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Extended Abstract–XR Cognitive Training for Early Dementia: User Reactions and Experiential Insights from a Pilot Study

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Abstract. This paper presents findings from a pilot user study assessing the user acceptance and selected user experience constructs for an immersive cognitive training system designed for individuals in the early stages of dementia. The comparative user study used a counter-balanced, within-subject approach in which users engage and assess two custom-modified versions of the same XR cognitive training game. Conducted in collaboration with the Alzheimer Athens organization, the study involved 20 older adults, 15 of whom were diagnosed with mild cognitive impairment (MCI) or more severe conditions such as aphasia. The assessment was performed with closed questionnaires and a short interview, facilitated by a neuropsychologist. Results suggest that the XR game was perceived as highly acceptable and accessible by the user group, elicited engagement, motivation and enjoyment, and was regarded as promising for cognitive training support. Challenges remain, yet the overwhelmingly positive feedback by the user group supports the viability of immersive playful activities for effective cognitive training.

Keywords: Immersive Cognitive Training, Telepresence, User Experience, Mild Cognitive Impairment, Immersive Learning, Extended Reality.

1 Introduction

Population ageing presents significant challenges for healthcare systems worldwide, particularly in relation to cognitive decline and neurodegenerative conditions. Individuals with mild cognitive impairment (MCI) or early-stage dementia experience gradual reductions in memory, attention, and executive functioning, affecting autonomy and quality of life. However, cognitive training interventions have been shown to support mental stimulation and delay functional deterioration when appropriately designed and consistently applied [1].

Such digital cognitive training platforms are typically deployed on tablets, smartphones, or desktop computers and rely on two-dimensional interfaces. While these solutions are accessible and cost-effective, they lack embodied interaction, which is critical for older adults, since cognitive decline in older populations is usually accompanied by movement impairments, rendering motor-related exercises necessary. In addition, other key categories of cognitive tasks are essentially spatial, such as spatial orientation and memory, highlighting immersive experiences as uniquely positioned for such training.

Therefore, in recent years, Extended Reality (XR) technologies have emerged as promising alternatives, offering immersive, multisensory, motor-cognitive training [2]. Yet, significant concerns exist around accessibility of such experiences for elderly users, alongside technological acceptance given low literacy, actual cognitive effectiveness, as well as overall operational feasibility. In mitigation of such concerns, two features have arisen as potential design parameters: intuitive (natural) interaction methods within XR, and close professional supervision out of XR, e.g. for user guidance, morale support, and observation-based assessment.

To that end, this study aims to examine the acceptance and accessibility of older adults with a XR cognitive training platform specifically designed to offer high levels of accessibility. For further contextualization of results, the study aims to compare the perceived value between an immersive and a non-immersive counterpart of the same cognitive training activity used in the study. Lastly, the study aims to assess the impact on the user experience of the provision of professional supervision, specifically on feelings of isolation and co-presence. Professional supervision is provided as a virtual telepresence within the immersive environment. Avoiding abstract

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visualizations such as avatars, the study implements and compares two realistic visual representation methods of the health professional: a video-based and a holographic-based (volumetric video) telepresence. The specific research questions are:

1. How acceptable and accessible is the XR cognitive training activity for this user group?
2. How is the XR cognitive training perceived compared to its counterpart on a tablet?
3. How do video and holographic telepresence of the health professional comparatively affect the sense of co-presence within the virtual environment?
4. How does video and holographic telepresence comparatively elicit feelings of motivation, confidence, support and perceived safety for the user during training?
5. What design implications emerge for future XR-based cognitive training systems?

By addressing these questions, the study contributes to the iLRN 2026 theme by exploring how immersive technologies can foster inclusive, empathetic, and participatory learning environments for ageing populations.

