Attitudes towards and Usability of Head-mounted Virtual Reality in Older Adults

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Abstract
Virtual Reality (VR) is increasingly being used for the assessment and treatment of mental health disorders. The use of VR in mental health has recently been boosted by the development of (low-cost) commercially available VR headsets. Despite this promising evolution, surprisingly little is known about the response of vulnerable populations to head-mounted VR devices that use head tracking (H-VR). The feasibility of using H-VR may be particularly challenging for a frail and ageing population. The aim of the current study is to investigate the attitudes towards and the usability of this technology in older adults and to explore which characteristics of older adults affect the usability and attitudes.

Author Keywords
Elderly; Virtual Reality; Attitudes; Usability; User Experience; Ageing; Cognition.

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Biography

Brenda Schraepen is a research assistant in the Department of Brain and Cognition at the KU Leuven. She works with Prof. dr. Céline Gillebert at the Neuropsychology Lab (http://www.neuropsychologylab.be/). Brenda is a trained clinical psychologist, with particular interest in the older population. She has gained expertise in caring for vulnerable older adults through her work in a geriatric-psychiatric facility, and in a nursing home. She is currently working on different projects aimed at assessing and treating neuropsychological disorders using new technologies.

Introduction

Virtual Reality in Mental Health Care

Virtual Reality (VR) allows us to develop immersive artificial and interactive environments [24]. This technology provides exciting opportunities to better understand, assess and treat a variety of mental health disorders [3]. For instance, the use of VR in exposure therapy has been shown to be equally or more effective than standard therapy for the treatment of phobias, post-traumatic stress and eating disorders [15,30]. VR has also proved to be useful for the rehabilitation of motor impairments in stroke, Parkinson's disease and multiple sclerosis [1,10,17]. In addition, it is now being used for the assessment and rehabilitation of cognitive deficits in ADHD, autism, Alzheimer's dementia, mild cognitive impairment (MCI) and stroke [12,13,14,27,28,29]. It has even been shown to improve activities of daily living in older adults with MCI or dementia [9]. All these studies suggest that VR can create better treatment and assessment protocols for a variety of mental health disorders.

Head-mounted VR in Health Care

Over the last decade, VR headsets such as the Oculus Rift, HTC Vive, and lower cost versions such as the Google Cardboard or Samsung Gear VR, have gained popularity. Recent advances in VR technology include the use of head-mounted devices with stereoscopic vision, stereophonic audio, and head position tracking to create an immersive experience - we will call this "*H-VR*". Recent VR systems also include controllers that can track hand movements such that feedback can be given about the user's interactions with the environment. H-VR induces immersive experiences beyond what is offered via devices such as the Nintendo Wii or Xbox Kinect. H-VR is placed further on the Milgram continuum that distinguishes between augmented, mixed and virtual reality [24] on the basis of the extend of mediation taking place. Therefore, it comes as no surprise that the interest in these newer H-VR devices for mental health care applications has grown. However, little is known about their acceptance and usability in patients with mental health disorders, which may be particularly challenging when dealing with older adults [5].

The Usability of VR in Older Adults

Earlier studies indeed showed that the acceptance and usability of devices such as the Wii or Kinect can be problematic in older adults [7,25], e.g., nearly 40% of patients in a geriatric day hospital refused to participate in a study examining the Nintendo Wii. The authors suggested that the reduced cognitive status of the patients may have had a negative impact on their motivation to use this device [7]. Other studies reported more discomfort using a head-mounted device [23] and generally more dizziness in older adults [8]. These studies illustrate that the use of new technologies is not straightforward in older adults and highlight the need of usability and acceptability studies in this population.

To the best of our knowledge, no studies have been published concerning the attitudes towards and the usability of H-VR in an ageing or frail population. Noteworthy, studies bumping into issues of usability and acceptability of new technologies for mental health care (such as VR) may not always be published. These issues may thus be underrepresented in the literature (a known issue in eHealth [11]). A better understanding of the attitudes towards H-VR and of the usability of H-VR in older adults is therefore warranted.

Biography

Hanne Huygelier is a PhD student in clinical neuropsychology. She works on a project to develop a new rehabilitation tool for stroke patients who suffer from (spatial) attention deficits. She has a master degree in Clinical Psychology and a master degree in Experimental Psychology of the University of Leuven. Through her education and experience in clinical psychology she has a strong background in mental health. Her experience in both fields of clinical and scientific work with patients will enable her to contribute to the discussions in this workshop.

