ensure that the experiences of people living with dementia and their support persons are to the fore. Demographic details are also provided for people living with dementia and their support person, which may aid transferability of the findings to other contexts.

3 Findings

Two main themes were developed relating to the design of MUVR for social connectedness, (i) promoting social connectedness through familiarity and (ii) an easy-to-use and adaptable MUVR design to enrich social connectedness.

3.1 Promoting Social Connectedness Through Familiarity

This theme related to the importance of a familiar MUVR design to support social connectedness. The idea of familiarity spanned across multisensory content in the MUVE, being in MUVR with familiar others and familiar activities.

Familiar, relatable and easily identifiable multisensory content within the MUVE was considered important to support social connectedness. Such content was considered crucial to evoke memories and spark conversations between people living with dementia and their support persons. Colourful, vibrant visuals and ambient sounds were perceived as focal discussion points by people living with dementia and their support persons while using the application. For example, emphasis was placed on incorporating bright colours, bird song and water sounds into the nature elements and outdoor forested areas. A colourful aesthetic and theme was positively perceived when reviewing the MUVE images (Figs. 1 and 2) and video as evidenced in this excerpt: "*I think that they [images of the MUVR application] are lovely, I really think it's great. I like the colours*" (Person living with dementia 9). When viewing the prototype video, a support person suggested adding more sounds: "*I would love the sound of rustling leaves*" (Support person 3).

Across all focus groups, people living with dementia and their support persons agreed that to promote social connectedness, the MUVE should have a familiar layout and theme each time. They noted that the application should portray an open, communal virtual space relatable to a real-life social environment. Ideas proposed during the focus groups included a village scene with various stores, a community centre, a carnival or funfair. People living with dementia and their support person also reiterated that in order to support social connectedness, there was a need for mutually familiar, interesting and fun

shared activities and music. Music and dance, nature, sport, travel, virtual vacations, cognitive stimulation activities (such as word searches or word games), fantasy and role-play games, meditation and mindfulness activities were common suggestions which held mutual interest for both people living with dementia and their support person. These activities were considered meaningful and resonated with participants' current or past interests. Additionally, they were also regarded as a means of reconnecting to activities which were no longer accessible due to dementia-related challenges, or presented a novel activity that they "*wouldn't normally get to do*".

Using MUVR with those whom people living with dementia had a pre-existing, close relationships with or with those who shared a common interest was seen as a source of comfort and encouragement. This was a consistent finding across focus groups. Familiarity between users was perceived to make the experience more engaging. This included how one was represented in the MUVE and avatar design. There was mutual agreement among people living with dementia and their support persons across all focus groups that to support social connectedness, the avatar designs must be familiar, friendly and approachable. Full-bodied, human-like avatars were universally favoured, attributed to their resemblance with real-life humans as opposed to half-body or partial-body options which were considered "*too abstract and unappealing*". One person with dementia noted: "*I'm not really into the head and hands [half-bodied avatars] [..] It just doesn't look like a person*" (Person living with dementia 6). Similarly, the MakeHuman avatar designs were considered "*menacing*" and unapproachable while the Ready Player Me options were perceived as "*brighter*" and "*friendlier*". Other suggestions to enhance the familiarity of avatars in the MUVE included having the option to account for age (when preferred), to include nametags close to each avatar and to highlight avatars when they are speaking in MUVR.

3.2 An Easy-To-Use and Adaptable MUVR Design to Support Social Connectedness

A common thread across all focus groups was the desire for an adaptable and intuitive application design to support social connectedness. An easy-to-use application, designed for sustainability, that could adapt to the changing needs of people living with dementia was also favoured. This included preferences for natural and accessible communication methods, minimal controller use and navigation, various activity levels and an undemanding aesthetic. Natural and accessible means of communication such as simple lip-sync and speaking into the HMD were perceived to facilitate shared experiences and reciprocal interaction between avatars in MUVR. One person living with dementia noted: "*I don't think it [verbal communication] has to be so perfect. I would be quite happy with that [talking through the HMD]*" (Person living with dementia 7). Adaptive sound and volume to accommodate the sensory needs of people living with dementia, such as those wearing hearing aids, was another key finding. In addition to verbal communication, simple non-verbal interactions through avatars were also perceived as important to support social connectedness. A support person emphasised the importance of physical gestures in MUVR and the ability to observe each other's avatar movements in the MUVE: "*The physical gestures are important; it's a big part of the novelty of being in the VR environments that you could express with your arms and that it will be seen by the other person*" (Support person 6).