2 Background and Related Work

Virtual and augmented reality technologies have increasingly been applied in cognitive rehabilitation and mental health contexts [3]. Research indicates that immersive environments can enhance engagement, memory retention, and emotional involvement through multisensory stimulation and embodied, motor-cognitive interaction [1, 4, 5]. For individuals with MCI and dementia, XR-based interventions have demonstrated feasibility and positive effects on motivation and participation [6]. Systematic reviews have highlighted the potential of immersive technologies to support safe, adaptive, and personalized training environments, especially when XR systems simulate real-world tasks while maintaining controlled conditions, making them suitable for vulnerable populations [7].

Whether in virtual and physical operational frameworks, embodied cognition theories emphasize the role of sensorimotor activity in learning and memory formation [8]. XR environments enable users to interact with digital objects using natural body movements, reinforcing cognitive processes through physical engagement. Presence—the subjective sensation of "being there"—has been identified as a key mediator of learning and emotional outcomes in immersive systems [9, 10].

In parallel, telepresence, or the perception of remote human presence in mediated environments, has the potential to further enhance social and emotional engagement, a key point in healthcare and training contexts, where professional presence can increase trust, motivation, and perceived safety [11].

Lastly, designing XR systems for older adults is known to require careful consideration of physical comfort, cognitive load, and accessibility. Common challenges include motion sickness, headset weight, controller complexity, and visual clarity.

3 System Description

This study was conducted using an experimental immersive cognitive training platform, Eligence XR. Eligence XR is an XR adaptation of an existing, web-based, cognitive training platform, Eligence, which is deployed and used daily by elderly people, especially in the Alzheimer Athens Centers, where the study took place. The XR training platform offers immersive versions of popular 2D games of the web-based Eligence (as shown in Figure 1). By virtue of being offered in two versions, this system allowed for comparison of the user experience between an immersive and non-immersive counterpart without requiring additional creation of artifacts. In addition, the platform offers healthcare professionals the capacity to remote control, supervise, and support the immersive training sessions through a desktop interface. This means that end-users do not need to engage with any UI or screen navigation and can directly play by putting on the headset (user presence mechanic) lowering digital literacy requirements. This is the first of the two core accessibility features of the chosen artifact.

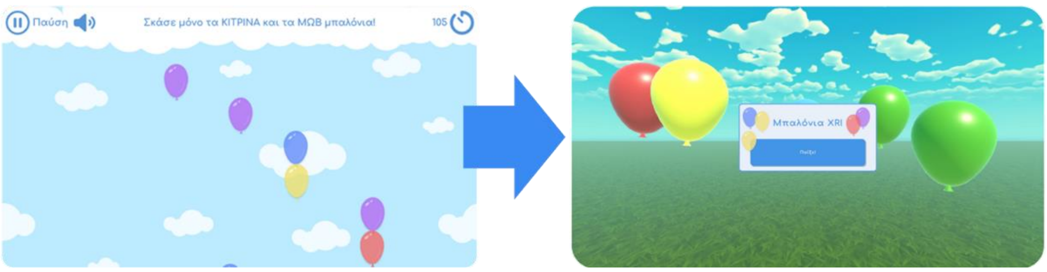

Fig. 1. 2D (left) and XR (right) versions of XR game used in experiment.

3.1 The Balloons XR Game

The “Balloons” game was selected because of the popularity of the 2D version in the Eligence platform, increasing chances that participations would have adequate previous personal experience. This reduced the need to add engagement time with the 2D game as part of the experiment protocol, reducing duration. The game design also involves combined cognitive and motor demands confirming it as an ideal XR design candidate. In the XR game, users are seated or standing, depending on their level of comfort and capabilities, and required to pop virtual balloons appearing at varying positions within the virtual environment. A hand controller was used for input (input modality) and the popping interaction was performed through simple physics collisions (interaction design). This natural “hitting” movement which avoids button presses or input combinations marks the second accessibility feature under examination. The task trains attention, visuospatial processing, and upper-limb coordination. Game parameters such as spawn rate, distance, and size can be adjusted in real time by facilitators to accommodate individual abilities.