Study objectives

To investigate the usability of H-VR in older adults we will study their attitude towards H-VR, their ability to use this technology and their response to a first experience with the Oculus Rift CV1. In addition, we will estimate the proportion of older adults in whom H-VR can be used based on the safety recommendations for this device and we will report on the prevalence of side effects of the experience. Furthermore, we will test whether the attitudes of older adults towards H-VR can be manipulated through a first user experience. Finally, we will assess which user characteristics (e.g., cognitive status, previous experience with computers, computer self-efficacy) influence the attitudes towards and the usability of H-VR. In summary, we aim to reveal important characteristics of older adults that must be taken into account when developing H-VR mental health care applications.

Methodology

Participants

We aim to test at least 40 older adults with no (H-)VR experience. We will recruit participants that represent a broad range of ages (55 to 90 years of age), education levels, socio-economic statuses and cognitive abilities. To avoid a recruitment bias towards participants who feel positive about new technologies, we will not mention the use of new technology during the recruitment process.

Research protocol

Our study will consist of two sessions (of 60-90 minutes each), administered with a maximum of 2 days in between the sessions (Figure 1).

SESSION 1

We will assess the general cognitive status of the participants, using the Montreal Cognitive Assessment (MoCA) [26] and measure praxis (the ability to plan and execute hand movements) using the praxis task of the Birmingham Cognitive Screen (BCoS) [18].

We will use questionnaires to measure computer self-efficacy (based on [2]), computer proficiency (based on [4]) and attitudes towards VR (based on [6]). We will also use the subscale "openness" of the NEO-FFI-3 to measure to what extent participants are open to new experiences [16].

SESSION 2

In the second session, we will instruct participants on the H-VR technology and the buttons needed to operate the application. Participants will then be exposed to the H-VR experience "Perfect" by nDreams [31]. In this application, participants will visit two realistic natural scenes. Participants will have the oppurtunity to freely explore the VR environment and, if needed, assistance will be provided to help them interact with objects using the Oculus Touch Controllers. To assess the skillfulness of the participants in interacting with the VR environment, screen and audio captures will be made and rated by two independent observers using a behavioral observation rating scale.

After the first VR experience, user experience will be measured using items of the Intrinsic Motivation Inventory [22], the Sense of Presence Inventory [21] and the Immersion questionnaire [19]. We will also re-administer the attitudes questionnaire and we will use the Simulator Sickness Questionnaire to measure potential side effects of the VR [20].

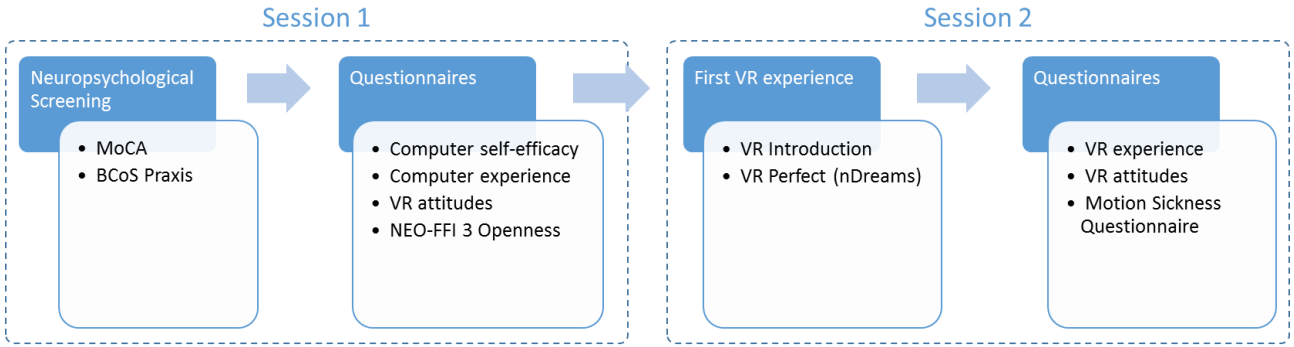

Figure 1. Study Protocol Overview.

Preliminary results

Attitudes

We have already conducted a pilot study on 5 frail older adults residing in a nursing home (3M/2F, age range: 74-90). Both the initial attitudes and the attitudes after the VR experience varied greatly across participants.