In a bid to support the dynamic needs of people living with dementia and to support their agency, people living with dementia and their support persons desired "*to have a choice*" (Person living with dementia 6) between interactive and less challenging, passive activities in MUVR. A support person reported: "*One day you might be in the mood just for listening to a*

concert and relaxing. Another time, you might be in the mood for something more energetic, and so a mix [of activity levels] will be perfect" (Support person 1). To also account for dynamic needs, people living with dementia consistently emphasised the importance of simple and intuitive menu options and user interface panels. This included clearly labelled and "*easy-to-find*" activities, accessed by one main controller button. Another popular suggestion for easing navigation and reducing navigational stress was to clearly signpost shared activities by mapping each to a relevant storefront in the MUVE. For example, music activities could be hosted within a dancehall storefront, so that clicking on the dancehall would directly load the music activities.

These features were considered crucial for simplifying interaction and navigation, allowing more focus on the social elements, thus promoting social connectedness. This was mirrored by a support person, who made the connection between ease of navigation and overall enjoyment of the MUVR experience: "*I think make it [navigation in MUVR] simpler and you would get much more from it. My mom would have much better enjoyment of the whole thing*" (Support person 5).

4 Discussion

This paper explored the design preferences of people living with dementia and their support persons to inform a MUVR application for social connectedness. When usability difficulties arise, it impacts the overall social experience. Therefore, to support positive social experiences such as social connectedness, the findings suggest that MUVR must be designed with familiarity, ease of use and adaptability at the fore. The findings of this paper and the derived design preferences discussed below contribute to the existing paucity of research pertaining to MUVR design in this area.

4.1 MUVR Design Preferences for Social Connectedness

Relatable avatar design and representation. People living with dementia and their support persons expressed a preference for relatable, full-bodied, humanistic avatars as opposed to more abstract half or partial-body options, reflective of other VR research with older adults [32]. Avatar relatability was considered important to assist people living with dementia to associate the avatars in MUVR with themselves and others [25, 53] and may contribute to key dimensions of social connectedness, namely closeness, social presence and awareness [8, 9].

Natural and easy means of avatar-mediated communication. People living with dementia and their support persons preferred simple avatar-mediated communication, speaking into the headset microphone as you would in real-life. Likewise, the value placed on authentic verbal communication in VR is mirrored in previous work by Baker et al. [40], O'Connor et al. [54] and Waycott et al. [55]. However, positive avatar-mediated communication was considered contingent on lip-sync functionality and clear representation of which avatars were speaking to avoid unnecessary anxiety or confusion.

Facilitate MUVR use with familiar others through familiar activities. Having the person living with dementia use the MUVR application with someone familiar was considered a means of promoting or maintaining social connectedness, by using knowledge of one's life story to scaffold conversation and interaction in MUVR. Previous research has also noted that designing VR for shared use with people living with dementia and their family members had social benefits [22, 33, 56]. This existing familiarity with one another must translate to the virtual world, where the person living with dementia can recognise their support person's avatar. Nametags and a variety of avatar design options should be implemented to facilitate this, alongside the aforementioned need for verbal communication.

Drawing on the focus group findings, it is recommended that MUVR designs include activities that are *familiar* and *mutually meaningful* for both people living with dementia and their support person. Mutual engagement in shared activities may play a crucial role in fostering social connectedness by addressing key dimensions such as 'knowing one another's experience' and 'shared understanding' [8]. Such activities may also provide opportunities to converse about the content and share personal life stories, a finding supported by Kolasinska et al. [17]. Moreover, this aligns with other VR researchers [25, 39, 57, 58], who found that meaningful activities, aligned with real-life interests, contributed to positive experiences for older adults and people living with dementia. While some of these studies focused on single-user environments, this paper extends these findings to a MUVR context, highlighting that the positive impact of tailored activities may persist even when multiple users are involved.