3.2 Telepresence Modalities

Extending the original XR platform, two modes of professional telepresence were implemented for the user study: a video telepresence, where a live video stream of the healthcare professional is displayed within the virtual environment, and a holographic telepresence, where a volumetric representation of the professional is projected into the virtual space. Both modalities allow real-time verbal communication and visual representation of the face and upper body of the health professional, as shown in Figure 2. The holographic telepresence feature was offered by the EU funded research project SPIRIT, while the video implementation was custom made for this user study.

Fig. 2. Video (left) and Hologram (right) telepresence conditions.

4 Methodology

4.1 Participants

Alzheimer Athens patients were invited to participate in this study contingent on their use of the Eligence platform (2D version). Only users able to independently provide consent were invited. At the beginning of the session, demographic information was gathered with a questionnaire including data on age, sex, familiarity with XR and familiarity with 2D version of the Balloons game. Twenty older adults (aged 61–88 years, M = 73.6, SD = 7.5) participated in the study. Fifteen were diagnosed with MCI at varying stages, including one individual with aphasia; the remaining five attended Alzheimer Athens day centers for preventive cognitive training. Seventy percent were women and thirty percent men. Eighty-five (85%) percent of participants reported no prior familiarity with XR technology, while 60% replied as familiar or very familiar with the 2D version of the game.

4.2 Design and Procedure

Sessions took place at the Alzheimer Athens Day Centers, familiar and supportive environments where beneficiaries habitually engage in cognitive and physical activities under the supervision of healthcare professionals. Each session was moderated by the researchers and an on-site neuropsychologist. A counterbalanced within-subject design was employed, where participants were divided into two groups: Group A “Video first, then hologram” and Group B “Hologram first, then video”. Participants received a short verbal introduction before engaging with the process and were helped with the fitting of a headset featuring an ergonomic design and limited occlusion of the physical environment (Quest Pro without side blockers). A researcher handled the app control (start/stop) of each condition, allowing participants to interact only with the main game (no UI). Each participant experienced both conditions during a single session lasting approximately 10–15 minutes. At the end of the session, participants completed an assessment questionnaire with the support of the on-site neuropsychologist and participated in a short interview for further qualitative information.

4.3 Instruments

Due to the sensitive nature of the participants, questionnaire length was minimized to absolute essentials. For this reason, instead of administering the entirety of standardized questionnaires, only selected questions from standardized questionnaires of interest were used, alongside custom ones targeting what was considered as core user experience traits for the study. Questions were split into two categories: questions on the game itself, and questions on the telepresence feature. All questions apart from one (1) were in the form of a 5-point Likert scale.

Assessment of the XR game comprised of two (2) questions on behavioural intention (willingness to play again, willingness to recommend to others), one (1) question on naturalness of interaction with virtual elements (taking input modality and interaction method into account), one (1) question on comfort of use/wear of the chosen VR headset during the experience (taking weight, fitting pressure, heat emission and mobility freedom into account), a multiple-choice selection from a list of four (4) descriptive statements (DS) on the user experience and one (1) binary (yes/no) question regarding the perceived value of XR games for cognitive trainings.

Assessment of the telepresence feature comprised of four (4) questions on the mutual awareness, as a factor to co-presence being a theoretical dimension of social presence, drawn from the "Guide to the Networked Minds Inventory questionnaire" translated to Greek [12], and five (5) custom questions to assess the visual clarity and latency of the telepresence feature, specifically on identification, facial expression, gestures, responsiveness and visual clarity.

To conclude, four (4) custom questions were issued on the overall user experience (taking game and telepresence into account), focused on feelings of confidence, support, safety and motivation. Interview questions were included, focused on positive and negative impressions and open comments, to capture a wider perception of the user experience.

5 Results

All data was pseudo-anonymized and audio recordings of interviews were deleted after offline transcription. The ethical approval and data management plan for this study was conducted by the Alzheimer Athens Association. Quantitative data were analyzed descriptively using the SPSS software for data analysis, while qualitative responses were thematically coded manually (no dedicated tool used).