Skillfulness

3/5 participants experienced difficulties in learning how to interact with the VR environment using the touch controllers. The participants either failed to find the correct buttons or could not discriminate between them. This observation suggests that touch controllers without visual feedback of a hand model may be difficult to use for older (cognitively vulnerable) adults.

User Experience and Side effects

The participants differed in their emotional responses to the H-VR experience. One participant was afraid to drown in a lake scene, which illustrates that the immersive nature of H-VR may limit its usability under certain circumstances. The other participants did not have negative experiences. Some of them even enjoyed it, and were grateful and proud that they could have experienced this new technology.

None of the participants reported headache, dizziness or nausea. There were only mild complaints of eye strain and some fatigue.

Conclusion

Our study will lead to a better understanding of the feasibility of H-VR in an ageing and frail population. We will be able to report on the attitudes of the older adults towards VR, as well as on the usability of this technology (including its safety). Furthermore, we will investigate the effect of a first user experience on the attitudes towards H-VR and the possible influence of user characteristics. A better understanding of the feasibility of using H-VR in older adults will help direct choices regarding what technology to use for new mental health applications in this frail population.

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References

1. Sergei V. Adamovich, Gerard G. Fluet, Eugene Tunik, and Alma S. Merians. 2009. Sensorimotor training in virtual reality: A review. *NeuroRehabilitation* 25, 1: 29–44.

2. Francisco G Barbeite and Elizabeth M Weiss. 2004. Computer self-efficacy and anxiety scales for an Internet sample: testing measurement equivalence of existing measures and development of new scales. *Computers in Human Behavior* 20, 1: 1–15.

3. Corey J. Bohil, Bradly Alicea, and Frank A. Biocca. 2011. Virtual reality in neuroscience research and therapy. *Nature Reviews Neuroscience* 12, 12: 752–762.

4. Walter R. Boot, Neil Charness, Sara J. Czaja, et al. 2015. Computer Proficiency Questionnaire: Assessing Low and High Computer Proficient Seniors. *The Gerontologist* 55, 3: 404–411.

5. Tim Broady, Amy Chan, and Peter Caputi. 2010. Comparison of older and younger adults' attitudes towards and abilities with computers: Implications for training and learning. *British Journal of Educational Technology* 41, 3: 473–485.

6. John Brooke. SUS: A "quick and dirty" usability scale. In P. W. Jordan, B. Thomas, B. A. Weerdmeester, A. L. McClelland (Eds.), Usability Evaluation in Industry. London: Taylor and Francis.

7. Tuen Ching Chan, Fei Chan, Yat Fung Shea, Oi Yee Lin, James Ka Hay Luk, and Felix Hon Wai Chan. 2012. Interactive virtual reality Wii in geriatric day hospital: A study to assess its feasibility, acceptability and efficacy. *Geriatrics & Gerontology International* 12, 4: 714–721.

8. Nicola R. Colledge, Janet A. Wilson, Cecilia C. A. Macintyre, and William J. Maclennan. 1994. The Prevalence and Characteristics of Dizziness in an Elderly Community. *Age and Ageing* 23, 2: 117–120.

9. Hannah Coyle, Victoria Traynor, and Nadia Solowij. 2015. Computerized and Virtual Reality Cognitive Training for Individuals at High Risk of Cognitive Decline: Systematic Review of the Literature. *The American Journal of Geriatric Psychiatry* 23, 4: 335–359.

10. Anuja Darekar, Bradford J. McFadyen, Anouk Lamontagne, and Joyce Fung. 2015. Efficacy of virtual reality-based intervention on balance and mobility disorders post-stroke: a scoping review. *Journal of NeuroEngineering and Rehabilitation* 12: 46.

11. Gunther Eysenbach. 2005. The Law of Attrition. *Journal of Medical Internet Research* 7, 1.

12. Ana Lúcia Faria, Andreia Andrade, Luísa Soares, and Sergi Bermúdez i Badia. 2016. Benefits of virtual reality based cognitive rehabilitation through simulated activities of daily living: a randomized controlled trial with stroke patients. *Journal of NeuroEngineering and Rehabilitation* 13.

13. Pedro Gamito, Jorge Oliveira, Carla Coelho, et al. 2015. Cognitive training on stroke patients via virtual reality-based serious games. *Disability and Rehabilitation*: 1–4.