Familiar and multisensory aesthetic. The findings propose a MUVR design that is familiar and multisensory for people living with dementia and their support person. Consistent with previous work [53, 59], the findings support the incorporation of a natural aesthetic, with colourful nature scenes and ambient sounds. The value of aesthetics in supporting engagement in VR has been acknowledged in previous VR design guidance for older adults [38, 53]. Moreover, this design preference closely aligns with other HCI research which signposted the link between aesthetics and technology acceptability for people living with dementia [60, 61].

Easy-to-operate and adaptive MUVR design. Considering the focus group findings, it is advisable to implement easy-to-operate and adaptive means of interaction, navigation and communication within the MUVR application. This may include natural verbal communication, one-button controller interaction and navigation, various activity levels (ranging from passive to more interactive), clear and intuitive user interface panels and signposting. Sanders et al. [62] similarly offered design guidance, emphasising the importance of incorporating varying levels of complexity and interactivity when developing VR for users of different ages and cultural backgrounds. While this design recommendation is novel to MUVR design for social connectedness, the need of adaptive design is widely supported by previous dementia researchers to ensure sustainability of technological solutions [4, 63].

4.2 Limitations

This paper shows that, with appropriate procedures, people living with dementia can meaningfully contribute to MUVR design through online focus groups. The co-produced focus group schedule fostered group synergy, enabling collaborative idea exchange from the comfort of home. Furthermore, using tangible prompts helped guide people living with dementia and their support persons to lead the conversation, foster collaborative dialogue and promote idea generation, particularly on abstract topics like avatars [62, 64]. As people living with dementia and their support persons were involved in earlier study phases, their existing familiarity with the research process, design methods, technology and each other strengthened data collection for this study. However, some limitations are noted.

The sample size may be considered small. However, this is not uncommon in early-stage technology design and dementia research [50]. Support persons occasionally dominated discussions, a challenge noted in dementia research [51]. The first author addressed this by gently verifying support persons' viewpoints with individuals with dementia and allowing time to review and feedback on early findings. Additionally, the focus group with one couple, due to scheduling conflicts, may have limited the depth of insights because of the lack of group interaction. Finally, people with dementia and their support persons based their discussions on images and a video of the MUVE rather than experiencing it firsthand through a VR headset.

Using the headset may have offered a more detailed perspective of the avatar designs and MUVR content, potentially eliciting more comprehensive feedback.

4.3 Implications for Future Research

As evidenced in the discussion, there is limited MUVR design research focused on people living with dementia and fewer still focused on social connectedness. This paper is the first of its kind to describe the preferences of people living with dementia and their support persons with respect to MUVR design for social connectedness. This paper provides evidence to support future MUVR development not only for social connectedness, but for MUVR design more generally. This is particularly pertinent given the increased global prevalence of dementia, rapid technological advancements and increased social disconnectedness [7].

As previously noted, the design preferences shared in this paper have been translated into a bespoke MUVR application to promote or maintain social connectedness [44]. Future research should build on this work to investigate how to optimally design MUVR to accommodate shared experiences across geographical distance or with different groups such as people living with dementia and their grandchildren or friends.

5 Conclusion

In conclusion, this paper contributes to addressing the paucity of research on MUVR design for people living with dementia. It further informs the development of MUVR technologies aimed at promoting or maintaining social connectedness for both individuals living with dementia and their support persons. The findings highlight two key themes: promoting social connectedness through familiarity and an easy-to-use and adaptable MUVR design to enrich social connectedness. These themes suggest design preferences that can guide the future development of MUVR applications for social connectedness. Specifically, these preferences include: relatable avatar design and representation, natural and intuitive means of avatar-mediated communication, facilitating MUVR use with familiar others through familiar activities, a familiar and multisensory aesthetic and an easy-to-operate and adaptive MUVR design. In summary, these findings aim to address the limited research on MUVR design for people living with dementia, particularly in the context of fostering or maintaining social connectedness. By highlighting these gaps and insights, this work seeks to encourage additional research in this field to advance the design and application of MUVR technologies.

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