5.1 Game Experience

In the game experience assessments, users reported the following:

- Intention to play again: 90% would play again.
- Intention to recommend: 90% recommend the experience.
- Naturalness of interaction: 95% found interaction natural.
- Comfort of VR use: 80% found the headset comfortable.

Table 1 shows the average value of the 5-point Likert scale and the standard deviation for the above.

Table 1. Results of User Experience Assessment of XR Game.

	Intention to play again	Intention to recommend	Naturalness of interaction	Comfort of use
Mean	4.75	4.7	4.95	4.25
Standard deviation	0.45	0.54	0.095	0.9

From the predetermined descriptive statements (DS) on the user experience:

- DS#1: 90% of participants selected the statement "I enjoyed the experience of the XR game".
- DS#2: 30% of participants selected the statement "I found it difficult to play wearing the VR headset".
- DS#3: 85% of participants selected the statement "I felt as if surrounded by real balloons and really popping them".

- DS#4: 60% of participants selected the statement “I perceived stronger cognitive training than with tablet-based play.”

Lastly, in the binary question, all users answered positively that XR games could support people with cognitive decline.

5.2 Telepresence features

The video condition received highly positive evaluations:

- 85% strongly agreed that they were in the same space as the professional.
- 95% found the image clear and recognizable.
- Over 70% clearly perceived facial expressions and gestures.
- Participants emphasized emotional comfort and visual clarity, contributing to strong engagement.

The hologram condition also produced positive results, though with greater variability:

- 75% agreed or strongly agreed that they shared the same space.
- 45% noticed minor motion delays.
- 45% rated image quality as clear, while 35% found it less distinct.
- Only 30–35% clearly perceived facial expressions.

Directly comparing the two conditions, 11 users preferred the video-based telepresence, while 9 users preferred the holographic-based telepresence.

5.3 Overall experience

In the final questions regarding feelings from the overall experience, 90–95% in the video condition and 80–90% in the hologram condition reported feeling highly confident, supported, safe and motivated. Table 2 shows mean and standard deviations for these reports across both telepresence conditions.

Table 2. Overall experience – feelings.

	Confidence	Support	Perceived Safety	Motivation
Mean	4.74	4.9	4.84	4.78
Standard deviation	0.53	0.3	0.35	0.67

Interview responses revealed strong emotional engagement. Participants described the experience as “pleasant,” “interesting,” and “stimulating.” Representative comments included statements such as “I felt like a child playing again”, “it made me feel active and happy”, and “it was more fun than on the tablet”. Positive themes included enjoyment, alertness, social connection, and novelty. Negative feedback focused on headset weight, occasional dizziness, and hologram quality.

6 Discussion

In summary, the findings from “intention to play again” and “intention to recommend” demonstrate that immersive XR cognitive training was highly accepted among older adults, despite of the limited technological familiarity of the user group. Findings from “naturalness of interaction” and “comfort of VR use” demonstrate a highly accessible setup of the overall experience - this is discussed in subsection “Intuitive interaction”. Findings from DS#2 on enjoyment alongside qualitative data from the interview highlight emotional responses observed (joy, curiosity, and playfulness), which support theories of emotional design and embodied cognition - this is discussed in subsection “Engagement and Enjoyment”. Answers to the question of “perceived value of XR games for cognitive decline” and DS#4 (immersive to non-immersive comparison) suggest that XR cognitive games show potential for further development. Telepresence conditions had different and not directly comparable characteristics - this is discussed in subsection “Telepresence Comparison”. Lastly, feelings of confidence, support, motivation, and safety were reported in both conditions, highlighting that the presence of the health professional was welcomed regardless of the representational medium. Noted challenges are discussed at the end.