14. Rebeca I. García-Betances, Arredondo Waldmeyer, María Teresa, Giuseppe Fico, and María Fernanda Cabrera-Umpiérrez. 2015. A Succinct Overview of Virtual Reality Technology Use in Alzheimer's Disease. *Frontiers in Aging Neuroscience* 7.

15. Lynsey Gregg and Nicholas Tarrier. 2007. Virtual reality in mental health. *Social Psychiatry and Psychiatric Epidemiology* 42, 5: 343–354.

16. H. A. Hoekstra, F. De Fruyt, Paula Costa, Robert R. McCrae, and Hans Ormel. 2014. *NEO-PI-3 en NEO-FFI-3: Persoonlijkheidsvragenlijsten.* Amsterdam: Hogrefe.

17. Matt C. Howard. 2017. A meta-analysis and systematic literature review of virtual reality rehabilitation programs. *Computers in Human Behavior* 70: 317–327.

18. Glyn W. Humphreys, Wai-Ling Bickerton, Dana Samson, and M. Jane Riddoch. 2012. *BCoS Cognitive Screen*.

19. Charlene Jennett, Anna L. Cox, Paul Cairns, et al. 2008. Measuring and defining the experience of immersion in games. *International Journal of Human-Computer Studies* 66, 9: 641–661.

20. Robert S. Kennedy, Norman E. Lane, Kevin S. Berbaum, and Michael G. Lilienthal. 1993. Simulator Sickness Questionnaire: An Enhanced Method for Quantifying Simulator Sickness. *The International Journal of Aviation Psychology* 3, 3: 203–220.

21. Jane Lessiter, Jonathan Freeman, Edmund Keogh, and Jules Davidoff. 2001. A Cross-Media Presence Questionnaire: The ITC-Sense of Presence Inventory. *Presence: Teleoperators and Virtual Environments* 10, 3: 282–297.

22. Edward McAuley, Terry Duncan, and Vance V. Tammen. 1989. Psychometric Properties of the Intrinsic Motivation Inventory in a Competitive Sport Setting: A Confirmatory Factor Analysis. *Research Quarterly for Exercise and Sport* 60, 1: 48–58.

23. Katharina Meyerbröker and Paul M. G. Emmelkamp. 2014. Virtual Reality Techniques in Older Adults.

24. Paul Milgram and Fumio Kishino. 1994. A taxonomy of mixed reality visual displays. *IEICE TRANSACTIONS on Information and Systems* 77, 12: 1321–1329.

25. Kimberly J. Miller, Brooke S. Adair, Alan J. Pearce, Catherine M. Said, Elizabeth Ozanne, and Meg M.

Morris. 2014. Effectiveness and feasibility of virtual reality and gaming system use at home by older adults for enabling physical activity to improve health-related domains: a systematic review. *Age and Ageing* 43, 2: 188–195.

26. Ziad S. Nasreddine, Natalie A. Phillips, Valérie Bédirian, et al. 2005. The Montreal Cognitive Assessment, MoCA: A Brief Screening Tool For Mild Cognitive Impairment. *Journal of the American Geriatrics Society* 53, 4: 695–699.

27. Alexandra Neguț, Silviu-Andrei Matu, Florin Alin Sava, and Daniel David. 2016. Virtual reality measures in neuropsychological assessment: a meta-analytic review. *The Clinical Neuropsychologist* 30, 2: 165–184.

28. Albert A. Rizzo, Maria Schultheis, Kimberly A. Kerns, and Catherine Mateer. 2004. Analysis of assets for virtual reality applications in neuropsychology. *Neuropsychological Rehabilitation* 14, 1–2: 207–239.

29. Sonia Valladares-Rodríguez, Roberto Pérez-Rodríguez, Luis Anido-Rifón, and Manuel Fernández- Iglesias. 2016. Trends on the application of serious games to neuropsychological evaluation: A scoping review. *Journal of Biomedical Informatics* 64: 296–319.

30. Lucia R. Valmaggia, Leila Latif, Matthew J. Kempton, and Maria Rus-Calafell. 2016. Virtual reality in the psychological treatment for mental health problems: An systematic review of recent evidence. *Psychiatry Research* 236: 189–195.

31. Perfect. *nDreams*. Retrieved July 26, 2017 from http://www.ndreams.com/titles/perfectvr/.