6.1 Intuitive Interaction

Participants found the movement and control more natural than in the 2D version of the game. All participants adapted quickly to the controller-based interaction, and even participants with mild aphasia or mobility challenges successfully participated, reinforcing the accessibility of the simplified XR design. One user remarked that the VR version felt “real” and “easier to coordinate” because the environment mirrored real-world physical dynamics. This suggests that embodied interaction may reduce the cognitive load associated with abstract 2D interfaces. It was also observed that most participants intuitively tried to pop the balloons without the controller, therefore hand tracking should be implemented in similar designs. Users appreciated the ability to directly play the games without the need to engage with control/settings, given that the XR game was fully controlled by the health professional.

6.2 Engagement and Enjoyment

Throughout sessions, participants exhibited high levels of engagement and enjoyment. Despite being first-time VR users, nearly all engaged with the application with success. Many described the experience as “fun,” “refreshing,” or “different from the usual exercises.” Several expressed childlike excitement, associating the playfulness of the activity with positive emotions: “I felt like a kid again,” one participant noted. One participant commented “now I can discuss with my grandson about this experience”. The affective component of play appeared to reinforce motivation and curiosity, key factors in sustained cognitive engagement. Although not a measure of cognitive performance by itself, such affective factors may play a crucial role in sustaining long-term engagement in cognitive training.

6.3 Telepresence comparison

Video-based presence achieved higher ratings in clarity and reliability, contributing to a stronger sense of reassurance. Holographic presence, while technically less mature, elicited a strong sense of spatial co-presence and interpersonal proximity. Participants often described feeling “closer” to the professional, suggesting that volumetric representation has the potential of providing stronger feelings of social presence. Both conditions though demonstrated the value of social interactions for engagement and support. Through the desktop interface, the health professional was providing feedback, suggestions, or praise in real time, which was highly valued. This observation suggests that examining the value of supported play, peer-to-peer interactions and social gaming in XR, e.g. with multiplayer mechanics, can be suited to this use-case.

6.4 Challenges

While no cases of motion sickness were reported, some participants mentioned that the headset felt “heavy” or “uncomfortable, even for the short period of the experiment. One participant had difficulty perceiving the controller’s position relative to her hand, leading to reduced success in gameplay. Such feedback highlights the need for lighter hardware, more ergonomic fit, and research into additional cues for depth and distance perception for user groups with heightened needs.

7 Limitations

Limitations include the small sample size, limited MCI representation, user profile distribution within groups, and a short session duration. This study did not include a condition with no telepresence, in order to assess the clearly impact of the health professional presence on the user experience and relied on self-report methods for data gathering. Since all users had no to low familiarity with XR technology, the novelty factor may also be biasing results, which the study could not mitigate. In addition, this study has not executed statistical tests asserting any correlation between the telepresence medium (video or hologram) and feelings of co-presence or any of the other four (4) feelings that were reported. This study did not investigate any claim on actual cognitive training benefits, only on the perception and attitude of the users towards the game/tool.

8 Conclusion and Future Work

This study provides evidence that XR-based cognitive training enriched with telepresence of a professional can offer engaging, emotionally supportive, and accessible experiences for older adults. The reproducibility of these findings should be reinforced with more rigid future experiments to amend the current limitations, as discussed above, e.g. expanding the participant sample, representation of other MCI profiles, the incorporation of objective data gathering methods (such as biomarkers), and the orchestration of longitudinal studies to examine the effect of familiarity on the findings. Yet, findings already successfully show that the accessibility of the used XR game and platform has positively contributed to a high user acceptance. Future work can explore further accessibility traits resulting in XR design recommendations for this user group. In addition, the health professional telepresence or other social dynamics can be examined in further comparative studies to assess their impact on the user experience. Regarding the telepresence medium itself, it was observed that video-based telepresence currently provides superior visual clarity and reassurance, while holographic presence shows promise for enhancing co-presence. Future work on holograms should focus on assessing the implied potential, targeting foremostly technical limitations regarding generation, compression and streaming. Most importantly, future research should focus on examining the user self-reporting on behavioral intention and perceived benefits with any actual clinical outcomes. By extending cognitive training beyond conventional screens into immersive environments, this work contributes to the development of inclusive and empathetic care practices.

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